ABSTRACTS
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*** Author Presenting Paper**

Animal Behavior, Housing, Well Being

1 Effect of recorded calf vocalizations on milk production with an automatic milking system. C. Jones*[1], E. Pajor[1], S. Donkin[1], J. Marchant-Forde[2], and M. Schutz[1], [1]*Purdue University,* [2]*USDA Livestock Behavior Research Unit.*

Ninety-three Holstein cows were milked with an Automatic Milking System (AMS) and used to evaluate the effects of calf vocalizations on milk production and behavior. Cows were balanced for lactation number and days in milk and randomly assigned to two treatment groups. Digitally recorded calf vocalizations (RCV) were played for 2 minutes at 60 dB then silenced for 12 minutes in a continuous loop through speakers mounted at the front of two AMS stalls. Speakers were active when cows in the RCV treatment group were present in the AMS stall; but speakers were inactive while control cows were milked in the same stalls. Daily 24-h milk production, milking time and number of milkings per day were recorded for seven d to establish a baseline. Then treatments were imposed for 10 consecutive days. Four video cameras, taping 24 h/d for the entire 17 d period, recorded an image once every 10 s to determine the effect of treatment on behavior defined as number of cows in the holding area, in the outside courtyard or at waterers. Video recordings were processed through a quad splitter and monitored to assess changes in where cows spent time following introduction of calf vocalizations. The RCV-exposed cows tended (P < .09) to have greater daily 24-h milk production for d 4, 3, and 2 before vocalizations were introduced, but no statistical differences on 24-h milk production were observed during playback of RCV. When analyzed as repeated observations, 24-h milk (P<=.211), milking time (P=.429), and number of milkings (P=.683) were not significantly affected by RCV. No difference was noted in cow behavior after the start of the RCV. This data showed no significant difference in milk production or number of milkings between the control and RCV-exposed cows within the milking system and unique RCV used in this experiment.

Key Words: Calf vocalization, Automatic milking system, Milk production

2 Effects of bedding on winter performance of feedlot cattle and nutrient conservation in composted manure. V. Anderson*, E. Aberle, and L. Swenson, *North Dakota State University.*

The value of bedding feedlot cattle during the winter with small grain straw has not been well characterized. A two year study explored the effects of bedding level on steer performance, carcass traits, economics, and nutrient loss in composted manure. Spring born steer calves (n=107) were randomly allotted to three bedding treatments and fed a common high concentrate diet (28.1 MCal/kg NEg) from November until slaughtered at a constant time on feed. The bedding treatments were: no bedding, modest bedding, and generous bedding. Modest bedding was the minimum amount of straw necessary so calves did not lay on snow, ice, or frozen manure (175 kg/hd). Generous bedding was targeted at double the modest bedding straw and averaged 306 kg/hd for the feeding period. Feed intake was not affected by bedding treatment (P<.05). However, weight gain responded positively (P<.05) to any bedding. Steers without bedding gained 1.28 kg/day over the entire feeding period, modestly bedded steers gained 1.67 kg, and generously bedded steers gained 1.60 kg per day. Feed efficiency tended to improve overall for bedded steers (P=.09). Marbling score improved with bedding as did the percent of carcasses grading choice (P < 0.05). Twenty three percent of carcasses from non-bedded steers graded USDA Choice vs. 45% for modest and 63% for generously bedded steers. Economic return increased for bedded steers with a gross return of 61.75*and*81.67, respectively, for modest bedding, and generous bedding treatments over the control. Nutrient loss decreased from raw to composted manure with increasing bedding amount. Nitrogen losses were 64.5% for manure without bedding from raw to compost, 32.2% for modest bedding and 19.4% for generous bedding. Phosphorous (P205) and potassium (K20) losses were also reduced with increased bedding. Bedding increased cattle comfort, resulting in increased average daily gain and economic return. Bedding may also have an added benefit of reducing nitrogen and phosphorus pollution from feedlots.

Key Words: Feedlot, Bedding, Nutrients

3 The effect of housing systems on sow longevity and performance- a comparison of stalls and pens with electronic sow feeders (ESF).

L. Anil*, J. Deen, S. S. Anil*, S. K. Baidoo, and R. Walker, *University of Minnesota*.

The study compared the longevity and production performance of 255 gilts and 475 sows housed in conventional gestation stalls and in pens with ESF at the Southern Research and Outreach Center, University of Minnesota, Waseca. Among the females 87 gilts and 243 sows were housed in pens with ESF. Both systems had fully slatted floor. The data were retrieved from the PigCHAMP database for the unit for 3 years and analyzed using descriptive statistics (mean ±SD), 2 sample proportion test and 2 sample t- test. There was no significant difference in the proportion of culling and mortality in gilts in the two housing systems. The proportion of sows culled was significantly higher (P #88040.05) in stalls and the proportion of mortality was higher in pens with ESF (P#88040.01). Locomotor problems (downer, lameness, joint infection) were the most important removal reasons after reproductive performance in both the housing systems. The proportion of females removed for locomotor problems was significantly (P#88040.001) higher in pens with ESF. The number of litters farrowed per year was significantly higher (P#88040.0001) in group housed sows (1.4±0.84) than in stalls (1.15±0.97). There was no significant difference in other reproductive parameters among the systems. However, it is a welfare concern that a higher proportion of females were removed from pens for painful locomotor problems which needs to be addressed to improve sow welfare in that system.

Key Words: Longevity, Performance, Sow housing system

4 Farrowing performance of sows housed in gestation crates vs. pens containing electronic sow feeders.

R. Walker*, D. Goetz, and S. Baidoo, *University of Minnesota*.

The confinement of gestating sows in crates has been criticized due to lack of ample space for sow movement. One alternative to gestation crates is group-housing sows in pens, thus allowing freedom of movement. This study compares farrowing performance of sows housed in gestation crates (C) vs. those housed in pens with electronic sow feeders (ESF). Sows of parity 2-9 were monitored for farrowing performance from March, 2004 through October, 2004 at the Swine Research Center of the University of Minnesota at Waseca. Gestation crates were 1.33m^2. Each pen housed 50 to 60 sows with about 1.89m^2 of space per sow. Environmental conditions were similar for both groups.

ESF sows had shorter gestation lengths, were heavier at weaning, and had heavier litters at birth and weaning. But, ESF sows took longer to return to estrus than C sows when limiting returns from 0 to 10 d. However, a higher % of C sows had delayed estrus (>10 d.) following weaning. There was no difference in the number of pigs born and weaned. This shows that pen gestation with ESF feeders keeps sows in better condition for farrowing, thus resulting in larger pigs born and weaned.

Sows used in this study were English Belles from GAP Genetics, Winnipeg, MB

Means, standard errors, and t-test significance levels of sow condition, litter performance, and re-breeding performance of C and ESF sows.

	(ESF)n=332 ESF n=332	SE SE	(C)n=334 Crate n=334	SE SE	P P	Sig. Sig.
Gest Length d.	116.0	0.1	116.6	0.1	0.000	<.001
Wean. Wt, kg.	231.1	1.4	216.3	1.2	0.000	<.001
N. Born Alive	10.3	0.2	10.5	0.2	0.544	NS
Litter Birth Wt., kg.	16.5	0.2	15.9	0.2	0.037	<.05
N. Weaned	9.4	0.2	9.6	0.2	0.337	NS
Litter Wean Wt., kg.	60.8	0.6	58.7	0.6	0.008	<.01
Days to Estrus, <10 d.	5.1	.05	4.9	.05	0.000	<.001
(n) % Delayed Estrus, >10 d.	(10) 3.0	0.9	(21) 6.3	1.3	0.045	<.05

Key Words: Swine, Electronic sow feeders, Gestation crates

5 The effects of sire line and floor space on growth performance and carcass and meat quality characteristics of pigs.

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Three studies were conducted to investigate the effects of sire line, floor space, and gender on growth and carcass measurements and meat quality of pigs housed in a commercial production system. All studies used pigs from matings of C-22 dams (PIC, Franklin, KY) to three sire lines: A, B, and C were of Pietrain, Hampshire, and Duroc ancestry, respectively. Study 1, carried out from weaning to wk 8 post-weaning, used RCB design with a 3 x 2 factorial: sire line (A, B, and C) and gender (barrows and gilts). Studies 2 and 3 used RCB designs with a 3 x 3 x 2 factorial: sire line (A, B, and C), floor space (0.74, 0.68, and 0.61 m^2/pig), and gender (barrows and gilts). Pigs from Study 1 were reallotted to Study 2. Study 2 was from 8-20 wk post-weaning, and Study 3 was from weaning to wk 20 post-weaning. In Study 2, pen size was adjusted to provide the desired floor space, and in Study 3, group sizes of 36, 32, and 29 pigs/pen were used to provide the desired floor spaces. Pigs were given ad libitum access to feed and water; diets were formulated to meet or exceed NRC (1998) recommendations. Feed intake was measured in Studies 1 and 2, but not in Study 3. Carcass measurements were recorded for all pigs in Studies 2 and 3, and meat quality measurements were taken on a subset of pigs from Study 2. Study 1 showed no effect of genotype or gender on growth performance. In Study 2, Line A pigs grew faster ($P < 0.05$), had higher ADFI ($P < 0.05$), and were heavier ($P < 0.05$) at wk 20. Line B pigs had leaner carcasses and greater ($P < 0.05$) longissimus depth, but higher longissimus muscle Minolta L* and lower subjective color scores, indicating paler meat. In Study 3, no differences ($P < 0.05$) were observed in overall growth performance among the lines. Studies 2 and 3 indicated that 0.61 m^2/pig reduced overall growth performance. These studies were inconsistent with respect to sire line.

Key Words: Floor space, Growth, Pigs

6 Effect of birth weight and creep feeding on lactating gilt and litter performance pre- and postweaning.

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A randomized complete block design with a 2 × 2 factorial arrangement of treatments was used to evaluate the effects of birth weight (light vs heavy) and creep feeding (creep vs no creep) on gilt lactation performance and litter performance to one wk postweaning. Gilts (PIC C-22; n = 108) were weighed and backfat depth was measured (P2 location) upon entry to the farrowing house and at weaning. Daily feed additions and refusals were recorded for the gilts. Piglet birth, 10d, weaning, one-wk postweaning body weights, and creep feed additions and refusals were recorded. At birth, piglets were assigned to either light or heavy (1.1 vs 1.5 ± 0.01 kg) litters of 11 pigs. At d10, piglets were offered a phase 1 creep feed in meal form ad libitum via a feeder mounted on the crate divider. At weaning (19 ± 2 days), piglets were transported to a wean-to-finish site where they were randomly assigned to mixed-sex pens of 28 pigs by treatment. They were given ad libitum access to feed and water and feed additions and refusals were recorded for one-wk postweaning. There was no effect of creep feeding on piglet body weight, or growth rate during any period, and there were no birth weight × creep feeding interactions. Litter size was greater ($P < 0.001$) for the heavy litters at d10 (9.30 vs 10.14; SEM 0.13) and weaning (9.06 vs 10.04; SEM 0.15). Piglets in heavy litters were heavier ($P < 0.001$) at d10 (2.89 vs 3.56; SEM 0.04 kg), weaning (5.20 vs 6.02; SEM 0.07 kg), and one wk postweaning (6.28 vs 7.27; SEM 0.07 kg). Piglets in heavy litters grew faster ($P < 0.05$) from birth to d10 (170 vs 194; SEM 3.72 g/d), d10 to weaning (262 vs 275; SEM 4.58 g/d), birth to weaning (210 vs 230; SEM 3.63 g/d), and wk 1 postweaning (135 vs 161; SEM 6.71 g/d). Feed disappearance for wk one postweaning was higher for pigs from heavy litters (237 vs 271; SEM 7.44 g/d; $P < 0.05$). This study suggests that birth weight is a major determinant of growth pre- and immediately post-weaning and that creep feeding has no effect on growth to one-wk postweaning.

Key Words: Creep feeding, Sows

7 Ovine phenotypic responses to endotoxin-induced acute inflammatory stress during fetal and adult development.

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Cells of the innate immune system play a key role patrolling the body for the presence of microbial pathogens. When these cells identify pathogen-associated molecular patterns (PAMPs), a localized inflammatory response (IR) is mounted to control the infection. Typically this IR remains localized, however during extreme conditions, the infection and IR may become systemic. Regulating the magnitude of the IR is crucial; a sufficient IR is required to control infection and initiate an appropriate immune response however, when this IR is excessive or prolonged it may damage tissues and contribute to, or exacerbate inflammatory diseases. The hypothalamic-pituitary-adrenal axis (HPAA) and autonomic nervous system (ANS) are both activated during the IR as part of a multi-directional communication pathway designed, in part, to regulate inflammatory and immune responses. Our group is specifically interested in the variable response of the neuroendocrine system to inflammatory stressors, and its programming during different stages of life development. We have used sheep as a model ruminant to explore the effects *Escherichia coli* endotoxin, a well-characterized PAMP and inflammatory stressor, on HPAA programming during fetal development, puberty, pregnancy and lactation, and ageing. Variable responsiveness of the HPAA was assessed by measuring cortisol concentrations in 120 ewes that were acutely challenged *iv* with endotoxin (400 ng/kg). Liver biopsy samples were collected from high (H) and low (L) stress responding ewes to characterize hepatic gene expression, and immune responsiveness was assessed to correlate stress and immune responsiveness. Results from the pregnancy and lactation studies suggest that HPAA responsiveness is altered during different stages of pregnancy, and that maternal inflammatory challenge may be sufficient to alter programming of the fetal HPAA.
Ontario Ministry of Agriculture and Food NSERC

Key Words: Entotoxin, HPAA, Ovine

8 Brain measures and animal welfare.

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Studies of the brain can tell us how an individual is coping with, enjoying or challenged by its environment. Brain systems can be damaged by high levels of stress hormones, particularly when the istressful events occur at early stages of brain development. Stereotypies in sows is associated with a down-regulation of μ and κ opioid receptors in the frontal cortex. When pigs are weaned younger than 21 days of age they show behavioral abnormalities, increased aggression, deficits in spatial memory and deficits in social recognition. Recent studies in our group demonstrated that the cognitive impairment experienced by early-weaned pigs is accompanied by changes in the expression of stress related genes in the hippocampus and frontal cortex. Frontal cortex and hippocampus are brain areas involved in memory processes, social behavior and emotional regulation. Understanding the factors that contribute to the disorganization of brain systems can explain the nature, significance, and magnitude of the challenges for animal welfare.
USDA- NRI; Michigan Agricultural Experiment Station

Key Words: Brain, Welfare, Stress

9 Relative changes in gene expression in the frontal cortex and hippocampus of pigs (*Sus scrofa*) weaned at different ages.

R. Poletto*, J. P. Steibel, J. M. Siegford, and A. J. Zanella, *Michigan State University*.

Pigs weaned younger than 21 days show behavior abnormalities, aggressive behavior, impaired learning and memory, and social recognition deficits. Our aim was to examine whether these consequences resulted from changes in gene expression in the frontal cortex (FC) and hippocampus (HP), brain areas involved in emotional regulation and memory. Early- (EW=6) and conventionally-weaned (CW=6) pigs were weaned 10 and 21 days after birth, respectively. Non-weaned pigs of both age groups (NW=6/6) remained with their dams. Half of CW, EW and NW animals were socially isolated (SI) for 15 minutes at 12 (EW) and 23 (CW) days of age, immediately before euthanasia. FC and HP were collected and RNA extracted. Quantitative real-time RT-PCR was used to examine the expression of the stress-related genes 11β-hydroxysteroid dehydrogenases 1 and 2 (11β-HSD1 and 11β-HSD2), glucocorticoid receptor (GR), and mineralocorticoid receptor (MR) in both brain areas. A multivariate linear mixed model was employed to analyze the data. Social isolation, age (12 and 23 days), weaning (weaned and non-weaned), gene and all the interactions were set as fixed, and litter as random effect. SI decreased 1.94 fold the expression of all tested genes ($p < 0.05$) in the FC of both 12 and 23 days old pigs. Hippocampus of early-weaned piglets, when compared with non-weaned at age 12 showed a significant decrease in the expression of the four genes ($p = 0.004$) by a mean fold of 2.52. No significant differences in the expression of the four genes were detected in CW compared to NW at age 23 ($p > 0.12$). Social isolation affected the FC of young piglets at 12 and 23 days of age while weaning age affected hippocampal gene expression. Weaning age changed the expression of important genes associated with the control of the stress axis, learning and memory, and this may explain the behavioral outcomes reported previously in early-weaned pigs.
This research was funded by the NRI USDA Grant #2001-0224 and Michigan Agricultural Experiment Station. We thank MSU Swine Teaching and Research Center, Animal Behavior and Welfare Group and Center for Animal Functional Genomics.

Key Words: Pig, Weaning stress, Gene expression

10 Social factors affecting injuries, eating order, and lying patterns of sows in electronic sow feeders.

M. L. Strawford*[1,2], Y. Z. Li[1], and H. W. Gonyou[1,2], [1]*Prairie Swine Centre Inc.*, [2]*University of Saskatchewan*.

Sows entering group housing are expected to experience social stress. A study was conducted to assess various factors that may affect group housed sows. Eight groups of approximately 35 sows were moved from breeding stalls into partially slatted electronic sow feeder pens managed as either static or dynamic (105 sows/pen) systems. To the extent possible, animals were assigned to groups to achieve a sub-group of focal sows representing a replicated 2 x 2 x 3 factorial of pre (<7 d post-breeding) and post (>35 d post-breeding) implantation, familiar vs unfamiliar with most group-mates, and parity (1, 2-3 and 4+). We assessed injury scores, feeder entry order and use of space. Injury scores assessing scratches, swellings and abscesses on 18 regions of the body were totaled prior to, and 4 and 28 days after grouping. Entry orders, for days 2, 4 and 28 after grouping, were calculated and ranged from 0 (first) to 1 (last). Space use was determined during an inactive morning period on 3 d/wk for weeks 1, 3, and 8 after grouping. Sows were recorded as lying on either the solid or slatted portion of the pen, or standing. Total injury scores increased from pre-grouping (2.04) to day 4 (4.77) and day 28 (5.31) but no differences were found among the main social factors. Entry order was unaffected by the main social factors on day 2, but pre-implant sows entered the feeder earlier than post-implant sows on days 4 (0.463 vs 0.582, sem= 0.037; P=0.04) and 28 (0.466 vs 0.596, sem= 0.041; P=0.03). On day 4, parity 4+ (0.469) and parity 2-3 (0.473) sows entered the feeder earlier than parity 1 (0.626, sem=0.045; P=0.01). During the first week, within static pens, older and familiar sows used the solid portion of the floor more than did younger, unfamiliar animals. Within dynamic pens, the post-implant animals used the slats more than the pre-implant animals during weeks 3 and 8 after grouping. Parity, familiarity and stage of pregnancy had limited effects on the social responses assessed.

Key Words: Sows, Social behavior, Electronic sow feeders

11 Effect of body size and stall width on behavior of gestating sows.

Y. Z. Li* and H. W. Gonyou, *Prairie Swine Centre Inc*.

Stalls remain the principle housing system for gestating sows in North America but their adequacy to accommodate large animals is being questioned. We examined the interaction of sow size and stall width on behavior. A total of 184 animals were categorized by parity (gilt) and body weight (small sows<200 kg, medium sows=200 to 230 kg, and large sows>230 kg) and assigned to four widths of stalls (55, 60, 65, and 70 cm), with the exception that gilts were not assigned to 70 cm stalls. During wk 4 and 14 of gestation, 24-h behavioral observations were conducted to assess sow postures (lying either laterally or ventrally, standing, and sitting) and whether their udder extended into the next stall while lying laterally. During wk 14 sows spent more time lying (82.5 vs 77.5%, sem=0.65; P<0.001) and less time standing (14.4

vs 19.8%, sem 0.65; P<0.001) than at wk 4. The proportion of time spent standing increased in wider stalls (12.6, 14.6, 13.5, and 17.9%, sem=1.8, for 55, 60, 65 and 70 cm stalls, respectively during wk 14; P=0.02), but sitting decreased (4.0, 3.8, 2.5, and 1.9% for 55, 60, 65, and 70 cm stalls, respectively during wk 14; P=0.001). Extension of the udder into the adjoining stall was expressed as a proportion of time spent lying laterally. This increased from wk 4 to wk 14 (20.8 vs 60.0%, sem=2.1; P<0.001), with larger sows (51.0 vs 77.8%, sem=3.1, for gilts and large sows during wk 14; P=0.01) and in narrower stalls (23.5 vs 91.7%, sem=3.1, for 70 and 55 cm stalls during wk 14; P<0.001). Extension of the udder into the adjoining stall was significantly affected by the interaction of sow size and stall width (P<0.05). Using the criterion of less than 50% of animals with udder extended into the next stall while lying laterally to assess stall width, we suggest that a 55 cm stall is suitable for gilts and small sows, a 60 cm stall for medium sows, and a 65 cm stall for large sows during the early stage of gestation (wk 4), but in later stages (wk 14) gilts and small sows should be housed in 65 cm, and medium and larger sows in 70 cm stalls.

Key Words: Gestation stall, Sow, Behavior

12 The effects of crowding on the performance of grower and finisher pigs on full and partial slat floors.

H. W. Gonyou*, T. A. Done, and Y. Z. Li, *Prairie Swine Centre Inc.*

Both floor type and crowding affect the productivity of grow/finish pigs, but it is not known if there is a significant interaction between the two factors. Four blocks of 216 grower pigs (ave. wt. 37 kg) were assigned to two floor types (full vs partial slats) and three levels of floor space allowance (0.38, 0.54, and 0.78 m^2/pig). The lowest space allowance treatment was discontinued after the grower phase. The space allowance coefficients, where k=area (m^2)/BW(kg)$^{.667}$, were approximately 0.025, 0.036, and 0.052 for the grower phase (to 58 kg), and 0.026 and 0.037 for the remaining treatments in the finisher phase (to 95 kg). Pigs were fed ad lib a series of mash diets, designed to meet NRC requirements, from wet/dry feeders. Within each block, pigs were assigned to 2 pens within each floor type x space allowance combination. Pens were balanced for sex within pens. Pigs were weighed and feed disappearance summarized on a weekly basis. ADG and ADFI were summarized for the entire grower phase, and for final 3-wk period of the finisher period. ADFI was affected by floor type or floor space allowance in neither the grower nor finisher phases. ADG tended to be less on partial than on full slat floors during the grower phase (1.036 vs 1.072 sem=0.010 kg/d; P=0.08) but did not differ in the finisher period. Pigs on the lowest floor space allowance grew slower than pigs on the other two space allowance treatments (1.013 vs 1.067 and 1.083, sem=0.010 kg/d, for 0.38, 0.54, and 0.78 m^2/pig, respectively; P=0.001) during the grower phase. ADG tended to be reduced by crowding during the finisher phase (0.953 vs 1.001, sem=0.013 kg/d, for 0.54, and 0.78 m^2/pig, respectively; P=0.06). In no circumstance was there a significant interaction between floor type and space allowance. Although crowding to a space allowance coefficient of 0.026 resulted in a reduction in ADG, there was no evidence that this effect differed depending on whether the floor was full or partial slats.

Key Words: Pigs, Space allowance, Flooring

13 The effects of housing grow-finish pigs at two different group sizes and space allocations.

B. R. Street* and H. W. Gonyou, *University of Saskatchewan.*

Both group size and crowding are known to affect the productivity of grow-finish pigs, but the extent of the interaction between these two factors on productivity is not known. Six blocks of 288 grower pigs (ave. wt. 36.3 kg) were assigned to two group sizes (large and small) as well as two space allowances (crowded and uncrowded) creating a 2 x 2 factorial experiment. Each large pen housed 108 pigs and each small pen housed 18 pigs. Two adjacent small pens were considered the experimental unit for each space allowance level. Crowded pigs were provided space at an allowance of 0.52 m^2/pig, while uncrowded pigs were provided space at an allowance of 0.78 m^2/pig. The space allowance coefficients, where k=area(m^2)/BW(kg)$^{.667}$, at the end of the finishing phase (ave. wt. 95 kg) were 0.025 and 0.038 for the crowded and uncrowded treatments, respectively. The pigs were fed mash diets, balanced to meet NRC requirements, ad libitum from wet/dry feeders. The animals were weighed and feed disappearance summarized on a weekly basis. The small groups (1.083 kg/d) outperformed the large groups (1.043 kg/d, sem=0.006; P<0.001), and the uncrowded pigs (1.084 kg/d) outperformed the crowded pigs (1.042 kg/d, sem=0.006; P<0.001) over the entire 8-wk trial. In weekly summaries, the small groups were seen to outperform the large groups during only the third week (1.105 vs 0.994 kg/d, sem=0.023: P<0.01). Uncrowded pigs outperformed crowded animals during weeks 5 (1.098 vs 1.020 kg/d, sem=0.016; P<0.01) and 7 (1.088 vs 1.015 kg/d, sem=0.022; P=0.04). ADFI did not differ among treatment combinations over the entire trial, with the exception of the final week when pigs in small groups consumed 3.46 kg/d compared to 2.89 kg/d (sem=0.14; P=0.02) in large groups. The proportion of animals removed from the study averaged 3.5 %, but did not differ among treatments. No significant interactions were found between group size and space allowance for any variables measured.

Key Words: Pigs, Group size, Space allowance

14 Impact of repeated out-of-feed events on growing pig performance.

M. Brumm* and S. Colgan, *University of Nebraska.*

Two hundred forty mixed sex growing pigs (initial wt 29.5 kg) were used to evaluate the effect of repeated out-of-feed events on performance for a 6 week period. There were 15 pigs (0.69 m^2/pig), 1 bowl drinker, and 1 2-hole wean-finish feeder (35cm wide feed holes) per pen in a fully slatted, naturally ventilated wean-to-finish facility. There were 4 pens per experimental treatment. Out-of-feed was accomplished by completely closing the feed delivery mechanism on the feeder from 1200 hr to 0800 hr a total of 0, 1, 2 or 3 times every two week period on a repeated, fixed schedule. Diets were corn/soybean meal based in meal form. There was a linear (P=0.077) decrease in daily gain for the 0-14 d period (0.811, 0.747, 0.725 and 0.735 kg/d for 0, 1, 2, and 3 x treatments, respectively) due to a linear (P=0.020) decrease in daily feed (1.56, 1.50, 1.46 and 1.41 kg/d for the 0, 1, 2, and 3 x treatments, respectively). There was a linear (P=0.065) decrease in daily feed for the 0-28 d period also. However, there was no effect (P>0.25) of experimental treatments on pig weight, daily gain, daily feed or feed conversion for the 0 to 42 d period. There was no effect (P>0.25) of experimental treatments on within pen variation in weight at 42 d as measured by the coefficient of variation (10.3, 11.7, 9.9 and 11.0% for 0, 1, 2, and 3 x treatments, respectively). It possible that the pigs adjusted to the repeated, fixed schedule in this experiment and that random out-of-feed events may result in significant treatment differences for the 42 day period.

Key Words: Pigs, Feed availability

15 Evaluation of low input dairy farming systems by on-farm research, protyping, and simulation modelling with emphasis on grazing management, seasonal calving, crossbreeding and outwintering.

D. Johnson*, E. Ballinger, J. Linn, M. Rudstrom, L. Hansen, A. Seykora, and B. Heins, *University of Minnesota.*

There is a need for an evaluation of the components of successful low input dairy production systems so farmers can design low input systems with an appropriate blend of old and new technologies. Our approach obtains dairy systems information from a diverse set of reduced input, moderate size dairy farms and a more intensively managed prototype farm. This system analyzes production and management information, consolidates the results to identify the range of performance on working farms, and tests the results by simulation modelling. Data collected from ten low input farms spanning the Minnesota dairy belt includes pasture characteristics, grazing efficiency, supplementary feeding, animal health and fertility, milk sales, other inputs. Farms are visited twice monthly during the grazing season and monthly during winter. The institutional prototype herd provides intensive data collection related to seasonal calving, pasture utilization, crossbreeding, outwintering, and rearing replacements. Data from participating farms is summarized by farm to identify a range of herd performance. The prototype herd serves as a base herd for simulations utilizing the extremes of the traits of cooperating farms. Simulation modelling utilizes SIMHERD (Sorensen, et al. - DK). The objective of the SIMHERD developers was to create a model which would be sufficiently detailed to include relationships likely to have significant effects at the herd level and yet simple enough to allow successful parameterization and interpretation of the results of the model. Crossbreeding was initiated in the prototype herd by mating Holstein cows to Jersey bulls, followed by Montbeliarde mating to

Holstein cows and Jersey by Holstein crosses. A separate high breeding value Holstein line is retained as a genetic control group. An additional stain utilized in outwintering studies utilizes Scandinavian Red by Jersey by Holstein genetics. Seasonal calving systems contrasts a spring calving group that is outwintered with fall calving with shed housing.

Key Words: Dairy systems, Grazing, Crossbreeding

Breeding and Genetics

16 Growth and carcass traits in crossbred cattle from Hereford, Angus, Norwegian Red, Swedish Red and White, Friesian, and Wagyu maternal grandsires.

E. Casas* and L. V. Cundiff, *USDA-ARS, U.S. Meat Animal Research Center*.

Postweaning growth and carcass traits were analyzed on 434 steers and 373 heifers (n = 807) obtained by mating F_1 cows to Charolais sires. Cows were obtained from mating Hereford, Angus, and MARC III (Hereford, Angus, Pinzgauer, and Red Poll) dams to Hereford or Angus (British Breeds), Norwegian Red, Swedish Red and White, Wagyu, or Friesian sires. Breed groups were slaughtered serially in each of two years (2002 and 2003). Postweaning average daily gain, slaughter weight, hot carcass weight, dressing percent, percentage choice, longissimus area, marbling score, USDA yield grade, fat thickness, retail product yield, retail product weight, fat yield, fat weight, bone yield, and bone weight were analyzed. Maternal grandsire breed was significant ($P < 0.05$) for all traits except dressing percent, percent choice, and longissimus area. Marbling score for animals with Norwegian Red, Wagyu, Swedish Red and White, British Breeds, and Friesian inheritance were 550, 544, 532, 530, and 515, respectively (SEM = 8). Retail product weight for these animals were 224 kg, 211 kg, 227 kg, 223 kg, and 223 kg, respectively (SEM = 2 kg). Maternal granddam breed was only significant ($P < 0.01$) for birth weight. Grandsire breed effects can be optimized by selection and use of appropriate crossbreeding systems.

Key Words: Beef Cattle, Breeds, Carcass Composition

17 Selection for an index of placental efficiency and litter size in swine.

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Genetic trends and parameters were estimated for individual and litter traits using data from four generations of replicated divergent selection on an index of reproductive traits. The selection index (**SI**) included total born (**TB**), birth weight (**BW**) and placental weight (**PW**) and was designed to increase (**H** line) or decrease (**L** line) the efficiency of placental function (**PE**), defined as the ratio BW:PW. (Co)variance components were estimated for direct and maternal additive effects using an animal model with **MTDFREML** procedures. Estimated breeding values (**EBV**) were calculated using records on individual BW (n=2111), PW (n=2006), PE (n=1677), and SI (n=1677). Litter traits were evaluated using records on 193 litters. The model included the fixed effects of contemporary group for all traits, with the addition of sex for individual traits and parity for litter traits. Litter was fitted as an uncorrelated random effect for all traits, and TB was used as a linear and quadratic covariate for BW, PW, and PE. Direct heritability estimates from single-trait models were 0.03, 0.25, 0.18, 0.11 and 0.08 for BW, PW, PE, SI, and TB, respectively. Estimated breeding values were compared between lines using a model including generation, line within generation, and replicate within line as the error term. Genetic divergence was 20.7 $\pm$ 2.7 g, 0.24 $\pm$ 0.03, and 0.11 $\pm$ 0.02 per generation for PW, PE, and SI respectively ($P<0.01$), but not significant for BW. Among litter traits, genetic divergence was 24.0 $\pm$ 5.8 g, 16.7 $\pm$ 2.1 g, 0.07 $\pm$ 0.02, and 0.06 $\pm$ 0.02 per generation for litter birth weight, litter placental weight, total born, and born alive, respectively ($P<0.01$). At generation four, direct EBV was higher in L than H for PW (55.9 $\pm$ 8.7 g vs. -24.2 $\pm$ 9.5 g, respectively; $P<0.01$), was higher in H than L for PE (0.58 $\pm$ 0.10 vs. -0.35 $\pm$ 0.09, respectively; $P<0.01$), and were not different for BW, SI or TB. Selection for a linear index of total born, birth weight and placental weight was effective in changing placental weight and efficiency in the desired direction, but the correlated genetic trend for total born was opposite to the expectation.

Key Words: Genetic parameters, Placental efficiency, Selection

18 Heritability estimate for bilateral ovulation in heifers.

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Recent studies have reported that cows giving birth to twin calves as a result of bilateral ovulations have lower incidences of dystocia and higher calf survival than twins born from the same uterine horn. Therefore, the objective of this study was to determine if bilateral ovulation in heifers is genetically influenced. The data set included multiple ovarian palpation records from a total of 3,910 heifers born from 1984 to 2002. The average number of estrous cycles per heifer was 7.5 times (total records = 29,548). Heifers were from a MARC herd selected for increased calving rate. Over the time span of this project, selection has increased total ovulation rate at an annual rate of 0.026. Bilateral ovulation was defined as a binomial trait within double ovulation records (1 = bilateral and 2 = unilateral; total records = 5,780). Ovulation rate was defined as the total number of corpora lutea per estrous cycle. Heritability and covariance components for bilateral ovulation and ovulation rate were estimated using a two-trait repeated measures animal model. Because the herd population was a composite of 11 different breeds, breed composition fractions for each heifer were considered as covariates. Linear and quadratic forms of age of heifer at palpation were also included as covariates. Year and season of birth subclass code was considered a fixed effect. The heritability estimate for bilateral ovulation was low (0.02 $\pm$ 0.01), as is common for most reproductive traits. The heritability estimate for ovulation rate was also low (0.09 $\pm$ 0.01), consistent with previous estimates. The estimated genetic correlation between bilateral ovulation and ovulation rate was 0.72. Selection response for bilateral ovulation in heifers will be slow. Cumulative advantages of selecting for bilateral ovulation in heifers may be determined by future studies that estimate the genetic relationships of heifer bilateral ovulation with calving rate, cow longevity, dystocia incidence, and calf survival.

Key Words: Reproduction, Twinning, Genetic

19 Realized difference among daughters of Holstein sires for milk yield and composition after four generations of selection for high and average fat plus protein yield.

P. J. Berger*, M. H. Healey, and A. E. Freeman, *Iowa State University*.

The objective of this research is to determine if enhancements in quantity and quality of milk can be achieved by selecting sires for high or average PTA fat plus protein yield. Data were all completed 305d mature-equivalent lactation records for cows (n = 978) in the Ankeny dairy breeding genetic resource population, 1988 to 2004. Data were edited to exclude lactations that ended in abortion, parity >6, or records that may have been influenced by other experimental protocols. Traits included in the analysis were: 305d ME milk, fat and protein yields; percentage fat and protein; and somatic cell score. Data were analyzed by using a sire model with repeated records in SAS PROC MIXED. Repeated lactation records were modeled assuming a constant variance over lactations and a positive correlation between any two measurements on the same cow. The model included fixed effects of year-month, parity, line (high vs average); sire, cow and residual were random effects. The high line had significantly ($P < .01$) higher yields for milk, fat, and protein than the average line; 493 kg $\pm$ 152, 27 kg $\pm$ 5.1, and 20 kg $\pm$ 4.5 for milk, fat, and protein yield, respectively. There was little difference between the high and average line for fat and protein percentage, and somatic cell score; 0.1 % $\pm$ 0.04, 0.04 % $\pm$ 0.02 and 0.14 $\pm$0.11, respectively. Implication of this research is that genetic change in milk composition can be achieved by selection for quantity of milk components and not percentage composition.

Key Words: Holstein, Milk yield and composition, Sire selection

20 Selection for intramuscular fat in Duroc swine. C. Schwab*[1], T. Baas[1], K. Stalder[1], and D. Newcom[2], [1]*Iowa State University,* [2]*Genetic Improvement Services.*

A study was conducted to evaluate the efficacy of selection for intramuscular fat (IMF) in purebred Duroc swine. Forty-five gilts were purchased from U.S. breeders and randomly mated for two generations to boars available in regional boar studs to develop a base population of 56 litters. Littermate pairs of gilts from this population were randomly assigned to either a select line (SL) or control line (CL) and mated to the same boar to establish genetic ties between lines. A total of 24 sires from 14 sire families were used to produce 50 CL and 45 SL litters in Generation 1. At an average weight of 110 kg, a minimum of four longitudinal ultrasound images were collected seven cm off-midline across the 10th-13th ribs of all pigs for the prediction of IMF (UIMF) by the method of Newcom et al. (2002). At least one barrow or gilt was harvested from each litter and carcass data were collected. A slice of the longissimus muscle from the 10th-11th rib interface was analyzed for carcass IMF (CIMF) by the Folch method. Breeding values for IMF were estimated by fitting a two-trait (UIMF and CIMF) animal model and the full relationship matrix in MATVEC. In the SL, selection in each subsequent generation was based on EBV for IMF with the top 10 boars and top 50% of gilts used to produce the next generation. One boar from each sire family and 50 gilts representing all sire families were randomly selected to maintain the CL. After three generations of selection, a total of 217 CL and 182 SL pigs have been harvested. Least squares means for carcass traits were estimated using PROC MIXED of SAS with a model that included fixed effects of line, generation, harvest group within generation, sex, and a linear covariate for carcass weight. Sire and dam within line were random effects in the model. Line LS means for IMF were 3.94% in the SL and 3.40% in the CL. Line LS means for tenth rib backfat and loin muscle area were 2.2 cm and 41.2 cm^2 in the SL, and 2.0 cm and 43.2 cm^2 in the CL, respectively. Selection for IMF using real-time ultrasound is effective.

Key Words: Intramuscular Fat, Ultrasound, Breeding Value

21 Adjustment of age of dam effects for yearling gain data in Angus field records. A. Hassen* and D. E. Wilson, *Iowa State University.*

The objective of the study was to calculate age of dam (AOD) adjustment factors and heritability estimates for yearling gain data. Analysis was done on data from progeny born between 1995 and 2002. Included in the analysis were US-registered Angus cattle measured between ages of 320 to 440d. Data were sampled separately for bulls and heifers. Age of dam at birth of progeny was divided into eleven classes based on previous study. Data were then analyzed separately for bull and heifer calves using a model that included fixed effects of contemporary group, AOD-management class, random effects of direct genetic, and residual effects. Regardless of sex and management, AOD showed a similar effect on yearling gain of progeny. Age of dam effect consistently declined with increasing AOD classes. However, these effects were important for non-creep fed heifer progeny from relatively younger cows. Age of dam effect estimates for older cow groups were generally associated with large standard error of estimates caused by limited number of observations. Yearling gain showed medium heritability values for heifer data ranging from 0.22 to 0.27. The corresponding values for bull data ranged from 0.21 to 0.31. Further study should be conducted to assess effects of the new AOD adjustment factors and heritability estimates on genetic trends and sire ranking.

Key Words: Beef cattle, Age of dam, Yearling gain

22 Reproduction and maternal performance of F1 cross females sired by Hereford, Angus, Norwegian Red-Swedish Red and White, Friesian and Wagyu sires. L. V. Cundiff*, *USDA, ARS, U.S. Meat Animal Research Center.*

The objective was to characterize reproduction and maternal traits of F1 cross females calving at 3 through 7 years of age in cycle VI of the Germplasm Evaluation Program at the U.S. Meat Animal Research Center. The females were produced in the spring of 1999 and 2000 as a result of artificial insemination matings of Hereford (H, 32), Angus (A, 30), Norwegian Red-Swedish Red and White (NS, 14 and 16, respectively, considered the same breed because of open herd books), Friesian (F, 24 non-Holstein influenced), and Wagyu (W, 19) sires to Hereford, Angus, and composite MARC III dams. With 32 twin births excluded, data included 1904 records for females exposed, 1740 calves born, and 1687 calves weaned in the fall of 2000 through 2004 as a result of natural service multi-sire matings to Charolais bulls. Data on calf crop born and weaned, calving difficulty score, unassisted births, birth weight (BW, kg), survival to weaning, 200-d weaning weight of progeny (WW, kg), and 200-d weaning weight per cow exposed (WW/CE) were analyzed by least squares procedures using a model that included random effects for maternal grandsire in maternal grandsire breed, and fixed effects for maternal grandsire breed, maternal grandam breed, sex of calf (BW and WW only), year-age of cow, and maternal grandsire breed x maternal grandam breed. Effects of maternal grandsire breed were significant ($P<.01$) for BW, WW, and WW/CE but not for any other trait. The means for progeny with H, A, NS, F, and W maternal grandsires were 43.8, 42.8, 43.2, 42.7, and 40.0 kg, respectively for BW; 245, 255, 267, 259, and 231 kg, respectively for WW; and were 222, 221, 232, 232, and 207 kg, respectively for WW/CE. The mean least significant difference among maternal grandsire breed means for BW, WW, and WW/CE was 1.5, 7, and 16 kg, respectively ($P<.05$). Females sired by breeds that have had a history of selection for milk production (NS, F) weaned heavier calves than those that had not been used for dairy production (A, H, W).

Key Words: Beef cattle, Breeds, Germplasm

23 Indirect estimation of genetic trends for carcass traits in beef cattle. J. D. Stroh*[1], M. L. M. Vuorisalmi[1], L. V. Cundiff[2], and L. D. Van Vleck[2], [1]*University of Nebraska,* [2]*ARS, USDA, U.S. Meat Animal Research Center.*

Records of carcass traits collected on steer progeny (n = 650) of 17 breeds of sire at USMARC and EPD from breed associations for birth, weaning and yearling weights of their sires were used to regress the carcass measurements of progeny at USMARC on sire EPD for the three weight traits. The model used also included fixed effects of sire line, dam line, age of dam and birth year. Dam and residual were random effects. The regression coefficients were then used to estimate genetic change in each carcass trait based on the genetic trends expressed by average EPD by year of birth for the weight traits as reported by the breed associations. Estimates of variance and covariance components with single- and two-trait analyses were obtained as a check on the regression coefficients using the MTDFREML programs. Genetic trends were estimated for 11 carcass traits for Angus, Charolais, Hereford, Limousin, Maine-Anjou, Red Angus, Shorthorn, and Simmental breeds. Results show that the regression equations would predict genetic change for carcass traits that are generally highly correlated with weight traits but only if change has occurred in the breed for the weight traits. Little change would be predicted for carcass traits with little or no correlation with weight traits even if change in the breed has occurred for the weight traits. As examples, the trio of multiple regression coefficients (phenotypic standard deviations of carcass traits per kg of EPD for birth, weaning, and yearling weights) 1) were -0.0056, -0.0063, and 0.0035 for fat thickness at 13th rib, 2) were 0.0070, 0.0006, and 0.0028 for estimated retail product, and 3) were -0.0011, -0.0053, and 0.0033 for marbling score

Key Words: Breeds, Carcass traits, Genetic change

24 Three designs for estimating variances due to competition genetic effects. L. D. Van Vleck*, *ARS, USDA, U. S. Meat Animal Research Center.*

Separation of (co)variance components due to direct and competition genetic effects and pen effects for models with imbedded competition effects is a challenge due to high degree of confounding of the effects in a pen. An earlier simulation with sires mated to five dams, each producing 10 full-sib (FS) progeny which were then assigned randomly to pens of size six, showed that those components would be partitioned. For this simulation, 60 sires were each mated to only one dam with dams unrelated. The 10 FS progeny were assigned to pens of size 10 in three ways: I) all to same pen, II) each progeny randomly to one of 60 pens, or III) 5 to pen 1 and 5 to pen 2 with another litter of FS furnishing the other 5 penmates for both pens 1 and 2. Number of replicates was 400 for each of 9 sets of parameters with statistical models for analysis including pens as random or as fixed effects. Of interest were 1) ability of designs to allow partitioning of the (co)variance components and

2) empirical standard deviations (SD) for estimated components. On average, all designs allowed estimation of covariance components with pens either random or fixed. The hypothesis was that the most difficulty (and greater variability of estimates) would be for Design I with each FS litter confounded with a pen effect. The result was the opposite: Design I empirical standard deviations of estimates were smallest for all components by multiples depending on true parameters and the component estimated with pens considered either fixed or random. Design II had somewhat smaller SD than Design III for estimates of direct genetic and residual variances. With pens considered random, SD for estimates of competition genetic variance, direct-competition covariance and pen variance were somewhat smaller for Design III than Design II. With pens fixed, those SD were smaller with Design II than Design III. Generally SD for estimates of competition variance and direct-competition covariances were smaller when pens were considered fixed rather than random. Design of pen assignment does not seem to be a simple problem when competition effects must be considered.

Key Words: Competition effects, Genetic variances, Sampling errors

25 Estimates of genetic parameters for yield traits and SCS for cows treated or not treated with Bovine somatotropin.

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Records from DRPC, Raleigh, NC were divided into three sets: 1) first lactation, 2) second lactation and 3) lactations from three to five. About 10% were for cows treated with bovine somatotropin (bST). Numbers of records for treated and untreated cows by set were 4,337 and 48,765; 3,730 and 37,796; and 3,645 and 33,957. A two-trait animal model with records of cows treated or untreated as different traits was used to estimate genetic parameters for milk traits and somatic cell score. Cows treated with bST produced more milk than untreated cows by 10.0, 9.6, and 7.7 kg/100, respectively. Cows with bST had lower SCS than cows not receiving bST for Set 1 (-0.4). Estimates of heritability for milk yield for treated and untreated cows were (0.13, 0.16 and 0.09) and (0.18, 0.18 and 0.14). Corresponding estimates of repeatability for Set 3 were 0.50 and 0.41 for treated and untreated cows. Estimates of heritability for fat for treated and untreated cows were (0.31, 0.16 and 0.12) and (0.27, 0.21 and 0.16), with estimates of repeatability of 0.45 and 0.40. Estimates of heritability for protein yield for treated and untreated cows were (0.13, 0.17 and 0.12) and (0.20, 0.23 and 0.16). In general, estimates of heritability for milk yield traits were less for Set 3 than for first and second lactations for both treated and untreated cows. Estimates of heritability for somatic cell score for treated and untreated cows were (0.09, 0.15 and 0.13) and (0.11, 0.13 and 0.13) with estimates of repeatability of 0.52 and 0.45. Estimates of genetic correlations were high between milk yields of cows with and without bST (0.99) for first and later lactations and about 0.70 for second lactations. Fat and protein had similar estimates of genetic correlations. Estimates of genetic correlations for somatic cell score were 0.99 for Sets 1, 2, and 3. Estimates of genetic correlations between treated and untreated cows were high enough to consider records to be one trait for selection.

Key Words: Heritability, Milk yield, Somatotropin

26 Biological efficiency in beef cattle: A comparison of weight of cow maintained to adjusted 205-day calf weaning weight.

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The objective of this research is to measure biological efficiency of beef production. Following NRC requirements it was assumed that the DMI increases with increasing cow weight. The kg of calf weaned per kg of cow maintained will be used as our measure of biological efficiency. Smaller cows that produce smaller calves may prove more biologically efficient than larger cows that produce heavier calves. The data set included records from 422 cows and 1120 calves. Traits analyzed included 205 d adjusted calf weight (d205) and the ratio of d205 to cow weight in a herd of cattle at the North Carolina Department of Agriculture, Tidewater Research Station, Plymouth NC. Data were recorded over thirteen years on crossbred cows. Breeds represented included Angus, Brangus, Gelbvieh, Limousin, Polled Hereford, Salers, and Simmental. Cows were divided into seven weight classes with the first weight class starting at 409 kg and increasing every weight class by 45.5 kg. Data were analyzed using the GLM procedure of SAS. The model included fixed effects of year (n = 11), age of cow at calving (ACC), cow weight category (CWC, 1 7), and sex of calf. Year, ACC, CWC and sex were significant ($P < 0.05$) for d205 and the ratio of d205 to cow weight. Cow breed composition and calf breed composition were entered as fixed regression covariates, found not to be significant, and dropped from the model. Least squares means for calf weight at weaning increased as cow weight increased, but kg of calf weaned per kg of cow maintained decreased as cow weight increased. Despite the positive relationship between cow weight and calf weight, the ratio of d205 to kg of cow maintained decreases significantly as cow weight increases. Smaller cows producing smaller calves are more biologically efficient. The optimum cow weight was between 454.5 and 545.5 kg. These cows produce smaller calves than their larger counterparts, but the calves they produce are almost half their body weight at weaning.

Key Words: Beef cattle, Efficiency, Weaning weight

27 Genetic parameters for growth of young dual purpose Simmental bulls using random regression.

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Additive genetic and permanent environment covariance functions and corresponding heritabilities and correlations were estimated for weight, height at withers, body length and heart girth of young dual purpose Simmental bulls. Data consisted of 11,890 records of 1,385 bulls born from 1974 to 2002. The pedigree file consisted of 3,274 animals. The bulls were raised in the performance test station at Varazdin, Croatia. Measurements were taken from 100 to 400 d of age, approximately once per month. Covariance functions were estimated by using polynomial random regression. Interaction of year x season and quadratic regression on age were defined as fixed effects, while animal and permanent environment due to measurements on the same bull were defined as random effects. Polynomials of order three to five were adequate in estimating covariance functions. Estimated heritabilities ranged from 0.36 to 0.54 for weight, from 0.20 to 0.50 for height at withers, from 0.20 to 0.58 for body length, and from 0.31 to 0.60 for heart girth. Genetic correlations between longitudinal records ranged from 0.71 to 0.99, and phenotypic correlations ranged from 0.39 to 0.97. The correlations declined as days between measurements increased. The estimated covariance functions from this study demonstrated heterogeneity of covariances of body measurements in young Simmental bulls implicating random regression as an appropriate method for estimating genetic parameters and breeding values. Thus, random regression should be used in procedures for genetic evaluation of growth traits in dual purpose Simmental cattle.

Key Words: Body measurements, Random regression, Simmental cattle

28 Prenatal mortality throughout gestation in lines of pigs selected for either ovulation rate or uterine capacity.

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Selection for 11 generations for either ovulation rate (OR) or uterine capacity (UC) resulted in 19.6% greater prenatal survival at term in UC compared to OR. Our objective was to characterize prenatal mortality throughout gestation in each line, including the unselected control line (CO). A sample of 50 gilts from each line for each of three farrowing seasons was subjected to unilateral-hysterectomy-ovariectomy surgery at approximately 160 d of age and mated within line at approximately 280-d age. Gilts were assigned within sire to be harvested at d 25, 45, 65, 85, or 105 of gestation. Ovulation rate and number of live fetuses were recorded for each pregnant gilt (n = 298). A mixed model analysis of variance was conducted. Fixed effects of farrowing group, line, gestation age, and two-way interactions were fitted. The random effect of sire (n = 88) of the gilt within farrowing group and line was used to test line differences. Ovulation rate of OR line gilts (18.3 ± 0.3) exceeded ($P < 0.001$) both the CO and UC line, 15.3 ± 0.3 and 14.1 ± 0.3, respectively. Line by gestation age interacted to affect number of live fetuses ($P < 0.001$). Least squares means for CO line were 10.7, 8.3, 7.9, 7.0, and 7.2 live fetuses for d 25, d 45, d 65, d 85, and d 105, respectively (average SE = 0.52). Corresponding means from the OR line were 13.6, 8.5, 8.1, 6.4, and 6.5 live fetuses, respectively (average SE = 0.49). UC line means were 10.3, 9.3, 8.4, 7.8, and 7.9 live fetuses, respectively (average SE = 0.53). In each line the number of live fetuses at d 25 was about 72% of ovulation rate. Mortality was highest in the OR line, intermediate in

the CO, and lowest in the UC line to d 45. Losses continued to occur from d 45 to d 105 but line differences in number of fetuses at d 45 were maintained to d 105. Selection for uterine capacity has improved fetal survival during the critical time period between d 25 and d 45.

Key Words: Fetal survival, Pigs, Uterine capacity

29 Bovine single nucleotide polymorphisms (SNPs) and their use in animal identification, parentage testing, and traceback.

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DNA marker technology represents a promising means for determining the genetic identity and parentage of an animal. DNA-based identification (ID) technologies differ from physical labeling methods (such as branding, tagging, and electronic implants) because DNA remains an integral and identifiable component of animal products long after they are separated from the carcass. DNA may be readily extracted and analyzed from samples of fresh, frozen, or cooked animal products. Thus, DNA-based ID technologies provide a "gold-standard" for auditing the fidelity of physical labels. Rapid traceability is critical for controlling animal disease, monitoring imports/exports, and is a requirement of some trading partners. This presentation will highlight the changes taking place in bovine SNP marker technology and provide three recent examples where SNP markers were used to solve practical problems of animal identification, parentage testing, and traceback.

Key Words: SNP, DNA markers, Traceback

30 Genetic optimization of sow productivity.

S. Oh*[1], M. See[1], T. Baas[2], R. Bates[3], A. Schinckel[4], K. Stalder[2], and R. Pfortmiller[5], [1]*North Carolina State University,* [2]*Iowa State University,* [3]*Michigan State University,* [4]*Purdue University,* [5]*National Swine Registry*.

Litter birth weight and the interval from weaning to mating are additional traits that deserve consideration to fully optimize sow productivity. This project utilized 11,578 records of pigs born alive, litter birth weight, 21-day litter weights, number of pigs weaned, and weaning to mating interval from Duroc, Yorkshire, Hampshire and Landrace sows from 10, National Swine Registry member herds. The analysis model for litter birth weight included the genetic effect of the sow and the fixed effects of contemporary group, herd, parity of sow and number of pigs born alive. The analysis model for weaning to mating interval include the genetic effect of the sow, a covariate for 21-day litter weight adjusted for age at weighing, and the fixed effects of contemporary group, herd, and parity of sow. Heritability estimates pooled across breeds were 0.32 and 0.20 for litter birth weight and weaning to mating interval, respectively. The range in EPDs for the 451 Yorkshire sires represented with daughter records was 2.23 kg of litter birth weight and 2.15 days in weaning to mating interval indicating dramatic genetic differences for these traits amongst animals. Assuming the cost of a non-productive sow day is $1.65/day the additional value due to genetic differences between daughters of the highest ranking and lowest ranking Yorkshire boars for weaning to mating interval would be $3.55/litter. A comprehensive sow productivity index has also been developed that includes number of pigs born alive, litter birth weight, number of pigs weaned, litter weight at 21-days, and weaning to mating interval. Utilization of these five traits in genetic selection allows for the selection of optimal sow productivity that more closely resembles the accepted industry measure of pigs per sow per year.

Key Words: Pig, Reproduction, Genetic parameter

31 Reproductive performance in daughters of Holstein sires selected for high and average milk yield or fat plus protein yield.

P. J. Berger, M. H. Healey, and G. A. Gutierrez*, *Iowa State University*.

The objective of this analysis was to compare the reproductive performance, i.e., number of services (NS), and days open (DO) between two long-term selection lines. Sires were selected for high or average PTA milk yield (1968-1987) and high or average PTA fat plus protein (1988-2002). Cows (n=1066) were restricted to have three consecutive conception dates at 0, 1^{st} and 2^{nd} parity. Heifers were excluded from analysis for DO. Data were analyzed by using a repeated measure model in SAS PROC MIXED. Fixed effects were year-season, parity, lines and interaction of parity by lines. Random effects of cows within lines were modeled assuming heterogeneous autoregressive (co) variance structure. Estimates of the correlation among repeated records were NS=0.07 and DO=0.15. There was evidence of significant differences ($P<0.01$) among effects for year-season and parity for NS and DO. Least-squares means were 2.3 $\pm$ 0.07 and 125d $\pm$ 3.0 for NS and DO, respectively. Differences between lines and the interaction of parity by lines were insignificant for all variables. Implications of this research are that heifers do not retain their fertility as they get older. Both NS and DO tended to increase with parity.

Key Words: Holstein, Number of services, Days open

32 A Bayesian threshold-linear evaluation of perinatal mortality, dystocia, birth weight, and gestation length in a Holstein herd.

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The objective of this research was to estimate variance components for a multiple trait evaluation of dystocia (DYS), perinatal mortality (PM), birth weight (BW), and gestation length (GL). Dystocia and perinatal mortality were both recorded as to categories (unassisted versus assisted and alive versus dead, respectively), while birth weight and gestation length were continuous traits. The data included 4612 calving records collected between 1968 and 2000 from the Iowa State University research dairy farm in Ankeny. The incidence of PM was 7.6%; calving difficulty was 24.6%. The mean BW was 40.5 kg; GL was 278.8 d. A threshold-linear model was used to estimate variance components via Gibbs sampling. Effects in the model were year, season, sex of calf, parity, sire group, random maternal genetic, and random permanent environment. Maternal heritabilities with standard errors in parentheses for DYS, PM, BW, and GL were calculated to be 0.09(0.025), 0.09(0.027), 0.13(0.022), and 0.18(0.019), respectively. Genetic correlations with standard errors in parentheses between maternal effects for DYS-PM, DYS-BW, DYS-GL, PM-BW, PM-GL, and BW-GL were estimated to be 0.98(0.023), 0.30(0.15), 0.27(0.13), 0.34(0.16), 0.15(0.14), and 0.39(0.086), respectively. Genetic trends in correlated traits will be discussed.

Key Words: Birth weight, Dystocia, Perinatal mortality

33 Selection lines for residual feed intake in yorkshire swine.

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Residual feed intake (RFI) is a measure of feed efficiency defined as the difference between observed feed intake and that predicted on the basis of average requirements for growth and maintenance. The objective of this study was to evaluate the initial generations of a selection experiment for RFI designed to evaluate responses to selection and to create lines of Yorkshire pigs that differ in RFI. The selection experiment started with random allocation of purebred Yorkshire littermates to a low RFI selection line (LRFI) and a control line. In each generation, electronically measured feed intake, body weight, and ultrasound backfat are evaluated from 40 to 115 kg on 90 boars from first parity LRFI sows and 90 gilts from second parity LRFI sows. Following evaluation of first parity boars, 12 LRFI boars and 70 gilts are selected to produce 50 litters for the next generation. About 30 control line litters are produced by random mating. Selection in the LRFI line is based on low EBV for RFI, which are computed by animal model analysis of average daily feed intake with group and sex (fixed), pen within group (random) and covariates for both on- and off-test weight and age, and for average daily gain and change in backfat. Analysis of feed intake data on 569 pigs over 4 generations (-1 to 2) resulted in an estimate of heritability for RFI of 0.30. Average EBV for RFI in the LRFI line were 0, -42.7 and -78.6 g/day, for generations 0, 1, and 2 respectively. In conclusion, RFI is a heritable trait and selection for RFI has significantly decreased the amount of feed required for a given rate of growth and backfat.

Key Words: Pigs, Residual feed intake, Selection

34 Sperm bull morphology evaluated by two different methods. G. Freneau*[3,1], R. Ellis[2], and P. Chenoweth[1], [1]*Kansas State University,* [2]*University of Nebraska GPVEC,* [3]*Universidade Federal de Goias.*

The objectives of this study were to compare two different methods of evaluating bull sperm morphology: bright-field (BF) microscopy of Nigrosin-Eosin (NE) stained dry-mount semen smears and differential interference phase contrast (DIC) microscopy of wet-mount semen fixed in isotonic formal saline. Seventy-two ejaculates were collected by electro-ejaculation from 40 2yo beef bulls in Nebraska, examined both pre and post breeding season. For both methods, 200 sperm were counted in random fields with defects categorized as major (MAD) and minor (MID). Sperm abnormalities were also placed into two other categories: those considered to be influenced by process (wet or dry; PROD) and those by optics (BF or DIC; OPD). Differences ($P<0.05$) occurred between DIC and NE methods respectively: MAD 23.3 / 16.1, MID 7.6 / 13.4, acrosome 3.8 / 1.1, midpiece 9.2 / 11.7, tail 2.0 / 4.7, droplets 8.3 / 4.2, PROD 14.2 / 21.4 and OPD 13.0 / 5.5; but not ($P>0.05$) in percent normal sperm (NORSP) 69.1 / 70.4 or sperm head defects 7.5 / 8.3. Acrosome, tail and droplet defects were observed in 98.2 / 80.5, 86.1 / 100 and 98.2 / 94.4 percent of bulls for DIC and NE respectively ($P<0.05$). Differences occurred between methods in specific sperm abnormalities. As NORSP did not differ between methods, BF assessment of NE preparations worked satisfactorily to categorize breeding soundness of bulls. However, DIC was more effective in visualizing MAD, while NE was considered to cause more MID. Thus DIC is considered the preferred method of semen assessment for accurate prognosis of individual bulls.
To CNPq, Brasilia, Brazil Scholarships

Key Words: Bull, Sperm mophology, Breeding soundness

35 Physical mapping of five pig genes whose expression level is acutely affected by *Salmonella* challenge. J. W. Kim*[1,2], S.-H. Zhao[1], J. J. Uthe[1,3], S. M. D. Bearson[3], and C. K. Tuggle[1], [1]*Iowa State University,* [2]*Yeungnam University,* [3]*USDA, ARS, National Animal Disease Center.*

Infectious diseases increase the cost of production in the pig industry. Disease resistance has genetic heritability, and breeders are interested in raising productive pig breeds with increased resistance to disease. The objective of this research was to map genes identified as having altered gene expression patterns within the mesenteric lymph node during infection in a *Salmonella enterica* serotype Choleraesuis challenge. These five genes (DNAJA4, HSP90, HSP105, CXCR4, and IP-10) responded to infection within 48 hours of exposure. PCR primers were designed using Oligo 5.0 software. The primers of these genes amplified products only from pig genomic DNA, not mouse or hamster DNA. These genes were assigned to cytogenetic locations by using the INRA Somatic Cell Hybrid Panel and to precise physical linkage groups by using the IMpRH mapping panel. DNAJA4 was mapped to SSC7q12-q23 corresponding to HSA15q25.1, HSP90 was located on SSC7q26 (HSA14q32.33), HSP105 was mapped to SSC11p13 (HSA13q12.3), CXCR4 was located on SSC15q12-q14 (HSA4q21) and IP-10 was mapped to SSC8q11-q12 (HSA4q21). For the RH mapping, the retention fraction for each gene was 0.23 (DNAJA4), 0.30 (HSP90), 0.27 (HSP105), 0.38 (CXCR4), and 0.35 (IP-10). The highest Lod score between DNAJA4, HSP90, HSP105, CXCR4, and IP-10 and the nearest locus was 7.23, 5.77, 7.13, 14.06, and 18.43, respectively. All physical mapping data was internally consistent, and the predicted location in pig based on human:pig comparative maps was confirmed by mapping data. These data also confirm the functional annotation of these sequences. The PCR amplicons can be used to develop SNPs at these expression candidate genes and to determine the association of these genes with variation in challenge response. Such associated markers can be used to develop pigs with improved resistance to bacterial diseases. J.W. Kim is a recipient of a KOSEF Post-doctoral Fellowship Program.

Key Words: Bacterial disease, Pig, Gene mapping

36 SNP discovery within the differentially expressed porcine ovarian transcriptome. J. Potts*, B. Simpson, and D. Pomp, *University of Nebraska - Lincoln.*

A large microarray experiment (Caetano et al, GENETICS, 2004) identified over 100 genes that were robustly differentially expressed in ovaries and/or ovarian follicles between female pigs with divergent phenotypes for ovulation rate. We designed primers to amplify 1-2 amplicons within 70 of these genes, and sequenced the resulting PCR products. SNPs were identified by comparing sequences across a panel of 24 pigs from commercially relevant maternal lines. Results to date have identified 325 SNPs within 50 of the targeted genes. Only a single SNP was found within 6 of the 50 genes (CRELD1, ENAH, HSD3B1, LHB, MIG6), while 34 SNPs were identified within G1P2. Theseand additional SNPs are now being evaluated for associations with reproductive phenotypes using 1,600 DNA samples from female pigs, representing three independent populations of commercially relevant maternal lines. This research was conducted with funds from the Biotechnology Research Development Corporation (BRDC). We gratefully acknowledge provision of samples and data from Monsanto Choice Genetics, Sygen International and Rodger Johnson at UNL, and assistance with SNP detection analysis from Nengbing Tao and Michael Grosz at Monsanto Choice Genetics.

Key Words: SNP, Porcine, Reproduction

37 The National Swine Registry Pork Alliance program. R. Bates*[1], P. Saama[1], K. Stalder[2], T. Baas[2], T. See[3], A. Schinckel[4], and R. Pfortmiller[5], [1]*Michigan State University,* [2]*Iowa State University,* [3]*North Carolina State University,* [4]*Purdue University,* [5]*National Swine Registry.*

The National Swine Registry, W. Lafayette, IN working with its members and its advisory committees has developed a Pork Quality Alliance program that allows its members to routinely gather meat quality data on pigs from their herds. Pigs are slaughtered monthly in commercial harvest facilities and meat quality data is measured at 24 h post-harvest. Data collection includes CIE L* (L*), pH and marbling score (MS) (1-10 scale) on the longissimus muscle near the tenth rib location of the ribbed carcass. Data collected through August 2004 consisted of 684 Yorkshire, 577 Landrace and 1240 Duroc records. (Co)variance components were estimated among these three traits with the following model; harvest contemporary group, and sex with animal as a random term using the VCE5 software. Harvest contemporary groups were defined as harvest date nested within herd and breed. For analysis, pH was transformed to hydrogen ion concentration (H+). Heritabilities for L*, H+ and MS were 0.16, 0.21 and 0.34, respectively. The genetic correlations of L* with H+ and MS were 0.05 and -0.19, respectively, while the genetic correlation between H+ and MS was 0.39. The phenotypic correlations of L* with H+ and MS were 0.18 and -0.07, respectively. The phenotypic correlation between H+ and MS was 0.17. The NSR has developed a meat quality evaluation program that allows their members to receive expected progeny deviations for sires, dams and retained littermates of harvested pigs so they can incorporate direct selection for meat quality traits into their genetic improvement program.

Key Words: Pig, Meat quality, Genetic parameters

38 Lack of association of calpastatin haplotypes with meat quality in a Duroc-Landrace swine resource population. D. Nonneman*, G. A. Rohrer, S. D. Shackelford, T. L. Wheeler, and M. Koohmaraie, *USDA-ARS, U.S. Meat Animal Research Center.*

Three main components of pork eating quality are tenderness, juiciness and flavor. A genome scan for meat quality traits was performed on a Duroc-Landrace F2 population to identify regions associated with these traits. QTL for taste-panel tenderness scores and slice shear force were detected on chromosome 2 (60-66 cM). Calpastatin maps near this region (72 cM) and is an obvious candidate for affecting meat tenderness in swine. BACs containing the calpastatin gene (CAST) were subcloned and sample sequenced to obtain genomic sequence. Roughly half of the coding region was sequenced from genomic DNA of eight F2 pigs and a total of 32 SNPs were identified. One SNP resulted in an arginine or lysine coding difference in exon 13 (nucleotide 939 of the full-length heart calpastatin cDNA). Three haplotypes were detected based on comparative sequencing and analysis of six SNPs in the F2 animals. Frequency

of the lysine coding allele was 0.74 based on 354 genotypes. For the haplotype, the frequency of the most common allele was 0.73 and the other two alleles had similar frequencies (0.13 and 0.14) based on 334 genotypes. Association analyses were conducted for measures of tenderness and CAST SNP genotypes. Effects of the haplotype and of the amino acid changing alleles were evaluated separately. No effect ($p > 0.20$) of CAST on tenderness in either analysis could be detected. Therefore, the QTL for tenderness detected must be caused by genetic variation at another locus in this resource population.

Key Words: Swine, Calpastatin, Association

39 Effect of three cathepsin genes on processing quality traits of fresh and dry-cured hams.

A. Ramos*, K. Stalder, N. Nguyen, and M. Rothschild, *Iowa State University*.

A trend has been observed for an increased demand for high quality fresh and processed pork products throughout the world. In order to meet these new consumer requirements, animal geneticists need not only to understand the genetics behind pork meat quality but also to develop strategies that will allow the selection of the animals carrying the most desirable genotypes for enhanced pork quality. Molecular genetics allows several good biological candidate genes affecting meat quality traits to be studied at the DNA level. Polymorphisms can be identified and used to accelerate genetic progress. Cathepsins are lysosomal enzymes involved in the proteolysis process observed during the dry curing process of hams. The effect of three cathepsin genes (cathepsins B, F and Z) on several processing characteristics of fresh and dry-cured hams was investigated in this study. Genotypes for all genes were obtained using PCR-RFLP procedures developed in our group (cathepsins B and Z) or published in the literature (cathepsin F). The association analysis conducted revealed significant effects of all genes on several traits. Cathepsin Z (CTSZ) genotypes significantly affected several fresh and dry-cured ham traits. The CTSZ genotype 22 was found to be associated not only with higher fresh and cured ham weight but also with higher yield. Similar results were detected for cathepsin F (CTSF). In fact, CSTF variants had a significant effect on fresh and dry-cured ham weight, average marbling and intramuscular fat. The fresh ham traits analyzed were not influenced by the cathepsin B (CTSB) variants. However, this locus had a significant effect on several dry-cured ham traits, including cured weight, yield, weight loss and moisture content. This study indicates that the variants at these three cathepsin genes are associated with increased quality characteristics of fresh and dry-cured hams. Therefore, these genes can be used by the swine industry as tools to select pigs with characteristics more suitable for dry-cured ham production.
Support was provided by Sygen International, ISU Department of Animal Science and CIAG and State of Iowa and Hatch funding

Key Words: Hams, Genetic markers, Swine

40 Heat-induced subfertility in male mice.

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The damaging effects of heat stress on male fertility have been extensively documented in many mammalian species. Fertility losses do not occur immediately following heat exposure in heat-stressed male mice, but instead are evident 18-28d post-stress. Mature spermatozoa in d18-28 ejaculates would have been at developmental stages during heat exposure. The objectives of this study were to 1) determine differences in variation in heat stress-induced subfertile versus control male mice, and 2) determine if TUNEL (terminal deoxynucleotidyl transferase-mediated dUTP nick-end-labeling) is an effective tool for identifying heat stress resistant and susceptible males. Mature male mice were exposed to heat stress ($35\pm1^{\circ}$ C; n=50) or thermoneutral ($21\pm1^{\circ}$ C; n=10) conditions for 24h and then hemicastrated (d1) for testis collection for future gene expression analyses. Males were placed with females in two periods, the first from d3-11 when no reductions in fertility were anticipated (2 females/male), and the second from d18-28 when variation in fertility was expected (8 females/male). Males were sacrificed at d29 and the second testis collected for sperm quality analyses. Pregnant females from period 2 were sacrificed at ~d17 of gestation. Heat stressed males were indexed by multiplying overall mean ovulation rate by pre-implantation survival and number of pregnant females by male. The five highest and lowest ranking males were identified as heat stress resistant and susceptible, respectively. Index CV in heat stressed males was 2x that of controls. Resistant and susceptible males differed by >3 SD in the index. Total fetuses in period 2 did not differ between control and resistant males (81.8 and 80.2 fetuses, respectively), but was lower in susceptible males (22.6 fetuses; $P<0.001$). Caudal epididymal sections were analyzed for DNA strand breakage in sperm nuclei using TUNEL. Control males had fewer TUNEL-positive cells ($P<0.001$) than resistant and susceptible males. Additionally, fewer TUNEL-positive cells were observed in resistant males than susceptible males ($P<0.05$), indicating TUNEL may be useful in identifying heat stress resistant males.

Key Words: Heat stress, Fertility, Mice

41 Divergent selection for heat loss in mice: I. Responses in heat loss, feed intake and body weight during four generations of re-initiated selection.

J. McDonald and M. Nielsen*, *University of Nebraska*.

Divergent selection for heat loss ($kcal \cdot kg^{-0.75} \cdot d^{-1}$), measured in 9- to 11-wk-old male mice, was applied. High (MH), low (ML), or unselected control (MC) lines were maintained in each of three replicates for a total of nine unique lines. Data reported herein are for Generations (G) 42 through 46. Divergent selection was practiced through G16; then intentional selection ceased and line size was expanded through G41. Using previously described protocols, selection for heat loss continued in G42 to test whether further responses would occur. Single heat-loss measurements were obtained overnight in direct, gradient-layer calorimeters. Male body weights were taken at 8 and 11 wk of age, and feed intake was measured weekly during this time on full-sib cages. Realized cumulative selection differentials (CSD), averaged across replicates, were 45.0 ($kcal \cdot kg^{-0.75} \cdot d^{-1}$) for MH and -27.8 for ML and ranged from 41.7 to 47.8 in MH and -27.0 to -29.4 in ML for the three replicates. Adjusted for standard deviation, realized CSD averaged across replicates were 2.6 for MH and -2.5 for ML. Direct responses per generation in heat loss ($kcal \cdot kg^{-0.75} \cdot d^{-1}$), as deviations from MC, were 4.21 ± 0.46 for MH and -0.34 ± 0.67 for ML. Realized heritability was 0.27 ± 0.04 based on divergence of MH and ML selection. Realized heritabilities for high and low selection were 0.38 ± 0.07 and 0.06 ± 0.09, respectively. Body weights did not change with selection. Feed intake differed (MH ML) by 14.8 $g \cdot kg^{-0.75} \cdot d^{-1}$ at G42, and 18.7 at G46; response in the last four generations was due to response in the MH lines. Regression of response in feed intake ($g \cdot kg^{-0.75} \cdot d^{-1}$) on generation number was 0.92 ± 0.16 based on divergence between MH and ML. Renewed selection, after being relaxed for 26 generations, has produced intended responses in heat loss and feed intake only in the high direction. Thus far, renewed selection for low heat loss has not produced further response in feed intake.

Key Words: Mice, Selection, Heat loss

42 Divergent selection for heat loss in mice: II. Correlated responses in milk production and dam feed intake during lactation.

J. McDonald* and M. Nielsen, *University of Nebraska*.

Divergent selection for heat loss was practiced to produce high (MH) and low (ML) lines. Three replicates included each of the selection lines for a total of six lines in this study. Selection was practiced through Generation (G) 16 and then followed by no intentional selection through G41. At G42, selection resumed using the same protocols. This study presents data from an intended 24 dams per MH and ML line in all replicates at G46 and tests whether lines differ in milk production and dam feed intake during lactation. Within each replicate, 12 dams from MH were matched by birth date to dams in ML and then pups were cross-fostered across line at 3 d of age. A similar number of dams within each line reared their own pups. All litters were reduced to eight pups within 1 d of birth. Lactation records of all dams were obtained by weighing litters before and after a 2-hr suckling period at 6, 9, 12, and 15 d. Maternal feed intake was also recorded between these dates. There was a significant effect of line on milk yield ($P = 0.10$) as MH dams produced more milk than the ML dams. Average milk yield over a 2-hr period was 1.70 ± 0.07 and 1.41 ± 0.07 g for MH and ML dams, respectively. Cross-fostering had no effect ($P > 0.87$) on milk yield, and there was no difference ($P > 0.97$) in milk consumption due to line of pups. Stage of lactation affected milk yield ($P = 0.01$); yields were 1.40, 1.56, 1.66,

and 1.61 ± 0.07 g for d 6, 9, 12, and 15, respectively. MH dams consumed more feed (P = 0.08) during lactation with 3-d averages of 50.8 ± 1.2 and 45.2 ± 1.2 g for MH and ML, respectively. Stage of lactation affected intake (P < 0.001); dam intake was 43.6, 48.8 and 51.6 ± 1.05 g for d 6 to 9, 9 to 12, and 12 to 15, respectively. Litter weights at 21-d weaning tended (P = 0.15) to be different between lines of dam (MH > ML), but dam weights were not affected by selection (P > 0.87). Selection to reduce heat loss, and hence maintenance requirements, resulted in reduced milk yield and reduced feed intake in lactating dams.

Key Words: Mice, Heat loss, Lactation performance

43 Genetics of gene expression of the insulin signaling pathway in polygenic obesity. A. D. Ferrell*[1], M. F. Allan[2], and D. Pomp[1], [1]*University of Nebraska,* [2]*USDA-ARS Meat Animal Research Center.*

Adequate characterization of complex traits such as growth and body composition will require innovative methods for determining genetic and physiological control mechanisms. Our objective is to utilize a mouse model, displaying polygenic obesity, to elucidate regulatory roles of specific loci in the insulin signaling pathway. Transcriptome mapping, a method to combine microarray analysis with QTL mapping, was used to evaluate gene expression endo-phenotypes within a QTL mapping population of M16/ICR F2 mice. The M16 line of mice is a result of selection for rapid growth rate from 3 to 6 weeks of age. These mice exhibit hyperphagia, hyperglycemia, NIDDM and are moderately obese compared to the ICR control line. mRNA was extracted from liver tissue of 8-week old F2 male mice with extreme body fat phenotypes (n=88, selected from 1200), and hybridized to probes for 96 well-characterized genes in the insulin signaling pathway (GEArray by SuperArray®). Probes on this macroarray represented insulin receptor-associated proteins, PI-3 kinase and MAPK pathways, and targets for insulin signaling, PPARg and SREBP-1. Gene expression endo-phenotypes were analyzed in QTL Express with multiple normalization methods. Evaluation of map positions of the resulting expression QTL (eQTL) relative to map positions for loci represented on the macroarray revealed potential cis- or trans-acting eQTL. Preliminary results indicate potential cis-acting eQTL for *Ptprf* on chromosome 4, *Ptpn11* on chromosome 5 and *Slc2a4* on chromosome 11. A potential eQTL representing a putative master regulator of several genes in the insulin signaling pathway exists on chromosome 4. Differences in gene expression and potential eQTL will be validated with Real-Time PCR (Taqman). Characterization of endo-phenotypes in relation to the physiological function of the insulin signaling pathway in liver tissue may contribute to a better understanding of the overall regulation of growth and body composition.

Key Words: Growth, Transcriptome mapping, eQTL

44 Exploring the effect of dietary phosphorous levels on gene expression in two lines of pigs using microarrays. L. Grapes*, A. Qu, L. Hittmeier, M. Rothschild, and C. Stahl, *Iowa State University.*

Despite the cost of phosphorous (P) supplementation in porcine diets, as well as public concern about the environmental effects of P in excreta, little research has focused on the genetic mechanisms controlling P utilization in pigs. To better understand these mechanisms, 36 total gilts (initial body weight 6.63 ± 0.78 kg) from 6 litters (3 gilts/litter) for each of 2 sire lines known to differ in bone structure were allotted to 3 dietary treatment groups. Treatment group 1 received a standard diet supplemented with inorganic P to meet NRC (1998) requirements. Group 2 received a similar diet with no inorganic P supplemented. Group 3 received the same diet as Group 1 for 7d followed by the diet group 2 received for 7d. After 14d on study, liver samples were collected and snap frozen in liquid nitrogen. The microarray study involved a loop design so that all pair-wise treatment comparisons were performed within litter. Liver cDNAs were labeled with Cy3 or Cy5 and hybridized to the pig oligonucleotide arrays containing approximately 13,000 genes. Mixed-model analysis was performed on normalized signal intensity data from 18 slides and included the fixed effects of sire line, diet and sire line by diet interaction. Differentially expressed genes (P<0.01) were seen between sire lines (103 genes), dietary treatments (122 genes), and for the interaction of sire line by diet (88 genes). For example, the P deficient animals in one sire line had significantly higher expression of the SRY (sex determining region Y)-box 9 (SOX9) and thyroid hormone receptor interactor 6 (TRIP6) genes (P<0.009 and P<0.0001, respectively) compared to the P adequate animals in the same line. However, there was no difference found between the adequate and deficient animals in the other sire line for these two genes. Results from this study will provide information about P utilization and help to identify pigs, based upon their genetics, that tolerate low dietary P levels while maintaining growth.

We thank Dan Nettleton for his advice on microarray analysis. Funding provided by the IAHEES, the ISU Office of Biotechnology and Sygen International.

Key Words: Microarray, Phosphorous, Pig

45 A refined comparative map between porcine chromosome 3 and human chromosomes 2, 7 and 16. M. Mousel*, D. Nonneman, and G. Rohrer, *USDA-ARS, U.S. Meat Animal Research Center.*

A QTL on chromosome 3 has been identified in the MARC Meishan-White Composite resource population that is significantly correlated with ovulation rate (OR) and has a large effect (3.21 corpora lutea). The current resolution of the human-porcine comparative map of chromosome 3 does not sufficiently distinguish chromosomal breakpoints needed for the selection of positional candidate genes controlling this trait. This study placed 48 known genes, ESTs and 1 microsatellite (SB42) onto the swine chromosome 3 map by radiation hybrid (RH) mapping. The 7,000 IMpRH panel was used to map all markers and 34 markers were mapped using the 12,000 IMNpRH2 panel to clarify gene order. Data were analyzed for two-point and multipoint linkage with the IMpRH mapping tool and submitted to the IMpRH database (http://imprh.toulouse.inra.fr/). Carthagene (http://www.inra.fr/bia/T/CarthaGene/) was used to estimate multipoint marker distance and order using all public markers on chromosome 3 in the IMpRH database and those developed in this study. Five breakpoints were identified on the p arm of porcine chromosome 3, beginning at p1.7 to p1.2, that correspond to HSA 7q22.1 (98.80-101.05 Mb), 7q11.22-q11.23 (72.29-73.51 Mb), 7q11.22-q11.21 (68.50-64.86 Mb), 16p11.2 (31.40-28.41 Mb), 16p12.2-11.2 (19.42-23.75 Mb), and 16p13.13-p13.3 (11.26-2.03 Mb). The q arm had conserved synteny with HSA 2q11.2-p24.2 (96.68-18.65 Mb). There were three breakpoints in the chromosomal region that surrounded the OR QTL (p1.2-p1.4). Breakpoint 1 linked HSA 7q22.1 to 7q11.22-q11.23, breakpoint 2 did not have sufficient coverage to close the gap and breakpoint 3 connected HSA 7q11.22-q11.21 to 16p11.2. These data refine the human-porcine comparative map and placed additional genes on chromosome 3 which are within an OR QTL.

Key Words: Swine, Radiation Hybrid Mapping, Ovulation Rate

46 Effects of prion haplotype on growth and carcass traits in sheep. B. J. Isler*, B. A. Freking, M. A. Heaton, R. M. Thallman, and K. A. Leymaster, *USDA, ARS, U.S. Meat Animal Research Center.*

Within the sheep industry, there is concern about potential antagonistic correlated responses of economic traits due to intensive selection for scrapie-resistant haplotypes of the prion gene. The objective was to test for associations of prion haplotypes with growth and carcass traits in a F_2 Dorset x Romanov population (n = 418), segregating at the callipyge locus. Animals were haplotyped at prion codons 136, 154, and 171 to determine scrapie susceptibility status, and genotyped at six flanking microsatellite markers to determine breed of origin of the prion region of ovine chromosome 13. A comprehensive set of growth, carcass shape, and composition traits were collected. Data were analyzed using a model consisting of fixed effects of year, sex, and callipyge genotype, random effects of sire, and six covariates corresponding to probabilities that an animal inherited a specific prion haplotype of either Dorset or Romanov origin. For carcass traits, the model also contained the linear and quadratic effects of chilled carcass weight as a covariate, along with the interaction between callipyge genotype and linear and quadratic terms. Within each breed of origin, contrasts between the resistant haplotype (ARR) and the average effects of the other prion haplotypes (ARQ, AHQ, VRQ) were tested to estimate effects of selection for ARR. Of the 21 traits analyzed, the only significant contrast was for carcass length in Romanov, where the ARR haplotype was associated ($P = 0.035$) with

increased carcass length. This study is the first to account for breed of origin while investigating haplotype associations in a F_2 population. This study provides little, if any, evidence of associations between prion haplotypes and growth and carcass traits.

Key Words: Carcass traits, Growth traits, Prion

47 Interval mapping of QTL for Marek's disease resistance with selective DNA pooling in crosses of commercial layer chicken lines. E. M. Heifetz*[1], J. E. Fulton[2], N. O'Sullivan[2], M. Soller[3], and J. C. M. Dekkers[1], [1]*Iowa State University,* [2]*Hy-Line Int.,* [3]*The Hebrew University of Jerusalem*.

Two partially inbred Leghorn lines that differed in resistance to Marek's disease (MD) were crossed to produce 2 reciprocal backcross populations (BC1 and BC2), each consisting of five grandparental families with an average of 167 and 238 progeny per family in BC1 and BC2 respectively. Resistance to MD was recorded as age of mortality up to 18 weeks following experimental challenge with a virulent MD virus. Low (20% shortest survivors) and high (20% longest survivors) DNA pools were created for 20 family x B blood type x BC combinations (five families x 2 BT x 2 BC), with 15-21 birds per pool for BC1, and 20-24 for BC2. Allele frequency differences between high and low pools were estimated for 200 microsatelite markers across the genome by quantitative PCR with shadow correction. A maximum likelihood interval mapping method that simultaneously utilizes information from multiple markers and families was used for analysis, allowing for different QTL effects for each combination. Analyses were conducted by combining data at the following levels: I. by BC x BT combination (5 data points/marker): II. by BC (10); III. by BT (10); and IV. across all BT and BC (20). Using 20% false discovery rate threshold, analyses I, II, III, and IV identified 7, 26, 21 and 25 significant QTL regions on 5, 11, 8 and 9 chromosomes respectively. Taken together, the analyses identified 30 regions on 11 chromosomes that appear promising for further analyses.
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Key Words: QTL, Marek's disease

48 Marker to marker linkage disequilibrium in commercial chicken breeding populations. E. M. Heifetz*[1], J. E. Fulton[2], N. O'Sullivan[2], H. Zhao[1], J. C. M. Dekkers[1], and M. Soller[3], [1]*Iowa State University,* [2]*Hy-Line Int.,* [3]*The Hebrew University of Jerusalem*.

In this study we explore the potential of using marker-QTL linkage disequilibrium (LD) for MAS, by examining the extent of marker to marker LD in commercial chicken breeding lines, under the assumption that it is predictive of the extent of marker-QTL LD. Two datasets were analyzed: 22 individuals from each of two lines that were genotyped for 24-48 microsatellite markers/chromosome across chromosomes 3, 4 and 5, and 4-11 markers/region clustered in regions <10 cM on chromosomes 1, 2, 6 and 8; and data on 32 individuals from each of three generations of each of two lines, which were genotyped for 28-43 markers/chromosome on chromosome 4 and 5. The LD measures D′ and χ^2′ (standardized Chi-square) were calculated between all possible pairs of markers. For non-syntenic marker pairs 0.08-0.3% and 16-31% showed LD >0.5 for χ^2′ and D′. For this reason and others, only χ^2′ was considered further. Using LD for non-syntenic markers as the null situation, LD values of 0.07 to 0.25 (depending on sample size) were significant at the 0.05 level. Across all datasets, lines and chromosomes, 40-50% of marker pairs located within <10 cM of one another had LD values >0.5. The LD between specific marker pairs within 5 cM had correlations of 0.86-0.96 over generations, compared to 0.13-0.42 for markers >20 cM apart and 0.11-0.22 for non-syntenic markers, demonstrating the persistence of this LD over generations. The extent of LD did not differ between chromosomes and lines, but did differ significantly (P<0.0001)between regions of #880410 cM within lines. These results indicate that marker-QTL LD may be a useful route to MAS in these lines.
Vaadia-BARD Postdoctoral Award No. PD FI-350-2003 from BARD, The United States - Israel Binational Agricultural Research and Development Fund. Hy-Line Int. BSF (US-Israel Binational Science Fund). Israel Poultry Council.

Key Words: LD, Linkage disequilibrium

49 Discriminant analysis for multitrait quantitative trait loci detection in a Berkshire x Yorkshire F_2 population. H. Zhao*[1], H. Gilbert[2], and J. C. M. Dekkers[1], [1]*Iowa State University,* [2]*INRA, Station de Genetique Quantitative et Applique*.

Use of multitrait instead of single trait analysis improves the power to detect quantitative trait loci (QTL) using genetic markers and improves mapping accuracy. Several methods for computationally efficient multitrait QTL analysis have been proposed, including principal component and discriminant analysis (DA). DA has been shown to be particularly suited to detect QTL with trait effects that are opposite to trait correlations. The objective here was to implement a DA method to detect QTL that break the positive correlation between backfat and marbling. Average backfat, lipid % and marbling were analyzed jointly for 12 chromosomes on 510 F_2 progeny from a Berkshire x Yorkshire cross. Residual trait correlations were 0.21 (backfat, marbling), 0.29 (backfat, lipid%), and 0.55 (marbling, lipid%). At each 1cM chromosomal position, two genetic groups were defined based on breed origin of the allele received from the F_1 sire and progeny phenotypes were allocated to each group by weighting trait values (pre-adjusted for fixed effects) by breed origin probabilities derived from genetic markers. The linear combination of the traits that best distinguished the two groups at a given position was constructed and analyzed univariately by regressing on sire, and additive and dominance QTL effects. The highest F value for QTL effects was used to identify the most likely QTL position and estimates of QTL effects at this position were obtained from a multivariate analysis of the original traits. For the analyzed chromosomes and traits, QTL detected by the DA analysis were similar to those obtained from single trait analyses, and no new QTL that decrease average backfat but improve marbling were detected. Power to detect such QTL may have been limited by the use of only two genetic groups, which optimizes detection of additive QTL only. Further work is ongoing to allow DA into three genetic groups by considering both the paternal and maternal alleles.
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Key Words: QTL, Multitrait, Discriminant analysis

50 Determining inheritance and genetic cause of a polydactyl phenotype in pigs. B. Mote*[1], D. Rocha[2], J. Loy[1], L. Totir[1], R. Fernando[1], and M. Rothschild[1], [1]*Iowa State University,* [2]*Sygen International plc, University of Cambridge*.

Pigs expressing a preaxial polydactyl phenotype were identified in a Yorkshire herd. Pedigree analysis of the first two individuals indicated a common ancestor. Planned matings created full and half sibs of the original affected individuals for use in the identification of a causal mutation and to help identify gene action. Two affected progeny were generated from these matings, both stillborn. Additional matings were designed between a founding sire and all female littermates (n=5) of the original two individuals along with the original affected female. The first litter from these matings was recently farrowed with one affected stillborn individual. These total results suggest the polydactyl phenotype is under genetic control and may be recesive. Literature searches were conducted to identify candidate genes. Multiple genes associated with polydactyl phenotypes in other species should, through comparative mapping, be located on pig chromosome 18, a marker poor chromosome in the pig. Primers for genes such as Limb Region 1 Protein (LMBR1), Sonic Hedgehog, Twist, Wnt-16, and other genes believed to reside on SSC18 were developed from human and pig EST sequences. PCR products were sequenced to ensure proper amplification and to identify SNPs. PCR-RFLP tests were designed to genotype SNPs and map those genes in Iowa State University's resource population. Genotypes from the first four litters were used to calculate LOD scores by the Elston-Stewart algorithm to test for linkage between markers and phenotype. This approach suggests a 10 cM region of interest between the genes Leptin and SPAM1, 35 cM away from our primary gene of interest (LMBR1). Production data are being recorded on all animals for future association studies. This combined approach will help to identify the causative mutation of this abnormal phenotype in swine.

Key Words: Swine, Polydactyl, Abnormalities

51 A QTL resource and comparison tool for pigs: PigQTLDB. Z.-L. Hu*[1], S. Dracheva[2], W. Jang[2], D. Maglott[2], J. Bastiaansen[3], J. Reecy[1], and M. Rothschild[1], [1]*Iowa State University,* [2]*National Center for Biotechnology Information,* [3]*Sygen International*.

Hundreds of quantitative trait loci (QTL) has been reported for growth, meat quality, reproduction, disease resistance and other traits in pigs. It is a challenge to correctly locate, interpret and compare QTL results from different studies. We developed a database (PigQTLDB) to integrate all available pig QTL data in the public domain, and subsequently to facilitate the use of QTL data in future studies. We also introduced a "trait ontology" to standardize names of traits and to simplify organization of the trait data in order to compare primary data from diverse sources and methods. We emphasized the use of existing pig map databases and other publicly available data resources to avoid redundant developmental work. The PigQTLDB was designed to include data representing major genes and markers associated with large effect on economically important traits. To date, the database contains over 790 QTLs covering more than 200 different traits. These data have been submitted to the Gene and Map Viewer resources at NCBI, where the information about markers has been matched to marker records in NCBI's UniSTS database. This allows automatic matching of markers to public sequence data by e-PCR. The data are retrievable from NCBI via Gene, Map Viewer, and UniSTS. All efforts were undertaken to improve integrated functional genomics resources for pigs.
This work was supported by the USDA/CSREES NAGRP Pig Genome and Bioinformatics Coordination Programs.

Key Words: Quantitative trait loci (QTL), Database

52 Marker-assisted selection on multiple QTL in a crossbred population. N. Piyasatian*, L. R. Totir, R. L. Fernando, and J. C. M. Dekkers, *Iowa State University*.

Efficiency of marker-assisted selection on multiple QTL for a trait with heritability 0.1 in a line-crossing program was evaluated on the basis of frequencies of favorable QTL alleles and genetic gain over ten generations of selection, starting in the F2. Three biallelic unlinked additive QTL were simulated in the middle of marker intervals (d) of 0, 10, and 20 cM, with each QTL explaining 12, 6, or 3% of genetic variance. Markers were fully informative for line origin. Responses to selection from the following models for genetic evaluation were compared to response to regular BLUP selection: M1 = BLUP with markers as fixed effects; M2 = M1 with random QTL effects (for d>0 only); M3 = BLUP with random QTL effects only. Selection on the number of favorable markers (M4) was evaluated also. Results were based on 50 replicates. QTL frequencies were fixed most rapidly with M4 (>0.9 in F4), followed by M1, M2, M3, and BLUP. Increases in frequencies were slightly greater for M1 than for M2 but considerably greater than for M3, which had only slightly higher frequencies than BLUP. For the large QTL, genetic gain in the F4 was up to 29 and 39% greater than BLUP for M1 and M2, but only up to 2% and 15% greater for M3 and M4. Extra gain declined over generations for all models, with smaller QTL effects, and with larger intervals, and became negative for M4 in the F5. Results for M1 and M2 are in Table 1. Here, random QTL effects were modeled assuming linkage equilibrium, which may explain the limited differences between M1 and M2, and between M3 and BLUP. Based on genetic gains, M2 appeared to be the best model, although it is more difficult to implement than M1. Results show that QTL detected in breed crosses can be used for subsequent selection within the cross, even using markers that are 20 cM apart.

This work was supported by CSREES IFAFS # 00-52100-9610

Genetic gain (% versus BLUP) in the F4 for M1 and M2 for different QTL effects

	Large	Large	Medium	Medium	Small	Small
d (cM)	M1	M2	M1	M2	M1	M2
0	30	-	29	-	9	-
10	29	39	19	23	4	12
20	11	26	13	16	4	13

Key Words: QTL, Marker-assisted selection, BLUP

Extension-Beef

53 Cultural energy analysis of pasturing systems for cattle finishing programs. H. Koknaroglu[1], K. Ekinci[1], M. P. Hoffman[2], and P. Tsengeg*[2], [1]*Suleyman Demirel University,* [2]*Iowa State University*.

A three-year study integrating pasture and drylot feeding systems was used to assess cultural energy analysis of cattle production systems. Cultural energy is the energy other than solar energy needed to produce food and fiber. Cultural energy includes labor, manufacture of machinery, transportation, tillage, production of fertilizers and herbicides, processing material and finally marketing the product. Each year, 84 fall-born and 28 spring-born calves of similar genotypes were used. Fall-born and spring-born calves were started on test in May and October, respectively. Treatments were: 1) fall-born calves directly into feedlot; 2 and 3) fall-born calves put on pasture with or without an ionophore and moved to the feedlot at the end of July; 4 and 5) fall-born calves put on pasture with or without an ionophore and moved to the feedlot at the end of October; 6 and 7) spring-born calves put on pasture with or without an ionophore and moved to the feedlot at the end of October. A 12.1 ha bromegrass pasture was divided into 16 paddocks. In the feedlot, steers were provided an 82% concentrate diet containing whole-shelled corn, ground alfalfa hay, a protein, vitamin and mineral supplement containing ionophore and molasses. Pens of cattle were harvested at approximately 522 kg. Cultural energy used for pasture establishment, feed consumption, and maintenance were calculated using the actual inputs and corresponding energy values from the literature. Cattle going directly to feedlot had higher and those spending longer time on pasture had lower total cultural energy expenditures than other treatments (P<0.01). Feed energy comprised more than half of the total cultural energy and was highest for cattle going directly to the feedlot and was lowest for cattle spending the longest time on pasture (P<0.01). Energy expended per kg live weight was higher for spring born cattle (P<0.01). The longer time cattle spent on pasture the better the energy output ratio as defined by kcal input/kcal output (P<0.01). Results show that pasturing cattle is an effective way of reducing cultural energy expenditure and supports the concept of sustainable agriculture.

Key Words: Cultural energy, Feedlot, Pasture

54 The effectiveness of synergistic blends of organic acids in the stabilization of wet distillers grains. S. Moore*, J. Smith, and V. Sewalt, *Kemin Agri-Foods North America*.

Wet distillers grains (WDG) represent a highly nutritious, high moisture alternative feed source providing both energy and protein, but requires stabilization, preferably at the ethanol plant, in order to minimize microbial growth and deterioration of its nutritive value. Wet distillers grains at 60-70% moisture were treated with one of four preservative treatments (ZeniPRO^{TM} brand preservative; TP1, an experimental blend of organic acids; TP2, an experimental blend of organic acids and antioxidants; and ammoniated propionic acid) at four levels (0, 2.5, 5.0, or 10.0 kg/T) to determine the stabilization capacities of each treatment type over time. Treated WDG were stored in coolers (6 replicates) in a limited-access, ambient temperature facility. Wet distillers grains were assayed for pH and mold and yeast counts weekly. Treating WDG with 10 kg/T of ZeniPRO^{TM} brand preservative stabilized WDG (lack of visible mold) for 21 days. Treatment with 10 kg/T of the two experimental formulations preserved the WDG for over 28 days. The WDG treated with ammoniated propionic acid molded within 14 days, and untreated WDG within 7 days. A strong correlation was observed between pH and yeast growth (correlation coefficient = .66; P<0.001). A moderately strong relationship between yeast and mold was observed (correlation coefficient = .53; P=0.013). The relationship between yeast control and mold growth lends credence to our hypothesis that yeast growth provides a subsequent environment of increased pH, moisture and heat that is favorable for mold growth. While ZeniPRO^{TM} brand preservative effectively stabilized WDG for 21 days, the two experimental formulations were able to provide even further extended stability. These results show that a synergistic blend of organic acids with or without the addition of

antioxidants can stabilize WDG and ensure its high nutritive value for long periods of time.

Key Words: Wet distillers grains (WDG), Stabilization, Organic acids

55 Comparison of doramectin and albendazole on feedlot steer performance and carcass traits.

J. A. Christopher*, T. T. Marston, and J. R. Brethour, *Kansas State University*.

The objective of this trial was to compare the effects of different deworming agents on feedlot steer performance and carcass traits. Steers (n=240) were fed at the KSU Agricultural Research Center-Hays. This experiment consisted of 2 replications (starting dates) with steers being fed a ground sorghum-grain based finishing diet (average d on feed=103). Prior to the start of each replication, steers were commingled for approximately 30 d and then stratified into high and low marbling groups via ultrasound measurements (Aloka 500, 5 MHz transducer and CPEC software). Within each marbling group steers were randomly allotted to a treatment (average starting weight=455 kg) therefore steer was the experimental unit. Treatments consisted of an oral application of albendazole or a SQ injection of doramectin dewormer. Dosages of deworming products followed label instruction. At time of treatment and 12 d later fecal grab samples were taken and analyzed for indications of internal parasite infestation. Both deworming agents reduced fecal eggs counts to minimal levels. Feedlot performance as measured by ADG and G/F ratios were unaffected by treatments ($P>0.58$). After a 24 h chilling period, carcass measurements were collected. Doramectin treated cattle had greater marbling scores (small 29 vs. small 08; $P<0.05$) and had a greater percentage of carcasses grading USDA Choice or greater then cattle given albendazole (62 vs. 52%, $P<0.10$; respectively). Steers receiving doramectin had greater backfat and yield grade measurements ($P<0.02$) than the albendazole treated steers (12.7 mm, 2.9 USDA yield grade; 11.2 mm, 2.6 USDA yield grade, respectively). Other carcass traits were similar between treatment groups. Our data indicate that both doramectin and albendazole deworming agents can effectively reduce internal parasites but that feedlot steers given doramectin can have increased amounts of both intramuscular and external fat deposition.

Key Words: Beef cattle, Feedlot, Deworming

56 Comparative efficacy and corrosivity of various liquid mold inhibitor formulations.

M. Burke*, T. Truong, A. Lamptey, and V. Sewalt, *Kemin AgriFoods North America, Inc.*.

Organic acid based mold inhibitors are widely used in grain preservation to assure maintenance of nutritional quality during storage. Use of mold inhibitors becomes imperative under conditions that are particularly conducive to mold growth (immature or wet crop, broken grain, suboptimal storage conditions such as high heat or humidity). The choice of mold inhibitor (MI), particularly the total organic acid content, additional ingredients such as surfactants, and degree of buffering, will impact the efficacy by which grain can be preserved, but also the potential corrosivity of the product. Studies were conducted to compare efficacy and corrosivity of three liquid mold inhibitors, including ammoniated propionic acid (AP, at least 75%), and two more complete mold inhibitor formulations containing 65% (MI1) or 56% (MI2) propionic acid in addition to other minor active ingredients. Efficacy was evaluated via Percent CO_2 Generation and Days to Mold analyses of two replicate samples of whole yellow corn treated with 0.5 or 1.5-kg/MT of the various MIs. In the CO_2 test, AP applied at the low inclusion rate, performed superior ($P<0.05$) to MI2 but not MI1. At the higher inclusion level, AP and MI1 were successful in suppressing CO_2 production for at least 33 days. Mold inhibitor 2 was less effective ($P>0.05$), even at the highest inclusion rate. Apparently, the inclusion of small amounts of additional active ingredients in MI1 improves antimicrobial efficacy equal to that of the simple AP containing at least 10% more propionic acid. Further, increasing the application rate of the more dilute MI2 did not compensate for its lower activity relative to MI1 or AP. Corrosivity was measured by immersion of a mild steel strip into each formula for a period of 30 days at 55°C, after which the weight loss of the immersed strip was converted to a corrosion rate (in mm/year). All MIs exhibited corrosion rates of < 1 mm/year and are, thus, not considered corrosive according to guidelines set by the US Department of Transportation.

Key Words: Mold inhibitor, Propionic acid, Corrosivity

57 Influence of early weaning on the requirement for winter protein supplementation of spring-calving beef cows grazing native tallgrass prairie.

K. W. Harborth*, D. A. Llewellyn, and T. T. Marston, *Kansas State University*.

An experiment was conducted to evaluate the impact of early weaning on subsequent winter performance and the requirement for winter protein supplementation of grazing beef cows. Ninety-six, pregnant, spring-calving, crossbred cows previously utilized in a collaborative study evaluating the effect of calf age at weaning on calf performance were blocked by winter pasture (n=3), stratified by body condition score (BCS) and body weight (BW) and randomly assigned to winter feeding groups within each previous treatment (early weaned [June 23, 2003] = EW, or fall weaned [Oct. 15, 2003] = FW) in a randomized complete block design. Winter feeding groups were bunk fed 3 d/wk with the amount of supplement prorated to deliver the designated daily quantity, and served as the experimental units. Two winter supplementation levels, each utilizing a common soybean meal-milo (40% CP; as-fed basis) supplement provided four treatments (with 6 replications per treatment) during the winter period from November 14, 2003 to calving (calving = early March 2004): Early weaning 100 % (EW100) cows received 1.80 kg/d of the winter supplement; Early weaning 70 % (EW70) cows received 1.27 kg/d; Fall weaning 100 % (FW100) cows received 1.80 kg/d; and Fall weaning 70 % (FW70) cows received 1.27 kg/d. Cows with calves weaned early were heavier and had higher initial BCS than cows that were weaned in the fall ($P < 0.01$ and $P < 0.01$, respectively). From Nov. 4 to Jan. 7, FW100 cows gained more ($P = 0.05$) BW than either group of early weaned cows; however there were no significant differences in BCS changes during the same period. The FW100 cows lost less ($P = 0.02$) BW and less ($P = 0.01$) BCS during the entire supplementation period (Nov. 14 to calving). While there was no difference in final BW between FW100 and EW70, EW70 cows did exhibit a higher final BCS ($P = 0.04$). In conclusion, BW and BCS of EW70 cows at the end of the supplementation period were consistent with FW 100 cows, indicating that cow calf producers can feed less winter supplement to spring calving cows and maintain cow BW and BCS.

Key Words: Protein, Supplementation, Early weaning

58 Early weaning and feedlot strategies to produce quality beef.

L. Berger*, *University of Illinois*.

Variations in nutritional status prior to entering the feedlot may have as much or more effect on performance and carcass characteristics as the nutritional management of the cattle while in the feedlot. As our marketing programs move toward pricing individual cattle on their carcass merit, identifying the effects of previous nutrition on carcass value will become increasingly important. In several studies marbling score has been one of the top variables explaining variation in profits of individual steers. Producers who retain ownership, or alliances which can influence the nutritional management of the cattle prior to entering the feedlot, can take advantage of enhanced performance and carcass merit. The literature indicates several mechanisms by which nutrition can affect composition of gain in ruminants. Diet composition influences volatile fatty acid profile which has been attributed to differences in composition of gain. Previous research shows that while acetate provided 70-80% of the acetyl units for lipogenesis in subcutaneous adipocytes, it only supplied 10-25% in intramuscular adipocytes. The majority (50-60%) of the acetyl units for lipogenesis in intramuscular adipocytes came from glucose. High-grain diets yield a greater proportion of propionate than forage-based diets. Propionate, a gluconeogenic precursor, may lead to greater glucose and hence greater marbling deposition. The negative correlation between the number of adipocytes per gram of longissimus dorsi tissue and the incorporation of acetate into that tissue supports the hypothesis that acetate is not the preferred carbon source for intramuscular fat deposition. It appears that if the proper substrates are present, marbling deposition may occur early in the growing period with little subcutaneous fat deposition. Feeding early-weaned calves so that they never have a high-acetate fermentation, may allow us to increase marbling deposition while limiting back fat development. In summary, cattle fed high-concentrate diets early in life often have higher marbling scores at the same backfat compared to those fed high-forage diets and may be a key to producing high quality beef.

Key Words: Early weaning, Beef, Quality

59 Managing the health status of early weaned calves. S. Loerch* and F. Fluharty, *The Ohio State University*.

Calves undergo significant stress during weaning, marketing, and adjustment to the feedlot environment. These stresses are responsible for morbidity, mortality, poor calf performance and reduced carcass quality. Typically, weaning of beef calves occurs between six and eight months of age. Some advantages in production and quality grade exist when weaning occurs at less than six months of age. The purpose of the present paper is to review nutrition and management strategies to enhance the health status of early weaned calves. There are several reasons why early weaned calves may be less susceptible to Bovine Respiratory Disease than calves weaned at seven months. Maternal antibodies obtained from colostrum provide passive immunity to the calf until approximately five months of age. Proper cow nutrition and health are essential for production of high quality colostrum. Additionally, early weaned calves typically are not marketed at weaning time. Thus, the stress of weaning is separated from stresses of marketing, transportation, and increased exposure to novel pathogens as a result of co-mingling. Post-weaning nutrition and management are critical to calf health. However, little direct research has been conducted to identify specific recommendations for early weaned calves. Most recommendations are based on inference from data obtained with calves weaned at approximately seven months of age. Accessibility and consumption of feed and water is a concern if feedlot facilities are not designed to accommodate calves weighing 100 to 150 kg. Gates and fences must also be designed to contain smaller calves. Early weaned calves consume less feed than typical feeder calves. As a result, nutrient density of the diet must be increased to provide the quantity of nutrients required to maximum immune function and optimum growth. Other issues that will be discussed include vaccination schedules, feedlot environment, and therapy for treatment of calves that develop Bovine Respiratory disease.

Key Words: Weaning, Health, Nutrition

60 Creep feeding calves to produce quality beef. D. B. Faulkner*, *University of Illinois*.

It is well documented that calves that are started on a high energy, high starch diet early in life deposit more marbling relative to backfat than those started later in life (e.g., early-weaned calves vs. normal weaned calves or yearlings). In creep feeding diets it is important to have high levels of starch to produce high quality beef because most of the fat cells in marbling come from propionate. Propionate is produced in higher amounts in the rumens of cattle fed high grain diets. Conversely, most fat cells in external fat come from acetate, which is produced in higher amounts in the rumens of cattle fed higher-forage diets. High dietary protein levels are important because they also increase marbling. This is probably due to improving starch digestion and absorption from the small intestine, while simultaneously increasing blood insulin and glucose. This will result in more propionate for the production of fat cells in marbling. Creep feeding high protein high starch diets will increase the ultimate quality grade of cattle. These nutritional factors are about 6 time more important than the genetic ability of the cattle to marble as measured by EPD.

Key Words: Beef, Quality, Creep feeding

61 Applying weaning management strategies in beef production systems. D. C. Adams* and L. A. Stalker, *University of Nebraska West Central Research and Extension Center*.

While traditionally viewed as a routine procedure, timing of weaning has dramatic economic and biological consequences. Impact of weaning date and supplementation strategy on profitability varies within and between production systems, and with marketing objectives. In beef production systems weaning date may impact cow body condition score, cow pregnancy rate, cow/calf feed costs, calf weaning weight, steer finishing costs, forage demand, marketing, carcass characteristics, and profitability. Unless supplemented, lactating cows grazing in the northern great plains will likely lose body condition in the late summer and fall. Weaning the calf lowers cow nutrient requirements which allows the cow to maintain body condition score on low quality forages. Weaning and removal of the calf from the ranch reduces overall forage consumption and extends a limited forages supply (e.g. during drought). Weaning date allows a producer to take advantage of seasonal variation in prices when marketing the cow, calf and yearling. For example, cows with earlier weaned calves may have greater cull value because of greater body weight, body condition and a late summer marketing date rather than a fall marketing date. Supplementation is a means to reduce negative impacts of lactation on the cow and makes extended grazing practical for the cow/calf pair when forage quality is low. The need for supplement to maintain body condition during winter grazing in a spring calving system is greater with later weaning dates. Weaning date and/or need to supplement will vary with the genetic potential of the cow to produce milk. Supplementation in combination with delayed weaning can extend grazing of the calf through the winter and reduce the total cost of grazing the cow and feeding the calf separately in a cow/calf yearling system. Protein supplementation of the cow during winter grazing may interact with weaning date to effect calf weaning weight, live weight at slaughter and carcass weight. Weaning date and supplementation strategy provides opportunity to adapt to variable forage supplies, markets and reduce labor and feed costs.

Key Words: Cattle, Body condition score, Economics

62 Economic effect of post-weaning disease on feedlot gain and carcass traits. W. D. Busby[1], P. Beedle[1], D. Strohbehn[1], J. F. Stika*[2], and L. R. Corah[2], [1]*Iowa State University,* [2]*Certified Angus Beef LLC*.

Calves (n=13,321) from 12 states fed at eight Iowa feedlots through the Iowa Tri-County Steer Carcass Futurity were used to evaluate the economic effect of post-weaning disease. A common diet was fed and similar implant and health programs were administered. Calf health was classified as no treatment (NT; n=10,987), single treatment (ST; n=1,440), or two or more treatments (2T; n=894). Calves were harvested when visually evaluated to have one centimeter of fat cover. Dollar return differences were based on the mean Kansas/Texas grid values for 2003 through September 2004. Mortality rates (%) and feedlot ADG (kg/day) were .05 and 1.45; 3.07 and 1.37; and 9.95 and 1.33 for NT, ST, and 2T calves, respectively (P<0.01). Percent prime, premium choice, low choice, select, and standard for NT, ST, and 2T calf carcasses were 1.61, 21.68, 51.00, 23.55, and 2.15; .90, 19.10, 44.65, 30.42, and 4.93; and .90, 14.56, 42.11, 33.15, and 9.29, respectively (P<0.02). Percent yield grade 1-2, 3, and 4-5 for NT, ST, and 2T calf carcasses were 56.95, 40.75, and 2.29; 67.71, 31.11, and 1.18; and 73.12, 26.54, and .34, respectively (P<0.01). Compared to NT calves, higher mortality rate, treatment cost, lower feedlot gain, and an increase in light weight carcasses for ST and 2T calves lowered per head return by 31.07,20.60, 24.49, and1.55; and 100.04,48.43, 35.71,1.58, respectively. Lower yield grade returned 2.90and4.59 more per head for ST and 2T calf carcasses, respectively, but lower quality grade for both groups decreased per head return by 10.39and19.41, respectively, compared to NT calf carcasses. Differences in the percent dark cutters accounted for .18$moreand$.58 less per head for ST and 2T calf carcasses, respectively, compared to NT calves. Given the cumulative effect of post-weaning disease, nontreated calves returned 85.02$morethanSTcalvesand$201.16 more than 2T calves. Post-weaning disease reduced dollars returned per head and multiple treatments magnified the effect.

Key Words: Health, Mortality, Quality grade

63 Effect of disposition on feedlot gain and quality grade. W. D. Busby*[1], P. Beedle[1], D. Strohbehn[1], L. R. Corah[2], and J. F. Stika[2], [1]*Iowa State University,* [2]*Certified Angus Beef LLC*.

A total of 13,315 calves fed at eight Iowa feedyards were used to evaluate the effect of disposition during the feedlot period on feedlot gain and carcass quality. The calves, representing 12 states, were consigned to the Iowa Tri-County Steer Carcass Futurity and were weighed upon arrival, after 35 days, at re-implant, and prior to harvest. A disposition score (Beef Improvement Federation six point scoring system - 1=very docile) was assigned at on test weighing, re-implant time, and pre-harvest. The six point system was condensed to three classifications for analysis - 1 and 2 = docile (n=9,642), 3 and 4 = restless (n=2,915), and 5 and 6 = aggressive (n=758). A common diet and health program was utilized at each feedlot. Calves were sorted and harvested when they were visually evaluated to have one centimeter of fat cover. Arrival weight (kg) and ADG (kg/day) were 286.6 and 1.44; 284.7 and 1.41; and 277.6 and 1.32 for docile, restless, and aggressive calves, respectively. Morbidity rate

for docile calves was significantly (P=0.001) higher (19.2%) than restless and aggressive calves (16.8% and 16.2%, respectively). However, mortality rate was higher (P=0.2) for aggressive calves (1.91%) than for docile and restless calves (1.09% and 1.02%, respectively). The percent prime, choice, select, and standard for docile, restless, and aggressive calf carcasses were 1.69, 72.45, 23.29, and 2.55; 1.17, 67.91, 27.49, and 3.43; and .13, 58.12, 36.2, and 5.55, respectively (P=0.01). Acceptance rates for black-hided Angus-type calves eligible for the *Certified Angus Beef* ® Program (CAB®) were 29.07, 22.83, and 14.3 (P<0.001) for docile, restless, and aggressive calves, respectively. When considering disposition effect on quality and yield grade, feedlot gain, death loss, and treatment costs, docile calves returned $62.19 more than aggressive calves. Calves with poor disposition were lighter upon arrival at the feedlot, gained less, had higher mortality rates, reduced quality grade, and reduced CAB® acceptance rates compared to docile calves.

Key Words: Disposition, Feedlot gain, Quality grade

64 Overview of the ethanol industry.

M. Gibson*, *Dakota Gold Research Association*.

Fuel ethanol has been used in the USA for over 100 years. The potable spirits industry has been around for much longer than that. Both industries produce by-products, mainly distillers grains, useful for feeding to livestock. The traditional markets for these feed products has been the ruminant sectors. However, the product originating from new-technology, dry-grind, fuel-ethanol plants is somewhat different than that from the potable distilleries. Further, the dramatic increase in fuel ethanol production, with a concurrent increase in distillers grains, is generating tremendous interest in the livestock feeding sectors. This is probably due to several factors: (1) a better understanding of the product from these new ethanol plants, (2) wider availability of product, and (3) a better understanding of how the product is used by animals. There is also an increasing acceptance of distillers grains in non-traditional feed markets. This paper will provide a brief overview of ethanol production, the current status of the fuel ethanol industry, and the feed products available from this industry.

Key Words: Ethanol, Distiller's grains

65 Ethanol industry coproducts: milling process, nutrient content, and variation.

P. H. Robinson*, *University of California at Davis*.

Distillers dried grains with solubles (DDGS) from corn grain is produced during ethanol distillation in a process which removes virtually all of the starch. Thus DDGS has approximately 3 times the nutrient levels of corn grain. The sharp increase in ethanol production in the Midwestern USA has dramatically increased production of DDGS, to as much as 4 million tonnes annually, most of which is being targeted at the dairy industry. DDGS has historically been recognized as a valuable feed for beef and dairy cattle, due to relatively high levels of fat and crude protein (CP) as well as its relatively low levels of neutral detergent fiber (NDF). It is also a source of several macro- and micro-minerals that are required by dairy cows. Due to variation in methods of production among and within distilling facilities, particularly relative to handling of distillers solubles and dehydration, DDGS has been known as a by-product feedstuff with wide variability in both its nutrient content and the digestibility of both its CP and NDF components. This has been considered to be detrimental to its economic value, since nutrient consistency among batches, in addition to high nutrient digestibility, increase the economic value of any animal feed. However many new distillation facilities have made efforts to make production of DDGS more consistent among and within facilities by introducing new equipment, standardizing production processes and treating DDGS as a co-product (rather than a by-product) of ethanol production. In a comparison of conventionally produced DDGS with a branded DDGS, the branded DDGS had lower variation in all measured organic and inorganic components, including estimated net energy for lactation (NEl), and levels of NDF, P and acid detergent soluble CP were lower in the branded product. Calculated NEl was 13% higher in the branded product. Based upon limited data, some new DDGS appear to have a higher overall nutritive value vs. old generation DDGS and, perhaps more importantly, the variability in the nutrient levels can be reduced. The combination of higher nutrient value and lower nutrient variability results in a higher economic value.

Key Words: Distillers, Variation, Nutrients

66 Using ethanol industry coproducts in diets for forage-fed cattle.

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Beef calves from weaning until they enter feedlots, developing heifers and beef cows are fed primarily forage diets. Especially in the winter, forages are low in protein and phosphorus and need to be supplemented. Further, the protein in forages is highly degraded in the rumen and the cattle may need to be supplemented with undegraded protein to meet metabolizable protein requirements. Distillers grains (wet or dry) is an excellent source of undegraded protein and phosphorus. The high escape protein value of distillers grains is due to the innate characteristics of the protein and not to drying or moisture content. Stocker calves, developing heifers and cows may need energy supplement in addition to supplemental protein and phosphorus. It is advantageous if the same commodity can be used for supplemental energy as well as protein. Experiments were conducted with calves fed grass hay and levels of distillers grains or corn. Apparent energy value of the distillers grains was 127% the energy value of dry rolled corn. Rate of in situ fiber digestion was lower (3.43% /h) when corn was supplemented than when distillers grains was supplemented (4.09%/h). Distillers grains contain little starch and therefore do not appear to depress fiber digestion as does corn. When distillers grains are fed as a supplement to low protein forage, degradable protein may be deficient while undegraded protein is in excess. Experiments showed no response to added urea suggesting N recycling is sufficient to meet degradable protein requirements of the rumen microorganisms. As forage prices increase, ethanol coproducts may be economical substitutes for grazed forages. Graded levels of distillers grains have been fed to calves consuming low- and high-quality forages and cool- and warm-season grass pastures. Increasing levels of distillers grains increase gain and decrease forage intake. The net effect is a high apparent economical value for distillers grains.

Key Words: Beef cattle, Forage, Distiller's grains

67 Using distillers grains in diets for growing and finishing beef cattle.

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Distillers grains can be fed wet (WDGS; 35 to 50% DM) or dry (DDGS; >88% DM) with or without solubles added. Dry milling plants produce either WDGS, DDGS, or combinations of both. Based on the current process of ethanol production from grains, fiber, protein, oil, and P concentrations are increased 300% in distillers grains compared to the original grain. Based on the average of 11 experiments, WDGS contains 130 (at 40% diet DM) to 157% (at 10% diet DM) of the energy value of corn. Generally, WDGS is fed at higher inclusions than DDGS as a source of both an energy and protein. Fewer data are available with DDGS, but DDGS is considered lower in energy than WDGS, generally fed at lower inclusion rates (<15% of diet DM), and fed primarily as a protein source. Both WDGS and DDGS are 28 to 34% CP and 65% UIP (% of CP). Despite the predominant source of protein as UIP, protein supply in diets containing more than 20% distillers grains is enough that no supplemental DIP (i.e., urea) is required. With increased supply of distillers grains in the future, more will need to be fed to beef cattle. Therefore, we evaluated the economic optimum inclusion rates in feedlot diets for WDGS. Based on cattle performance responses, the optimum inclusion rate is 40% if the feedlot is near a plant. Accounting for an increase in corn price, distance from the plant, increased cost of feeding, and inclusion rates, returns to cattle feeders are between $0.08 and $0.14 per steer per day above feeding corn alone assuming WDGS priced at 95% of corn price on a DM basis. The optimum inclusion rate for WDGS varies from 30% to 40% of diet DM depending on distance from plant. One challenge in the future will be managing higher dietary P and appropriately distributing the manure P, primarily because of improper distribution in the past. Distillers grains can reduce acidosis, improve performance, and improve cattle feeding economics when fed between 20 and 40% of diet DM. However, fewer data are available on feeding

DDGS to growing and finishing cattle, but it appears to have 125% the energy of corn in forage-based growing diets.

Key Words: Distillers grains, Feedlot cattle, Energy

68 Storage, ensiling, and handling wet ethanol coproducts.

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Wet distillers grains (WDG) are an excellent source of energy and protein for ruminants. Unfortunately, their average shelf life ranges from 6 to 10 days during the winter, and is reduced by half during the summer. Its use is thus limited to livestock producers that can feed large enough quantities within a short period of time to minimize spoilage. Organic acids added to WDG can extend its shelf life to several weeks depending on application rate. Alternatively, WDG can be ensiled, which results in high air exclusion, minimizing spoilage and dry matter losses. One advantage of WDG is that it comes from the processing plant with a pH between 3.1 and 3.5. Fermentation experiments of straight WDG (30% DM) showed little changes when preserved in silo bags for 14 days. Preservation of WDG is excellent if bagged immediately most likely due to its low initial pH rather than to fermentation (very little changes in pH and volatile fatty acids over time). This can be used advantageously by mixing WDG with other feeds, which results in an initial drop in the pH of the blend. Blending WDG with other feeds that contain fermentable carbohydrates has resulted in fermentation patterns that differ from the traditional lactic acid fermentation towards a more acetic one. Blends of WDG and corn silage ensiled on an as-fed basis in 50:50 and 75:25 corn silage to WDG ratios, resulted in increased acetic acid concentrations and improved aerobic stability versus corn silage alone. Another advantage of blending feedstuffs with WDG is that the larger particle size of the blend makes feed removal easier during the winter months when straight WDG will freeze.

Key Words: Insiling, Wet distiller's grains, Wet ethanol coproducts

69 Using ethanol industry co-products in dairy rations.

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There is a growing supply of ethanol industry co-products in the Midwest as new plants continue to come on line. This paper will focus on the use of dry and wet distillers grains in dairy rations. Variation in the nutrient composition of distillers grains and handling/storage considerations for wet distillers grains are topics of other presenters at this symposium. We will review and summarize the scientific literature regarding the use of distillers grains in dairy rations. The role that distillers grains play in the following areas of dairy cattle nutrition will be discussed: CP, RUP/RDP and amino acid supply, moderation of dietary NFC and starch, NDF, digestible NDF and physically-effective NDF contributions, supplemental fat, and phosphorus supply. The use potential for distillers grains in dairy rations as concentrate and forage substitutes will be explored along with limitations to inclusion amounts placed upon distillers grains by their lysine, fat, and phosphorus contents. Supplementation strategies to augment the use of distillers grains in dairy rations along with potential impacts on ration costs will be discussed.

Key Words: Distiller's grains, Dairy cows, Nutrition

Extension-Dairy

70 Increasing cow stayability in dairy herds.

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Longevity is critically important, but genetic selection for this trait is challenging. Trait definition, data collection, validation, and statistical analysis have many pitfalls. Challenges in trait definition are reflected by various names, such as longevity, survival, productive life, stayability, and herdlife. These are prefaced by true or functional, to differentiate voluntary and involuntary culling. Longevity is farmer-recorded and is susceptible to bias. Culling risk is influenced by many factors, such as availability of replacements, plans for expansion, competence of herdsmen, or milk quota restrictions. Data validation poses challenges, often due to limitations of the DHI system. Culling codes (sold for dairy, sold due to mastitis) lack specificity and flexibility. Primiparous cows culled before first test may not enter the system, and multiparous cows culled before first test may have errant culling dates. Statistical analysis is hampered by skewed distributions of survival times and high percentages of censoring. Time-dependent covariates must account for management changes within and between lactations. Factors such as disease exposure, facility modernization, and milk prices change often, and all affect risk of culling. Data should be analyzed using failure-time methodology to account for non-normality, censoring, and time-dependent covariates, so the instantaneous risk of culling for a cow can be calculated at any given time for any set of explanatory variables. Inference should be based on relative risks of culling for high, average, and low-producing cows within a herd. Optimal schemes yield low risk of involuntary culling among high-producers and high risk of voluntary culling among low-producers. If possible, selection for components of longevity, namely health and fertility, should augment or replace direct selection on culling data. On-farm recording of health disorders is common, and methods to validate and store such data across herds are needed. Traits such as pregnancy rate, body condition score, lameness, mastitis, and ketosis are measured early in life, and substantial genetic variation exists between sires for these traits.

Key Words: Longevity, Culling, Dairy

71 Nutritional impacts on culling.

M. Hutjens*, *University of Illinois*.

Feeding programs can impact culling and longevity. Six areas leading to increased culling can be investigated when designing and delivering a feeding program: transition cow feeding approaches, rumen acidosis, lameness, pregnancy status, mastitis, and death. Each area has various levels of economic importance with key management related factors that can minimize the impact. Michigan, Minnesota, and New York field studies using DHI data indicated 34, 26, and 29 percent, respectively, of all cows culled occurred in the initial 63 days after calving with no differences related to milk yield (rolling herd average) or parity. Dairy managers can measure the impact of feeding on longevity using benchmarks including dry matter intake, feed efficiency, level of metabolic disorders, culling rate, reasons for culling, and nutrients delivery by the feeding program. Dairy nutritionists have a tool box of feed additives that can be used to modify culling risk factors that can lead to premature culling (loss of milk yield and animal value) including rumen buffers, glucose precursors, non-esterified fatty acid (NEFA) lowering additives, rumen stabilizers, immunity enhancement additives, and hoof improvement additives. Effective feeding strategies can lower cull rates and extend productive life.

Key Words: Culling, Feeding, Dairy

72 Managing cows to minimize culling.

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Between 25 to 45 percent of the cows that are culled from dairy herds are culled in the first sixty days of lactation. Because early lactation should be the most profitable period of a cow's lactation, removal of cows in early lactation from either death or culling is an expensive proposition. The first goal of dairy management should be prevention of postpartum diseases and conditions that result in the removal of cows in early lactation. Nutritional management of cows through the transition period is an important component of promoting cow health in early lactation. In addition, mastitis control and vaccination programs can aid in the reduction of postpartum health problems. Since even with the best prevention programs, some cows in early lactation will develop postpartum diseases, the second goal of management should be to minimize death and culling losses associated with these diseases through the early identification and treatment of these conditions.. Intensive fresh cow monitoring programs through the first ten to fourteen days of lactation can aid in the early identification postpartum diseases. In conjunction with early identification of disease, appropriate treatment protocols need to be developed

which includes the selection of appropriate drugs, dose, and duration of treatment. Early identification can reduce secondary complications such as abomasal displacement, fatty liver and salmonellosis which are associated with reduced dry matter intake from the primary disease condition. An additional benefit that has been observed in herds following the implementation of programs for monitoring fresh cows has been an increase in peak milk production for the herd.

Key Words: Culling, Post partum disease

73 Timing of the culling event.

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Every cow is eventually culled. Thus, it is not a question of if a cow will be culled, but rather when she will be culled. Culling is primarily an economic risk management practice, moderated by existing economic conditions, both internal and external to the dairy operation, and further mitgated by risk tolerance and management capability of the dairy management team. The only exceptions to this would be loss due to death, theft, or cows that are simply too difficult to manage (eg. kickers). Knowledge of three factors is necessary to successfully manage culling: 1) how often does the event occur (rate), 2) when does the event occur (timing), and 3) why the event occurred at that time. The cow's life is a continuum from birth to death, divided into a growth and maturation process followed by a series of parturition/lactation events. Thus, the risk of cull is more than a simple function of increasing risk with increasing time because the initiation of each new lactation increases the risk of cull every time it occurs. Subsequent pregnancy reduces the likelihood of being culled. Internal and external, controllable and uncontrollable factors influence culling. An example of an uncontrollable risk is increased culling associated with age. An external uncontrollable factor is beef price. Many factors however are within management purview, such as mitigating disease incidence, changing risk tolerance, production level, reproductive performance, transition cow care, and herd long-term growth goals. High production and good reproductive performance both reduce the risk of being culled. Culling management is more complex than simply reducing herd turnover rate. There is an optimum time to cull a cow based on her productive, reproductive and health status and probability for future economic success. Culling too early limits profitability through the loss of the ability to recover costs of investment. Culling too late limits profitability because of lost opportunity to gain higher profits with a more profitable cow. Opportunity exists to better manage the timing of cull events, however there is no global optimum culling rate.

Key Words: Culling, Risk managment, Herd turnover

74 Trends in dairy heifer supply and culling rates in the US.

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Within dairy herds, culling rates are driven by many factors. Those factors include availability of replacement heifers, heifer prices, calving interval, milk price, cow and heifer mortality rate, conception rates, and a host of other factors. On a national or regional basis, heifer supply is a major factor affecting the rate at which cows are culled. Historical numbers of US milk cows and dairy replacement heifers weighing >227 kg were obtained from USDA since 1920 and by state since 1989. While cow numbers have declined from around 27.8 million in 1945 to about 9.1 million in 2003 (67% decline), dairy replacement heifers >227 kg declined only from 6.3 million to 4.1 million (24% decline) in the same time period. Proposed explanations for the vastly slower decline in heifer numbers include consistency of reporting, directed breeding for dairy (versus beef) offspring, and especially decreased mortality. Estimated culling rates based upon cow and heifer numbers increased over time from around 13% in the 1920s to around 33% in the decade ending in 2002. On a national basis, culling rates appear to be limited by heifer supply. The highest estimated annual culling rate of 38% occurred in 1986 and coincided with the national Dairy Buyout Program. As with milk cow numbers, heifer production appears to have moved from the Midwest to the West, though at a slower rate. During expansion of cow numbers, heifers are purchased from outside the state or region. Therefore, caution must be used when attempting to determine state or regional culling levels. Supply of dairy cows varied inversely with monthly ratio of milk price to feed price from 1995 to 2003 (Pearson correlation coefficient = -.5). Similarly, annual number of imported females varied proportionally with milk:feed price ratio (Pearson correlation coefficient = .63) prior to the closing of the Canadian border to live animal imports in 2003. However, relationships of numbers of cows or replacement heifers with milk:feed price ratio were not readily discernable on an annual basis.

Key Words: Culling rate, Heifer supply, Milk price

75 Silo-King® enhances the storage life and digestibility of wet distillers grains.

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Enhancing the storage life of wet corn distillers grains (WDG) would increase its value as a commodity. The nutritional quality of WDG can rapidly decline due to spoilage from mold and yeast growth. Silo-King® enhances the fermentation and storage of forages by enhancing lactic acid production which inhibits yeast and mold growth. The objective was to evaluate Silo-King® to enhance storage life and nutritional quality of WDG. Fresh commercially produced WDG was obtained, split into 4 lots, and subjected to 1 of 4 treatments. Treatments were untreated (C), Mold-X® applied at 907g (M), Silo-King® applied at 453.6g (SK-1) or Silo-King® applied at 907g (SK-2) per 907 kg of WDG. The experimental period was 21 days with measurements repeatedly collected on several days. Data were analyzed as repeated measurements. Storage temperatures (29.1, 13.9, 14.8, and 13.0 ^{O}C for C, M, SK-1, and SK-2, respectively) were significantly (P <.01) reduced for all treatments compared to C. Higher application rates of Silo-King® (SK-2 compared to SK-1) tended (P<.08) to result in lower storage temperatures. In vitro dry matter digestibility (55.7, 62.0, 63.2 and 63.9% DM) was improved with M, SK-1, and SK-2 compared to C. Lactic acid concentrations were highest for SK-2, which was similar to SK-1, but significantly greater (P<.05) than M or C. Acetic acid concentrations (1.41, .40, .38, and .38% DM) were greatest for the C compared to the other treatments. Mold counts (6.02, 4.24, 4.02, and 3.98 $\log_{10}$ CFU/g) and yeast counts (7.42, 5.88, 5.58, and 5.27 $\log_{10}$ CFU/g) were highest for C compared to other treatments. This study demonstrated the nutritional profile and quality of WDG if left untreated will deteriorate from yeast and mold growth in a short period of time. This deterioration of quality also reduces dry matter digestibility and nutrient supply to the animal. Treating WDG with Mold-X® or Silo-King® will extend the storage life and maintain the nutritional profile and quality of WDG, thereby increasing the value of WDG as a commodity for feeding livestock.

Key Words: Wet distiller's grains, Silo-King®, Storage life

76 Efficacy of on-farm pasteurized waste milk systems on dairy and custom calf rearing operations.

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The objective of this study was to evaluate the efficacy of on-farm milk pasteurizers in a commercial environment. Thirty-one on-farm pasteurizers were evaluated by collecting one sample each of raw (RWM) and pasteurized (PWM) waste milk from a daily pool. Waste milks were sampled from dairy or custom calf feeding operations using batch or continuous flow pasteurizers. Both RWM and PWM were analyzed for fat, protein, lactose, bacterial plate count, and SCC. Milk was plated, incubated and colony forming units/ml of *Salmonella sp, Coliform sp, Streptococcus sp, Staphylococcus sp*, and *Enterococcus sp*, determined. Presence of β-lactam and non β-lactam antibiotics and alkaline phosphatase (AP) activity were also determined. Mean fat content of RWM was higher (P<0.01) than PWM at 4.42 and 3.90 percent, respectively. Mean protein contents of RWM and PWM were similar at 3.25 percent. Fat (2.79-4.70), protein (2.89-5.10) and lactose (3.78-4.80) contents of PWM were highly variable between operations resulting in a wide range of metabolizable energy (4.75-6.61 Mcal/kg) contents in PWM. Four pasteurizers did not denature AP, indicating failure of pasteurization. Pasteurization significantly (P<0.001) reduced standard plate count and all bacterial populations in waste milk. Pasteurization had no effect (P = 1.0) on β-lactam and non β-lactam antibiotic residues in waste milk.

Milk from the same operation tested positive for β-lactam or non β-lactam residues in RWM and PWM, indicating pasteurization had no effect on antibiotic activity. We observed a 50.0% incidence of antibiotic residues in pasteurized waste milk. Further research is needed to determine what effect antibiotic residues have on calf nutrition. Based on these observations PWM should be routinely evaluated because nutritional and microbiological characteristics of PWM fed to calves can be extremely variable.

Key Words: Waste milk, Calves, Pasteurization

77 Using Ovsynch as a model to test the relationship between time of AI and time of ovulation in lactating dairy cows.

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Synchronization of ovulation (Ovsynch) technologies are reproductive management tools designed to improve pregnancy rates and labor efficiency. During the past 40 years, estrus detection and conception rates of lactating dairy cows have steadily declined. These trends are likely attributable to the tremendous physiologic changes related to increased milk production in the lactating dairy cow during this period since estrus detection and conception rates of heifers have remained relatively constant during this period. Ovsynch technologies allow for the opportunity to reverse the trends in estrus detection rate by commanding when cows receive first and subsequent artificial insemination (AI). Unfortunately, current Ovsynch technologies do not have the capabilities to improve fertility unless standard reproductive practices are sub par. One aspect of applied reproductive research at Michigan State University is currently focused on improving fertility of lactating dairy cows by gaining a greater understanding of the interaction between time of AI and time of ovulation in dairy cattle. Ovsynch, GnRH, 7 d later $PGF_{2\alpha}$, 48 h later GnRH, is the current model being used to test this interaction. Ovsynch allows for the regression of corpora lutea and the ovulation of a newly formed dominant follicle in approximately 87 % of treated cows. In previous work, time of ovulation ranged from 24 to 32 h following the final GnRH induced LH surge in cows that had luteal regression in response to the $PGF_{2\alpha}$. This allowed for the testing of AI at different intervals from this synchronous time of ovulation. In recent data, extending the time of AI prior to ovulation affected % pregnancies per AI, % of female calves born as a result of that AI, and pregnancy losses in cows that were inseminated to low fertility bulls. This paper will explore the relationship of timing of AI relative to ovulation and the potential to use Ovsynch as a model to gain a greater understanding of fertility problems of lactating dairy cows.

Key Words: Ovsynch, Fertility, Dairy cows

78 Response of heat stressed lactating dairy cattle fed dried seaweed meal.

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The objective of this study was to quantify the effects of feeding Tasco-14® seaweed meal on feed intake, milk production, milk component concentration, rectal temperature, rear udder surface temperature, and respiration rate of heat stressed lactating dairy cattle. Twenty-four Holstein cows were assigned to one of twelve blocks by lactation number, days in milk (DIM), and energy corrected milk production. Treatments consisted of total mixed ration (TMR) control diet or control diet with 56.7 g of Tasco-14® seaweed meal per cow daily as a top-dressing. Data were collected for five weeks following a 7-day adjustment period during which 113.4 g/cow daily of seaweed meal was fed to treated cows. There was no significant difference in feed intake ($P > 0.05$); however, milk production was greater (($P < 0.01$) for cows receiving seaweed meal (33.5 versus 35.3 kg/cow daily for control and seaweed diets, respectively). Milk fat and milk protein percentages and milk fat production was similar (($P > 0.05$). Milk protein yield was greater (($P < 0.01$) for treated cows (1.11 kg/cow daily) as compared to controls (1.02 kg/cow daily). Respiration rates were similar (($P > 0.05$) across treatments as well as rectal and rear udder surface temperature (($P > 0.05$). The increase in milk protein yield resulted from greater milk production and a trend for higher milk protein percent for cows receiving Tasco-14® seaweed meal. Since feed intakes were similar, increased milk production likely resulted from an increase in lactation efficiency for treated over control animals. Previous studies reported a reduction in respiration rates and body temperature during heat stress for animal receiving seaweed meal. In this study, the addition of brown seaweed to diet did not reduce the normal heat stress responses typically observed in dairy cattle. Additional research is needed to specify the factors responsible for the observed increase in milk and milk protein yield.
Research support provided by Acadian Agritech, Nova Scotia, Canada

Key Words: Heat stress abatement, Milk production, Feed additive

79 Somatic cell count, yield and chemical composition of milk from cross-bred cows.

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Six hundred pooled milk samples were collected from cross- bred cows belonging to Livestock farm and Field progeny testing units of Kerala Agricultural University, India. The data on milk yield, age, parity and stage of lactation of these cows were also recorded. The milk samples were subjected to analysis of somatic cell count (MF-DNA method) as well as percentages of fat (Gerber), total solids (TS-Gravimetric), solids-not-fat (SNF), protein (Dye binding), lactose (Feitosa-Teles) and chloride (Titrimetric method). The correlations between somatic cell count and individual chemical components of milk were analysed by comparing means of observations (ANOVA). Data were grouped into different classes based on milk yield, fat per cent and SNF per cent and correlations were tested within groups. The association between the milk-yield of the cows and somatic cell count was also analyzed. Lactose per cent in milk was negatively correlated with somatic cell count (P#88040.05). TS and SNF per cent of milk had a negative correlation with somatic cell count in samples with fat per cent between 3.5 and 4.5 (P#88040.05) or SNF per cent between 8.5 and 8.99 (P#88040.05). Above groups of samples constituted a major share of total samples collected. Chloride content of milk had no significant correlation with somatic cell count. Somatic cell count had a negative correlation with milk yield of cows in all groups (P#88040.05). The results suggest that low lactose level in milk may indicate high somatic cell count in milk. Key words- milk-somatic cell count- lactose
Authors acknowledge the facilities provided by Dean, College Veterinary & Animal Sciences Mannuthy for this research project.

Key Words: Milk, Somatic cell count, Lactose

80 Dietary supplements for prevention of fatty liver and ketosis.

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Studies have been conducted evaluating feed additives for prevention of ketosis in transition dairy cows. Glycerol, a coproduct from production of biodiesel, is an effective treatment for ketosis when drenched; however, diets containing up to 1L of glycerol fed to dairy cows from 3 wk pre- to 3 wk postpartum failed to have a positive impact on blood glucose. To understand this, high-producing dairy cows were administered glycerol via drench, esophageal tube, or feeding. Results indicate that if the glycerol is associated with feeding, it is fermented to butyrate within the rumen and metabolized to betahydroxybutyric acid (**BHBA**) during absorption. Likewise, feeding liquid whey has been shown to increase ruminal butyrate concentrations. To understand the impact of BHBA production from ruminal fermentation of lactose in whey, mid-lactation dairy cows were fed increasing quantities of lactose and whey. Because BHBA synthesis was found to occur at a modest rate, transition dairy cows were fed lactose at 15% of diet DM. Concentrations of ruminal butyrate and blood BHBA were increased in the cows fed lactose, but blood glucose concentrations were not affected. Liver lipid concentrations were decreased and milk production during the first 70 d of lactation was increased by feeding lactose. Lastly, feeding propionate has been demonstrated to aid in prevention of ketosis in dairy cows. It has been hypothesized that, if fed in combination with dietary fat, this effect may be enhanced through synergistic pathways for glucose synthesis and fatty acid oxidation. We determined that when propionate is added to diets containing supplemental fat, prepartum feed intake depression is prevented and carbohydrate status is improved. A second experiment demonstrated that when fat (200 g/d) is added to diets containing propionate (230 g/d), concentrations of nonesterified fatty acids in blood are decreased and energy status is improved. Diets that favor modestly enhanced rates of ruminal fermentation and corresponding increases in post-ruminal delivery of energy-containing substrates improve the carbohydrate status of the transition dairy cow.

Key Words: ketones, glucose, transition dairy cow

81 Review of factors influencing sow longevity. K. Stalder*, T. Serenius, M. Knauer, B. Mote, T. Baas, and J. Mabry, *Iowa State University*.

Poor sow longevity in commercial pork production systems can result in a sow remaining in the herd for an insufficient length of time for producers to recoup the investment they have made in its' production or purchase. Poor longevity can also result in welfare concerns by the general public. Improving sow longevity would improve a pork producers profitability by reducing replacement gilt expenses and associated development, isolation, and acclimation costs. Additionally, an older sow herd can confer improved disease resistance to their offspring and hence, improve the health status, performance, and associated economic benefit of finishing animals. The literature and commercial industry suggest that young sows typically leave the breeding herd primarily because of reproductive failure and feet and leg problems. As sows get older (greater than parity 3), they are primarily removed from the breeding herd because of poor productivity relative to the rest of the breeding herd and old age. Numerous factors may contribute to sow longevity challenges swine herds; for example, gilt development, feed and water, performance levels, seasonal effects, health, housing effects, genetic factors particularly pertaining to reproduction and feet and leg problems, management skills, and sow behavior. The factors having a negative influence on the length of time a sow remains productive in a commercial swine breeding operation can do so individually or in conjunction with one or more factors. Many of these factors are environmental and / or management related. Much of the research relating the affect of various factors to improved sow longevity is dated. Additional research is needed with modern commercial maternal lines that will investigate everything from identifying individual genes to management, gilt development, nutrition, and a whole host of factors that contribute to improved sow longevity. Once factors influencing sow longevity are identified, intense management and genetic improvement of these factors can occur.

Key Words: Sow Longevity, Lifetime Productivity, Swine

82 Sow longevity: Culling decisions based on economics or welfare? A. Johnson*, *National Pork Board*.

The Pork Checkoff has recognized through its research initiatives and programatic endeavors that sow longevity continues to be a challenge in U.S. commercial swine herds. At least two distinct categories can be identified that may result in a sow being culled from the herd. The first is sow economical longevity (SEL) decisions; the second is sow welfare longevity (SWL) decisions. Although this paper will focus on SWL, an example will be provided which compares the difference between SEL and SWL. A sow that is healthy and has good welfare but who can not provide an economical return on investment through PPSPY will be culled by a producer using an SEL decision. In regards to SWL, few studies have comprehensively tackled producer decisions for culling over multiple parities and across different gestation systems. Some research has focused on SWL factors which may result in culling, for example detrimental behaviors, overall sow health, feet and leg problems, injury levels and locomotion disorders. To complicate the categories further, some SWL factors may result in the final culling decision to be classified under SEL. An example could be extensive postural adjustments in the farrowing phase that results in unacceptable preweaning mortality. The sow may be healthy, with great structural soundness but her inability wean a high number of PPSPY after two successive parities will decrease her overall return on investment and she may be culled through an SEL decision. The industry has been funding projects (Bates, 2002; Rodriguez-Zas, 2002; Hill, 2003; Curtis, 2004; Stalder, 2004) to address SWL however, future funding endeavors should strive to encompass multiple funding sources, to utilize a multi disciplinary team that can collaborate with the industry. By comparing, at the same time, different housing systems across multiple parities a comprehensive data base for both SWL and SEL factors could be constructed. This could provide an invaluable tool for producers, humane groups and policy makers to build a comprehensive sow longevity program based on science to improve her retention time within the herd and increase her overall return on investment.

Key Words: Housing, Longevity, Welfare

83 Genetics of sow longevity. T. Serenius* and K. J. Stalder, *Iowa State University*.

Sow longevity plays an important role in economically efficient piglet production, as sow longevity is related to the number of piglets produced during her productive lifetime. However, selection for sow longevity is not commonly practiced in any pig breeding program. That is probably due to lack of knowledge about the genetic parameters (genetic variation, genetic correlations), or methods available for breeding value estimation. This paper summarizes the current knowledge about the genetics of sow longevity and discusses available methods in breeding value estimation. Literature studies clearly point out that sow longevity is a complex trait and that even the definition of sow longevity is unclear. In general, the measures and analyses of sow longevity can be divided to (i) continuous traits (e.g. productive lifetime) analyzed with proportional hazard models and (ii) more simple binary traits like stayability until fixed parity. However, most of the studies have concluded that there exist enough genetic variation to select for sow longevity, as the reported heritability estimates have ranged between 0.02 and 0.25. Moreover, sow longevity has been shown to be genetically associated with prolificacy and leg conformation traits. These mixed findings have led to a lack of consensus among swine breeders concerning the validity of methodologies for estimating breeding values for longevity traits. One can not deny the superiority of survival analysis in the modeling approach of longevity data. However, multiple trait analyses are not possible using currently available survival analysis software, whereas less sophisticated approaches can utilize the genetic associations between sow longevity and other traits. Additional research is needed to identify the most efficient methods to select for sow longevity. The future research needs to concentrate on multiple trait analysis of sow longevity traits. Moreover, as longevity is a fitness trait, the non-additive genetic effects (e.g. dominance) may have an important role in the inheritance of sow longevity. Currently, not a single estimate for dominance variance of sow longevity could be identified from the literature.

Key Words: Survival analysis, Swine

84 Needs assessment identifying educational opportunities in the show pig industry: A survey of packers. J. A. Sterle* and C. T. Boleman, *Texas A&M University*.

Each year, about one million show pigs are exhibited at county/state fairs and major livestock shows in the United States. It is estimated an additional one million pigs are raised as show pigs, not exhibited for various reasons, but still enter the food chain. These animals account for approximately 2% of the national supply. Market access is increasingly difficult, due in part to packer consolidation as well as decreased acceptability by packers for some of these animals. A census study was designed to identify packer concerns with pigs raised by youth for exhibition in order to develop educational programs addressing these concerns. Thirteen (65%) of twenty swine packing companies responded. Slaughter capacity of respondents ranged from less than 250 to over 10,000 hd/d. Twelve production concerns were asked using a Likert scale defined as 1 = *None*, 2 = *A Little*, 3 = *Quite a Bit*, 4 = *High*. The top five packer concerns were: Use of feed additives ($mean$ = 3.00, SD = 1.23); color of hair ($mean$ = 2.92, SD = 0.95); fatigued animals and downers ($mean$ = 3.92, SD = 0.95); residues ($mean$ = 2.77, SD = 1.42); and belly thickness (too thin) ($mean$ = 2.64, SD = 1.03). One open ended question asked respondents to identify ways to improve acceptability of show pigs by exhibitors or show management. Responses were placed into themes using qualitative analysis techniques. Themes included: feed additives and medication use, continued education/cooperation with fair management, accountability (workload to process paperwork of individual owners), handling at fairs and shows, ultra lean pigs, hair clipping/show oils, stress gene, and consistent supply of pigs. These survey results provide an opportunity for increased communication between packers, breeders, youth exhibitors and show management. Educational curricula, science-based articles and extension guide sheets will be developed for youth exhibitors, volunteers, and show officials, anticipating changes in knowledge and management practices, possibly increasing acceptability of these pigs by the packing industry.

Key Words: Swine, Meat quality, Stress

85 Effect of piglet birth weight and weaning weight on nursery off-test weight. A. L. Smith*, T. V. Serenius, K. J. Stalder, T. J. Baas, and J. W. Mabry, *Iowa State University, Ames*.

The objective of this study was to evaluate the effect of piglet birth weight and weaning weight on nursery off-test weight and to evaluate linearity of these relationships. Data were from Danbred maternal line pigs from a commercial farrow-finish operation. Both barrows and gilts from 175 purebred Landrace sows made up the population (n=1,438) for this study. Pigs were phase-fed four diets that were 23.0% CP, 20.2% CP, 17.7% CP, and 18.0 % CP, respectively. All statistical analyses were conducted using the PROC MIXED procedure of SAS. Individual piglet birth weights and weaning weights were partitioned into nine categories scaled by one-half SD (0.32 kg for birth weight and 1.35 for weaning weight). Fixed effects of birth weight (or weaning weight) category and parity, and linear, quadratic, and cubic regressions of weaning age were included in the all statistical models for weaning weight. The linear regression of nursery off test age was included in the statistical model for off-test weight and significant quadratic and cubic covariates of weaning age were included in the model for weaning weight. Birth weight category was a significant source of variation in the analyses of weaning and off-test nursery weights (P<.0001). Without exception, weaning weights significantly (P<0.05) increased with increasing birth weight category, and nursery off-test weights significantly (P<0.05) increased with increasing birth weight category. Similarly, nursery off-test weights significantly (P<0.05) increased with increasing weaning weight category. However, weaning weight is a better predictor of nursery off-test weight, as the effect of one-half SD of weaning weight on nursery off-test weight is greater when compared to the effect of one-half SD of birth weight. The relationship of birth and weaning weight categories appear to be linearly related to pig weight at the end of the nursery phase of production.

Key Words: Weaning weight, Birth weight, Swine

86 Implementation of recommendations made to livestock producers from a third-party site assessment. R. Mikesell* and K. Kephart, *Penn State University*.

We reported previously on an extension program designed to assess the potential for odor related complaints arising from the operation of proposed swine facilities. Each assessment included a detailed letter describing the site and surroundings along with suggestions for reducing odor risk. The purpose of the present study was to survey individuals (n=58) who participated in the program in 2000-2003, which included swine and poultry evaluations, and quantify their implementation of the recommendations provided in the respective site evaluation letters. The respondents (n=29) who returned surveys were considering the construction of facilities for swine finishing (n=21), farrow to wean (n=2), broilers (n=3), and boars (n=3). Eight of the individuals had constructed their facility, two had abandoned the project as a result of the assessment, eight had abandoned the project for other reasons, and 11 were still pursuing the construction or permit process. Eleven individuals had presented the site assessment letter to the township or other government entity. Of these, six felt that the letter helped to secure a building permit. Nineteen of the 29 respondents felt that the value of the site assessment program was high or very high. Twenty-two of the respondents believed the program enhanced the image of the livestock industry. Collectively, a total of 20 recommendations were made to the 8 participants who had constructed their facilities. The predominant recommendations included one or more of the following: 1) changing the location or orientation of the building; 2) exhaust fan biofiltration; 3) incorporation or injection of manure; 4) planting vegetation around the facility; 5) reducing the size of the facility. Of the 20 recommendations made, eight were implemented, seven were expected to be implemented in the future, and five were not going to be implemented. We conclude that site assessment participants valued the program and that a majority followed, or planned to follow recommendations.

Key Words: Odor, Evaluation, Swine

87 Evaluation of a method to analyze pig live weight data from animal sorting technologies. A. Schinckel*, M. Einstein, and D. Miller, *Purdue University*.

A method to analyze pig BW data collected by an animal sorting technology scale without individual pig identification was evaluated. Data for ten 1000-pig grow-finish barns were simulated by a stochastic model. The BW at each age was modeled as a predicted BW plus a daily residual error (mean=0 and SD=1.4kg) and a within day residual error (mean=0 and SD=0.98kg). The number of times each pig was weighed was simulated to vary amongst pigs and daily for each pig. Two data sets were simulated. A complete data set had biweekly data from 70 to 196 d of age. A truncated data set was simulated to reflect typical serial marketing of pigs and included biweekly data from 70 to 154 d of age and weekly truncated data from 161 to 175 d of age. The percentile means of the BW data were calculated and assigned a percentile identification of 1 to 100. The percentile means were fit to a mixed model nonlinear function (Bridges) with two random effects predicted for each percentile. Four BW variables were evaluated: (1) the actual BW data for individual pigs, (2) the actual percentile mean BW data, (3) the predicted BW data for each percentile using the complete biweekly data set and (4) the predicted BW data for each percentile using the truncated data set. The means and SDs of the individual BWs and percentile mean BWs were within 0.07 and 0.18kg of each other, respectively. The fitting of the percentile mean BW data to mixed nonlinear equations reproduced the mean and SD for predicted age to achieve 120 kg BW within 0.23 d of the individual BW data. The serial marketing of pigs may produce small biases (0.13 kg) which causes over prediction of actual mean BW at each age. The fitting of the mean percentile data can be used to model the underlying mean and variation of BW growth and potentially forecast future marketing dates.

Key Words: Mixed effects model, Nonlinear growth functions, Swine growth

88 A comparison of six maternal genetic lines for sow longevity. T. Serenius*[1], K. J. Stalder[1], T. J. Baas[1], J. W. Mabry[1], and R. N. Goodwin[2], [1]*Iowa State University,* [2]*National Pork Board*.

Data from the National Pork Producers Council Maternal Line National Genetic Evaluation Program were used to compare the sow longevity of six different genetic lines, and to estimate the associations of gilt backfat thickness, age at first farrowing, litter size at first farrowing, litter weight at first farrowing, average feed intake during lactation, and average backfat loss during lactation on sow longevity. The lines evaluated were American Diamond Genetics, Danbred North America, Dekalb-Monsanto DK44, Dekalb-Monsanto GPK347, Newsham Hybrids, and National Swine Registry. In the trial, no culling due to poor production was allowed until a sow had reached her fourth parity. First, the analyses were carried out by utilizing the information from all the sows (n = 3567), and then following productive lifetime until fourth (55% censored) or sixth parity (17% censored). Next, the gilts never farrowing were removed from the data, and the same approach was completed for the sows that farrowed at least once (n = 2549). All the analyses were based on nonparametric proportional hazard (Cox model). The results showed that the sows of Dekalb-Monsanto GPK347 had a clearly lower risk of being culled than the sows of other five lines. For example 78% of the Dekalb-Monsanto GPK347 sows reached their fourth parity, whereas the corresponding percentage averaged over the five other lines was 66%. Moreover, the shape of the survival distribution function of Delkab-Monsanto GPK347 is clearly different than the other five lines. There were high culling rates due to reproductive failure after first weaning in the sows of the five other lines, whereas such increased culling rate did not exist in the Dekalb-Monsanto GPK347 line. The results showed further that sows with poor feed intake and greater backfat loss during lactation had the shortest productive lifetime. As a conclusion, the between line differences indicate that it is possible to select for sow longevity. More research is needed to show the most efficient methods to select for sow longevity.

Key Words: Longevity, Sow, Survival analysis

89 Effects of dried distillers grains on heifer consumption of low or high quality forage. S. Morris*, T. Klopfenstein, and D. Adams, *University of Nebraska-Lincoln*.

Ninety heifer calves (BW = 286 ± 1.71 kg) were used in a 2 x 5 factorial to determine effects of increasing levels of dried distillers grains plus solubles (DDGS) on forage intake and ADG. Heifers were individually fed using Calan electronic gates for 84 days, and were fed ad libitum diets of either a 60% alfalfa hay and 40% sorghum silage mix (66% TDN), simulating a high quality forage (HQF), or smooth brome grass hay (48% TDN), simulating a low quality forage (LQF). Diets were supplemented with one of five levels of DDGS (0, 0.68, 1.36, 2.04, or 2.72 kg DM DDGS). Heifers were limit fed five days before and at the end of the 84 day experiment and weights were recorded for three consecutive days. Orts were collected once weekly. Total forage dry matter intakes were determined by dry matter offered minus orts, with the assumption that all DDGS were consumed. Average daily gain was significantly different ($P < 0.001$) between forage diets, and increased linearly ($P < 0.001$) within each diet as level of DDGS increased. The rate of increase was greater for the LQF diet (0.265 kg per kg DDGS) than the HQF diet (0.203 kg per kg DDGS). Forage intakes were significantly ($P < 0.001$) different between forage sources; heifers receiving no supplemental DDGS consumed 5.95 kg and 3.96 kg on the HQF and LQF diets, respectively. Forage intake linearly ($P < 0.001$) decreased for both forage diets as level of DDGS increased. Forage intake and ADG were regressed on DDGS intake and regression equations were determined as follows, for ADG: HQF y = 0.2026x + 0.638 ($R^2 = 0.9236$), and LQF y = 0.265x + 0.1894 ($R^2 = 0.8866$), for forage intake: HQF y = -0.5312x + 5.8349 ($R^2 = 0.9709$), and LQF y = -0.3272x + 4.1534 ($R^2 = 0.811$). Dried distillers grains appear to be a viable supplement to cattle on forage based diets, resulting in increased animal performance and decreased forage intakes. Forage intakes can be predicted for cattle on either high or low quality forage diets supplemented with up to 2.72 kg DM DDGS.

Key Words: Dried distiller's grains, Forage, Intake

90 Effect of melengestrol acetate (MGA) as an alternative to induce molting on egg quality. J. M. Koch*[1], J. S. Moritz[1], D. C. Lay Jr.[2], and M. E. Wilson[1], [1]*West Virginia University,* [2]*USDA-ARS LBRU*.

Inducing hens to molt increases egg quality, egg production and extends the productive life of the hens. Molting is normally accomplished by feed withdrawal, which has received criticism, and alternatives described thus far have resulted in poor post-molt performance. Previous studies have shown that MGA at a dosage of 4 or 8 mg/day, when incorporated into a balanced layer diet, leads to reversible regression of the reproductive tract. However, this alternative must also result in an increase in egg quality post-molt to be considered an adequate method by the industry. Hy-Line W-36 (n=72) laying hens at 67 weeks of age were randomly assigned to receive either a diet containing 0 mg MGA (control) throughout the experiment, or 4 or 8 mg MGA/ day for 2, 4 or 6 weeks. Eggs were collected daily to determine percent lay throughout the experiment. Upon reaching 50 and 70 percent lay, following removal of MGA, eggs were collected for four days and measurements of egg quality, including haugh units (i.e., internal egg quality), as well as shell thickness and breaking strength (i.e., measures of external egg quality) were determined. Egg quality measured by haugh units was greater ($p< .05$) for those eggs laid by hens molted with a diet containing 8 mg of MGA for four or six weeks compared to controls (81.2 ± .7 vs. 78.4 ± .5). Following MGA induced molt, shell thickness was greater ($p< .05$) when hens were treated with 4 mg for six weeks and 8 mg MGA for four and six weeks compared to control (.341 ± .004, .334 ± .005, .358 ± .004 vs. .320 ± .002 mm). Egg breaking strength was greater ($p< .05$) than controls for all hens fed MGA regardless of dosage or duration of feeding (4.48± .06 vs. 3.88 ± .04 kg). When utilized as an alterative method to induce molt, MGA leads to an increase in both the internal (i.e., haugh units) and external (i.e., shell thickness and breaking strength) egg quality compared to non-molted hens.

Key Words: MGA, Molting, Egg quality

91 Impact of feeding distiller's grains on beef tenderness and sensory traits. D. L. Roeber, R. K. Gill*, and A. DiCostanzo, *University of Minnesota*.

Knowledge regarding quality and sensory traits of beef from cattle fed distiller's grains (DG) is limited. This study was designed to evaluate effects of feeding DG on color, tenderness, and sensory traits of Holstein steers. This study complements studies conducted at the Univ. of Illinois (Exp. 1) and Iowa State Univ. (Exp. 2) to evaluate feeding wet (WDG) or dry (DDG) DG on feedlot performance. From Exp. 1, treatments were whole corn-corn silage diets supplemented with soybean meal (Control), 12.5% DDG plus urea, 25% or 50% DDG or WDG (DM basis). From Exp. 2, treatments were cracked corn-corn silage-hay diets supplemented with soybean meal (SBM Control) or urea (Urea Control), 10%, 20% or 40% DDG or WDG (DM basis). Within study, one strip loin (n=16/treatment; 45.7% and 66.6% of steers in Exp. 1 and 2, respectively) from each of four steers in each of four replicate pens (pen=experimental unit) per treatment were aged for 13 d at 21°C for color, tenderness, and palatability evaluation. Color of steaks was measured objectively (HunterLab Miniscan XE spectrophotometer) and subjectively (trained panel). Tenderness was measured using the Warner-Bratzler shear force on steaks cooked to 70°C. Consumers (n=95) were recruited to evaluate sensory traits on cooked steaks. Panelists evaluated 14 steak samples using a 9-point, hedonic scale where 1 = dislike extremely and 9 = like extremely. In Exp.1, steaks from steers fed 25% WDG had higher $a*$ values ($P < 0.05$) after 138 h than all other treatments except from those steers fed 12.5% DDG. In Exp. 2, a greater ($P < 0.05$) percentage of steaks from steers fed 40% DDG and 40% WDG were moderately unacceptable. No differences ($P > 0.05$) were observed in average shear force values (Exp. 1 and 2 were 1.60 ± 1.35 kg and 1.60 ± 1.33 kg, respectively) or taste panel attributes (5.7 ± 2.1, 6.0 ± 1.9, and 5.6 ± 2.1 in Exp. 1, and 6.2 ± 2.1, 6.2 ± 1.8, and 5.8 ± 2.0 in Exp. 2 for tenderness, flavor, and juiciness, respectively). Feeding DG at up to 50% of the diet DM did not affect tenderness or palatability, therefore, DG may be a viable feed alternative.

Key Words: Beef, Distiller's grains, Palatability

92 Developmental potential of porcine nuclear transfer embryos using non-differentiated donor cells. K. Lee*[1], W. L. Fodor[2], and Z. Machaty[1], [1]*Purdue University,* [2]*University of Connecticut*.

Nuclear transfer has been successfully used in a number of farm animal species. However, the efficiency of the technology is very low; the majority of cloned embryos do not survive the pre-implantation stage. Inadequate reprogramming is believed to be the primary reason for this poor development. It has been reported that development after nuclear transfer can be improved if less differentiated cells are used as nuclear donors. In the present study we investigated the developmental potential of early embryos reconstructed using olfactory ensheathing cells (OECs). OECs are located in the olfactory bulb and thought to have remarkable developmental plasticity. They were isolated from pig fetuses; fetal fibroblast cells that are known as fully differentiated cells were used as controls. Two differentiation-related markers were utilized to characterize the cell types. Lamin A/C is expressed in differentiated cell types only, while Oct-4 is a marker for non-differentiated cells. The presence of these markers was analyzed by immunocytochemistry. We found that OECs lacked lamin A/C antigen and showed Oct-4 expression, while fetal fibroblast cells showed the presence of lamin A/C and lacked the Oct-4 protein. The cells were then transferred into enucleated porcine oocytes. A total of 205 embryos were constructed using OECs and 188 embryos from fibroblast cells. In the group of embryos that derived from OECs, 56.6% cleaved, 42.9% reached 4-cell and 22.4% reached the 8-cell stage. During subsequent culture, 8.3% developed to the morula stage and 1.9% of them formed blastocysts. In the control group 36.7% cleaved, 23.4% reached the 4-cell, and 11.2% developed to the 8-cell stage. The morula and blastocyst formation rate was 3.72% and 1.1%, respectively. The developmental rate up to the 8-cell stage was significantly higher in embryos reconstructed using OECs ($p<0.005$); however, after the 8-cell stage the difference was not significant. The results demonstrate that OECs can successfully be used to produce pig embryos by nuclear transfer. Further experiments are needed to determine the potential for term developmental of the nuclear transfer embryos.

93 The relationship between mitochondrial function and feed efficiency in crossbred Angus steers.

W. H. Kolath*, M. S. Kerley, and J. W. Golden, *University of Missouri-Columbia*.

The objective of this study was to examine the relationship between mitochondrial function and feed efficiency (FE). Crossbreed Angus steers (n=40) had their individual feed intakes recorded via the Growsafe® feed intake system over a four-month period. Intakes were used to calculate residual feed intake (RFI), a measure of efficiency. Tissue samples were taken from the longissimus lumborum muscle from both the high (RFI -0.83; n = 9) and low (RFI +0.78; n = 8) FE animals. Mitochondria were isolated for measurement of oxygen consumption and hydrogen peroxide production. Both groups gained at the same rate throughout the experiment however the low FE animals consumed 1541.6 g more feed day-1 ($P < 0.0001$). High FE steers exhibited a higher respiratory control ratio and hydrogen peroxide production when provided with glutamate or succinate than low FE steers ($P < 0.05$). Acceptor control ratios (ACR) and ADP:O ratios were not different for either substrate ($P > 0.05$). However when oxygen consumption is expressed as a ratio to hydrogen peroxide production there was no difference ($P > 0.05$) between groups signifying that electron leak is not greater in either group. It appears that mitochondrial function is not reduced in low FE steers but rather the flux of substrates through the TCA cycle and ETC may be impaired in low FE steers.

Key Words: Mitochondria, Feed efficiency, RFI

94 Endocrine and follicular dynamics in beef heifers divergently selected for peripheral IGF-I concentrations.

D. Dauch*, K. Fike, M. Mussard, G. Bridges, C. Gasser, D. Grum, M. Davis, and M. Day, *The Ohio State University*.

The objective of this experiment was to compare estradiol concentrations and ovarian follicular dynamics prior to ovulation and subsequent luteal progesterone concentrations between genetic lines of beef heifers divergently selected for peripheral concentrations of insulin-like growth factor-I (IGF-I). Angus heifers, selected for high (n=7) or low (n=7) IGF-I concentrations, were synchronized to a common day of the estrous cycle (day of estrus = d 0). On d 6 all ovarian follicles were aspirated. All heifers received $PGF_{2\alpha}$ (25 mg) on d 11. From d 7 until ovulation, ovaries were examined by daily ultrasonography to characterize follicular growth and determine the day of ovulation. Blood samples were collected every 6 h from d 6 to 8.5 and every 12 h from d 8.5 to ovulation to quantify concentrations of estradiol (E). From ovulation to d 28, blood samples were taken daily to measure concentrations of progesterone (P). Data were analyzed with the MIXED procedure of SAS, accounting for repeated measures when appropriate. The day of ovulation (d 15.2 ± 0.3) did not differ between lines. Across day of the experiment, diameter of the largest follicle and concentrations of E and P did not differ between lines. When data were standardized to the day of ovulation, interactions of line x day relative to ovulation were detected ($P < 0.05$) for diameter of the largest follicle leading to ovulation and concentrations of P subsequent to ovulation. Diameter of the largest follicle was greater ($P < 0.05$) in the low than the high IGF-I line on d 5 and 6 prior to ovulation. Concentrations of P were greater ($P < 0.05$) in the high than the low IGF-I line, 13 d following ovulation. In heifers divergently selected for high or low IGF-I, diameter of the largest follicle 5 and 6 d prior to ovulation and concentrations of progesterone during the mid-luteal phase differed between lines. The physiological significance of these variations in follicular and endocrine characteristics is currently unknown.

Key Words: Cattle, IGF-I, Estrous cycle

95 Effects of a high fiber diet and frequent feeding on the behavior, reproductive performance, and nutrient balance of gestating sows.

J. Holt*, L. Johnston, S. Baidoo, and G. Shurson, *University of Minnesota*.

Mixed parity sows (n = 239) were studied to determine the effects of diet (corn-soybean meal, CON or corn-soybean meal-40% soybean hulls, FIBER) and feeding frequency (once, 1X vs twice, 2X daily) on the welfare and performance of gestating sows. Daily feed allowance (CON, 2.03 vs FIBER, 2.42 kg) attempted to provide equal ME intake between dietary treatments. Sows fed 1X received their entire meal at 0730 h while sows fed 2X received one half their feed at 0730 h and half at 1430 h. Sow weight and backfat depth were measured five times during gestation and lactation. Percentage of time engaged in specific postures and activities was observed for 67 focal sows on d 1, 40, and 80 of gestation. Saliva samples were collected from focal sows to determine cortisol concentration. Energy and nitrogen balance was determined for 36 sows. No interactions ($P > .05$) between main effects were observed. Sows fed FIBER spent more time standing and less time lying ($P < .05$) than sows fed CON throughout 24 h on d 40 and 80. Around mealtimes, FIBER sows spent more time feeding ($P < .05$) than sows fed CON (d 40: 17.2 vs 13.3%; d 80: 18.1 vs 13.2%, respectively). Percentage of time involved in stereotypic behaviors around mealtimes ranged from 34.0 to 61.8% and was not affected by diet. Neither diet nor feeding frequency affected salivary cortisol concentration. FIBER sows gained less body weight (14.3 vs 19.1 kg) and lost more backfat (1.8 vs .5 mm; $P < .05$) during gestation than CON sows. During gestation, 1X sows gained less body weight (12.3 vs 21.1 kg) and lost more backfat (1.5 vs .7 mm; $P < .05$) than 2X sows. FIBER sows farrowed fewer pigs per litter than CON sows (10.8 vs 11.7; $P < .05$). Sows fed FIBER had a lower dry matter digestibility and had reduced nitrogen retention and ME compared to sows fed CON. Soybean hulls depressed reproductive performance and did not enhance welfare of gestating sows as measured by stereotypic behaviors and salivary cortisol. Soybean hulls do not appear to be a useful fiber source for gestating sows.

Funding for this experiment was provided by the National Pork Board.

Key Words: Welfare, Fiber, Sows

96 Highly fermentable sugars and slow-release urea in diets fed to lactating dairy cows.

G. Golombeski*, K. Kalscheur, A. Hippen, and D. Schingoethe, *South Dakota State University*.

A study was designed to test the inclusion of liquid co-products from the ethanol and cheese industries in dairy rations and their interaction with a source of nonprotein nitrogen. Eight multiparous and four primiparous Brown Swiss cows (96±46 d in milk) were blocked by parity and randomly assigned to one of three 4 4 Latin squares. Basal diets were formulated for CP 16.6% and NE_L 1.55 Mcal/kg and contained 35% of dietary dry matter (DM) as corn silage, 15% alfalfa hay, 34% of a varying concentrate mix of ground shelled corn and soybean meal (SBM) and 16% of a constant premix. The constant premix contained equal proportions of soy hulls, heat treated SBM, corn distillers grains, vitamins and minerals across all diets. Treatments were: 1) control (**CON**); 2) fermentable sugars (**FS**; 8.64% RationMate); 3) slow-release urea (**SU**; 0.61% Ruma Pro); and 4) fermentable sugars and slow-release urea in combination (**FSSU**; 8.64% FS, 0.61% SU). Feeding FS decreased milk production ($P = 0.05$) and increased ruminal butyrate concentration ($P < 0.01$) compared to feeding CON and SU diets. Feeding SU decreased DM intake ($P = 0.04$), and increased feed efficiency ($P = 0.05$) compared to cows fed CON and FS. Milk fat percent increased for FS ($P < 0.01$) and SU ($P < 0.01$) compared to CON. Dietary treatment had no effect on FCM, milk protein percent, milk fat yield, milk protein yield, or MUN. No interactions between FS and SU were observed. Feeding FS increased milk fat percentage and ruminal butyrate concentration while SU improved feed efficiency and milk fat percentage.

Item	CON	FS	SU	FSSU	SEM
Milk, kg/d	26.9	25.5	26.8	25.4	1.3
Milk, fat%	4.19	4.52	4.36	4.46	0.11
Milk, protein %	3.73	3.76	3.76	3.73	0.07
DMI, kg/d	21.3	21.3	19.7	20.0	1.7
ECM/DMI	1.48	1.47	1.64	1.57	0.08
Acetate, molar %	63.3	62.8	62.8	63.3	0.6
Propionate, molar %	21.8	20.6	21.9	21.1	0.5
Butyrate, molar %	10.6	12.2	10.6	11.6	0.27

Key Words: Fermentable sugars, Milk fat, Urea

97 Effect of corn hybrid and processing method on digestibility.

M. Luebbe*[1], G. Erickson[1], T. Klopfenstein[1], and W. Fithian[1], [1]*University of Nebraska-Lincoln,* [2]*J. C. Robinson Seed Co.*.

Six ruminally cannulated steers (BW = 436 ± 8 kg) were used in a 6x6 Latin square to determine effects of corn hybrid and processing method on nutrient digestibility and ruminal fermentation. Treatments consisted of three hybrids: H-8562 (1), 33P67 (2), and H-9230 (3), two processing methods: dry-rolled corn (DRC), and high-moisture corn (HMC)

in a 3x2 factorial arrangement. Periods were 14 d, with a 9 d adaptation, and a 5 d collection of feces, continuous pH, and intake. Ruminal fluid samples were taken on d 14 of each period. In a previous experiment, G:F was 0.185 for cattle fed hybrid 1 compared with ratios of 0.175 and 0.169 for cattle fed hybrids 2 and 3, respectively. Kernel hardness measurements indicate that hybrid 1 is the softest kernel followed by 2 and 3. An interaction between hybrid and processing method existed ($P < 0.05$) only for propionate molar %. DMI was greater ($P > 0.01$) for HMC than DRC, and total time spent eating was longer ($P > 0.01$) for animals consuming HMC diets. Total tract DM, OM, and starch digestibilities were higher ($P < 0.10$) for HMC than DRC. Nutrient digestibilities were also higher ($P < 0.05$) for hybrid 1 than for hybrids 2 or 3. There were no differences in average pH. pH change (maximum to minimum) and pH variance were greater ($P > 0.05$) for HMC than for DRC. Total VFA concentrations were not influenced by processing method or hybrid ($P > 0.50$). However, acetate molar % was greater ($P < 0.01$) for DRC than HMC. Molar % of propionate was influenced by processing method and hybrid. HMC had a greater ($P < 0.01$) molar % of propionate than DRC and hybrid 1 had a greater ($P < 0.01$) molar % of propionate than hybrids 2 or 3. The increase in propionate from DRC to HMC for hybrid 3 was greater than the increase for hybrids 1 or 2. The acetate: propionate (A: P) ratio was different for both processing method and hybrid with HMC having a lower ($P < 0.01$) A:P ratio than DRC and hybrid 3 having a higher ($P < 0.01$) A:P ratio than 1 or 2. More intense processing methods or selection of hybrids with softer kernels will result in a greater digestibility and more propionate production.

Key Words: Corn hybrid, Processing, Rumen digestion

Graduate Student Paper Competition Ph.D.

98 Apparent and true ileal amino acid and energy digestibility and weanling pig performance of five sources of distillers dried grains with solubles.

N. D. Fastinger* and D. C. Mahan, *The Ohio State University*.

An experiment evaluated the apparent and true ileal amino acid digestibility of distillers dried grains with solubles (DDGS) from five plants. The experiment involved a total of 12 pigs in a 6 X 6 Latin Square design in 2 replicates (BW=21.2 kg). Pigs were cannulated at the distal ileum with a simple T cannula. Five diets contained 60% DDGS as the only protein source while the sixth diet was a low protein casein diet used to determine endogenous amino acid losses. Two plants had a lower apparent ($P < 0.05$) and true ($P < 0.05$) lysine digestibility (27 and 67%) when compared to three plants with apparent and true lysine digestibilities of 48 and 75%, respectively. In Exp. 2 a weanling pig performance trial determined the growth responses of the same DDGS sources to validate the amino acid digestibility responses of Exp 1. The performance trial was conducted with 128 pigs (initial 4.7 kg BW) in a RCB in 4 replicates. Three treatments contained a C-SBM mixture at 0.45, 0.65 and 0.85% lysine (total). Five C-SBM diets with 20% DDGS (contributed 0.15% lysine (total)) contained 0.60% lysine (total). Gain:feed and ADG responded linearly (R^2 =.96) to the C-SBM diets and were used to estimate the biological efficacy of lysine from DDGS. The results demonstrated that plants from Exp 1 with low lysine digestibilities had weanling pig responses similar to the 0.45% lysine (total) C-SBM diet, whereas the three plants with higher lysine digestibilities had higher ($P < 0.05$) pig responses than those fed the 0.45% lysine C-SBM diet. These results demonstrate that there is a wide range in lysine digestibilities between DDGS processing plants, but those plants producing higher quality products had higher digestibilities with greater pig performances than DDGS from plants producing a lower quality product. Growth performances resulted in a similar pattern of DDGS quality as the ileal digestibility trial.

Key Words: Digestibility, Distiller's Grains, Lysine

99 Evaluation of various sources of corn distillers dried grains plus solubles (DDGS) for lactating dairy cattle.

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Manufacturing practices differ among ethanol plants, resulting in variations in the nutrient content of DDGS among plants. The objective of this study was to evaluate the effects of feeding DDGS from different sources on intake and milk production and composition in lactating dairy cows. Eight multiparous and four primiparous Holstein cows were used in a replicated 4 × 4 Latin square design with 28-d periods. Dietary treatments consisted of total mixed diets containing soybean meal as the primary protein supplement (C), or 20% DDGS from source 1 (DDGS-1), source 2 (DDGS-2), or source 3 (DDGS-3). Dried distillers grains replaced a portion of the ground corn and soybean meal in DDGS diets to allow diets to be isonitrogenous at 16% CP. All diets had a forage to concentrate ratio of 55:45. Dry matter intake (21.4 kg/d) did not differ among treatments but cows fed diets containing DDGS had greater yields of milk (34.6 vs. 31.2 kg/d; $P < 0.01$), 4% fat-corrected milk (32.7 vs. 29.6 kg/d; $P < 0.01$), and energy-corrected milk (35.4 vs. 32.3; $P = 0.01$) compared to cows fed the C diet. As a result, feed efficiency was greater ($P = 0.03$) in cows fed DDGS compared to C (1.78 vs. 1.63). Even though there was a tendency ($P = 0.10$) for milk fat percentage to be greater in cows fed DDGS-3 compared to DDGS-2, differences were not observed among treatments. Milk fat yield was greater ($P = 0.02$) in cows fed DDGS compared to those fed C (1.26 vs. 1.14 kg/d). Milk protein percentages (3.28, 3.13, 3.19, and 3.17 % for C, DDGS-1, 2, and 3, respectively) were greater ($P < 0.01$) for C vs. DDGS and tended ($P = 0.10$) to be lower for DDGS-1 than for DDGS-2 and 3. Milk protein yields tended ($P = 0.10$) to be greater for cows fed DDGS than for those fed C (1.09 vs. 1.02 kg/d). Concentrations of milk urea nitrogen were lower ($P < 0.01$) in cows fed DDGS compared to C (9.36 vs. 10.6 mg/dl). Overall, the source of DDGS used in this study did not affect lactation performance.

Key Words: Distiller's dried grains, Dairy cattle, Ethanol co-products

100 Effects of orally administered 25-hydroxyvitamin D_3 and vitamin E on calcium and vitamin D metabolites in plasma and on vitamin D metabolites in beef *longissimus dorsi* muscle.

K. M. Carnagey*, A. E. Wertz, T. J. Knight, R. L. Horst, E. J. Huff-Lonergan, A. H. Trenkle, and D. C. Beitz, *Iowa State University*.

Recent research indicates that 25-hydroxyvitamin D_3 (25-OH D_3) might affect plasma calcium similarly to effects obtained with dosage of vitamin D but without leaving excessive vitamin D residues in meat. We hypothesized that a single 500 mg dose of 25-OH D_3 7 d before harvest would increase calcium concentrations in plasma and possibly promote tenderness by increasing cellular calcium, which could lead to enhanced proteolytic activity of calpains without high residues of vitamin D metabolites in muscle and that supplementing 1000 IU vitamin E for 104 d prior to harvest would decrease oxidation and loss of activity of calpains in *longissimus dorsi* muscle (LM). Forty-eight crossbred heifers were allotted to one of four dietary treatments: 1000 IU vitamin E/d, 500 mg 25-OH D_3 administered orally 7 d before harvest, both vitamin E and 25-OH D_3, or neither vitamin E or 25-OH D_3 (control). Oral dosage of 500 mg 25-OH D_3 7 d before harvest resulted in a 26% increase in calcium in plasma 1 d before harvest ($P<0.05$). An increase in both 25-OH D_3 and 1,25-dihydroxyvitamin D_3 (1,25-$(OH)_2$ D_3) concentrations in plasma of heifers treated with 500 mg 25-OH D_3 was observed in samples drawn 1 d before harvest ($P<0.05$). Supplementation with 500 mg of 25-OH D_3 7 d before harvest increased 25-OH D_3 in LM from 0.58 to 2.7 ng/g muscle ($P<0.05$). There was no increase in 1,25-$(OH)_2$ D_3 concentration in LM when cattle were given 25-OH D_3 ($P>0.05$). Unexpectedly, an increase in 1,25-$(OH)_2$ D_3 concentration in the LM, however, occurred when vitamin E was fed for 104 days before harvest. In conclusion, feeding heifers 500 mg of 25-OH D_3 7 d before harvest, with or without vitamin E, increases plasma calcium with only minimal increases in concentration of vitamin D metabolites in meat.

Key Words: 25-hydroxyvitamin D_3, Beef

101 Influence of Finisher Facilities on Growth Performance. D. B. Edwards*, M. E. Doumit, C. W. Ernst, and R. O. Bates, *Michigan State University*.

Growth performance can be dependent on environmental and housing differences. Pigs from the F_2 generation of a three-generation resource population with foundation grandparents of RYR1 normal Pietrain females mated to Duroc males were evaluated in two facilities. Pigs were raised in similar conditions during farrowing and nursery phases. From 11 farrowing groups, 986 F_2 pigs were placed into one of two finishers at 10 wk of age. Six groups were finished in a modified open front (MOF) finisher with 2/3 solid, 1/3 slatted floors, wet-dry feeders, and supplemental heat with 12 to 18 pigs per pen. Five groups were finished in test station pens (TS) in groups of 4 with bedded, solid floors, dry feeders, bowl drinkers, and manual curtain ventilation. Ultrasound composition and BW were measured every 3 wk from 10 to 22 wk of age. A total of 958 animals had carcass and meat quality records. Data were analyzed using a model of gender and finisher as fixed effects, animal and farrowing group as random effects, and age at measurement as a covariate. For post-harvest traits slaughter date was substituted for farrowing group. Loin muscle area at 22 wk of age (37.7 vs. 36.3 cm^2, $P = 0.24$) and ADG (898.5 vs. 888.9 g/d, $P = 0.48$) from 10 to 22 wk of age were similar for both finishers. However, pigs in MOF were fatter at the tenth rib at 22 wk of age (26.1 vs. 22.8 mm, $P = 0.04$), carcass last rib (30.2 vs. 26.9 mm, $P = 0.02$), and carcass last lumbar vertebrae (23.1 vs. 20.7 mm, $P = 0.05$) than pigs in TS. While ADG from 10 to 22 wk of age did not differ between finishers, random regression analyses revealed that the growth curve did differ, with pigs in TS growing slower at first, but then BW gain accelerated to match that of pigs in MOF. Primal cut weights, pH at 45 min and 24 h after slaughter, and quality traits of color, marbling, firmness, and drip loss were not different between MOF and TS. Temperature at 24 h postmortem (3.04 vs. 2.40 °C, $P = 0.05$) was higher for MOF than TS. Finishing facility type influenced rate of growth between pigs of similar genetic merit.

Key Words: Pig, Growth, Finishing

102 Inflammatory cytokines differentially modulate the adiponectin receptors 1 and 2 in pig subcutaneous adipocytes. S. Jacobi* and M. Spurlock, *Purdue University*.

Adiponectin is an adipocytokine that plays an important role in immune modulation, insulin sensitivity, glucose homeostasis, and lipid metabolism. Adiponectin functions through two known receptors, adipoR1 and adipoR2, both of which are expressed in adipocytes. Additionally, insulin resistance in some metabolic aberrations has been linked to inflammation in adipose tissue. The aim of this research was to test the hypothesis that pro-inflammatory cytokines act directly on adipocytes to down regulate adiponectin receptor expression. Porcine adipocytes were isolated from the dorsal subcutaneous adipose tissue of finished pigs (barrows, n=5). Cells were incubated in DMEM with 3% BSA in the presence and absence of recombinant porcine TNF-α or IL-6 (30 ng per mL). Cells were harvested at 0, 2, 4 or 6 hours and total RNA extracted for cDNA synthesis for real time PCR analysis of receptor expression. Over time, both adipoR1 and adipoR2 were differentially regulated; the overall mRNA expression of adipoR1 was significantly up-regulated, while that of adipoR2 diminished over the 6 hour incubation period (P#88040.0001). Compared with the control, neither TNF-α or IL-6 altered adipoR1 expression (P#88050.05). Although adipoR2 expression was not influenced by either cytokine at 2h (P#88050.05), it was down-regulated by TNF-α at 4 and 6 hours (6.15 vs. 6.00, P#88040.05, and 6.02 vs. 5.86, P#88040.01, 4 and 6 hours, respectively, log starting quantity). This is the first report of differential regulation of the adipoR1 and adipoR2 receptors in porcine adipose tissue by pro-inflammatory cytokines. These data indicate that TNF-α may act locally on adipocytes and adipose macrophages to down-regulate the sensitivity of cells to adiponectin.

Key Words: Adiponectin receptors, Adipocyte, Pig

103 Effect of level of wet distillers grains on feedlot performance of finishing cattle and energy value relative to corn. K. Vander Pol*, G. Erickson, T. Klopfenstein, and M. Greenquist, *University of Nebraska*.

Two hundred eighty-eight crossbred yearling steers (BW = 351 ± 11 kg) were utilized in a completely randomized design to evaluate the effect of level of wet distillers grains plus solubles (WDGS) on feedlot performance and carcass characteristics. Dietary treatments consisted of 0, 10, 20, 30, 40, and 50% dietary inclusion (DM basis) of WDGS, replacing corn. Basal ingredients consisted of high-moisture and dry-rolled corn, fed at a constant 1:1 ratio (DM basis), plus ground alfalfa hay and dry supplement each fed at 5% of diet (DM basis). Steers were stratified by weight and assigned randomly to pen. Pen, serving as the experimental unit, included eight steers, was assigned randomly to treatment, and was replicated six times. Steers were fed for 125 d, and were slaughtered on d 126 at a commercial abattoir. Results indicate a significant quadratic response ($P < 0.0001$) for DMI, final BW, ADG, and G:F, as level of WDGS in the diet increased. However, with the exception of HCW, there were no significant differences ($P > 0.05$) for carcass characteristics (i.e. liver score, REA, 12th rib fat, marbling, and yield grade). Further, utilizing G:F, an improvement above the 0% WDGS diet was calculated for each pen/treatment, considering the inclusion rate of WDGS. Results from these calculations generated a significant quartic response ($P = 0.0003$). These data clearly demonstrate the performance improvements achievable when WDGS are utilized in finishing diets. In conclusion, feeding WDGS in this trial up to 50% of the diet in place of corn, resulted in improved performance compared to feeding high-moisture/dry-rolled corn.

WDGS Level:	0	10	20	30	40	50	SE
Final BW, kg[a]	561	584	587	597	597	576	5
DMI, kg	10.9	11.2	11.4	11.3	11.1	10.6	0.1
ADG, kg	1.66	1.85	1.87	1.96	1.94	1.78	0.04
G:F, kg/kg	0.153	0.165	0.164	0.173	0.176	0.169	0.003
Energy, %[b]		178	138	143	137	121	8

[a]Calculated from hcw divided by a common dress of 63%.
[b] Value relative to corn, calculated by difference of g:f, divided by wdgs inclusion.

Key Words: Corn, Distillers grains, Finishing cattle

104 Effects of feeding polyclonal antibody preparations against *Streptococcus bovis* and *Fusobacterium necrophorum* on target bacteria and rumen fermentation patterns of steers fed high-grain diets. N. DiLorenzo*, G. I. Crawford, F. Diez-Gonzalez, and A. DiCostanzo, *University of Minnesota*.

Avian-derived polyclonal antibody preparations (PAP) against *Streptococcus bovis* (PAPSb) or *Fusobacterium necrophorum* (PAPFn) were effective in reducing counts of target bacteria and improving feed efficiency of steers fed high-grain diets. Sixteen rumen-cannulated steers fed high-grain diets were used in a completely randomized design with a 2 X 2 factorial arrangement of treatments (PAPSb or PAPFn) to test effects of PAP on target bacteria, rumen VFA, NH_3 -N and pH. Diet was comprised of 83% corn grain, 12% corn silage and 5% supplement, and was formulated to contain (DM basis; 1.39 Mcal NE_g/kg DM, 12.5% CP, 0.65% Ca, and 0.35% P). The supplement delivered 300 mg monensin/hd/d and 100 mg tylosin/hd/d. Polyclonal antibody preparations were top-dressed. Either PAP was effective at reducing ($P < 0.05$) rumen counts of *S. bovis* measured in samples collected pre-feeding. Feeding both PAP tended ($P = 0.07$) to reduce rumen *S. bovis counts*. Feeding PAPSb had no effect ($P > 0.15$) on rumen counts of *F. necrophorum*. Steers fed PAPFn alone had lower ($P < 0.05$) counts of *F. necrophorum* in the rumen. Except for pH at 6 h post-feeding, rumen pH of steers fed both PAP was greater ($P < 0.05$) throughout a 24-h collection period. Rumen pH of steers fed either PAP was greater ($P < 0.05$) 2 h post-feeding. Rumen VFA did not ($P > 0.15$) differ among treatments. Rumen NH_3-N concentrations were lower ($P < 0.05$) for steers fed both PAP at 0, 2, 4 and 9 h post-feeding. Rumen NH_3-N concentrations were lower ($P < 0.05$) during the first 2 h post-feeding for steers fed either PAP alone. Feeding either PAP was effective in

increasing rumen pH post-feeding without negatively affecting VFA or NH_3-N. However, rumen NH_3-N beyond 2 h post-feeding in steers fed both PAP was in concentrations lower than those required to maintain maximum microbial growth (5 mg NH_3-N/100 ml).

Key Words: *Streptococcus bovis*, *Fusobacterium necrophorum*, Antibodies

105 Evaluation of the threonine to valine requirement ratio for lactating sows. K. Soltwedel*[1], V. Perez[1], D. Fernandez[2], J. Cuaron[3], and J. Pettigrew[1], [1]*University of Illinois,* [2]*Universidad Nacional Autonoma de Mexico,* [3]*Instituto Nacional de Investigaciones Forestales Agricolas y Pecuarias*.

This study was conducted to determine whether the dietary threonine (THR) to valine (VAL) requirement ratio for lactating sows with high weight loss is above or below 0.79 (0.76 analyzed). Data were collected on 408 sows and their litters, of which 239 were used in the analysis. Removals were as follows; 138 due to missing data, 16 due to excessive mortality and pig removals, and 15 as outliers. Experimental diets were formulated to 0.67% standardized ileal digestible (SID) lysine (0.74% total). Crystalline lysine was used in the diets to ensure lysine was not first limiting. Dietary treatments were arranged in a 2 x 2 factorial; two levels of dietary SID THR (formulated to 0.33 and 0.46%) and two levels of dietary SID VAL (formulated to 0.44 and 0.61%). Sows were allotted to treatment on the basis of parity group (PG): parity (P)1 sows, P2 sows, P2 sows, and P3+ sows. Post-partum body weight (PPBW) was calculated from an equation (R2=0.96) generated from similar sows using pre-farrow BW, total born, and total birth weight as predictors. Backfat (BF) and loin depth were measured at the last and 10th rib by ultrasound at the time of farrowing and weaning. Sow body protein content at farrowing and weaning was estimated using equations of Dourmad et al. (1997) for calculation of body protein loss (BPL). Main effects of THR included decreased BW loss (36 vs 33 kg, p=0.07), decreased BPL (185 vs 152 g/d), and increased overall litter ADG (2.37 vs. 2.46 kg, p=0.05). The main effect of THR on litter ADG was observed in early lactation (d1 to 9), but not late lactation (d9 to wean). Additionally, PG∗THR and PG∗VAL interactions were observed for litter ADG in early lactation. These results confirm that the dietary THR to VAL requirement ratio for these lactating sows with high weight loss was greater than 0.76.

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Key Words: Threonine, Valine, Lactating sow

106 Effect of conjugated linoleic acid and/or a specific Δ6-desaturase inhibitor on body composition of mice. K. M. Hargrave*[1], M. J. Azain[2], M. G. Obukowicz[3], and J. L. Miner[1], [1]*University of Nebraska,* [2]*University of Georgia,* [3]*Pfizer Global Research and Development*.

Dietary conjugated linoleic acid (CLA) causes a loss of body fat that is enhanced when mice are fed a diet deficient in essential fatty acids. CLA can be desaturated and elongated to a conjugated isomer of arachidonic acid. The rate-limiting enzyme of this conversion is Δ6-desaturase. The objective of this study was to determine if inhibition of CLA conversion to a conjugated isomer of arachidonic acid by inhibiting Δ6-deasturase would block the CLA-induced loss of body fat. Male mice (n=146; 12 or 15 weeks of age) were blocked by body weight and randomly assigned to a dietary treatment. The diets were arranged as a 2 x 4 factorial testing 0 vs 0.5% CLA and 0, 10, 30, or 100 mg kg BW^{-1} d^{-1} of a specific Δ6-desaturase inhibitor, SC-26196 (INH). Mice were fed for 14 d, then body fat and lean mass were measured by dual x-ray densitometry (PIXImus). Epididymal and reteroperitoneal fat pads and livers were collected and weighed. Reteroperitoneal fat pads and livers were analyzed for fatty acid concentration by gas chromatography. Inhibition of Δ6-desaturase was confirmed by a reduction ($P < 0.05$) in the concentration of desaturase products, C20:3n6, C20:4n6, and C22:6n3 in adipose tissue and liver from mice fed increasing doses of the inhibitor. Additionally, there were increases ($P < 0.001$) in desaturase substrates C18:1n9 and C18:2n6, as well as the elongation product of C18:2, C20:2n6, in the liver. Mice fed CLA were 25% leaner ($P < 0.001$) than controls. They also had reduced ($P < 0.05$) feed intake, body weight, and increased liver weight. There was a trend ($P = 0.08$) for a CLA x inhibitor interaction in that mice fed the INH-100+CLA diet did not differ in body fat from mice fed the INH-100 diet (15.5 vs 17.2 %, respectively). The inhibitor also increased ($P < 0.001$) liver weight. In conclusion, dietary inclusion of this Δ6-desaturase inhibitor appears to reduce CLA-induced body fat loss. This indicates that CLA may require metabolism in order to induce a full response.

Key Words: Conjugated linoleic acid, Body fat, Δ6-desaturase

Growth and Development, Muscle Biology and Meat Science

107 A mechanism for linking the peripheral layer of cellular myofibrils to the muscle cell sarcolemma. R. C. Bhosle* and R. M. Robson, *Iowa State University*.

The objective of this study was to determine whether the unique intermediate filament (IF) protein synemin, which has an unusually long C-terminal tail and forms heteropolymeric IFs with the major muscle IF protein desmin, interacts directly with the large costameric protein dystrophin located along and subjacent to the sarcolemma. We previously showed that avian synemin interacts with the actin-binding protein α-actinin, which is located both within myofibrillar Z-lines and the costameres located in a periodic fashion along the sarcolemma. Dystrophin is a 427-kDa protein belonging to the same protein family as α-actinin. Full-length mammalian (mouse) dystrophin cDNA was divided, cloned and expressed as eight domains/regions, namely the N-terminal domain, five regions of the long spectrin-like repeat containing rod domain, cysteine-rich domain, and C-terminal domain. The full-length mammalian cDNAs of the α- and β- splice variants of synemin were divided, cloned, and used to express seven specific regions of the synemin C-terminal tail domain. Solid-phase protein binding assays demonstrated that tissue-purified avian synemin interacted specifically with the cysteine-rich domain and one region (spectrin repeats 15-19) of the dystrophin rod domain. We found that the expressed C-terminal regions of both the mammalian α- and β-synemin tail domains interacted specifically with the cysteine-rich domain of dystrophin. Our results demonstrate the presence of direct and specific interactions between synemin and dystrophin. These protein interactions would help enable the desmin/synemin heteropolymeric IFs to link the Z-lines of the peripheral layer of myofibrils to the dystrophin present in the costameric regions of the cell membrane skeleton, and thereby help maintain overall cytoskeletal integrity. In summary, we have identified a new mechanism whereby the intermediate filaments surrounding the Z-lines link the peripheral layer of cellular myofibrils to the costameric sites located periodically along the sarcolemma in developing and adult muscle cells.

Key Words: Intermediate Filaments, Muscle, Sarcolemma

108 Respiratory chain complex activity in longissimus and spinalis dorsi muscle in high and low feed efficient swine within a single genetic line. E. A. de Feliz*[1], C. Ojano-Dirain[2], M. E. Davis[1], C. V. Maxwell[1], M. Iqbal[2], and W. G. Bottje[2], [1]*University of Arkansas,* [2]*University of Arkansas*.

Phenotypic expression of feed efficiency has been linked to mitochondrial function, specifically respiratory chain complex activities in broilers. The objective of this study was to determine if similar relationships between respiratory chain complex (Cx) activity and feed efficiency are present in swine. Monsanto Choice Genetics furnished a total of 14 pigs selected from 427 individuals from a single line using Feed Intake Recording Equipment. Seven of the pigs used in this study were from the top 1/6 of pigs in feed efficiency (HFE), and seven represented the bottom 1/6 in feed efficiency (LFE). A common diet was fed prior to slaughter. Immediately after pigs were slaughtered, LM and spinalis dorsi (SD) samples were collected from each of the 14 pigs. Mitochondria were isolated from LM and SD by differential centrifugation. Mitochondrial respiratory chain complex activities were measured by UV

spectrophotometry, and reported in units/mg protein. Complex I activity was greater (P < 0.01) in the SD compared to the LM, whereas Cx III, Cx IV, and Cx V activities were greater (P < 0.01) in the LM compared to the SD. Pigs in the HFE group had greater Cx I activity compared to pigs in the LFE group. There was no difference in Cx II activity within the LM of the HFE and LFE pigs, whereas Cx II activity was greater (P < 0.01) in the SD of the LFE group compared to the SD of HFE pigs (muscle type × feed efficiency group interaction; P < 0.01). For the combined muscle groups, Cx I activity was positively correlated (P < 0.05) to feed efficiency. The results of this study indicate a muscle-dependent link between respiratory chain activity and phenotypic expression of feed efficiency in swine.

Effects of feed effiency and muscle type on respiratory chain complex activities.

	Muscle			FE Group			Muscle × FE
	LM	SD	P<	HFE	LFE	P<	P<
CxI	8.10	16.83	0.01	15.45	9.47	0.01	0.60
CxII	7.60	26.74	0.01	13.14	21.20	0.01	0.01
CxIII	37.43	5.41	0.01	20.00	22.83	0.60	0.50
CxIV	13.41	3.71	0.01	8.95	8.18	0.80	0.60
CxV	24.63	2.81	0.01	14.81	12.62	0.40	0.40
G:F	-	-	-	0.51	0.34	0.01	-

Key Words: Feed conversion, Pigs, Respiratory chain

109 Microbial colonisation affects Toll-like receptor gene expression in the pig small intestine.

B Willing* and A Van Kessel, *University of Saskatchewan.*

In previous gnotobiotic pig experiments we have observed increased inflammatory cytokine production, intestinal epithelial cell (IEC) proliferation and apoptosis associated with the inoculation of pigs with sow feces (CV) or non-pathogenic *Escherichia coli*(EC) but not *Lactobacillus fermentum* (LF) as compared to germ-free (GF). Toll-like receptors (TLRs), some of which have been shown to be present on IEC, recognise pathogen associated molecular patterns (PAMPs) present on microbes including Gram(+) and Gram(-) bacteria and are thought to play a key role in innate immunity by the recognition of lumenal bacteria. In two separate experiments sixteen piglets were derived by caesarian-section, allocated to one of four treatment groups including GF, mono-association with EC (Gram(-)), or with LF (Gram(+)) or conventionalised with CV and reared to 14 days of age. In experiment 2 the LF group was contaminated with *Klebsiella pneumoniae* making it di-associated (LFKP). Whole intestinal tissue was collected at 75% of the small intestine (SI) length and IEC were harvested from an 80 cm length proximal to the 75% location then snap frozen. The expression of TLR2, 4 and 9, proliferating cell nuclear antigen (PCNA) and TNFalpha were measured in whole tissue and IEC using quantitative PCR (qPCR) and apoptotic activity was measured in IEC by Western-blot against active caspase-3. All TLRs showed greater expression in whole tissue as compared to IEC and TLR2 had the greatest transcript abundance in both tissues. TLR2 was upregulated over 3-fold in whole tissue and IEC in the CV treatment ($P < 0.05$) and tended to be up regulated by Gram(-) bacteria ($P < 0.09$), while TLR4 transcript abundance was only slightly increased in CV and TLR9 was not affected by any treatment. TLR2 gene expression was significantly correlated ($P < 0.05$) with inflammatory response (r^2=0.596), apoptotic activity (r^2=0.601) and proliferation (r^2=0.590) as indicated by TNFalpha, activated caspase-3 and PCNA respectively. Intestinal colonisation by Gram(-) bacteria is associated with increased inflammation, epithelial cell turnover and upregulation of Gram(+) responsive TLR2.

Key Words: Toll-like receptor, gnotobiotic, pig

110 Including flax in feedlot diets alters beef fatty acid profiles.

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To assess the effects of dietary flax addition and flax processing on beef fatty acid fractions 128 yearling beef heifers were blocked by weight and assigned randomly to diets that included no flax, whole flax, rolled flax, or ground flax. Heifers were fed a growing ration (31% corn, 30% corn silage, 18% barley malt pellets, 14% alfalfa, 4% linseed meal, and 3% supplement; DM basis) for 56 d followed by a finishing ration (79% corn, 7% corn silage, 7% alfalfa, 4.75% linseed meal, and 2.25% supplement; DM basis). Flax replaced all linseed meal and partially replaced corn at 8% of diet DM. Diets provided 0.5 mg melengestrol acetate, 2000 IU vitamin E, and 232 mg monensin daily. Heifers were implanted (20 mg estradiol benzoate, 200 mg testosterone propionate) on d 1. At 24-h post-harvest, loin (m. longissimus lumborum) sections were removed, transported to North Dakota State University, vacuum packaged, and aged for 14 d. Following aging, samples were analyzed for phospholipid and neutral lipid fatty acid fractions. Flax inclusion increased ($P < 0.0001$) phospholipid content of total n-3 fatty acids including 18:3n-3 ($P < 0.0001$), 20:5n-3 ($P < 0.0001$), 22:5n-3 ($P = 0.0005$), and 22:6n-3 ($P = 0.02$) while decreasing phospholipid content of 20:4n-6 ($P < 0.0001$). Processing flax (rolled or grinding) increased phospholipid fractions of 18:3n-3 ($P < 0.0001$), 20:5n-3 ($P = 0.007$), 22:5n-3 ($P = 0.0005$), and 22:6n-3 ($P = 0.01$); and decreased 20:4n-6 ($P = 0.05$) compared to whole. Ground flax increased ($P = 0.04$) phospholipid content of 18:3n-3 compared to rolled flax. Flax addition increased ($P < 0.0001$) neutral lipid 18:3n-3. Moreover, flax addition increased neutral lipid content of 18:2n-6 ($P = 0.004$) and 20:4n-6 ($P = 0.03$). Additionally, 18:3n-3 levels were greater ($P = 0.0008$) in processed (rolled and ground) flax compared to whole flax and ground flax increased ($P = 0.04$) 18:3n-3 concentrations when compared to rolled flax. These data suggest that feeding flax alters beef fatty acid profiles and that a portion of unsaturated fatty acids escape biohydrogentation in the rumen and are absorbed in the small intestine. Feeding flax can increase n-3 fatty acid content in fresh beef.

Key Words: Beef, Fatty Acid, Flax

111 Effects of ractopamine feeding level on carcass cutting yield and loin quality measurements.

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The effects of various ractopamine feeding programs of 0 ppm, 5 ppm, and 10 ppm were investigated as they relate to carcass cutting yield, loin quality attributes (ultimate pH, Minolta L* a* b*, NPPC color, marbling, and firmness, drip loss, and proximate analysis) and trained sensory panel evaluation by assigning 75 barrows and 75 gilts to a randomized complete block design with ractopamine treatment randomly assigned to 30 pens of 5 pigs each. Carcass and quality data were collected on the 2 pigs closest to average pen weight for each pen. Statistical analysis was performed using the GLM procedure of SAS to examine dietary treatment, gender, and all interactions. Ractopamine increased the weight of the bone-in loin, trimmed boneless loin, boneless tenderloin, and boneless sirloin at both 5 ppm and 10 ppm (P < 0.05). Bone-in ham, inside, outside, knuckle, and light butt weights were greater (P < 0.05) for 10 ppm when compared to 0 ppm. The untrimmed belly was heavier at both 5 ppm and 10 ppm (P < 0.05). Ractopamine did not affect any of the weights of cuts from the shoulder (P > 0.05). None of the afore mentioned loin quality measurements yielded any differences (P > 0.05) with the exception of the Minolta a* which was lowered by both levels of ractopamine and b* which was lower for 10 ppm (P < 0.05). Proximate analysis of a 25 mm loin chop yielded no differences (P > 0.05) concerning percent moisture or fat. Trained sensory evaluation did not detect any differences (P > 0.05) in juiciness, tenderness, or off flavor. No significant differences were revealed by Warner-Bratzler shear force (P > 0.05). Feeding RAC at both the 5 ppm and 10 ppm levels resulted in a favorable response in yield of loin and ham, but yielded no substantial differences across RAC treatments for quality measures.

Key Words: Ractopamine, Cutting yield, Quality

112 Effect of ractopamine feeding level on growth performance and carcass composition.

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To determine magnitude of ractopamine (RAC) response by feeding level in the diet during different phases of feeding, 75 barrows and 75 gilts

(initial BW = 77 kg) were randomly allotted to one of three dietary treatments. The dietary treatments (as-fed basis) were: 1) Control diet containing no RAC; 2) RAC 5 ppm; and 3) RAC 10 ppm. Pigs, within a gender, were randomly assigned to treatment (5 pigs per pen and 10 pens per treatment). All diets were formulated to contain 1.2% lysine and fed for a five-wk period. Feed allocation was recorded daily, and pigs were weighed and feed weighed back every wk. Jugular blood samples were obtained from 2 randomly selected pigs per pen on d 0, 7, 14, 21, 27, and 33 for determination of plasma urea nitrogen (PUN) concentrations. Fat thickness (BF) and loin area (LEA) were measured by real-time ultrasound on d 33 and all pigs were sent to a commercial slaughter facility. Carcass data collected at the slaughter facility included hot carcass wt (HCW), fat (FD) and loin depth (LD) as measured by the Fat-o-meter, and carcass yield. Overall, ADG was increased (1.03 vs. 0.93 kg/d; P = 0.02), live wt was greater (110.9 kg vs. 107.0 kg ; P < 0.01), carcass wt was greater (83.5 kg vs. 78.9 kg; P < 0.001), and carcass yield was increased (75.3% vs 73.8%) for pigs fed RAC compared to the control. Loin measures were greater for the 5 ppm treatment than the 10 ppm or Control (LEA; 44.7 cm2 ^{a}, 43.0 cm2 ^{a,b} , 41.5 cm2 ^{b}; P = 0.04; and LD: 61.1 mm ^{a}, 58.5 mm ^{b}, 55.8 mm ^{c}; P < 0.001). ADFI, BF and FD did not differ across treatments (P > 0.15). The concentrations of PUN were decreased (P < 0.10) at d 14 and 21 with 10 ppm RAC feeding. This decrease is consistent with the mode of action of the RAC molecule. Feeding RAC at both the 5 ppm and 10 ppm levels resulted in a favorable response in growth performance and yielded more lean pork.

Key Words: Ractopamine, Growth performance, Carcass

113 The effect of ractopamine feeding level on fatty acid profiles in belly and clearplate fat of finishing pigs.

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One hundred fifty pigs (75 barrows and 75 gilts, initial weight 77 kg) were used to investigate the effect of ractopamine (RAC) on fatty acid profile in the belly. Pigs, within gender, were randomly assigned to three treatments, which consisted of 0 (control diet), 5 or 10 ppm of RAC. Each treatment contained 10 pens and each pen had 5 pigs. Pigs were fed experimental diets for five weeks and were sent to a commercial slaughter facility. Fat was sampled from the clear plate of the hanging carcasses and from the belly primal. Lipids were isolated from the fat samples in duplicate and fatty acid composition was analyzed by gas-liquid chromatography. The iodine value (IV, grams of iodine bound per 100 g of fat) was calculated from the fatty acid composition. Feeding RAC had no effects (P > 0.10) on fatty acid profile and calculated IV of belly fat, but had an effect (P < 0.05) on linoleic acid in clearplate fat. The percentage of linoleic acid in clearplate fat from pigs fed 10 ppm RAC (18.6) was on average 7% higher (17.4) than pigs fed control diet and 5 ppm RAC. This resulted in a 3% increase in IV, 8% increase in polyunsuturated fatty acid and 8.5% decrease in the ratio of monounsaturated to polyunsaturated fatty acids from pigs consuming 10 ppm RAC compared to pigs consuming control and 5 ppm RAC diets. No significant difference was detected between pigs fed control diet and 5 ppm RAC. The results indicate that feeding the higher level of RAC increased the enrichment of linoleic acid in clearplate fat, but there was no overall effect of RAC on the fatty acid profile of belly fat of finishing pigs.

Key Words: Ractopamine, Pig, Fatty acid

114 Effect of cooking temperature on tenderness and cook loss in Landrace and Berkshire boneless loin chops.

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The experiment was conducted to determine the relationship of cooking temperature with tenderness and cook loss of pork loin derived from Landrace (n=52) and Berkshire (n=38) swine. Three end-point temperature treatments were evaluated (LT, 62.7° C; MT, 71.1° C; HT, 79.4°C). At 72 h post-harvest, three 5.08 cm, bone-in loin chops were removed from the right-hand side of each carcass beginning at and posterior to the 10th to 11th rib. Chops were vacuum-packed and aged until 7 d post-harvest, randomly assigned to a treatment temperature, and frozen. Frozen chops were cut to uniform width of 2.54 cm, allowed to thaw at approximately 2.2° C, de-boned, and cooked in an Impinger oven set at 190.5 C. Pre- and post-cooked weight and cooked temperature were recorded. Cook loss (CL) was calculated as 1 - ((cooked weight ÷ pre-cooked weight) × 100). Loins were cooled to 20° C and six, 1.27-cm cores were removed parallel to the muscle fiber orientation. Warner Bratzler Shear Force (WBS) measures represented the average of six cores per loin. The mixed model for WBS included breed and treatment, a breed × treatment interaction, and a linear covariate of temperature within treatment. For CL, treatment was used as a fixed effect with a linear covariate of temperature within treatment. Pig was a random effect for WBS and CL. A breed × treatment interaction was observed for WBS. Shear force of Berkshire-derived loins were not different at LT (2.18 kg) and MT (2.25 kg), but increased and was significantly greater when cooked to HT (2.47 kg). In contrast, within Landrace-derived loins, WBS was less at LT (2.90 kg), increased significantly at MT (3.40 kg), and increased significantly again at HT (4.00 kg). Cook loss was lowest at LT (14.9 %), increased significantly at MT (18.7 %) and again increased significantly at HT (30.1 %). The results indicate that LT provided the most favorable combination of WBS and CL, while HT contributed to increased WBS and CL across both breeds. At intermediate temperatures, breed effects influenced tenderness.

Key Words: Pork quality, Tenderness, Cook loss

115 Histological characterization of pork longissimus muscle: Correlations with pork quality attributes.

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The objective of this research was to determine the relationship between histological characters of pork *longissimus* muscle and traditional pork quality attributes. A total of 90 purebred Berkshire and Landrace pigs (n=38 and 52, respectively) were harvested at the Ohio State University abattoir and characterized for pork quality traits including: pH_{45m} and pH_{24h} post-harvest; 10^{th} rib backfat and loin muscle area; subjective color (COLOR), marbling (MARB), firmness (FIRM), and wetness (WET); and Minolta reflectance (MIN). *Longissimus* muscle was sampled for histological characterization at the 10^{th} rib location in an orientation parallel to the muscle fibers and in a manner to prevent contraction prior to fixation in formalin. Samples were dehydrated, embedded in paraffin, cross-sectioned at 5 μm, and stained with hematoxylin and eosin to allow for visualization of the muscle morphology. Sections were measured for average fiber diameter (AFD), % of degenerative fibers (DF), average endomysial width (AEW), and % of non-measurable endomysium (NME). On the same carcass side, two 2.54 cm loin chops were sampled at the $13^{th}/14^{th}$ rib location for determination of purge loss (PURGE), cooking loss (CLOSS), and Warner-Bratzler shear force (WBS). Data were analyzed using a general linear model to test for the effects of and interactions between breed (n=2), sex (n=2), and harvest group (n=5). Age at harvest was included as a covariate to standardize harvest age. Residual correlations were estimated using a multivariate analysis of variance. Breed differences were significant (p#88040.05) for all traits except CLOSS, AFD, DF, AEW, and NME. With regard to histological characters, significant correlations were detected between AFD and pH_{45m}, WET, PURGE, and WBS (r=-0.33, -0.25, 0.24, and 0.27, respectively); %DF and WBS (r=-0.26); AEW and pH_{45m} (r=-0.39); and NME and pH_{45m} and WBS (r=0.31 and -0.25, respectively). While these data give evidence of an association between muscle histological characters and pork quality attributes, healthy morphological phenotypes are not necessarily indicative of better pork quality.

Key Words: Pork quality, Muscle morphology

116 Evaluation of ascorbic acid and Origanox^{TM} to decrease the incidence of pork lumbar vertebrae darkening in different packaging types.

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The effectiveness of ascorbic acid (AA) and Origanox(OG) on pork bone discoloration, while packaged in modified atmosphere (MAP) or polyvinyl chloride film (PVC) during simulated retail display, was evaluated. Six 2.54 cm sections were cut from the lumbar region of 48 pork backbones at 6 d postmortem. Solutions of 1.25%, 1.875%, or 2.5% AA; or combinations of 0.15% AA + 0.30% OG or 0.225% AA + 0.45% OG

were applied in 0.5 ml aliquots to different bone sections, with sections from one backbone represented in all treatments. Each package contained all five treatments and control from one backbone. Three packaging systems were used: 1) high-oxygen (80% O_2, 20% CO_2) (HiOx) MAP; 2) ultra-low-oxygen (70% N_2, 30% CO_2) (ULOx) MAP; and PVC film. Packages were displayed for 8 d at 2°C under continuous fluorescent light (2153 lux, 300K, CRI=85) and evaluated by a trained panel for visual color. CIE L*, a*, and b* measurements were taken with a Hunter Labscan 2 (Illuminant A). By d 8 of display, all antioxidant-treated lumbar vertebrae packaged in HiOx MAP had superior ($P < 0.05$) visual color scores than those packaged in PVC. An antioxidant effect in ULOx MAP was not observed by the visual panel. Control bones packaged in HiOx MAP had the lowest ($P < 0.05$) L* values on d 8 compared to treatments. All bones treated with an antioxidant and packaged in HiOx MAP had higher ($P < 0.05$) a* values on d 8 than all other bones, with the highest ($P < 0.05$) a* value for 2.50% AA. Likewise, antioxidant-treated bones packaged in HiOx MAP had higher b* values on d 8. The a*/b* ratio, an indicator of discoloration, showed that all bone treatments packaged in PVC, or control bones packaged in HiOx MAP, had the most ($P < 0.05$) discoloration on d 8. The least ($P < 0.05$) discoloration on d 8 was observed for bones treated with 1.875% or 2.50% AA and packaged in ULOx MAP. Bones packaged in HiOx MAP darkened less when an antioxidant was applied; however, this was not always observed in ULOx MAP and PVC.

Key Words: Pork bone, Discoloration, Antioxidant

117 Ultrasound determination of degree of doneness in beef steaks.

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As degree of doneness (DOD) of a steak increases, changes in palatability attributes occur which are detectable by the consumer. Use of thermometers is the most accurate method for monitoring steak DOD; however, this is an invasive method that causes an undesirable break in the steak surface. This study examined the use of ultrasound, a non-invasive procedure, to determine DOD in beef steaks. As DOD increases, both protein coagulation and water loss from collagen shrinkage contribute to a gradual increase in density of the steak. By monitoring the increase in density using ultrasound, a prediction of the DOD of a steak was calculated. Eight USDA choice striploins were purchased and frozen. Frozen loins were trimmed 7.62 cm from the anterior end. Six, 2.54 cm steaks were cut from central portions of the loin, labeled with their assigned DOD, vacuum-packaged, and stored frozen. Steaks were thawed and a thermocouple was placed in the center to monitor temperature changes. Steaks were cooked to one of six endpoint temperatures, 55, 60, 63, 71, 77 or 82° C, depending upon their assigned DOD. Ultrasound images of steaks were obtained both before cooking and after reaching their assigned DOD using an Ultramark 9 clinical scanner and a 3 MHz convex array scan head. Cooking loss was calculated for each steak and Warner-Bratzler Shear force analyses were performed. As DOD increased, Warner-Bratzler Shear force increased ($P < .05$). Image intensities were analyzed and comparisons were made between steaks cooked to similar DOD. Quantitative decays in image intensities were produced as intensities peaked at the surface of the steak and decreased towards the center. Results indicated an observable, although not significant, trend from very rare to medium rare. However, results past medium rare were ultimately deemed inconclusive. Further studies will determine the cause of variation in the results.

Key Words: Ultrasound, Meat, Cooking

118 Influence of lactate, salt, phosphate, and acetate on properties of injection enhanced beef.

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Many meat products are injection enhanced with a variety of solutions. Our objective was to determine the influence of lactate, phosphate, salt, and acetate on injection enhanced beef rib and strip steak properties. Treatment solutions were: No Lactate or Acetate - 0.3% salt, 0.3% phosphate, 0% lactate and acetate; Lactate Control - 1.5% potassium lactate, 0.3% salt, 0.3% phosphate; Lactate + High Salt - 1.5% potassium lactate, 0.6% salt, 0.3% phosphate; Lactate + Acetate - 1.5% potassium lactate, 0.3% salt, 0.3% phosphate, 0.1% acetate; and Lactate + Acetate (No PO4) - 1.5% potassium lactate, 0.3% salt, 0% phosphate, and 0.1% acetate. All treatments had 580 ppm rosemary and were injected for an 8.5% pump. All treatments were applied to ribs in seven replications. Three 2.54-cm thick steaks were cut from each treatment from each rib, packaged in high-oxygen MAP, and evaluated on d 2, 9, and 14 post injection. The first four treatments were applied to strip loins, cut into three 1.91-cm steaks for sensory analysis and one 2.54-cm steak for WBSF. Rib steaks were evaluated for visual color, darkening, discoloration (metmyoglobin), visual gloss, instrumental color and gloss, microbial growth, odor, and oxidation. Strip steaks were used for sensory properties and WBSF. Lactate Control steaks were the most red and stable throughout. Lactate + High Salt steaks had the poorest visual color, reduced color stability, and were darker ($P < 0.05$) than all other treatments. All treatments except the Lactate Control had significant darkening from d 2 to d 9. Treatment did not affect discoloration. However, after d 10, the spinalis showed greater discoloration than the longissimus ($P < 0.05$). Microbial growth never exceeded 1 log at any point, but TBARS increased ($P < 0.05$) each day of analysis. Day 14 steaks were the least glossy while d 2 samples were more glossy ($P < 0.05$) than d 14 steaks but not different from d 9 steaks. As time in MAP increased, rancidity, oxidized meat, stale, and brown/roasted flavors increased. The Lactate Control effectively reduced gloss and enhanced color life.

Key Words: Lactate, Enhanced beef, Gloss

119 Effects of polyvinyl chloride film, high-oxygen modified atmosphere, or ultra-low oxygen modified atmosphere packaging on bone marrow discoloration in beef humeri, ribs, thoracic vertebrae, and scapulas.

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Meat retailers have reported bone marrow discoloration to be a problem, especially in modified atmosphere packages (MAP). Therefore, it is important to determine the prevalence and cause(s) of bone marrow discoloration in different beef bones and packaging systems. Thirty-six beef humeri, ribs, scapulas, and thoracic vertebrae from USDA Select and Choice carcasses from a commercial abattoir were cut into 2.54-cm-thick sections at 4 d postmortem and packaged in either: 1) polyvinyl chloride film (PVC) overwrap; 2) high-oxygen (80% O_2, 20% CO_2) (HiOx) MAP; or 3) ultra-low-oxygen (70% N_2, 30% CO_2) (ULOx) MAP. Instrumental reflectance (d 0, 2, and 4) and visual-color scores (d 0 to 4) were taken. Marrow was extracted from humeri, ribs, and thoracic vertebrae for analysis. Ribs, scapulas, and thoracic vertebrae packaged in PVC and HiOx developed gray or black discoloration, but not in ULOx MAP. Discoloration was much more extensive for ribs, scapulas, and thoracic vertebrae than for humeri when packaged in PVC and HiOx. The a* values for ribs, scapulas, and thoracic vertebrae decreased ($P < 0.05$) over time. Chroma showed that bones discolored during display, but graying was dramatically less for bones packaged in ULOx and for humeri in PVC and HiOx MAP. Humeri had smaller ($P < 0.05$) 2-thiobarbituric acid reactive substances (TBARS) values than did ribs and thoracic vertebrae. Bones in ULOx had the least change in TBARS from d 0 to 4. Thoracic vertebrae had larger ($P < 0.05$) TBARS values at d 4 of display than at d 0 in PVC and HiOx packages. Humeri marrow had dramatically less ($P < 0.05$) total iron (Fe) and hemoglobin (Hb) than did ribs and thoracic vertebrae. The much larger amounts of Fe and Hb in ribs and thoracic vertebrae likely corresponds to marrow discoloration. Bone marrow discoloration is not a problem in humeri but occurs in ribs, scapulas, and thoracic vertebrae packaged in PVC or HiOx. Bones packaged in ULOx had minimal discoloration.

Key Words: Beef bone marrow, Discoloration, Packaging

120 Effects of ascorbic acid, rosemary, and Origanox™ in preventing bone marrow discoloration in beef lumbar vertebrae packaged in polyvinyl chloride film, high-oxygen modified atmosphere, or ultra-low oxygen modified atmosphere packaging.

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Bone marrow discoloration has been reported in high-oxygen, modified atmosphere packaged (MAP) beef and pork in addition to cuts packaged in polyvinyl chloride film (PVC). Our objective was to evaluate the effects of different antioxidant treatments in preventing bone marrow discoloration in beef lumbar vertebrae. Seventy-two beef lumbar vertebrae from USDA Select and Choice carcasses held at 2°C either 6

or 14 d postmortem before packaging were obtained from a commercial abattoir. Lumbar vertebrae were cut into 2.54 cm thick sections and packaged into one of three packages: 1) PVC overwrap; 2) high-oxygen (80% O_2, 20% CO_2) (HiOx) MAP; and 3) ultra-low-oxygen (70% N_2, 30% CO_2) (ULOx) MAP. Prior to packaging, bones sections were treated with one of the following antioxidant treatments: control with no treatment application; 1.25% or 2.5% ascorbic acid (AA); 0.1% or 0.2% rosemary (RM); or a combination treatment of 0.15% Origanox^{TM} + 0.3% ascorbic acid (Or-AA). Lumbar vertebrae treated with 0.1 and 0.2% RM, and the controls discolored ($P < 0.05$) to gray or grayish-black based on visual color scores and a* values. Also, RM was not effective in preventing discoloration in PVC and HiOx MAP. The 1.25% AA and Or-AA maintained desirable color scores through d 2 but not through d 4 of display in PVC. The 2.5% AA treatment was most effective in preventing discoloration and maintaining initial color in both PVC and HiOx MAP. The 1.25% AA treatment was as effective ($P < 0.05$) as the 2.5% AA treatment in preventing bone discoloration in ULOx MAP. Lumbar vertebrae treated with AA and(or) packaged in ULOx had the highest ($P < 0.05$) a* values over display time. In general, discoloration tended to be greater in bones held 14 d postmortem than those held 6 d. Ascorbic acid treatments, particularly the 2.5% application, were very effective in preventing bone marrow discoloration and were superior to other treatments.

Key Words: Beef bone marrow, Discoloration, Antioxidant

121 A single nucleotide polymorphism in the bovine leptin gene and the effect on gain and carcass characteristics.

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A trial was conducted to determine the effect of a single nucleotide polymorphism (SNP, cytosine to thymine 305 base pairs from the start of exon 2) in the bovine leptin gene on carcass characteristics. Previous research indicates C homozygotes appear leaner than T homozygotes. At the beginning of the trial, ultrasound measurements of 12th rib fat and LMA were taken. Crossbred steers were identified by genotype (CC = 21, CT = 107, TT = 61) and fed a common diet. Steers were weighed at d 71; and weighed and ultrasounded at d 160. Steers were slaughtered in four groups (d 176, 182, 190, 196). Data were analyzed using the MIXED procedure of SAS (genotype was fixed effect and slaughter group was random effect) with mean separation by least squares protected by an F-test ($P<0.10$). BW at d 71 (278 ± 8 kg), 160 (545 ± 12 kg), and final weight (570 ± 10 kg) were not different among genotypes. When compared to TT (1.70 ± 0.05 kg), CT steers (1.80 ± 0.05 kg) had a higher ($P=0.01$) initial ADG. There was no difference in final ADG between genotypes (1.57 ± 0.05 kg). TT steers had a higher ($P\#88040.04$) initial 12th rib fat depth (0.24 ± 0.03 cm) when compared to CT (0.19 ± 0.03 cm) and CC steers (0.17 ± 0.04 cm). There was no difference in carcass 12th rib fat (1.26 ± 0.12 cm) or 12th rib fat change from initial measurement (1.06 ± 0.10 cm). No differences were detected in LMA between genotypes at d 0 (52.1 ± 1.4 cm^2) or at d 160 (81.4 ± 1.8 cm^2). TT steers had a smaller ($P\#88040.04$) final LMA (79.7 ± 1.4 cm^2) compared to CC (84.3 ± 2.1 cm^2) and CT (82.5 ± 1.2 cm^2) steers. TT steers also had a smaller ($P=0.02$) LMA change (27.3 ± 1.5 cm^2) compared with CC (32.1 ± 2.1 cm^2) and CT (30.4 ± 1.4 cm^2). Hot carcass weight (359 ± 6 kg), marbling score (450 ± 23), and KPH fat (2.19 ± 0.16 %) were not different. TT steers had higher ($P=0.03$) yield grades (3.32 ± 0.17) compared to CC steers (2.91 ± 0.21). Units of marbling per unit of YG (149.3 ± 9.6) were not different. We conclude that the CC genotype appears to be leaner with greater longisimus area compared to TT steers.

Key Words: Leptin, Intake, Cattle

David Baker Symposium

122 Implications of intestinal microbiota on protein nutrition.

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Bacteria colonizing the pig intestine exceed by 10 fold the number of host cells, represent a hugely diverse taxonomy and a combined genome of perhaps 2 million genes (versus 30 000 in the pig). We hypothesize that protein nutrition of the pig is directly affected by microbial competition for ingested proteins and indirectly as a result of intestinal metabolic responses to the complex luminal microbiota. However, study of the magnitude and nature of theses effects has been limited due to the complexity of the microbial community and the lack of comprehensive and quantitative profiling methods. Molecular microbial profiling techniques, including our own development and application of chaperonin 60 (cpn60) based library and quantitative PCR diagnostics, will aid identification and enumeration of bacteria which impact protein nutrition such as those species shown to lack proteases necessary for direct metabolism of intact protein. To permit study of intestinal metabolic responses to specific bacterial species we established a gnotobiotic pig model which permitted comparison of germ-free (GF), *Lactobacillus fermentum* (LF)-monoassociated, *Escherichia coli* (EC) monoassociated and conventional (CV) pigs. A marked effect of the microbial status on the protein requirement for maintenance of the intestine was indicated by several observations. Epithelial cell replacement rate was extremely low in GF compared with CV pigs as indicated by a 2-3 fold increase in villus height, increased PCNA transcript and activated caspase-3 protein abundance. Lower aminopeptidase N activity in CV pigs was associated with increased transcript abundance suggesting marked microbial metabolism of secreted proteins. Intestinal proinflammatory cytokine expression was also markedly higher in CV versus GF pigs. Generally, LF pigs demonstrated intestinal responses similar to GF pigs. However, EC pigs demonstrated responses intermediated between GF and CV pigs. We conclude that evidence suggests that the composition of bacteria colonizing the intestine may significantly affect protein nutrition in the pig.

Key Words: Microbial ecology, Gnotobiotic, Protein nutrition

123 Approaches to estimation of nutrient requirements using broken-line regression analysis.

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Our objective was to evaluate various broken-line regression models for estimating nutrient requirements from nutrient dose response data. Broken-line regression analysis: 1) is relatively simple using standard non-linear regression software; 2) provides a function that describes the response to nutrient dose across all dose levels; and 3) provides a point estimate (requirement) and its estimated variance. Linear broken-line regression presumes that the response to nutrient dose is linear when in fact it is not. The rate of change to nutrient dose declines as the nutrient dose approaches its requirement. For some data sets, linear broken-line regression can account for a substantial proportion of total variation and yields a requirement estimate that is a nutrient dose above which there is no significant change in the dependent variable. For other data sets, the response is curvilinear as the requirement is approached and broken-line analysis using a straight line, single breakpoint model often underestimates the requirement. We used the growth and plasma urea nitrogen (PUN) response data of Parr et al. (J. Anim. Sci. 2003. 81:745-752) who evaluated the isoleucine requirement of growing swine. We used SAS version 9.0 (2002) PROC NLIN. For the growth data we fitted three different broken-line regression models: a simple 2-straight- line, 1-breakpoint model; a 3-straight line, 2-breakpoint model; and a quadratic broken-line model in which the response below the single breakpoint was quadratic with a plateau above the breakpoint. The 2-straight-line, 1-breakpoint model yielded a requirement estimate of of 0.47±0.008; the quadratic breakpoint model yielded a requirement estimate of 0.50±0.014; and the 3-straight-line, 2-breakpoint model yielded breakpoints at 0.44±0.007 and 0.54±0.129. For growth data, the quadratic broken-line model accounted for the largest proportion of variation and thus provided best fit. For PUN data, the best was fit was achieved with the 2-straight-line, 1-breakpoint model and also yielded a requirement estimate of 0.50±0.045. Model descriptions and SAS code will be presented and discussed.

Key Words: Nutrient Requirements, Regression Analysis

124 Free muscle amino acid concentration in growing pigs fed diets containing crystalline amino acids as partial replacement for protein-bound amino acids. F. Guay, J. B. Moore, and N. L. Trottier*, *Michigan State University*.

Twenty-four barrows were used to determine if partial replacement of protein-bound AA with crystalline AA (CAA) reduces AA use for growth. Barrows (44.2 ± 1.3 kg BW) were assigned to four diets in a randomized block design. Diets consisted of 16.1% CP with no CAA, and 12.8, 10.1 and 7.8 % CP (analyzed values, as fed) containing CAA. As CP decreased, CAA were gradually included in increasing concentrations to meet true ileal digestible requirements. Feed was given at 0800 and 1600 daily for 14 d providing five times ME required for maintenance. Barrows were weighed on d 0 and 14. Blood samples were collected prior to a.m. feeding (pre-absorptive) on d 0, 6 and 12, and 2 h post meal (absorptive) on d 14. Following 2-h post meal blood collection, pigs were euthanized, liver and right longissimus dorsi (LD) muscle removed and weighed, and samples frozen at -70°C. Reduction in dietary CP did not reduce daily feed intake but linearly decreased ($P < 0.05$) ADG, G:F, final BW, LD weight, LD weight to BW ratio, LD dry matter (DM), LD DM to BW ratio, LD CP and LD CP to BW ratio. Reduction in dietary CP decreased absorptive and pre-absorptive plasma IGF-I and insulin concentrations (quadratic and linear, respectively, $P < 0.05$). In muscle free AA pool, reduction in dietary CP increased ala, asp, glu, gln, gly and decreased asn and tyr concentration (linear, $P < 0.05$). In free indispensable AA pool, muscle concentrations of ile, lys, phe, met, thr, trp and val decreased as CP decreased from 16.1 to between 12.8 and 10.1% but increased as CP further decreased between 10.1 and 7.8% (quadratic, $P < 0.05$). In summary, reduction in dietary protein-bound AA reduces whole body and LD growth, alters free AA pool profile in LD muscle and decreases insulin and IGF-1 plasma concentrations. As CAA replacement for protein-bound AA increased, 1) higher free ala and gln muscle concentration indicates increase in muscle protein breakdown; 2) curvilinear nature of the change in free AA pool profile suggests that indispensable AA utilization by LD muscle initially increased but decreased thereafter.

Key Words: Amino acid, Muscle, Pig

125 Trials and tribulations utilizing supplemental amino acids in poultry and swine diets. B. J. Kerr*, *USDA-ARS-SOMMRU*.

Amino acid nutrition of swine and poultry has been investigated using individual amino acids since the discovery of threonine by W. C. Rose in 1935. With commercially available sources of synthetic methionine and crystalline lysine in the early 1960s and because these two amino acids are typically first limiting in poultry and swine, respectively, there has been a plethora of research estimating their required needs. As additional crystalline amino acids became commercially available, tryptophan and threonine in the early 1980s and isoleucine and valine in the late 1990s, research on their estimated requirements, and ratios relative to lysine, has also expanded our understanding on how to formulate diets to minimize amino acid excesses while meeting minimal nutritional needs. Research trials with these amino acids, however, are far fewer in number and often more variable than trials noted with methionine and lysine. Nevertheless, only through a comprehensive understanding of these next limiting amino acid(s) in a diet can further progress in utilizing supplemental amino acids be made. High protein commodity prices (most notability the soybean meal prices of 1973, 1977, 1988, and 2004), economically available alternative feed ingredients, and the increasing awareness of the impact of livestock production on the environment has also stimulated interest in feeding reduced protein, amino acid supplemented diets to swine and poultry. A summary of research will presented on applications of crystalline amino acids in poultry and swine diets, their ability to maintain or improve animal productivity and carcass lean development, challenges in feeding reduced crude protein-amino acid supplemented diets, and potential impacts of feeding these diets on the environment.

126 Effect of increasing dietary crude protein concentration on growth performance and serum insulin-like growth factor-I concentration in growing-finishing barrows and gilts. R. Fischer* and P. Miller, *University of Nebraska, Lincoln*.

Sixty-four crossbred pigs (32 barrows and 32 gilts) with an initial BW of 34.1 kg were used in a 26-d growth study. The pigs were randomly allocated to one of four dietary treatments and individually penned (8 replicates/treatment sex combination). The diets were standard corn-soybean meal diets, which were formulated to contain 10, 14, 18, or 22% CP by changing the ratio of corn to soybean meal. Pig and feeder weights were recorded weekly for the determination of ADG, ADFI, and feed efficiency (ADG/ADFI). Blood samples were collected weekly and analyzed for urea and IGF-I concentrations. Three barrows and three gilts were slaughtered at the initiation of the experiment for the determination of organ weights and carcass composition. At the termination of the experiment, pigs were slaughtered to determine carcass accretion rates of protein, water, fat, and ash. There was no difference ($P > 0.10$) in ADFI among treatments; however, barrows consumed more feed than gilts (1.79 versus 1.68 kg/d; $P = 0.01$) throughout the 26-d period. Dietary protein concentration had linear and quadratic effects on ADG and ADG/ADFI ($P < 0.01$). Also, barrows gained weight faster (ADG: 0.71 versus 0.64 kg; $P < 0.01$) and were more efficient (ADG/ADFI: 0.40 versus 0.38 kg/kg; $P = 0.02$) than gilts throughout the experiment. Increased dietary protein concentration resulted in increased fat-free lean gain and carcass protein accretion rate (41.70, 82.70, 104.96, and 119.96 g/d, respectively; linear, $P < 0.01$; quadratic, $P < 0.01$). Protein concentration had linear and quadratic effects ($P < 0.01$) on plasma urea concentrations (25.80, 27.32, 28.05, and 33.85 mg/dL, respectively) and serum IGF-I concentrations (217, 357, 428, and 421 ng/mL, respectively). These results suggest that the consumption of a diet marginally deficient in CP (18%) does not inhibit the production of IGF-I; however, pigs consuming the 22% CP diet had greater protein accretion rate ($P < 0.01$) than pigs consuming the 18% CP diet indicating that the actions of IGF-I are partially inhibited.

Key Words: Pigs, IGF-I, Crude Protein

127 Ideal amino acid formulation in gestation diets to improve gestation and subsequent lactation performance of sows. F. Ji[1], G Wu[2,1], M. F. Miller[1], and S. W. Kim*[1], [1]*Texas Tech University*, [2]*Texas A&M University*.

Thirty-four pregnant gilts were used to test the hypothesis that feeding pregnant gilts diets with ideal AA ratios improves their performance during gestation and subsequent lactation. In Exp. 1, 14 gilts were allotted to a control group (C1, 7 gilts) and an ideal protein (IP1, 7) group at d 30 of gestation. In Exp. 2, 20 gilts were allotted to a control group (C2, 10) and an ideal protein (IP2, 10) group at d 30 of gestation. Pregnant gilts were provided with two meals of a gestation diet (2.0 kg/d, 3.1 Mcal ME/kg, 12.2% CP) from d 30 to 112 of gestation. The C1 and C2 had the same diet from d 30 to 114 of gestation (lys:thr:arg=100:77.3:128.0). The IP1 was formulated to provide an ideal dietary AA ratio for maternal and fetal tissue gains (100:49.4:95.3 for d 30 to 60 and 100:50.8:103.6 for d 60 to 114), whereas the IP2 diet for maternal and fetal tissue gains as well as maternal maintenance (100:79.4:89.3 for d 30 to 60 and 100:71.2:97.9 for d 60 to 114). BW and backfat thickness (BF) were measured at d 30, 60, 90, and 109 of gestation. Immediately after farrowing, the number of total and live born piglets and individual piglet weights were recorded. All sows were fed the same lactation diet ad libitum. Feed intake of all sows was recorded daily during lactation. BW and BF of sows and BW of piglets were measured at d 0, 7, 14 and 21 of lactation. All sows weaned at d 21 of lactation. Days of return-to-estrus were recorded. In Exp 1, BF of the IP1 at d 109 of gestation was higher ($P < .05$) than that of the C1. The IP1 tended to have greater ($P < .07$) BF gain than the C1 during lactation. In Exp 2, compared with the C2, the IP2 had greater ($P < .01$) BW gains during d 60 to 109 and d 30 to 109 of gestation and had more ($P < .05$) BF during d 30 to 60 and d 30 to 109 of gestation. The mortality of piglets at weaning was reduced by 87% ($P < .05$) in the IP2 compared with the C2. Collectively, feeding a gestation diet with the ideal dietary AA ratio for both protein accretion and maintenance enhanced maternal BW and BF gains of gilts during gestation and improved piglet survival during the subsequent lactation.

Key Words: Ideal protein, Sows, Gestation

128 Evaluation of corn distillers dried grains with solubles and a polyclonal antibody on growth performance and the ability of pigs to resist an infection from *Salmonella* Typhimurium. M. Spiehs*, G. Shurson, L. Johnston, and K. Seifert, *University of Minnesota*.

A two part study was conducted to determine if growth performance and the incidence of *Salmonella* shedding were influenced by the inclusion of 50% corn distillers dried grains with solubles, or a polyclonal antibody (IMT^{+TM}, CAMAS, Inc) in the diets of growing and finishing pigs. For Part 1, 135 pigs (14 kg initial BW) were blocked by weight and randomly allotted within block to one of three dietary treatments: corn-soybean meal control (C), C+ a polyclonal antibody (PCA), or a corn-soybean meal diet containing 50% corn distillers dried grains with solubles (DDGS). Diets were formulated to contain equivalent ME, apparent digestible Lys, total Ca, and available P across all diets in each of 5 phases. Overall ADG and ADFI for pigs fed the DDGS diets (690 and 1870 g/d, respectively) were less ($P < 0.05$) than pigs fed the PCA diets (780 and 1970 g/d, respectively) or C diets (740 and 1960 g/d, respectively). Overall G:F for the pigs fed the DDGS diets (0.37) was less ($P < 0.01$) than pigs fed PCA diets (0.39) and tended to be less ($P = 0.09$) than pigs fed the C diet (0.38). Pigs fed the C and PCA diets had similar ADG, ADFI, and G:F. Part 2 of the study began on d 105 and involved randomly selecting 40 pigs (109 kg BW) for a disease challenge. Thirty pigs (10 C, 10 PCA, and 10 DDGS) were inoculated with *Salmonella* Typhimurium at d 7, 14, and 33. Ten pigs were not inoculated (NC). Overall *Salmonella* infection was low after each of the 3 inoculations. There were no differences between challenged and NC pigs, or among challenged pigs fed the three dietary treatments in *Salmonella* prevalence of fecal or tissue samples, or serum haptoglobin, $\alpha_1$glycoprotein, IgM, and IgG concentrations. These results indicate that growing-finishing pigs fed diets containing 50% DDGS will have decreased ADFI and ADG compared to pigs fed C or PCA diets. The disease challenge model used in this study was unsuccessful in producing an acute salmonellosis infection in finishing pigs inoculated with *Salmonella* Typhimurium.

Key Words: Salmonella, Distillers grains, Polyclonal antibody

129 The effect of replacing specialty protein sources with synthetic amino acids in phase II nursery pig diets. N. Z. Frantz*[1], S. S. Dritz[1], M. D. Tokach[1], J. M. DeRouchey[1], R. D. Goodband[1], J. L. Nelssen[1], and J. L. Usry[2], [1]*Kansas State University,* [2]*Ajinomoto-Heatland LLC*.

A 10-d growth study with 1,500 pigs (7 d after weaning and 6.6 kg BW) was conducted to determine the effects of replacing SBM with either fish meal, poultry meal, or synthetic amino acids in a phase II diet without plasma on nursery pig performance. Diets were corn-soybean meal based with 10% dried whey and 3% added fat. Diets were formulated to 4.5 g TID lysine/Mcal ME. The five dietary treatments formulated on a TID basis were: 1) a negative control diet containing 0.15% L-lysine HCl; 2) a positive control diet containing 0.3% L-lysine HCl, 0.15% DL-methionine, 0.1375% L-threonine, 2.25% fish meal, and 0.83% blood meal; or the negative control with 3) 4.5% fish meal, 4) 5% poultry meal, or 5) synthetic amino acids (0.525% L-lysine HCl with 0.25% threonine, 0.27% methionine, 0.125% valine, 0.10% isoleucine, and 0.025% tryptophan). From d 7 to 17 post-weaning, feeding pigs the positive control diet or the synthetic amino acid diet resulted in improved ($P < 0.01$) ADG and G:F compared to pigs fed the negative control, fish meal, or poultry meal diets. Pigs fed the positive control or synthetic diet were heavier at d 17 ($P < 0.01$) than pigs fed the negative control diet or diets containing fish or poultry meal. There was no treatment effect on ADFI ($P > 0.34$). In summary, diets containing large amounts of synthetic amino acids appear to be a suitable replacement for specialty protein sources when formulated on a TID basis.

Table 1. The effect of different protein sources in phase II nursery pig diets.

	Negative control	Positive control	Fish meal	Poultry meal	Synthetic amino acids	SE
ADG, g	194[b]	231[a]	186[b]	180[b]	218[a]	10
G:F	0.627[b]	0.722[a]	0.615[b]	0.595[b]	0.690[a]	0.0190

[a,b]$P < 0.05$

Key Words: Nursery pigs, Protein sources, Synthetic amino acids

130 The effects of dietary Biotite V supplementation on growth performance, nutrients digestibility and fecal noxious gas content in finishing pigs. Y. J. Chen*, O. S. Kwon, B. J. Min, K. S. Son, J. H. Cho, and I. H. Kim, *Dankook University*.

Previous research suggested that clay minerals such as zeolite and bentonite have beneficial effects for livestock. A commercially clay mineral additive is currently being marketed under the trade name of Biotite V (Seobong BioBestech Co., Ltd, Seoul, Korea). This experiment was conducted to evaluate the effects of dietary Biotite V (BV) supplementation on growth performance, nutrients digestibility and fecal noxious gas content in finishing pigs. A total of eighty pigs (initial BW 88.0±1.35 kg) were used in a 35 day growth trial. Pigs were blocked by weight and allotted to five dietary treatments in a randomized complete block design. There were four pigs per pen and four pens per treatment. Dietary treatments included: 1) Control (CON; basal diet), 2) 200 mesh BV1.0 (basal diet + Biotite V 1.0% 200 mesh), 3) 325 mesh BV1.0 (basal diet + Biotite V 1.0% 325 mesh), 4) 200 mesh BV2.0 (basal diet + Biotite V 2.0% 200 mesh) and 5) 325 mesh BV2.0 (basal diet + Biotite V 2.0% 325 mesh). Through the entire experimental period, there were not significant differences in ADG, ADFI and gain/feed among the treatments ($P>0.05$). With the addition of Biotite V in diets, DM and N digestibilities were increased significantly ($P<0.01$). Also, Ca and P digestibilities tended to increase in pigs fed Biotite V supplemented diets ($P<0.01$) compared to pigs fed control diet. Supplementation of Biotite V in the diet reduced the fecal NH3-N and volatile fatty acid (VFA) compared to CON treatment ($P<0.01$). In conclusion, supplementation of Biotite V can increase nutrients digestibility and reduce fecal NH3-N and volatile fatty acid (VFA) concentrations in finishing pigs.

Key Words: Biotite V, NH3-N, Finishing pigs

131 Evaluating oregano oil as a growth enhancer in nursery pig diets. C. R. Neill*, J. L. Nelssen, R. D. Goodband, M. D Tokach, S. S. Dritz, J. M. DeRouchey, K. R. Lawrence, and C. N. Groesbeck, *Kansas State University*.

A total of 224 nursery pigs (PIC L 327 L42), initially 5.85 ± 1.36 kg and 21 d of age, were used in a 28 d feeding trial. The objective of our study was to evaluate the effects of oregano oil with or without an in-feed antimicrobial on growth performance of weanling pigs. Oregano oil has been reported to have antimicrobial-like activity. Oregano oil is an extract derived from the Greek oregano herb, Origanum vulgare. The oregano oil (5%) is mixed with an inert carrier (95%) to make a premix that is added to the diet. There were four dietary treatments in a 2 2 factorial. Dietary treatments were fed in meal form and in two phases, which consisted of a negative control (without an antibiotic or oregano oil), or the control diet with neomycin (154 ppm) and oxytetracycline (154 ppm; NT), the control diet with oregano oil, or the control diet with both NT and oregano oil. Oregano premix levels were 0.10% in phase I (d 0 to 14) and 0.05% in phase II (d 14 to 28). Pigs were blocked by weight and randomly allotted to dietary treatments with seven pigs per pen and eight pens per treatment. Pigs were weighed weekly to determine ADG, ADFI, and G:F. There was no oregano oil by antibiotic interaction observed ($P > 0.15$). From d 0 to 28 pigs fed diets containing NT had improved ($P < 0.05$) ADG (420 vs 361 ± 12.2 g), ADFI (542 vs 481 ± 18.4 g), G:F (0.78 vs 0.75 ± 0.007) and final weight (17.6 vs 16.0 ± 0.84 kg) compared with pigs not fed NT. Adding oregano oil to nursery pig diets did not improve ADG (393 vs 388 ± 12.2 g), ADFI (512 vs 511 ± 18.4 g), or G:F (0.77 vs 0.76 ± 0.007) over the 28 d trial compared to pigs not fed oregano oil. In conclusion, oregano oil was not effective in enhancing growth performance in this experiment, whereas NT improved growth performance.

Key Words: Nursery pigs, Antimicrobial, Oregano

132 Effects of weaning time (pm or am) on nursery pig growth performance. C. R. Neill*, M. D. Tokach, J. L. Nelssen, R. D. Goodband, S. S. Dritz, J. M. DeRouchey, C. N. Groesbeck, and K. R. Lawrence, *Kansas State University*.

An experiment was conducted to evaluate the effects of weaning time (PM or AM) on nursery pig growth performance. The objective was to determine whether removing sows from the farrowing crates 12 h before moving pigs to the nursery would influence how weanling pigs adjust to the nursery environment. Each sow and litter was randomly allotted to a wean time of either 18:00 on d 0 (d 0 PM) or 6:00 on d 1 (d 1 AM). For pigs weaned on d 0 PM, the sow was removed leaving the pigs in the farrowing crate until d 1 when the other litters that remained on the sow were weaned. All pigs, both PM and AM treatments, were moved from the farrowing house to the nursery on the morning of d 1. A total of 542 weanling pigs (PIC L 327 x L42) from 50 litters were used in the experiment. Pigs were approximately 21 d of age with an average initial body weight of 6.05 kg. All pigs were weighed in the farrowing house just prior to weaning the d 0 PM litters. Pigs were weighed again on d 7, 14, 21, and 28 to determine ADG, ADFI, and G:F. There was an improvement in G:F (0.88 vs 0.79; $P < 0.01$) from d 0 to 7 for pigs that were left on the sow until actual weaning on d 1 AM compared with those weaned on d 0. The reason for this difference was that d 1 AM litters were allowed to nurse for an additional 12 h compared to those litters whose sows were removed on d 0 PM. Although not significant ($P = 0.17$), pigs that had their sow removed on d 0 PM tended to have higher ADFI compared to the d 1 AM weaned pigs for d 0 to 7 (166 vs 159 g, respectively). From d 0 to 28, removing sows from the farrowing house early (d 0 PM) had no influence on ADG (391 vs 391 g), ADFI (506 vs 504 g), or G:F (0.77 vs 0.78). This suggests that weaning time may be scheduled for either early or late in the day to optimize workflow in the sow farm without influencing nursery growth performance.

Key Words: Nursery, Weaning, Growth

133 Particle size of salt and grinding of samples influence the results of mixing efficiency testing. C. N. Groesbeck*, R. D. Goodband, M. D. Tokach, S. S. Dritz, J. L. Nelssen, and J. M. DeRouchey, *Kansas State University*.

Two experiments were conducted to evaluate the effect of salt with different particle sizes and sample preparation (unground or ground) on mixing efficiency testing (time required to achieve a CV of 10% or less among 10 feed samples). A 1,360.8 kg capacity horizontal ribbon mixer was used to mix batches of feed. Ten samples were collected at eight times during mixing (0, 30, 60, 120, 210, 330, 480, and 630 s) from pre-determined locations in the mixer. Coefficient of variation was used to measure mixer efficiency by analysis for chloride concentration with Quantab chloride titrators. In Exp. 1, four 1,360.8 kg batches of feed were prepared, two with 440 micron salt and two with 730 micron salt. Samples were analyzed as collected (unground; approximately 700 microns), or ground with a coffee grinder (ground; approximately 400 microns). A salt particle size sample preparation mixing time interaction ($P < 0.001$) was observed; however, a CV of 10% or less was never achieved, indicating inadequate mixing. In Exp. 2, all samples were collected from 907.2 kg batches of feed made in the same 1,360.8 kg capacity mixer. Salt particle sizes of 440, 730, 1,999, and 3,000 microns were analyzed as unground or ground. A salt particle size sample preparation mixing time interaction ($P < 0.04$) was observed. As salt particle size decreased and mixing time increased, there was a decrease in CV. Grinding samples before analysis decreased CV compared with the unground samples, but to a greater extent with coarse salt compared with fine salt. Batches with 440 and 730 micron salt (ground) reached a CV of less than 10%, indicating a uniform mixture. All other treatments did not reach a CV of 10% or less. When the mixer was filled to the rated capacity, we were unable to achieve an acceptable CV for mixing efficiency. Our study also showed that when conducting mixer efficiency testing it is important to use a fine mixing salt.

Key Words: Mixing efficiency, Particle size, Salt

134 Effects of in-feed antimicrobials on growth performance of weanling pigs in a research environment. R. O. Gottlob*, J. M. DeRouchey, M. D. Tokach, R. D. Goodband, S. S. Dritz, J. L. Nelssen, C. W. Hastad, C. N. Groesbeck, and K. R. Lawrence, *Kansas State University*.

A total of 168 weanling pigs (initially 6.3 kg) were used to determine the effects of different feed-grade antibiotics on pig performance. There were six pigs per pen and seven pens per treatment. Pigs were fed 4 experimental diets: a control diet with no in-feed antimicrobials; or the control diet with tiamulin (39 ppm) and chlortetracycline (441 ppm; tiamulin/CTC), neomycin sulfate and oxytetracycline (154 ppm; Neo/oxy), or carbadox (55 ppm). Carbadox had been the standard in-feed antimicrobial fed in this research facility for the previous 10 years. The corn-soybean meal-based diets contained 15% dried whey and 3.75% fishmeal from d 0 to 14. No other specialty protein sources or pharmacologic concentrations of Zn or Cu were used in either phase. From d 0 to 28 after weaning, pigs fed diets containing tiamulin/CTC or Neo/oxy had greater ADG and ADFI ($P<0.05$) than pigs fed all other diets and had improved G:F compared to pigs fed the control diet. Pigs fed carbadox were intermediate and had greater ($P<0.05$) ADG and G:F compared to pigs fed the control diet. The addition of in-feed antimicrobials resulted in improved growth performance in this research facility. The magnitude of response was surprising because the pigs used were healthy and the herd of origin is free of all major swine pathogens. In order to prudently use in-feed antimicrobials, further research is needed to predict the conditions that result in optimum benefit while minimizing usage.

	Control	Tiamulin/CTC	Neo/oxy	Carbadox	SED
ADG, g	327^{a}	381^{c}	399^{c}	358^{b}	11.50
ADFI, g	426^{a}	472^{b}	472^{b}	440^{a}	10.72
G:F	0.76^{a}	0.81^{b}	0.85^{b}	0.81^{b}	0.02

^{abc}Means in the same row with different superscripts differ ($p < 0.05$).

Key Words: Nursery pig, Antimicrobial, Growth

135 Evaluation of normal corn and quality protein maize in feed rations for laying hens. S. W. Zhai*[1,2], G. H. Qi[1], and F. Z. Liu[2], [1]*FRI,Chinese Academy of Agriculture Science,* [2]*Northwest Sci-Tech University of Agriculture and Forestry*.

This experiment was carried out to study the effect of diets containing quality protein maize (QPM)-Zhongdan9409 on the performance and egg quality. 528 157-day-old Hyline brown commercial laying hens were divided into three treatments of four replicates each. The treatment 1(T1) was fed normal corn (NC) diet with lysine level 0.71%, the treatment 2 (T2) was fed QPM diet with lysine level 0.76%, and the treatment 3 (T3) was fed QPM diet with lysine level 0.69%. The results were as follows. Laying hens fed on QPM diets had higher daily feed intake than NC diet ($P<0.05$), it indicated the palatability of QPM was better than that of NC. T3 had significantly higher egg production than T1 and T2 ($P<0.05$). However, there was no significant difference between T1 and T2. There were no significant differences in the average egg weight, feed conversion and soft-shell egg and broken egg ratio among any two treatments ($P>0.10$). Compared to T1 and T2, T3 tended to have the highest performance and T2 tended to have the worst performance. The egg yolk color was improved by replacing NC with QPM equally ($P<0.10$), but Haugh unit score and eggshell strength were not increased by replacing NC with QPM ($P>0.10$). These results indicate that performance of layers could be improved by replacing NC with QPM equally and maintaining an optimal lysine level. The improvement of QPM nutritive value was due to the changing of amino acid content and composition.

Key Words: Quality protein maize, Laying hens, Normal corn

136 Effects of long term feeding of virginiamycin in growing-finishing pigs fed phosphorus deficient diets. J. H. Agudelo*[1], M. D. Lindemann[1], M. C. Newman[1], G. L. Cromwell[1], and R. D. Nimmo[2], [1]*University of Kentucky,* [2]*Phibro Animal Health*.

A study was conducted to evaluate the effects of removing 0.15% dietary dicalcium phosphate (DICAL; i.e., 0.028% P) when virginiamycin (VIR) was supplemented to the diet (11 mg/kg) of growing-finishing pigs on growth, metacarpal (MC) and metatarsal (MT) responses, carcass traits, and ileal bacterial populations. The level of DICAL removal was based

on earlier demonstrations of VIR improvement of P digestibility. Four replications of crossbred pigs (24 gilts and 8 barrows; two pigs/pen) with average initial and final weight of 29.1 and 113.2 kg, respectively, were used. Feed and water were supplied at libitum. A basal (B) corn-soybean meal diet was formulated for each stage of growth (29 to 50, 50 to 80, and 80 to 113 kg). Dietary treatments were: 1) B, 2) B + VIR, 3) B - DICAL, and 4) B + VIR - DICAL. Diets 1 and 2 met all NRC (1998) requirements with Ca/aP of 0.60/0.23, 0.50/0.19, and 0.45/0.15 for the three growth stages, respectively. Diets 3 and 4 were slightly P deficient. The removal of DICAL reduced bone ash contents (P = 0.01) and mean bone strength (P = 0.05) as anticipated. Although the amount of phytate-utilizing organisms tended (P = 0.13) to increase with VIR, the diminished bone strength associated with the DICAL removal was not recovered with VIR supplementation.

Effect of virginiamycin and phosphorus removal in grow-finish pig diets

Treatment:	1	2	3	4	VIR	P-value DICAL	VIR x DICAL
ADG, kg	0.751	0.786	0.797	0.738	0.75	0.97	0.20
MC-MT strength, kg	138.2	145.1	128.9	131.2	0.39	0.05	0.67
MC ash, %	59.5	59.7	59.2	59.1	0.54	0.01	0.17
MT ash, %	57.5	57.2	56.5	56.4	0.54	0.01	0.84
LEA, cm^2	44.1	46.4	44.7	43.5	0.68	0.46	0.25
Backfat, cm	2.21	2.08	2.16	2.11	0.68	0.97	0.85
Ileal bacteria (Log_{10} CFU/g), individual means							
Phytate-utilizing	7.35	8.26	7.97	8.24	0.13	0.46	0.44
Lactobacilli	9.58	7.84	8.25	8.69	0.10	0.36	<0.01

Key Words: Virginiamycin, Phosphorus, Bacteria

137 Effect of sex and slaughter weight on pig performance and carcass quality.

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The aim here was to examine the effect of sex and slaughter weight on performance and carcass quality in pigs of a lean genotype. Forty five single sex pairs of pigs (meatline Landrace sire on Landrace x Large White sows) were used in a 3 (sex) x 3 (slaughter weight) factorial design with 5 pairs per treatment. The experimental period was from weaning (mean = 26 days and 8.6 kg) to slaughter. Sexes were boar (B), castrate (C) and gilt (G) and the slaughter weights were 80, 100 and 120 kg liveweight. All pigs were fed the same diets based on wheat, barley and soybeanmeal ad libitum as dry pellets. Nutrient content of the diets were 14.5 MJ/kg digestible energy (DE) and 13.0 g/kg total lysine (LYS) from weaning to 15 kg;14.1 MJ/kg DE and 13.0 g/kg LYS from 15 to 30 kg and 13.7 MJ/kg DE and 11.1 g/kg LYS from 30 kg to slaughter. Sex x slaughter weight interaction effects were not significant (P>0.05). Daily weight gain and feed conversion ratio (FCR) were 737, 753 and 710g (s.e. 9.6; P<0.01) and 2.30, 2.45 and 2.47 (s.e. 0.04; P<0.05) for B, C and G respectively. Backfat depth, muscle depth and carcass lean meat content (by Hennessy Grading Probe) were 11.0, 13.3 and 11.2 mm (s.e. 0.4; P<0.01); 51.2, 52.3 and 53.6 mm (s.e. 1.1; P>0.05) and 563, 544 and 567 g/kg (s.e. 4, P<0.01) for B, C and G respectively. Daily weight gain and feed conversion ratio (FCR) were 717, 735 and 748 g (s.e. 10, P=0.11) and 2.15, 2.43 and 2.64 (s.e. 0.04; P<0.01) for slaughter weights of 80,100 and 120 kg respectively. Backfat depth, muscle depth and carcass lean meat content were 10.2, 12.2 and 13.1 mm (s.e. 0.4; P<0.01); 46.2, 53.2 and 57.7 mm (s.e. 1.1; P<0.01) and 568, 557 and 549 g/kg (s.e. 4; P<0.01) respectively. Boars grew faster than gilts, more efficiently than gilts and castrates and had a greater lean content than castrates. Growth rate increased, FCR deteriorated and lean meat content reduced as slaughter weight increased.

Key Words: Sex, Slaughter weight, Castration

138 Apparent and true ileal amino acid digestibility and DE and ME of specialty protein sources intended for nursery pig diets.

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Two experiments were conducted to determine the apparent (AID) and true (TID) ileal digestibility of amino acids, and DE and ME of rice protein concentrate (RPC), salmon protein hydrolysate (SPH), whey protein concentrate (WPC), and spray-dried animal plasma (SDAP). In Exp. 1, six barrows (initially 29.5 kg) were surgically fitted with simple T-cannulas and fed each of 4 corn starch-based diets containing 12.5% CP in a balanced crossover design. During the last period, pigs were fed a protein free diet to calculate TID. Ileal digesta was collected, analyzed, and AID and TID values were calculated (Table 1). In Exp. 2, six barrows (initially 37.6 kg) were fed each of 4 corn-based diets containing 20.0% CP in a balanced crossover design. A corn control diet containing 8.2% CP was also included to calculate energy values by difference. Feces were collected and DE and ME were calculated. In Exp. 2, DE and ME values were 4724 and 4226, 4173 and 3523, 4949 and 4352, and 4546 and 3979 kcal/kg for RPC, SPH, WPC, and SDAP, respectively. Although RPC and SPH have lower amino acid digestibility than WPC or SDAP, the values are similar to published values for soybean meal. The high amino acid digestibility, coupled with relatively high DE and ME values, indicates these protein sources may warrant further investigation as potential ingredients for nursery pig diets.

Table 1. Apparent and true ileal digestibility of ingredients, %

	RPC		SPH		WPC		SDAP	
Amino Acids	AID	TID	AID	TID	AID	TID	AID	TID
Isoleucine	75.6	80.7	72.2	81.2	90.8	94.3	87.1	92.8
Lysine	80.0	86.6	85.6	89.7	93.3	95.7	92.8	95.4
methionine	65.6	69.0	85.5	88.7	89.9	93.9	85.7	93.5
Threonine	68.4	78.9	69.8	80.2	83.6	88.4	86.5	92.2
Tryptophan	84.7	103.9	65.4	104.8	92.3	102.2	91.2	101.0
Valine	76.0	81.3	73.7	83.4	87.4	92.5	89.2	93.8

Key Words: Digestibility, Protein source, Amino acid

139 The effects of Natuphos® phytase, Ronozyme® phytase, and a combination of the two products on nutrient digestibility in growing pigs.

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Sixteen crossbred barrows (56 kg) were used over 2 experimental periods to evaluate the relative efficacy of the addition of Natuphos® phytase (NP), Ronozyme® phytase (RP) or a combination of the two products (N+R) to corn-SBM based diets on growth performance, feed efficiency, and nutrient digestibility. Dietary treatments consisted of a negative control diet (NC) with 0.10% aP and 0.43% Ca, and the NC diet supplemented with 500 U/kg of NP, RP, or N+R (250 U/kg of each product). Pigs were individually housed in metabolism pens (1.2 m^2) for 10 d per period with a total collection occurring in the final 3 d of each period. Pigs fed diets supplemented with phytase had increased (P<0.005) ADG (0.747 to 0.990 kg/d) and increased (P< 0.05) G:F (0.292 to 0.355) compared to pigs fed the NC diet. However, no additional improvements were observed in growth or feed efficiency in pigs fed the N+R diet compared to pigs fed the NP or RP diets. There were no differences detected in ADFI among treatment groups. Phytase supplementation increased (P<0.005) P digestibility (24.3 to 38%), increased (P<0.0001) Ca digestibility (41.2 to 52.9%), and tended to decrease DM digestibility (86.4 to 85.2%) compared to pigs fed the NC diet. Pigs fed the N+R diet tended to have increased (P<0.10) P digestibility (36.1 to 41.3%), increased (P=0.05) Ca digestibility (60.4 to 67.9%), and tended (P<0.10) to decrease DM digestibility (85.7 to 84.1%) compared to the NP and RP fed groups. However, no differences were detected in P, Ca, or DM digestibility between pigs fed the NP or RP diets. In conclusion phytase supplementation improved P and Ca utilization by increasing P and Ca digestibility by 36 and 28% respectively. The NP and RP enzymes were equally effective in enhancing nutrient digestibility. However, supplementing with a combination of the two products resulted in a further improvement in P (13.3%) and Ca (11.0%) digestibility compared to feeding each source separately.

Key Words: Phytase, Pigs, Phosphorus

140 Effect of lactation nutritional supplements on the pre-weaning performance of gilts and their litters. C. R. Bertelsen*[1], M. Ellis[1], B. F. Wolter[2], S. Webel[3], and D. Webel[3], [1]*University of Illinois,* [2]*The Maschhoffs,* [3]*United Feeds*.

Excessive sow weight loss during lactation leads to decreased future performance and reduced longevity in the herd. Recently, it has been proposed that certain feed supplements can increase lactation sow feed intake, thus reducing sow weight loss. One such additive is PUSH^{TM} (Land O'Lakes) which has been claimed to improve lactation performance in sows and piglets. Also, spray-dried plasma (SDP) is known to increase feed intake in newly-weaned pigs and could have a similar effect in lactating sows. Therefore, a randomized complete block design was used to evaluate the effects of topdressing these two nutritional supplements on sow and litter performance during lactation. Gilts (PIC C22; n = 96) were allotted at farrowing based on body weight and backfat thickness to one of three treatments: 1) Control, 2) PUSH^{TM} supplement at 145 grams/sow/day, or 3) SDP at 25 grams/sow/day. The lactation diet (3475 kcal/kg ME, 20.3% crude protein, and 1.22% lysine) was formulated to meet NRC (1998) recommendations. Gilts were weighed and backfat depth measured (P2 location) upon entry to the farrowing house and at weaning (19 $\pm$ 2 days). Cross-fostering was performed to equalize litter size and weight across treatments. Piglet body weights were taken at birth, d10, and weaning. Daily feed additions and refusals were recorded. Lactation body weight loss was reduced ($P < 0.05$) in gilts fed SDP (-37.2, -37.8, and -32.4 $\pm$ 1.68 kg for Trt. 1, 2, and 3, respectively) as was the percentage of body weight lost (-16.1, -16.4, and -14.1 $\pm$ 0.70%, respectively; $P < 0.05$). There was no effect of treatment on gilt backfat loss (-2.4, -2.1, and -2.7 $\pm$ 0.71 mm, respectively) or average daily feed intake (4.2, 3.9, and 4.1 $\pm$ 0.13 kg). Also, there was no difference in piglet weaning weight (5.8, 5.8, and 5.9 $\pm$ 0.13 kg). This study suggests that topdressing with SDP to sows during lactation was effective in reducing lactation sow weight loss.

Key Words: Sows, Lactation, Feed Intake

141 Evaluation of beta-glucan and antibiotics on growth performance of weanling and finishing pigs. R. Cueno*, S. Carter, T. Morillo, M. Lachmann, and J. Park, *Oklahoma State University*.

Two experiments were conducted to determine the effects of beta-glucan (BG) on growth performance of pigs. In Exp. 1, a total of 176 pigs (21 d; avg BW = 5.63 kg) were allotted randomly to four dietary treatments (8 pens/trt): 1) No antibiotic or BG (negative control); 2) 0.25% carbadox; 3) 0.2% BG; or 4) 0.4% BG. Pigs were fed in three dietary phases (1.6, 1.4, and 1.2% lysine) during the 42-d study. Pigs and feeders were weighed weekly to determine ADG, ADFI and feed:gain (F:G). In Exp. 2, a total of 144 pigs (20 d; avg BW = 5.39 kg) were blocked by weight and allotted randomly to four dietary treatments (6 pens/trt; 6 pigs/pen) in a 2 x 2 factorial design with two levels of carbadox (0 vs 0.25%) and two levels of BG (0 vs 0.20%). Following the 42-d nursery phase, four pigs from each nursery pen were randomly chosen, allotted to pens, and fed the same dietary treatments with chlortetracycline (CTC; 0.10%) replacing carbadox as the antibiotic until a final weight of approximately 105 kg. Pigs and feeders were weighed every 2 wk. Carcass traits were collected from two pigs per pen. In Exp. 1, there were no differences ($P>0.10$) in ADG, ADFI and F:G of pigs fed diets with carbadox or 0.2% BG. The pigs fed diets with 0.4% BG had ADG and ADFI similar to negative control pigs, but lower ($P<0.10$) than those fed diets with carbadox or 0.2% BG. In Exp. 2, there were no interactions ($P>0.10$) between BG or carbadox inclusion. The addition of carbadox or BG tended to increase ($P<0.06$) ADG, but had no effect ($P>0.10$) on ADFI and F:G. During the finishing phase, there were no effects ($P>0.10$) of dietary treatments; however, the inclusion of either CTC or BG numerically improved ADG by 4 and 6%, respectively. For the entire period, ADG was improved by 4 to 5% with addition of antibiotic or BG. Carcass traits were not affected ($P>0.10$) by dietary treatment. These results suggest a potential for BG to serve as an alternative, or in combination with antibiotics, to improve growth performance of weanling to finishing pigs.

Key Words: Pigs, beta-glucan, antibiotics

142 Energy content of maize grain: sample variability and prediction by near infra-red spectroscopy. T. Sauber*, D. Jones, D. Sevenich, R. Allen, F. Owens, M. Hinds, D. Rice, and G. Baldner, *Pioneer-A DuPont Company*.

Digestible energy (DE) and metabolizable energy (ME) contents of 390 discrete maize grain samples were determined in pigs using a total collection technique. Samples differed in chemical composition and genetics (198 hybrids) and were produced in isolated plots (IA, IL, KS, MN, NE) from 1999-2003. Samples were ground to similar geometric mean particle size (D_{gw} 450-550 microns; $s_{gw}<2.5$) by altering hammermill screen size. Each trial consisted of three consecutive wks with 4-day adaptation and 3-day feces/urine collection periods. Twelve samples (8 reps/sample) and one check (12 reps) were evaluated in 36 pigs (IW 15 $\pm$2 kg) for a total of 108 animal measurements/trial. Diets contained 89.5% maize, 8% casein and 2.5% vitamins/minerals. Constant GE intake per unit of metabolic body size was fed. Data were analyzed as a mixed effect model with covariance adjustment (Proc Mixed, SAS 8.2, Cary, NC) with sample nested in trial*pig group as the fixed effect and the average of checks within pig group, trial, period, and room used as covariates. Overall sample D_{gw} mean was 515 microns, SD 63. Mean pig wt gain for each 3-week trial was 10.6 kg. GE, DE and ME means and SD (kcal/kg DM) were 4500, 95; 4044, 79; 3951, 75, respectively. Ratio means and SD for DE:GE, ME:GE, ME:DE were 0.897, 0.012; 0.877, 0.015; 0.978, 0.007, respectively. Whole grain near infrared spectra acquired in transmittance mode (NIT) were used to develop prediction models (WinISI v1.50e, Infrasoft International) with 18 samples reserved as an independent validation set. NIT prediction model statistics for the SE of calibration (SEC, kcal/kgDM), R^2 and SE of cross validation (SECV, kcal/kgDM) for GE were 21, 0.90, 22 and for DE were 37, 0.74, 39. SE of prediction (SEP) for the independent validation set was 25 kcal/kg DM, R^2=0.70. Instrument repeatability and reproducibility contributed 3.5% and 0% of the predicted value variance so variation among samples accounted for 96.5% of the DE difference predicted by the NIT measurement system. NIT prediction of energy values was both accurate and precise. Management of maize energy variation could be used to enhance feed formulation precision.

Key Words: Energy, Maize, Pigs

143 Effect of dietary crude protein versus crystalline amino acids on growth performance and serum insulin-like growth factor-I concentration in growing-finishing gilts. R. Fischer* and P. Miller, *University of Nebraska, Lincoln*.

Fifty-six crossbred gilts with an initial BW of 33.1 kg were used in a 26-d growth study. The pigs were randomly allocated to one of seven dietary treatments and individually penned (8 replicates/treatment). Seven dietary treatments were used; four were standard corn-soybean meal diets, which were formulated by changing the corn and soybean meal ratio and three were reduced crude protein amino acid-supplemented diets formulated to contain similar lysine, methionine, tryptophan, and threonine concentrations as the corn-soybean meal diets. The dietary treatments were 1) 10% CP diet; 2) 14% CP diet; 3) 10% CP + AA; 4) 18% CP; 5) 14% CP + AA; 6) 22% CP; and 7) 18% CP + AA. Pig and feeder weights were recorded weekly for the determination of ADG, ADFI, and feed efficiency (ADG/ADFI). Blood samples were collected weekly and analyzed for IGF-I concentrations. On d 26, real-time ultrasound backfat and longissimus muscle area measurements were recorded and used for the calculation of fat-free lean gain. There was no difference ($P > 0.10$) in ADFI among treatments throughout the 26-d period. Pigs fed the corn-soybean meal diets had greater ADG (0.82 versus 0.76 kg; $P < 0.05$) and ADG/ADFI (0.44 versus 0.40 kg/kg; $P < 0.05$) than pigs fed the reduced CP amino acid-supplemented diets throughout the experiment. Fat-free lean gain (184, 307, 301, 412, 379, 417, and 424 g/d, respectively) was affected by dietary treatment ($P< 0.01$); however, no differences ($P > 0.40$) in estimated carcass composition were observed between gilts fed the corn-soybean meal (378 g/d) versus CP amino acid-supplemented diets (368 g/d). Serum IGF-I concentrations (243, 311, 305, 445, 411, 444, and 422 ng/mL, respectively) were affected by dietary treatment ($P < 0.01$); however, IGF-I concentration was not different ($P > 0.30$) between gilts fed the corn-soybean meal versus CP amino acid-supplemented diets (400 vs 378 ng/mL, respectively). These results suggest that the form of dietary amino acid supplementation does not affect serum IGF-I concentrations.

Key Words: Pigs, IGF-I, Amino Acids

144 Evaluation of high synthetic lysine diets for 30-52 kg growing gilts reared under commercial conditions. A. M. Gaines*[1], B. W. Ratliff[1], P. Srichana[1], G. L. Allee[1], J. L. Usry[2], G. F. Yi[3], C. D. Knight[3], and K. R. Perryman[3], [1]*University of Missouri,* [2]*Ajinimoto Heartland, LLC,* [3]*Novus International, Inc.*

Two experiments were conducted at a commercial research site in order to evaluate the effects of high synthetic lysine inclusion on the growth performance of growing gilts. In Exp.1, a total of 735 gilts (TR-4 × C22; 32.1 ± 0.15 kg) were used in a RCBD with 7 replicate pens/treatment and 21 pigs/pen (on test 21 d). Pigs were allotted to one of five dietary treatments containing 0.10, 0.20, 0.30, 0.40, and 0.50% added L-Lysine·HCl, respectively. Diets were formulated at a 1.00% true ileal digestible (TID) lysine with supplementation of only L-Thr and Alimet® feed supplement. For Exp.1, diets supplemented with 0.50% L-Lysine·HCl resulted in decreased (Treatment, P < 0.06; Quadratic, P < 0.05) ADG (942, 951, 942, 966, and 907 g/d) and decreased (Treatment, P < 0.01; Linear, P < 0.001) G:F (0.484, 0.476, 0.478, 0.480, and 0.463) compared to diets with 0.10-0.40% L-Lysine·HCl inclusion. In Exp.2, a total of 1,029 gilts (TR-4 × C22; 29.5 ± 0.20 kg) were used in a RCBD with 7 replicate pens/treatment and 21 pigs/pen (on test 23-d). Pigs were allotted to one of six dietary treatments containing 0.10, 0.20, 0.30, 0.40, 0.50, and 0.60% added L-Lysine·HCl, respectively. Diets were formulated at a 1.00% TID lysine and additional L-Thr, Alimet® , L-Trp, L-Ile, and L-Val were supplied as necessary to meet minimum amino acid ratios. For Exp.2, there were no differences in ADG (P=0.21) with increasing L-Lysine·HCl inclusion (935, 948, 922, 929, 942, and 926 g/d). However, diets supplemented with 0.60% L-Lysine·HCl resulted in decreased (Treatment, P< 0.01; Linear, P<0.01) G:F (0.481, 0.481, 0.481, 0.476, 0.475, and 0.468) compared to diets with 0.10-0.40% L-Lysine·HCl inclusion. Collectively, these two experiments indicate that in practical diet formulations, up to 0.40% L-Lysine·HCl can be added with only L-threonine and Alimet® supplementation, whereas up to 0.50% L- Lysine·HCl can be added in diets if supplemented with additional synthetic amino acids. (ALIMET® is a trademark of Novus International, Inc., and is registered in the United States and other countries)

Key Words: Gilts, Lysine·HCl, growth

145 Efficacy of liquid DL-methionine hydroxy analog free acid and DL-methionine as methionine sources for pigs. B. G. Kim[1], M. D. Lindemann*[1], G. L. Cromwell[1], and M. Rademacher[2], [1]*University of Kentucky,* [2]*Degussa AG.*

The replacement rate of liquid DL-methionine hydroxy analog free acid (MHA-FA, 88%) to DL-methionine (DLM, 99%) is a subject of debate. Most of the studies that have been conducted with pigs have involved diets based on cereals other than corn. Thus, the objective of the present study was to evaluate the efficacy of MHA-FA compared with DLM to support N-retention in pigs fed diets based on corn and soybean meal. A total of 30 weanling barrows (mean initial BW of 16.83 ± 0.51 kg) were used in a metabolism study. There were two periods: a 7-d adaptation period and a 5-d collection period for total collection of feces and urine; feed intake was standardized within replicates. The basal diet was formulated to contain 16.85% CP and 0.212% methionine. Dietary treatments included: 1) basal diet, 2) basal plus 0.03% DLM, 3) basal plus 0.06% DLM, 4) basal plus 0.046% MHA-FA, and 5) basal plus 0.092% MHA-FA. The levels of DLM and MHA-FA used were approximated to provide similar methionine equivalents based upon the commercial products used and literature estimates that MHA-FA would have a relative bioequivalence of about 65% on average compared to the DLM. Analysis of the diets for inclusion of the two products demonstrated actual inclusion rates of 0.027 and 0.058% DLM and 0.044 and 0.088% MHA-FA. There was no difference in fecal N output among the treatments (P>0.05). However, urinary N (g) linearly declined (P=0.03 for DLM and P=0.01 for MHA-FA) with increasing amounts of both products. This resulted in a linear increase (P=0.01) in retained N (g/d) for both DLM and MHA-FA (10.96, 11.34, 12.11, 11.35, and 12.12, respectively). Also, N retention rate (%) increased linearly (P=0.01) with increasing levels of DLM and MHA-FA (63.5, 65.8, 69.9, 65.4, and 69.9, respectively). A slope-ratio procedure for comparison of the responses indicated a relative effectiveness on a weight for weight basis for the MHA-FA to DLM of 65.9% for grams of N retained per day and 63.9% for N retention rate.

Key Words: Methionine, Methionine hydroxy analog, Pigs

146 The optimal true ileal digestible (TID) lysine and total sulfur amino acid (TSAA) requirement for finishing pigs fed Paylean®. N. Z. Frantz*, M. D. Tokach, R. D. Goodband, S. S. Dritz, J. M. DeRouchey, J. L. Nelssen, and C. L. Jones, *Kansas State University.*

A total of 1,887 pigs (PIC 337 C22; 97 kg initial BW) were used in a 28-d growth assay to simultaneously examine both the TID lysine and TID TSAA requirements and to determine the appropriate TID TSAA:lysine ratio in finishing pigs fed Paylean (5 ppm). Four TID lysine (0.66. 0.79, 0.92, and 1.05%) and four TID TSAA (0.47, 0.52, 0.57, and 0.63%) concentrations were evaluated. Lysine treatments were formulated with a minimum TID TSAA:lysine ratio of 60%, and TSAA diets were formulated with 1.05% TID lysine. The highest lysine and TSAA concentrations were combined in the same diet, which gave a total of 7 diets. There were eleven or twelve replications per treatment. No gender treatment or treatment week interactions were observed (P > 0.13). Increasing TID lysine improved (linear, P < 0.01) ADG (0.94, 0.97, 1.01, and 1.02) with the greatest response at 0.92% TID lysine. Increasing TID TSAA did not influence (P > 0.76) ADG (1.02, 1.02, 1.02, and 1.02 kg/d) resulting in a TID TSAA:lysine ratio of not more than 51% for ADG. Increasing TID lysine did not affect ADFI (P > 0.60), but ADFI decreased (linear, P < 0.04) with increasing TID TSAA. Increasing TID lysine and TSAA linearly (P < 0.01 and P < 0.09, respectively) improved G:F (0.332, 0.341, 0.354, and 0.359 for lysine and 0.346, 0.355, 0.357, and 0.359 for TSAA). The greatest improvement in G:F was observed as TID lysine increased to 0.92% and TID TSAA increased from 0.47% to 0.52%, resulting in an optimum TID TSAA:lysine ratio of 57%. Regression analysis indicates that the maximum G:F response was obtained with a TID TSAA:lysine ratio of 58%. Increasing TID lysine had no effect on any carcass criteria (P > 0.11), but increasing TID TSAA from 0.47 to 0.52% tended to improve fat free lean (quadratic, P < 0.10). In summary, a TID TSAA:lysine ratio of 58% optimized growth performance of finishing pigs fed Paylean®.

Key Words: Lysine, Methionine, Paylean

147 Evaluation of the true ileal digestible (TID) total sulfur amino acid (TSAA) to lysine ratio for finishing pigs weighing 33 to 60 kg. K. R. Lawrence*, C. N. Groesbeck, R. D. Goodband, M. D. Tokach, S. S. Dritz, J. M. DeRouchey, J. L. Nelssen, and C. R. Neill, *Kansas State University.*

The objective of this trial was to evaluate the true ileal digestible (TID) total sulfur amino acid (TSAA) to lysine requirement for early finishing pigs. A total of 126 pigs (PIC L326 x L42; initially 33.1 kg) were blocked by sex and weight and allotted to one of nine dietary treatments in a 27 d trial. There were two pigs per pen with 4 replicates of barrows (initially 33.7 kg) and 3 replicates of gilts (initially 32.3 kg). Dietary treatments included five TID lysine (0.79, 0.87, 0.94, 1.02 and 1.10%) and five TID TSAA (0.53, 0.57, 0.61, 0.66 and 0.70%) concentrations. The highest lysine (1.10%) and TSAA (0.70%) were combined in one diet and used in both the lysine and TSAA titrations. All experimental diets were corn-soybean meal-based. In diets evaluating increasing TID lysine, methionine & cysteine ratios were 64 to 66% of lysine and in diets evaluating TSAA, diets were formulated to 1.10% TID lysine. Increasing TID lysine increased ADG (linear, P<0.01) and improved G:F (quadratic, P<0.03) with the greatest response at 1.02% TID lysine. Increasing TID lysine had no effect (P>0.05) on ADFI. Increasing TID TSAA had no effect (P>0.05) on ADG or ADFI. There was a linear trend (P<0.15) for an improvement in G:F maximized at 0.61% TID TSAA. Using a TID lysine requirement of 1.02% and TID TSAA requirement of 0.61% suggests a total sulfur amino acid to lysine ratio of 60%. Using the response surface for G:F suggests a similar TID TSAA:lysine ratio of 59%.

Effect of increasing true ileal digestible (TID) lysine and TSAA in 33 to 60 kg pigs

Item	0.79	TID 0.87	Lysine, % 0.94	1.02	1.10	SE	Linear	Quadratic
ADG, kg	0.95	0.99	1.00	1.07	1.06	0.065	0.01	0.65
G:F	0.453	0.472	0.494	0.515	0.491	0.023	0.01	0.03
Item	0.53	TID 0.57	TSAA, % 0.61	0.66	0.70	SE	Linear	Quadratic
ADG, kg	1.00	1.02	1.02	1.02	1.06	0.065	0.22	0.73
G:F	0.471	0.478	0.498	0.492	0.491	0.023	0.15	0.32

Key Words: Sulfur amino acids, Lysine, Finishing pig

148 True ileal digestible (TID) isoleucine:lysine ratio of late-finishing barrows fed corn-blood cell or corn-amino acid diets.

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Two experiments were conducted to determine the TID isoleucine:lysine ratio of late-finishing barrows fed corn-RBC (red blood cell) diets or corn-AA diets. In Exp. 1, 150 barrows (TR4 x C22, BW=89.9 kg) were allotted to six dietary treatments with five replicates of five pigs per pen. Dietary treatments included a five-point titration (TID isoleucine:lysine: 47, 54, 61, 68 and 75%) containing 3.9% RBC and a corn-SBM control diet. All diets contained 0.52% TID lysine and 3.45 Mcal/kg ME. Results indicated linear (P<0.001) and quadratic (P<0.001) improvements in ADG (0.628, 0.841, 1.074, 1.120 and 1.151 kg/d, respectively) and G:F (0.242, 0.300, 0.330, 0.337 and 0.327, respectively) to increasing isoleucine:lysine ratio. A linear increase (P<0.001) was observed in ADFI (2.575, 2.804, 3.262, 3.325 and 3.523 kg/d, respectively). Pigs fed the corn-RBC diet with an isoleucine:lysine ratio of 75% tended to have higher ADG (1.151 vs. 1.064 kg/d, P=0.06) and ADFI (3.325 vs. 3.293 kg/d, P=0.07) than pigs fed control diet. In Exp. 2, 45 individually-penned barrows (96.9 kg) were used in a 5-point TID isoleucine:lysine titration (45, 51, 57, 63 and 69%) utilizing all-corn diets fortified with synthetic amino acids. All diets contained 0.52% TID lysine and 3.40 Mcal/kg ME. A quadratic response in ADG (0.811, 0.935, 0.892, 0.855 and 0.844 kg/d, respectively; P=0.07) and ADFI (3.254, 3.563, 3.574, 3.400 and 3.280 kg/d, respectively; P<0.01) was observed to increasing isoleucine:lysine ratio. No difference was observed in G:F (0.249, 0.262, 0.250, 0.251 and 0.256, respectively; P>0.10) among treatments. Based on these data, TID isoleucine:lysine ratio of late-finishing barrows was estimated to be 61.7% (ADG) and 57.9% (G:F) for pigs fed corn-RBC diets and 50.7% (ADG) and 53.0% (ADFI) for pigs fed all-corn diets fortified with synthetic amino acids.

Key Words: Isoleucine, Blood cell, Pigs

149 Effects of protein source on true ileal digestible (TID) isoleucine: lysine ratio in late-finishing barrows.

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Two 22-day experiments were conducted to determine the effects of protein source on TID isoleucine:lysine ratio of late-finishing barrows. In Exp. 1, 144 barrows (TR4 x C22, BW= 87.1 kg) were blocked by weight and allotted to one of nine dietary treatments with eight replicates of two pigs per pen. Treatment 1 was a corn-SBM control diet with an inclusion of 0.15% L-lysine HCl. Treatments 2 to 9 were a 2 x 4 factorial design. The factors included: two protein sources (3% SBM plus synthetic AA or 3.85% red blood cells (RBC)) and four levels of TID isoleucine:lysine ratio (54, 60, 66 and 72%). All diets were formulated to contain 0.52% TID lysine and 3.44 Mcal/kg ME. Exp. 2 utilized the same dietary treatments as Exp. 1 with six replicates per treatment (BW= 89.9 kg). Because there was no interaction between experiment and dietary treatment (P>0.05), data from the two experiments were pooled. Pigs fed corn-SBM+AA diets or the corn-RBC diets with isoleucine:lysine over 60% had similar performance as control pigs. Interactive effects (P<0.05) on ADG, ADFI and G:F were observed between protein source and TID isoleucine:lysine ratio. In corn-SBM+AA diets, no benefit was observed for TID isoleucine:lysine ratios above 54%. However, increasing isoleucine:lysine ratio improved performance of pigs fed corn-RBC diets in terms of ADG (linearly, P<0.01 and quadratically, P<0.05), ADFI (linearly, P<0.01) and G:F (linearly, P<0.01 and quadratically, P<0.05). Using breakpoint analysis, TID isoleucine:lysine ratio of late-finishing barrows fed corn-RBC diets was estimated to be 61% for ADG and 61% for G:F. In conclusion, TID isoleucine:lysine ratio of late-finishing barrows was affected by dietary protein source; pigs fed corn-RBC diets need a higher TID isoleucine:lysine ratio to maximize growth performance than pigs fed corn-SBM diets.

Key Words: isoleucine, blood cell, pigs

150 Evaluation of the true ileal digestible (TID) tryptophan requirement for late nursery pigs fed high L-lysine HCl diets.

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Two experiments were conducted to determine the effect of dietary TID tryptophan concentration on the growth performance of late nursery pigs fed diets containing high levels of L-lysine HCl. In Exp. 1, 135 pigs (TR-4 C22; 13.4 ± 0.01 kg) were allotted to one of five dietary treatments in a randomized complete block design with six replicate pens per treatment. These pigs were housed in a segregated early weaning facility. In Exp. 2, a commercial nursery facility was utilized in which 922 pigs (TR-4 C22; 14.8 ± 0.15 kg) were allotted to the same dietary treatments as Exp. 1 in a randomized complete block design with six replicates per treatment. All diets contained 0.7% L-lysine HCl and were formulated to 1.30% TID lysine with a lysine:CP ratio maintained at 7.0%. Treatments consisted of a titration of dietary TID tryptophan concentration including 0.165, 0.185, 0.205, 0.225, and 0.245% achieved through the addition of L-tryptophan to the basal diet. Exp. 1 and 2 were conducted over a 17-d or 15-d growth period, respectively, with ADG, ADFI, and G:F calculated at the conclusion of the experiments. Similar growth responses were observed for the two nursery experiments. Average daily gain, ADFI, and G:F were similar (P>0.05) across all dietary treatments as TID tryptophan concentration increased in the diet. Average daily gain for Exp. 1 and 2 were 603, 621, 631, 621, and 626 g/d (SE=19.1) and 549, 572, 572, 576, and 576 g/d (SE=13.6), respectively for the five dietary treatments. Gain:feed for Exp. 1 and 2 were 0.711, 0.733, 0.720, 0.728, and 0.708 (SE=0.011) and 0.654, 0.671, 0.676, 0.667, 0.676 (SE=0.009). These data indicate that the TID tryptophan requirement for late nursery pigs may not be greater than 0.165% when pigs are consuming a diet containing 0.7% L-lysine HCl.

Key Words: Tryptophan, Pigs, L-Lysine HCl

151 Body weight has no effect on the threonine requirement in growing pigs.

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Threonine is generally the second or third limiting amino acid in cereal-based diets. Relative to other amino acids, endogenous losses of threonine are quite high. Consequently, the contribution of maintenance to the total requirement is higher for threonine than for most other amino acids. Total ileal digestible threonine requirements are usually expressed relative to that of lysine (thr:lys). If the contribution of maintenance to the total amino acid requirement changes during growth, the optimum thr:lys ratio will vary. A series of experiments was conducted to determine the effect of BW on the optimum thr:lys ratio in growing pigs. In experiment 1, fifteen blocks of four pigs each (initial BW 55 kg) were fed one of four diets in which the thr:lys ratio varied between 55 to 70%. Diets were based on corn, wheat and barley and soybean meal and differed only in the added threonine content. Lysine (0.67% as-fed) was the second-limiting amino acid. Pigs were housed individually and were pair-fed within a block. Average daily gain during a 3-wk period was used as the response criterion. In experiment 2, the effect of BW on the thr:lys requirement was tested (initial BW 20, 50 or 90 kg) using a design similar to experiment 1. The thr:lys ratio varied between 55 and 75% using six pigs per diet and BW (with 0.88, 0.68 and 0.45% total lysine for the three stages). The hypothesis that lysine was the second-limiting amino acid in the experiment was confirmed in a separate experiment in which additional lysine was added to the diet with the highest thr:lys ratio. Ileal digestibility of the diets without added threonine was determined in 40-kg pigs with an ileo-rectal anastomosis. Performance was analyzed using either a linear-plateau (LP) or a curvilinear-plateau model (CLP). Average daily gain ranged from 720 g/d (BW = 20 kg) to 880 g/d (BW = 90 kg). Using model CLP, the optimum thr:lys ratio was 65% with no significant effect of BW on this ratio. The estimate when using model LP was about 3%-point lower.

Although the maintenance requirement for threonine may increase during growth, its contribution to the total threonine requirement and the thr:lys ratio is relatively small.

Key Words: Pigs, Threonine, Growth

152 The optimal true ileal digestible (TID) lysine and threonine requirement for finishing pigs from 36 to 60 and 77 to 105 kg. N. Z. Frantz*[1], M. D. Tokach[1], S. S. Dritz[1], J. L. Usry[2], R. D. Goodband[1], J. M. DeRouchey[1], J. L. Nelssen[1], and C. L. Jones[1], [1]*Kansas State University,* [2]*Ajinomoto-Heartland LLC.*

A total of 4,388 pigs (PIC 337 C22; Exp. 1, 1,070 gilts, initially 36 kg BW; Exp. 2, 3,318 pigs, initially 77 kg BW) were used in 28-d growth assays to examine the TID lysine and threonine requirements, and a TID threonine:lysine ratio for finishing pigs. In Exp. 1, four TID lysine (0.71, 0.81, 0.91, and 1.01%), and five TID threonine (0.50, 0.56, 0.62, 0.68, and 0.74%) levels were evaluated. In Exp. 2, four TID lysine (0.56, 0.64, 0.72, and 0.80%), and five TID threonine (0.43, 0.48, 0.53, 0.58 and 0.63%) levels were evaluated. The diet with the highest lysine and second highest threonine was combined as one diet to give a total of nine diets in each study. In Exp. 1, increasing TID lysine increased ADG (quadratic, $P < 0.06$), with the greatest response occurring from 0.71 to 0.81%. Increasing TID lysine also increased ADFI (quadratic, $P < 0.03$) up to 0.81% TID lysine and improved G:F (linear, $P < 0.01$). Increasing TID threonine did not affect ADG ($P > 0.69$) or ADFI ($P > 0.29$), but improved G:F (linear, $P < 0.05$), with the maximum response at 0.68% TID threonine. Values of 1.01% lysine and 0.68% threonine suggest an optimal TID threonine:lysine ratio of 67% for G:F. In Exp. 2, a treatment gender interaction ($P < 0.02$) was observed for G:F. Gilts had a greater response to increasing TID lysine, whereas barrows had a greater response to increasing TID threonine. Increasing TID lysine improved ADG (linear, $P < 0.05$) in gilts and barrows ($P < 0.07$), and increased G:F (linear, $P < 0.01$) in gilts as lysine increased to 0.72%. Increasing TID threonine improved ADG and G:F (linear, $P < 0.04$) in barrows and improved ADG and ADFI (linear, $P < 0.06$) in gilts as the threonine increased to 0.48%. Values of 0.72% TID lysine and 0.48% TID threonine suggest an optimal TID threonine:lysine ratio of 67%. The TID threonine:lysine ratio suggested by this study for pigs from 36 to 60 and 77 to 105 kg is 67%.

Key Words: Finishing pigs, Lysine, Threonine

153 True digestibility of amino acids in raw and heat-treated soy products: comparison of values obtained with cannulated pigs, cecectomized roosters, and an *in vitro* IDEA™ assay. C. Schasteen[1], J. Wu*[1], G. Yi[1], C. Knight[1], C. Parsons[2], J. Li[3], and D. Li[3], [1]*Novus International, Inc.,* [2]*University of Illinois,* [3]*Ministry of Agriculture Feed Industry Center.*

Two *in vivo* experiments were conducted to determine the essential amino acid (EAA) digestibility of 5 soy products using ileally cannulated pigs, and precision-fed cecectomized roosters. The soy products evaluated were 2 commercial solvent-extracted soybean meal (SBM, hulled and dehulled), and a commercially prepared raw soyflake which was further cooked for 0, 12 or 18 min in a small laboratory autoclave. The ileally cannulated pig assay yielded results for EAA digestibilities that were highly correlated ($r^2 = 0.81$ to 0.99) with those of the rooster assay. No differences in EAA digestibility were observed between the ileally cannulated pig assay and cecectomized rooster assay across soy products ($P=0.08$), except for lower cystine digestibility in pigs ($P<0.02$). Experiments were also conducted to assess the ability of an Immobilized Digestive Enzyme Assay (SBM IDEA™ kit, a proprietary product of Novus) on predicting *in vivo* AA digestibility of the same soy products. The results indicated that there were strong correlations of IDEA assay with true ileal AA digestibility determined in swine ($r^2 = 0.79$ to 0.98) and true AA digestibility determined by cecectomized roosters ($r^2 = 0.86$ to 0.99). Results of this study indicated that AA digestibility obtained by the precision-fed cecectomized rooster assay provides good predictor of soy product protein digestibility in growing pigs. Results also demonstrated that the SBM IDEA kits can be used as a rapid and inexpensive predictor of soy product *in vivo* true AA digestibility for swine and poultry, and may be applied as a QC tool for feed manufacturers. (™ IDEA is a trademark of Novus International, Inc.)

Key Words: soy product, true amino acid digestibility, IDEA assay

154 Effects of increasing meat and bone meal on finishing pig growth performance. R. O Gottlob*, R. D. Goodband, M. D. Tokach, J. M. DeRouchey, S. S. Dritz, J. L. Nelssen, C. W. Hastad, K. R. Lawrence, and C. N. Groesbeck, *Kansas State University.*

A total of 156 finishing pigs (initially 49.9 kg) were used to determine the effects of increasing porcine meat and bone meal on finishing pig growth performance. Pigs were blocked by initial weight and sex, and allotted to one of six dietary treatments. There were two pigs per pen and 13 pens per treatment. Trial duration was 67 d. The dietary treatments were corn-soybean meal-based and formulated on a true ileal digestible (TID) lysine basis, and fed in three phases. In each phase, diets contained 0, 2.5, 5.0, 7.5, 10.0, or 12.5% porcine meat and bone meal. The diets were formulated to 0.85, 0.70, and 0.57% TID lysine in phases 1, 2, and 3, respectively, slightly below the pig's anticipated requirements, so that if the amino acid digestibility of meat and bone meal was different than typical values, changes in growth performance could be observed. A TID of 80% (NRC, 1998) for meat and bone meal was used in diet formulation. Adding 2.5 or 5.0% meat and bone meal increased (quadratic, $P<0.02$) ADG, while feeding greater than 5.0% resulted in ADG similar to that of pigs fed the control diet. Overall, ADG was 0.99, 1.08, 1.05, 1.01, 1.02, and 0.99 kg for pigs fed 0, 2.5, 5.0, 7.5, 10.0, and 12.5% meat and bone meal, respectively. Increasing meat and bone meal also improved (quadratic, $P<0.01$) G:F compared with pigs fed the control diet. Overall, G:F was 0.33, 0.35, 0.34, 0.34, 0.34, and 0.34 for pigs fed 0, 2.5, 5.0, 7.5, 10.0, and 12.5% meat and bone meal, respectively. Increasing meat and bone meal decreased (linear, $P<0.02$) ADFI; however, the greatest decrease in ADFI was observed in pigs fed greater than 5.0% meat and bone meal. Because the diets were formulated slightly below the pig's anticipated requirements, the results suggest that the meat and bone meal used in this study was relatively high quality and had greater amino acid digestibility than expected. In conclusion, replacing a portion of soybean meal with meat and bone meal had no negative effects on pig performance.

Key Words: Finishing pigs, Meat and bone meal

155 Portal appearance of amino acids in growing pigs fed diets containing crystalline amino acids as partial replacement for protein-bound amino acids. R. Tabet*[1], B. J. Kerr[2], J. T. Yen[3], J. B. Moore[1], and N. L. Trottier[1], [1]*Michigan State University,* [2]*USDA National Swine Research Information Center,* [3]*USDA Meat Animal Research Center.*

The objective of this study was to determine if partial replacement of protein-bound AA with crystalline AA (CAA) increases portal blood appearance of AA. Six barrows (30 kg ± 0.5 BW) were assigned to three diets in a repeated Latin Square design. Diets consisted of a 16.9% CP (Control: C), and a 14.5 (Medium: M) and 12.5 % CP (Low: L) containing CAA. The M diet contained L-lys, L-thr, and DL-met, and the L diet contained L-lys, L-thr, DL-met, L-trp, and L-cys to meet true ileal digestible requirements. Feed was given twice daily providing 2.6 times ME required for maintenance. A catheter was placed in the portal vein and blood samples were collected at times (t) -30, 30, 60, 90, 120, 150, 180, 210, and 240 min relative to feeding. Portal lys concentration (μmol/L) at t30 was higher ($P<0.001$) in pigs fed L (347.38 ± 18.24) and M (296.4 ± 18.38) compared to C (210.32 ± 18.24). At t60, compared to C (268.42 ± 18.24), lys was higher ($P<0.01$) in pigs fed L (362.01 ±18.23) but similar in pigs fed M (286.35 ±18.36). Post t60, lys did not differ between L, M and C. Portal thr concentration at t30 was higher ($P<0.05$) in L (311.37 ±17.13) than in M (257.61 ± 17.23) and C (229.09 ±17.13). At t60, portal thr in L (333.08 ±17.13) was higher ($P<0.05$) compared to M (263.19 ±17.23) and C (284.96 ± 17.13). Portal thr between M and C did not differ at any time point. Portal met concentrations at t30 and t60 were higher ($P<0.05$) in pigs fed L (102.01 ±7.37 and 104.82 ±7.37, respectively) compared to C (72.19 ±7.37 and 85.40 ± 7.37, respectively) and did not differ between M (87.70 ±7.41 and 84.37 ± 7.41, respectively) and C. Portal trp at t30 was similar in L (87.35 ±4.61) compared to C (81.49 ± 4.61) and M (77.02 ±4.64), but at t60 was lower ($P<0.05$) in M (78.39 ±4.64) compared to C (94.17 ± 4.61). At t60, portal trp was not different between L (88.60 ±4.60) and C. Partial replacement of protein-bound AA with CAA increases AA concentrations in portal blood, implying that CAA are absorbed more rapidly than protein-bound AA even in diets formulated on true ileal digestible basis.

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Key Words: Amino acid, Portal, Pig

156 Enzyme-based protein digestibility (IDEA^{TM}) assay accurately predicts poultry *in vivo* Lysine digestibility for Distiller's Dried Grain and Solubles (DDGS). C. Schasteen*[1], J. Wu[1], and C. Parsons[2], [1]*Novus International, Inc.*, [2]*University of Illinois*.

IDEA^{TM} is a patented enzyme-based assay designed for rapid prediction of amino acid digestibility of poultry feed ingredients including soybean meal, meat and bone meal, poultry byproduct meal, and feather meal with assay times from 2 hours to <1day for animal and plant proteins, respectively. The objective of this study was to evaluate the applicability of IDEA^{TM} technology to predict the amino acid digestibility of distiller's dried grains and solubles (DDGS) produced for animal feed. Commercial North American DDGS samples (n=28) were collected and IDEA^{TM} analysis run as well as determination of true amino acid digestibility determined in the precision-fed cecectomized rooster assay (Fernandez & Parsons, 1994). True lysine digestibility varied in this sample set from 59.1% to 83.6% with an average of 70.3%. IDEA^{TM} analysis of these samples indicated a strong correlation of IDEA values with the true lysine digestibility determined in roosters (r^2 of 0.88). Crude protein in this sample set ranged from 24.5% to 30.2%. Other amino acid true digestibilities determined for this sample set did not vary to the same extent as lysine (25%), with cysteine having the next greatest variability (20%) and methionine and alanine showing the least variation (8%). IDEA^{TM} analysis showed poor correlation (r^2 of <0.5) for amino acids other than lysine. Results of this study suggested that variations in poultry *in vivo* Lysine digestibility existed among US commercial DDGS products and that other amino acids did not show the same variability. IDEA^{TM} provided a good prediction of *in vivo* poultry digestibility of Lysine for DDGS. Extension of IDEA^{TM} to test the prediction of true ileal digestibility of DDGS amino acids in swine is underway.

Key Words: DDGS, IDEA, Digestibility

157 Effectiveness of in vitro procedures to estimate CP and amino acid digestibility coefficients in dried distillers grain with solubles by growing pigs. C. Pedersen*, A. Pahm, and H. H. Stein, *South Daktota State University*.

The in vivo digestibility of CP in dried distillers grain with solubles (DDGS) was correlated to values obtained from two enzyme-based in vitro procedures (i.e., a pepsin-based and a pepsin/pancreatin-based procedure). The in vivo digestibility coefficients for both CP and amino acids (AA) in DDGS were also correlated to values obtained using colorimetric assays based on L, a, and b values generated by Hunter or Minolta equipment. Both un-ground and finely ground samples were used in the colorimetric assays. The standardized ileal digestibility coefficients of CP and AA were measured in 14 samples of DDGS using growing pigs equipped with a T-cannula in the distal ileum. The pepsin procedure estimated CP digestibility after 16 h of sample incubation with pepsin at pH 1. In the pepsin/pancreatin procedure, samples were incubated with pepsin for 6 h at pH 2 followed by a 16 h incubation with pancreatin at pH 6.8. Samples were filtrated after the incubation period and the filtrate was analyzed for the concentration of CP. Results showed that the correlation (r^2) between in vivo digestibility of CP and the digestibility obtained using the pepsin procedure was 0.29. For the pepsin/pancreatin procedure, an r^2 value of 0.55 was obtained. The r^2 for the correlation between the in vivo digestibility coefficients and data obtained from the colorimetric assays were higher for the unground compared to the ground samples (P #8804 0.05). Regardless of the sample, the lowest r^2 was found for Trp while the r^2 for Lys were between 0.55 and 0.69. It was also demonstrated that the values obtained using the Minolta equipment were better (P #8804 0.05) correlated to the in vivo values compared to values obtained using the Hunter equipment. It is concluded that the pepsin/pancreatin procedure and the colorimetric assays potentially may be used to predict the in vivo digestibility of CP and AA in DDGS, but additional work is needed to improve the correlations. In particular, it is necessary to obtain in vivo digestibility coefficients for additional samples of DDGS.

Key Words: DDGS, In vitro digestibility, Pigs

158 Effects of dietary nucleotides on intestinal morphology and microbial activity in newly weaned pigs. C. D. Mateo*, D. N. Peters, R. I. Dave, A. Rosa, and H. H. Stein, *South Dakota State University*.

Two experiments were conducted to determine effects of nucleotides in diets for weanling pigs. In Exp. 1, 20 pigs were weaned at 19 d of age and allotted to two treatment groups. Pigs on treatment group 1 were fed a conventional starter diet (Diet 1). Pigs allotted to treatment group 2 were fed Diet 1 supplemented with nucleotides (Diet 2) in amounts that correspond to 100% of the quantities of nucleotides found in sow milk on d-14 of lactation. Five pigs from each treatment group were sacrificed on d-14 post-weaning, and the remaining five pigs were sacrificed on d-28. Pig performance, serum IgG, intestinal morphometry and microbiology, and the DNA, RNA, and protein concentration in intestinal tissue were measured. No differences between treatment groups were observed for pig performance, serum IgG, and intestinal tissue DNA, RNA, and protein concentration. On d-14, duodenal villus height (VH) was lower ($P = 0.03$) in pigs fed Diet 2 compared to pigs fed Diet 1 (353 vs. 426μm), but ileal VH and VH:Lamina Propria Debt (LPD) were higher ($P = 0.01$) in pigs fed Diet 2 compared to pigs fed Diet 1 (321 vs. 239μm and 1.56 vs. 1.23μm, respectively). On d-28, duodenal LPD and VH:LPD were higher (P #8804 0.05) in pigs fed Diet 2 compared to pigs fed Diet 1 (398 vs. 326μm and 1.78 vs. 1.38μm, respectively). Exp. 2 was an in-vitro study that was conducted to determine the antimicrobial and prebiotic properties of nucleotides. Bacterial growth in broth with or without nucleotide supplementation was measured over a 16-h period. The broth supplemented with nucleotides increased ($P = 0.03$) total coliform count compared to broth without nucleotide supplementation at 8 h (10.22 vs. 10.12 log10 cfu/g). At 16 h, broth supplemented with nucleotides had a lower Cl. perfringens count (P #8804 0.01) compared to broth not supplemented with nucleotides (6.78 vs. 7.15 log10 cfu/g). All bacterial counts considered in this study linearly increased (P #8804 0.01) from 0 to 16 h in broth of both treatment groups. The results of the experiments indicate that nucleotide supplementation during the post-weaning period positively influences gastrointestinal morphology and microflora.

Key Words: Intestines, Nucleotides, Pigs

159 Evaluation of high synthetic amino acid inclusion and supplemental arginine in starter diets. B. W. Ratliff*[1], A. M. Gaines[1], P. Srichana[1], G. L. Allee[1], and J. L. Usry[2], [1]*University of Missouri-Columbia*, [2]*Ajinomoto Hearland, LLC*.

Two experiments were conducted at commercial farms with the following objectives: 1) evaluate high synthetic amino acid inclusion in starter diets and 2) evaluate the addition of supplemental arginine in both high and low crude protein (CP) starter diets. In Exp. 1, a total of 414 pigs (TR-4 × C22; 5.3 ± 0.05 kg) were allotted to one of three dietary treatments in a randomized complete block design with 6 replicate pens/treatment. Diet 1 was formulated to contain 0.15% L-lysine HCl, while diets 2 and 3 both contained 0.50% L-lysine HCl. Diet 2 also contained a 50:50 mixture of glutamine and glycine in order to maintain a 7.1 total lysine:CP ratio similar to Diet 1, whereas the lysine:CP ratio in Diet 3 was 8.1. In all diets minimum amino acid ratios were maintained. Pig weights and feed intake were recorded on d 0, 7 and 13. In Exp. 2 a total of 500 pigs (PIC 337 × Genetiporc; 4.7 ± 0.06 kg) were allotted to one of four treatments in a 2 × 2 factorial design with 5 replicate pens/treatment. Main effects included L-lysine HCl level (0.15 vs. 0.50%) and supplemental arginine (0.00 vs. 0.20%). In all diets minimum amino acid and lysine:CP ratios were maintained. Pig weights and feed intakes were recorded on d 0, 7 and 14. In Exp. 1, there were no growth performance differences (P>0.79) from d 0 to 7. From d 7 to 14, Diets 1 and 2 maintained at a 7.1 Lysine:CP ratio had improved (P < 0.02) ADG and G:F as compared to Diet 3 (8.1 Lysine:CP). In Exp. 2, there was no effect of L-lysine HCl level (P>0.16), supplemental arginine (P>0.26), and (or) interactions (P>0.50) for any of the growth performance parameters. Collectively, these experiments indicate that starter diets can contain up to 0.50 L-lysine HCl if supplemented with non-essential amino acids and there appears to be no benefit of supplemental arginine in high or low CP diet formulations.

Key Words: L-Lysine HCl, Arginine, Pigs

160 Determining the optimal lysine:calorie ratio for growth performance of 10 to 25 kg nursery pigs. J. D. Schneider*, M. D. Tokach, S. S. Dritz, R. D. Goodband, J. L. Nelssen, and J. M. DeRouchey, *Kansas State University*.

Two studies were conducted to evaluate the effects of increasing dietary lysine and energy density on performance of Genetiporc nursery pigs. Experiment 1 was organized as a combination of two simultaneous experiments with one set of diets consisting of five treatments with increasing true ileal digestible (TID) lysine (0.99, 1.07, 1.14, 1.22, and 1.30%) and the second set of diets consisting of five treatments with increasing energy density (2,952, 3,093, 3,236, 3,377, and 3,520 kcal of ME/kg). The highest level of both lysine and energy (1.30% and 3,520 kcal/kg, respectively) was combined as one diet for a total of 10 treatments. Pigs were randomly allotted to 8 replications with 5 pigs per pen. Increasing TID lysine linearly (P<0.01) improved ADG and G:F. While increasing energy density had no effect on ADG, ADFI decreased (linear, P<0.01) which resulted in a quadratic (P<0.08) improvement in G:F. Regression analysis of the response surface indicated the optimal lysine:calorie ratio was 3.7 g lysine/Mcal ME. In Exp. 2, pigs were fed diets with two different energy densities (2.95 or 3.28 Mcal ME/kg) with TID lysine:calorie ratios ranging from 3.1 to 4.1 g/Mcal ME. There was an energy density by TID lysine:calorie ratio interaction (P<0.03) for ADG. The greatest ADG was achieved for pigs fed a lysine:calorie ratio of 3.60 for pigs fed the low energy diets and 3.36 for pigs fed the high energy diets. Feed efficiency improved (quadratic, P<0.01) as lysine:calorie ratio increased for pigs fed the low energy diet with the best G:F observed at 3.87. Pigs fed the high energy diets had a quadratic (P < 0.07) improvement in G:F as the lysine:calorie ratio increased with the best feed efficiency at 4.07; however, little improvement were observed when the ratio was increased above 3.36. Based on these results, the optimal lysine to calorie ratio seems to be 3.30 to 3.87 g of TID lysine/Mcal ME for pigs in these facilities.

Key Words: Lysine, Energy, Nursery pigs

161 Comparison of the relative bioefficacy of Alimet® feed supplement and DL-methionine in nursery pigs. A. M. Gaines*[1], G. F. Yi[2], B. W. Ratliff[1], P. Srichana[1], G. L. Allee[1], C. D. Knight[2], and K. R. Perryman[2], [1]*University of Missouri,* [2]*Novus International Inc*.

A 21 d growth assay experiment was conducted under commercial research conditions to compare the relative bioefficacy of Alimet feed supplement and DL-methionine. A total of 1,232 pigs (TR-4 × C22; initial BW 10.9 ± 0.37 kg) were allotted to 7 dietary treatments in a RCBD with 8 replicate pens (22 pigs) per treatment. The basal diet (Diet 1) was a corn-soybean meal-amino acid based diet formulated to contain 0.50% true ileal digestible (TID) methionine + cystine (SAA) with no supplemental Alimet® or DL-methionine. Diets 2-7 consisted of the basal diet supplemented with three equimolar levels of Alimet® or DL-methionine that corresponded to TID SAA concentrations of 0.56, 0.62, and 0.68%, respectively. The highest level of TID SAA was below the requirement estimate for pigs of this weight range. There was no effect of methionine source (P = 0.13) or methionine source × TID SAA level interactions (P = 0.66) for any of the growth performance parameters measured. Increasing the TID SAA level from 0.50 to 0.68% resulted in linear increase in ADG (P < 0.001), ADFI (P < 0.05), and G:F (P < 0.001). Using the slope ratio method, the relative bioefficacy of Alimet® vs. DL-methionine on an equimolar basis was determined to be 122% and 110% for ADG and G:F, respectively. These results indicate that no difference exists in the biological activity of DL-methionine or Alimet® when diets are formulated on an equal molar basis, confirming the 88% bioefficacy value for Alimet® feed supplement. (Alimet® is a trademark of Novus International, Inc, and is registered in the United States and other countries).

Key Words: Nursery pigs, Alimet® feed supplement, DL-methionine

162 Estimation of the ideal ratio of true ileal digestible sulfur amino acids:lysine in 12 to 24 kg pigs and comparison of methionine sources. A. M. Gaines[1], G. F. Yi*[2], B. W. Ratliff[1], P. Srichana[1], G. L. Allee[1], C. D. Knight[2], and K. R. Perryman[2], [1]*University of Missouri,* [2]*Novus International Inc*.

The objective of this research was to validate our previous sulfur amino acid:lysine (SAA:LYS) ratio estimate for 12 to 24 kg nursery pigs under commercial conditions and compare Alimet® feed supplement and DL-methionine as methionine sources. A total of 1,544 nursery pigs (TR4 × C22; 12.4 ± 0.13 kg) were allotted to one of nine dietary treatments in a RCBD with 8 replicate pens (22 pigs/pen) per treatment. The basal diet (Diet 1) was a corn-soybean meal based diet with no supplemental Alimet® or DL-methionine (TID SAA:LYS 49%). Diets 2-9 consisted of the basal diet supplemented with four equimolar levels of Alimet® or DL-methionine to deliver TID SAA:LYS ratios of 54, 59, 64, and 69%, respectively. There were no effect of methionine source (P = 0.60) or methionine source × TID SAA:LYS ratio interactions (P = 0.10) for any of the growth performance parameters. Increasing the TID SAA:LYS ratio increased ADG (quadratic, P < 0.01) and improved G:F (quadratic, P < 0.01), but had no effect on ADFI (P = 0.87). The current data were pooled with a previous study and fitted with a two-slope broken-line regression model and a quadratic regression model. The breakpoint of the broken-line regression model, the intercept of the broken-line and quadratic regression curve, and the 95% upper asymptote of the quadratic response indicated that the optimum TID SAA:LYS ratios were 59.1, 60.0, and 58.7% for ADG, respectively and 60.6, 61.5 and 61.3% for G:F, respectively. Collectively, these data suggest that the optimum sulfur amino acid:lysine ratio for late nursery pigs is approximately 60% and there is no difference in the methionine sources (DL-methionine vs. Alimet®) when expressed on the same molar equivalency. (ALIMET® is a trademark of Novus International, Inc, and is registered in the United States and other countries).

Key Words: Nursery pigs, Growth, Methionine source

163 Effects of feeding diets containing spray dried corn condensed distillers solubles and associated fractions to early-weaned pigs on intestinal morphology, immune status, circulating IGF-1 concentrations, and organ weights. J. Knott*, G. Shurson, M. Hathaway, and L. Johnston, *University of Minnesota*.

Intestinal morphology and serum acute phase protein and insulin-like growth factor 1 (IGF-1) concentrations were measured to determine the effectiveness of corn distillers solubles by-products as potential replacements for carbadox and porcine plasma in diets for early-weaned pigs. Barrows (n=560; 5.06 kg) were blocked by initial weight, and randomly allotted to one of 56 pens (10 pigs/pen). Pigs were fed one of seven experimental diets consisting of a negative control (NC), NC + 15% spray dried distillers solubles (DS), NC + 7.5% spray dried yeast cream (YC), NC + 15% spray dried residual solubles (RS), NC + 55 ppm carbadox (AB), NC + 6% spray dried porcine plasma (PP), and NC + AB + PP (PC) for the first 10-d post-weaning. On d 10, one pig from each pen (n=56) was sacrificed to determine villi height (VH) and crypt depth (CD) at 25, 50, and 75% of the small intestine (SI) length. Blood samples were collected on d 0, 3, 7, 10, 14, 21, 28, 35, and 42, and used to measure serum α_1-acid glycoprotein (AGP), serum haptoglobin (Hp), and IGF-1 concentrations. Pigs fed the RS and PC diets had longer villi (P<0.05) and greater villi height:crypt depth ratio (VCR; P<0.05) in the upper 25% of the SI compared to pigs fed the NC, DS, YC, and AB diets. There was no effect of diet on VH, CD, or VCR in the 50% and 75% portions of the SI length or overall. Small and large intestine length and weight were not affected by diet. Serum AGP concentration was not affected by diet on d 3 or d 10. However, Hp concentrations were lower (P<0.05) on d 10 for pigs fed AB and PC diets indicating a lower immune system activation. Circulating IGF-1 levels were not affected by treatment. These results suggest that feeding diets containing RS and PC promotes greater villi height and VCR compared to pigs fed diets containing carbadox. However, pigs fed diets containing carbadox appeared to have lower immune system activation compared to pigs fed diets that did not contain carbadox.

Key Words: Distiller's solubles, Early-weaned pigs, Antimicrobial alternatives

164 Effects of feeding diets containing spray dried corn condensed distiller's solubles (CDS) and associated fractions on growth performance of early-weaned pigs. J. Knott*, G. Shurson, M. Hathaway, and L. Johnston, *University of Minnesota*.

Growth performance trials were conducted to determine the effectiveness of corn condensed distiller's solubles (CDS) by-products as a potential replacement for carbadox and porcine plasma in phase 1 diets. Trial 1 utilized 560 barrows (5.06 kg) for a 6-wk feeding period and 441 barrows and gilts (6.19 kg) were fed for 5-wks in Trial 2. Dietary treatments for both trials were: negative control (NC), NC + 15% distiller's solubles (DS), NC + 7.5% yeast cream (YC), NC + 15% residual solubles (RS), NC + 55 ppm carbadox (AB), NC + 6% porcine plasma (PP), and NC + AB + PP (PC). Experimental diets were fed for the first 10-d post-weaning (phase 1). Common phase 2 diets were fed for 11-d, and phase 3 diets were fed for the remaining 21-d in Trial 1 and 14-d in Trial 2, respectively. In trial 1, pigs fed the PC diet had greater ADG (P<0.05) during phase 1 compared to pigs fed NC, DS, YC, RS, and AB diets, but ADG was not affected during phase 2 or 3, or overall. Pigs fed DS and RS diets tended to have a greater relative increase in ADG (P=0.09) during the subsequent phases of growth compared to pigs fed the other diets. Diet had no effect on ADFI and G:F for phase 1, 2, or 3, or overall, or on relative changes in ADFI and G:F during phase 2 and 3. In trial 2, overall ADG was not affected by treatment, but pigs fed the PP and PC diets had higher ADG (P<0.05) and ADFI (P<0.05) during phase 1. Pigs fed PC had higher ADFI (P<0.05) for the overall 5-wk feeding period than pigs fed NC, DS, YC, and RS diets. Pigs fed PP and PC had lower relative change in ADG during phase 2 than pigs fed the other diets, but pigs fed NC had a lower relative change in ADG (P<0.05) during phase 3 compared to pigs fed PP. Relative change of ADFI and G:F was not affected by diet in phase 2 and 3. These results suggest that feeding the NC diet or diets containing DS, YC, and RS fractions provides similar growth performance to pigs fed diets containing carbadox, but lower ADG and ADFI compared to pigs fed diets containing porcine plasma. Feeding diets containing DS and RS during phase 1 may improve subsequent growth.

Key Words: Distiller's solubles, Early-weaned pigs, Growth

165 Effect of lactose addition in 8 to 15 kg pigs reared under commercial conditions. P. Srichana*, A. M. Gaines, B. W. Ratliff, and G. L. Allee, *University of Missouri*.

Two experiments were conducted at a commercial research site in order to evaluate the effect of lactose addition in diets for 8 to 15 kg pigs. In Exp. 1 (7 d period), a total of 760 pigs (TR-4 × C22; 8.68 ± 0.10 kg) were allotted to one of five dietary treatments in a completely randomized block design with 7 replicate pens/treatment. The control diet (Diet 1) was formulated to contain no supplemental lactose (0% lactose). Diets 2-5 consisted of the control diet supplemented with two levels of crystalline lactose or Dairy Lac 80® that corresponded to total lactose levels of 7.0 and 14.0%, respectively. In Exp. 2 (14 d period), a total of 893 pigs (TR-4 × C22; 8.04 ± 0.06 kg) were assigned to one of five dietary treatments (0, 3.5, 7.0, 10.5, and 14% lactose, respectively) in a completely randomized block design with 8 replicate pens/treatment. In Exp. 1, there was no effect of lactose source (P>0.75) and (or) lactose source × lactose level interactions (P>0.44) for ADG, ADFI, or G/F (Diets 2-5). Increasing the lactose level increased ADFI (499, 526, and 540 g/d) and improved (linear, P=0.06) ADG (390, 408, and 413 g/d). In Exp. 2, from d 0 to 7, increasing the lactose level increased (linear, P<0.001) ADFI (472, 490, 522, 513, and 540 g/d) and ADG (390, 395, 440, 445, and 472 g/d). There was also an improvement (linear, P<0.01) in G/F (0.819, 0.806, 0.847, 0.862, and 0.870). From d 7 to 14, increasing the lactose level increased ADFI (653, 699, 708, 694, and 717 g/d) and improved (quadratic, P<0.04) ADG (518, 572, 568, 558, and 554 g/d). For the overall period (d 0 to 14), lactose supplementation increased (linear, P<0.001) ADFI (562, 594, 612, 603, and 626 g/d) and ADG (454, 481, 503, 499, and 513 g/d). Results from these two experiments indicate that pigs respond linearly to lactose supplementation from 8 to 11 kg BW with a plateau suggested at 7.0%. Whereas, from 11 to 15 kg BW there was a quadratic response to lactose supplementation with a plateau at 3.5%.

Key Words: Pigs, Nursery, Lactose

166 Response of weanling pigs to declining energy intake when amino acid intake declines either in direct proportion to energy or at a reduced rate. T. F. Oresanya[1,2], A. D. Beaulieu[1], and J. F. Patience*[1], [1]*Prairie Swine Centre Inc.*, [2]*University of Saskatchewan*.

Reducing energy intake (DEi) through the simple restriction of daily feed allowance results in a parallel and proportional reduction in amino acid intake (AAi). This leads to questions about the adequacy of amino acid nutriture under such conditions, especially at very low feed intakes. This experiment was conducted to determine if investigations on the impact of reduced DEi, achieved through restricted daily feed allowance without adjustment of amino acid levels, are confounded by amino acid supply. Individually penned PIC barrows (n=56; age=35.0 days; BW=10.2±0.9 kg; mean±SD) were allotted to one of 7 dietary treatments in a RCBD. Treatments included a control diet (ad libitum feed access) or feed intake limited to 70, 60 or 50% of ad libitum. Within each DEi treatment, there were two amino acid intake treatments: declining in direct proportion to DE (PR) or declining at a reduced rate, such that lysine intakes were 18, 25 and 39% above the comparable PR intake levels for the 70, 60 and 50% DEi treatments, respectively. Wheat, corn, barley and SBM based diets were formulated to contain 3.41 Mcal DE/kg. Ideal amino acid ratios were maintained throughout. BW was determined bi-weekly and daily feed allowance adjusted per pig on a BW basis, relative to the ad libitum fed pigs. ADFI, ADG and final bodyweight decreased with decreasing DEi (P<0.01) but were not affected by AAi (P>0.05) or by the interaction of DEi x AAi (P>0.10). Gain:feed ratio was reduced by AAi (P<0.05) and the affect was greatest on the PR treatment (DEi x AAi, P<0.05). Using these growth data, the AA requirement for maintenance plus protein deposition was calculated factorially and suggested that amino acid intake may have been limiting, but only in the PR treatment. These results confirm that the response of weaned pigs to declining energy intake, achieved through limiting daily feed allowance, may be confounded by amino acid supply

Key Words: Pigs, Energy intake, Amino acid intake

167 Relative availability of phosphorus in feed phosphates by growing pigs. G. I. Petersen*, C. Pedersen, and H. H Stein, *South Dakota State University*.

The relative availability of P in five feed phosphates was determined using growing pigs. The P-sources were dicalcium phosphate (DCP), monocalcium phosphate with 70% purity (MCP70), monocalcium phosphate with 85% purity (MCP85), monocalcium phosphate with 100% purity (MCP100), and monosodium phosphate (MSP). A basal diet (0.10% P) was formulated. Ten additional diets were formulated by adding 0.07 or 0.14% P from each of the five feed phosphates to the basal diet. Fortyfour pigs (initial BW 16.8 ± 4.3 kg) were allotted to the 11 diets, housed individually, and fed on an ad libitum basis during the 28-d experimental period. At the conclusion of the experiment, all pigs were euthanized and five bones (i. e., the tibia, and both sets of third and fourth metacarpals) were harvested and the bone breaking strength was determined in the metacarpals. The relative bioavailability of P in each of the feed phosphates was calculated using slope ratio methodologies based on breaking strength. The bone mineral density (BMD) and bone mineral content (BMC) was measured in different parts of the tibia using two scanning machines (i.e., Dual-energy X-ray Absorptiometry (DXA) and Peripheral Quantitative Computed Tomography (pQCT)). Correlation coefficients from DXA and pQCT data to breaking strength were developed. The availability of P in DCP, MCP70, MCP85, and MCP100 was 49.5, 68.9, 66.3, and 84.9%, respectively, relative to MSP. The slope of the regression line for MSP was steeper (P #8804 0.05) than the slopes for pigs fed DCP, MCP70, or MCP85, but not different from that of pigs fed MCP100. The slope for MCP100 was also steeper than the slope for DCP ((P #8804 0.05), but not different from the other sources of P. The correlation between BMD or BMC and the breaking strength was between 0.73 and 0.79, dependent on which part of the tibia was measured, but regardless of which machine was used for the scanning. In conclusion, P in MSP is more available than P in DCP and MCP, but there is no significant difference in P-availability between different sources of MCP. The breaking strength of bones can be predicted with reasonable accuracy using either a DXA or a pQCT scan.

Key Words: Phosporus, Pigs, Relative availability

168 Body P partitioning in pigs as influenced by dietary P regimen. T. S. Stahly*, T. R. Lutz, D. R. Cook, B. C. Tooker, and J. Zamzow, *Iowa State University*.

Pigs were fed diets containing 0.2, 0.3, 0.4, 0.5, 0.6 or 0.7% bioavailable P (aP) from 8 to 33 kg BW. Seven sets of seven littermate barrows of a high lean strain were allotted within litter to one of six P regimens consisting of a basal, corn-soy-whey diet (.54% analyzed P) supplemented with incremental additions of dicalcium phosphate at the expense of starch-limestone. Dietary calcium was adjusted in each diet to achieve a 2.5 to 1 Ca/aP ratio. One pig in each litter was killed for determination of initial body composition. Total bone, muscle, skin, fat tissues (of carcass-head) and viscera of each pig were individually isolated, weighed and analyzed for P content. Digestible dietary P (dP) was determined to be 0.32, 0.42, 0.51, 0.56, 0.63 and 0.70% for the six P regimens. Daily body P accretion (2.4, 3.3, 3.7, 4.2, 4.5, 4.6 g, $P<0.01$) and the P content of body gain (3.7, 4.8, 5.4, 6.2, 6.8, 6.6 g/kg, $P<0.01$) increased quadratically as dietary concentrations of dP increased. Total P accrued in bone (54, 82, 94, 112, 128, 117 g, $P<0.05$), muscle (22, 23, 28, 29, 23, 26 g, $P<0.14$) and viscera (12, 13, 15, 14, 18, 17 g, $P<0.05$) also increased quadratically as dP increased. Increases in body P accretion from the first incremental addition of dP were the result of increased tissue mass accretions and increased concentration of P per unit of accrued tissue. The increases from subsequent incremental additions of dP were the result of increasing P concentration (g/kg) in the accrued tissues (bone, 23 to 42; muscle, 1.7 to 2.4; viscera, 1.9 to 2.5). Bone P accretion accounted for 65 to 85% of the increases in body P accretion resulting from the first two incremental additions of dP and 100% of the changes induced by subsequent incremental dP additions. Based on these data, body P partitioning is dependent on dietary P adequacy. Partitioning of body P in a marginal P deficiency (in presence of constant Ca/aP ratio) consists principally of lowering P content of bone not accrued bone mass. Whereas P partitioning in moderate and significant P deficiencies, respectively, consists of reducing the P content of each P containing tissue not accrued tissue mass and reducing the accretion of each tissue mass.

Key Words: Pigs, Phosphorus, Bone

169 Microarray analysis of the effects of phosphorus on gene expression in porcine muscle. A. Qu*, L. Grapes, M. Rothschild, and C. Stahl, *Iowa State University*.

Adequate dietary phosphorus (P) is essential for optimal muscular and skeletal growth. However, environmental concerns and costs associated with supplementing inorganic P, has lead to attempts to minimize the amount of P added to swine diets. We examined changes in gene expression in muscle due to different dietary P level. Thirty-six gilts (6.63 ± 0.78 kg) from 6 litters (3 gilts/litter) for each of two sire lines, one selected primarily for growth performance (GP) the other for meat quality (MQ), were allotted to 3 groups. Pigs received either P adequate (+P, 0.71% total P, 0.41% available P, 0.86% Ca), P deficient (-P, 0.43% total P, 0.14% available P, 0.52% Ca), or P repletion (RP, +P for 7d then -P for 7d) diets for 2 wks. After 2 wks, muscle RNA samples were obtained for analysis using microarrays spotted with over 13,000 unique oligos. The microarray study involved a loop design with all pair-wise treatment comparisons performed within litter. Mixed-model analysis was performed on normalized signal intensity data from 36 slides and included the fixed effects of sire line, diet and sire line by diet interaction. Microarray results show significant differences in gene expression ($P<0.01$) between sire lines (339 genes), diet (18 genes), and sire line by diet interaction (31 genes). For example, in GP +P pigs, DNA topoisomerase II beta expression was significantly different from other treatments ($P<0.007$ and $P<0.008$, respectively). However in MQ sire line, this difference was only found between +P and RP pigs. In MQ, sodium/hydrogen exchanger 1 expression was different ($P<0.005$) between +P and -P as well as +P and RP. But this difference between +P and RP in GP pigs was not seen. These results may help to elucidate differences in the homeorhetic control of P metabolism between genetically diverse pigs, and in the future may help identify pigs that can maintain growth performance in a more environmentally friendly manner.

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Key Words: Phosphorus, Gene expression, Microarray analysis

170 Effect of supplementing zinc oxide and biotin on growth performance and the stability of the intestinal flora in nursery pigs. H. Wilt* and M. Carlson, *University of Missouri-Columbia*.

A 28-d nursery experiment was conducted to evaluate the effects of supplementing zinc oxide (ZnO) and biotin on growth performance, fecal Zn concentrations and the stability of the intestinal flora in nursery pigs. Ninety-six crossbred pigs (5.89 ± kg and 19 ± 1 d of age) were weaned and allotted to one of four treatments based on weight, sex and ancestry in a randomized complete block design (3pigs/pen and 8 reps). Phase 1 (d 1 to d 14) and Phase 2 (d 15 to d 28) nursery diets were fed in meal form. Fecal grab samples and colonic swabs were collected weekly. Fecal floras were analyzed for metabolic activity and fermentative capacity to calculate similarities within pigs over time and treatment. Phase 1 and 2 diets utilized 4 dietary treatments in a 2x2 factorial arrangement: (1) Basal diet contained 135 ppm Zn as ZnSO4 and no supplemental D-biotin, (2) Basal + 3,000 ppm Zn as ZnO, (3) Basal + 440 ppb D-biotin, (4) Basal + 3,000 ppm ZnO + 440 ppb D-biotin. Supplementation of Zn and D-biotin altered microbial populations. Pigs fed 3,000 ppm ZnO for 28 days postweaning had greater ADG ($P < 0.0001$) and ADFI ($P < 0.05$) than control or biotin fed pigs during Phase 1, Phase 2 and overall. In Phase 1, Gain/Feed improved ($P < 0.05$) when pigs fed the 3,000 ppm Zn independent of biotin supplementation. Fecal Zn concentrations were greater ($P < 0.05$) in pigs fed the 3,000 ppm Zn. These results prove that supplementing nursery pigs with 3,000 ppm Zn as ZnO for 28d postweaning increases ADG by 19% and feed intake by 13%. Biotin supplementation had no impact on growth performance of nursery pigs.

Key Words: Zinc, Biotin, Nursery pigs

171 Effect of supplementing zinc oxide and biotin with an oral dose of *Escherichia coli* on growth performance and stability of intestinal flora in nursery pigs. H. Wilt* and M. Carlson, *University of Missouri-Columbia*.

A 28-d nursery experiment was conducted to evaluate the effects of supplementing zinc oxide (ZnO) and D-biotin with or without an Escherichia coli challenge on nursery pig performance and metabolic activities of fecal flora. Thirty-two crossbred pigs (7.16 ± 0.469 kg and 19 ± 1 d of age) were weaned and allotted to one of four treatments based on ancestry weight and sex in a randomized complete block design (1 pig/pen and 4 reps). Phase 1 (d 1 to d 14) and Phase 2 (d 15 to d 28) nursery diets were fed in meal form. Weight data and colonic swabs were collected weekly. Phase 1 and 2 diets utilized 4 dietary treatments in a 2x2 factorial arrangement: (1) Basal diet contained 135 ppm Zn as ZnSO4 and no supplemental D-biotin, (2) Basal + 3,000 ppm Zn as ZnO, (3) Basal + 440 ppb D-biotin, (4) Basal + 3,000 ppm ZnO + 440 ppb D-biotin. The oral inoculation of E. coli (Cytonecrotizing factor 1; 500 x 106 CFU) was administered on d2 creating an additional x2, making the total arrangement as 2x2x2. Fecal floras were analyzed by metabolic activity and fermentative capacity to calculate similarities within pigs over time and treatment. Dietary treatments had little impact on growth performance. During wk 3, pigs inoculated with E. coli had decreased ADG compared to pigs that were not inoculated ($P < 0.03$). Pigs inoculated with E. coli and supplemented with biotin had greater ADG ($P < 0.04$) than pigs not inoculated with E. coli or fed supplemental biotin (E. coli X biotin). Pigs inoculated with E. coli had greater Gain:Feed ratios ($P < 0.007$) than pigs inoculated during Phase 1 and overall. During Phase 2, pigs inoculated with E. coli and fed supplemental biotin had greater Gain:Feed ($P = 0.01$) than pigs not inoculated and fed biotin (E. coli x biotin). Overall, pigs supplemented with 3,000 ppm Zn had greater Gain:Feed ($P = 0.01$) than control or biotin supplemented pigs, independent of E. coli inoculation. These results indicate that nursery pigs exposed to a disease challenge may respond with improvements in growth performance when either ZnO or D-Biotin is supplemented.

Key Words: Zinc, Biotin, Escherichia coli

172 A technique for mammary biopsy in lactating sows. J. Pérez Laspiur, R. N. Kirkwood, B. J. Moore, N. K. Ames, and N. L. Trottier*, *Michigan State University*.

The objective of this study was to develop a biopsy technique to obtain mammary tissue (MT) from lactating sows in sufficient amount for RNA and protein extraction and histology examination, while maintaining the physiological integrity of the mammary gland (MG) and welfare of the sow. Eighteen multiparous lactating sows were used. Biopsies were performed between d 4 and 7 and d 17 and 19 of lactation on the first and second thoracic MG, respectively. Piglets were removed and sows anesthetized with an intramuscular injection of TKX (250 mg tiletamine and 250 mg zolazapam in 2.5 mL ketamine and 2.5 mL xylazine-100) at 1 mL per 34 kg BW. During anesthesia, sows were positioned in lateral recumbency to expose one entire side of the udder. One MG was prepared for biopsy using Betadine scrub followed by rinsing with 70% alcohol and cleaning with Betadine solution. The incision area was numbed with sub-cutaneous and intra-mammary administration of Lidocaine (1 mL, 2%). A 2-cm incision was made vertical to the plica lateralis, aligned with the nipple and approximately 5 cm dorsal to the perimeter of the nipple areola. Hemorrhage was minimal but, if evident, was controlled by pressure with gauze. Mammary tissue (400 to 850 mg, n=2) was exteriorized with forceps and excised with a scalpel in a circular motion. The incision was closed using simple interrupted sutures. Time from incision to closing was approximately 5 min. Piglets were returned to suckle following full recovery from anesthesia. Average daily gain of piglets suckling the glands subjected to biopsy versus that of piglets suckling intact glands did not differ. Sow feed intake on the day following biopsy was not different than that of sows on the day prior to biopsy. In all but one sow, there were no local or systemic infections. In conclusion, up to 1.7 g MT can be obtained in a live lactating sow without adversely affecting lactation performance.

Key Words: Mammary gland, Biopsy, Sow

173 Effects of dried distillers grains with solubles on feed preference in growing pigs. C. W. Hastad*, J. L. Nelssen, R. D. Goodband, M. D. Tokach, S. S. Dritz, J. M. DeRouchey, and N. Z. Frantz, *Kansas State University*.

Three studies were conducted to evaluate the effects of dried distillers grains with solubles (DDGS) on palatability and feed intake of growing pigs. In Exp.1, 90 gilts (initially 26.4 kg) were used to evaluate a corn-soybean meal-based diet with or without 30% DDGS from two different sources on feed preference. Source 1 was obtained from an ethanol plant built before 1990 and source 2 was obtained from a plant built after 1990. Each pen had two feeders, one with the corn-soybean meal diet and the other with one of the DDGS sources. There were 10 pens with six pigs per pen and 10 pens with three pigs per pen. Feeder locations were switched twice daily. From d 0 to 7, there were no differences in ADFI among the dietary treatments. However, from d 7 to 13 and overall, feed intake was lower ($P < 0.01$) for both DDGS diets when compared to the corn-soybean control. For Exp. 2 and 3, there were four feeders in each pen, each containing a different diet. Feeder locations were switched twice daily. In Exp. 2, 187 barrows and gilts (initially 23.6 kg) were used to examine the effects of increasing DDGS (source 2) in a 21 d preference study. Treatments consisted of a control (corn-soybean meal) diet, or the control diet with 10, 20, or 30% DDGS. There were 17 pigs per pen and 11 pens. Increasing DDGS decreased (linear; $P < 0.01$) ADFI (776, 524, 331, and 153 g/d) for the overall trial. In Exp. 3, 120 barrows and gilts (initially 18.9 kg) were used to examine the effects of adding Sucram, a feed flavor additive, in 21 d preference study. Treatments were arranged as a 2 x 2 factorial with 0 or 30% DDGS and either 0 or 0.02% Sucram. There were 15 pigs per pen and 8 pens. For the entire trial, adding DDGS to diets decreased ($P < 0.01$) ADFI. Adding Sucarm had no effect ($P > 0.71$) on feed intake in either the corn-soybean meal or DDGS diets. These studies demonstrate that pigs prefer corn-soybean diets compared with diets containing DDGS and the source of DDGS or addition of a feed flavor did not influence palatability.

Key Words: Pigs, Feed Intake, DDGS

174 The effect of dried palm oil powder containing different amount of monoglyceride on the growth performance and serological cholesterol changes in weaned pigs. B. J. Min*, O. S. Kwon, W. B. Lee, J. W. Hong, and I. H. Kim, *Dankook University*.

This experiment was conducted to determine the effect of dried palm oil powder containing different amount of monoglyceride on the growth performance and serological cholesterol changes in weaned pigs. One hundred twenty five cross-bred pigs (DYL, 6.00 ± 0.79 kg average initial BW) were used in a 21 d growth assay. Dietary treatments included SOY (containing 5% soybean oil), PALM (containing 5.5% dried palm oil powder) and SOPM0, 12.5 and 25 (containing 2.5% soybean oil and 2.7% dried palm oil powder containing 0%, 12.5% and 25.0% monoglyceride, respectively). For the whole period, ADFI was increased in dried palm oil powder containing monoglyceride and PALM treatments compared with SOY and SOPM0 treatment ($P<0.05$). Digestibility of fat was higher($P<0.05$) for pigs fed the SOY diet than fed other diets. SOPM diets containing monoglyceride showed increased fat digestibility compared with PALM diet ($P<0.05$). However, there were no significant differences in digestibility of DM, N and DE ($P>0.05$). Backfat thicknesses were not significantly different among treatments. There was a decrease in total cholesterol, HDL-cholesterol, triglyceride, total lipid and increase in free fatty acid ($P<0.05$) in serum of pigs fed SOY diet. Also, triglyceride concentration in serum was increased in PALM treatment compared with SOPM treatment ($P<0.06$). In conclusion, feeding soybean oil in weaned pigs showes a higher digestibility of fat and lower concentration of cholesterol and triglyceride in blood than feeding only dried palm oil. Also, feeding dried palm oil powder containing monoglyceride result in improved digestibility and ADFI.

Key Words: Dry palm oil powder, Monoglyceride, Pigs

175 The effects of herbal plant mixture(Miracle20) supplementation on the productions of lactating sows and growth performance and hematological changes of piglets. B. J. Min*[1], O. S. Kwon[1], J. W. Hong[1], W. B. Lee[1], K. S. Son[1], Y. H. Yu[2], and I. H. Kim[1], [1]*Dankook University,* [2]*HANPEL TECH Co., Ltd.*.

This study was conducted to evaluate the effects of dietary herbal extracts mixture(Miracle; included *Angelicae Gigantis radix, Rehmanniae radix, Cnidii rhizoma, Glycyrrhizae radix, Schizandrae fructus, Plantago asiatica and Dioscoreae radix*) on the productions of lactating sows and growth performance and hematological changes of piglets. Twenty seven sows (Yorkshire×Landrace×Duroc, 1 to 3 parities) were used in a 21 day trial. Dietary treatments included 1) CON (control; basal diet), 2) HPM0.1 (basal diet + herbal plant mixture 0.1%) and 3) HPM0.2 (basal diet + herbal plant mixture 0.2%). Backfat thickness loss from farrowing to weaning was decreased in HPM treatments compared with CON treatment (linear effect, P#88040.003). ADFI was decreased in sows fed herbal plant mixture (linear effect, $P<0.05$). Also, treatments of dietary herbal plant mixture reduced day of return to estrus compared with control (linear effect, $P<0.05$). Availability of digestible energy was improved in HPM treatments compared with control(linear effect, P#88040.05). In piglets, weight gain ($P>0.34$) and survivability ($P>0.89$) after weaning were not affected by treatment. No statistical differences were found for albumin, WBC, lymphocyte and monocyte concentration among treatments($P>0.05$). In conclusion, dietary herbal plant mixture reduces backfat thickness loss and day of return to estrus and improves availability of digestible energy in lactating sows.

Key Words: Herbal plant mixture, Lactating sow, Piglet

176 Effect of phosphorous deficiency and genetics on bone characteristics and gene expression in young pigs. L. Hittmeier*, R. Lensing, L. Grapes, M. Rothschild, and C. Stahl, *Iowa State University*.

Phosphorous (P) is essential in supporting bone growth and maintenance; however, little research has focused on the genetic mechanisms controlling P utilization. To better understand these mechanisms, we examined the effects of P deficiency in 36 gilts (6.63 ± 0.78 kg) from 6 litters (3 gilts/litter) sired by two lines known differ in bone structure (one considered heavier-boned (HB) and the other lighter-boned (LB)).

Pigs were assigned to 3 dietary treatments: P adequate (0.41% available P for 2 wks), repletion (0.14% available P for wk 1, 0.41% available P for wk 2), or P deficient (0.14% available P for 2 wks). After 14-d, pigs were harvested and bone marrow was collected for analysis of gene expression by real-time PCR, and radial bones were collected for breaking strength analysis. In the LB line, repletion pigs had higher ADG (P<0.01) than the other treatments, and in HB pigs P deficiency caused a decrease in ADG (P<0.01) compared to the other treatments. In LB pigs P deficiency did not affect ADG. The radial bone strength of P deficient pigs was less (P<0.01) than that of the other treatments in both sire lines. In HB, but not LB pigs, treatment affected the expression of calcitonin receptor (P<0.05), IL-6 (P<0.05), oxytocin receptor (P<0.11), IGFBP-3 (P<0.06), and vitamin D receptor (P<0.04). Expression of osteocalcin and osteoprotegerin was not affected by sire or treatment. Bone traits and expression levels were analyzed using a mixed model with sire line, treatment and the interaction between sire line and treatment fit as fixed effects. Based on this study, the HB line appears to be more responsive to dietary P deficiency than the LB line. A better understanding of the role genetics plays in P homeorhesis will enable selection for pigs that will require and excrete less P, as well as allow for the recommendation of specific genetic lines for producers with different waste management strategies.
This work was funded in part by the IAHEES, the Office of Biotechnology, and Sygen International.

Key Words: Phosphorous, Gene expression, Bone

177 A comparison of whey protein concentrate and spray-dried animal plasma in diets for weanling pigs.

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A total of 180 weanling pigs (initially 6.2 kg and 21 ± 3 d of age) were used to evaluate the effects of whey protein concentrate (WPC) or spray-dried animal plasma (SDAP) on growth performance of weanling pigs. Pigs were blocked by initial weight and sex and allotted to one of five dietary treatments. There were six pigs per pen and six pens per treatment. Pigs were fed one of 5 experimental diets; a negative control with no specialty protein sources, or the negative control diet with 2.5 or 5.0% SDAP or 2.5 or 5% WPC. All experimental diets contained 15% spray-dried whey with no added antimicrobial or pharmacological levels of ZnO. The WPC contained 80.2% CP and 7.5% lysine (as-fed). Experimental diets were fed from d 0 to 14 after weaning, with all pigs fed a common phase 2 diet from d 14 to 27 after weaning. From d 0 to 14, increasing SDAP increased ADG and ADFI (linear, P<0.01). Increasing WPC had no effect on ADG or ADFI, but increased G/F (quadratic, P<0.01). Pigs fed diets containing SDAP had greater (P<0.01) ADG and ADFI than pigs fed diets containing WPC. Overall (d 0 to 27 after weaning), increasing SDAP from d 0 to 14 increased ADG (linear, P<0.03) and tended to increase ADFI (linear, P<0.11). Pigs fed diets containing SDAP also had greater overall ADG (P<0.03) and tended to have increased G/F (P<0.12) compared to pigs fed WPC. Increasing WPC from d 0 to 14 had no effect on overall ADG or G/F. In conclusion, pigs fed diets containing SDAP during the first 14 d after weaning had improved overall growth performance while pigs fed WPC did not compared to pigs fed the diet without SDAP or WPC. Previous data suggested similar growth performance among pigs fed SDAP or WPC. The lack of WPC response in this study may be an indication of product variation and manufacturing processes between sources. Therefore, further research is needed to determine differences in growth performance as a result of variation between WPC sources.

Key Words: Nursery pigs, Spray-dried animal plasma, Whey protein concentrate

178 Chelated minerals in diets for weaned piglets.

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The use of mineral contents in diets above NRC (1998) requirements is a common practice in swine production. The search for highly available mineral sources, the antagonism between minerals and the concern about environmental pollution have motivated research on organic forms of minerals. The objective of this experiment was to compare a trace mineral supplement containing Zn (80 ppm), Cu (5 ppm), Mn (20 ppm), Se (0.25 ppm) and Fe (80 ppm) in organic form (carbochelate, Tortuga), with a supplement containing the same minerals in inorganic form (sulphate, except for Se, which was added as sodium selenite), by measuring piglet performance and red cell count. Fifty-six male and female piglets, 21-day-old in average, were used in a randomized block design with two treatments (organic vs. inorganic mineral source) and ten replicates. During the experimental period (33 days), all animals received similar diets, except for micromineral source. Data indicated higher average daily gain (ADG, P=0.06) and better feed conversion (AFC, P=0.008), during the whole experimental period, as well as higher red cell count (RC, P=0.10), for animals fed organic minerals. In conclusion, piglets fed organic minerals showed better performance.

Performance and blood variables

Treatment	ADG (g/day)	AFC	RC (10^6/mm^3)
Inorganic minerals	474[a]	1.79[a]	6.512[a]
Organic minerals	503[b]	1.73[b]	6.695[b]
CV (%)	10.73	3.46	5.32

[ab]Means in the same column followed by different letters are different.

Key Words: performance, blood, organic minerals

179 Phytobiotics and organic acids as alternatives to the use of antibiotics in nursery pig diets.

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Two experiments were conducted to evaluate the use of phytobiotics in nursery pig diets as an alternative to the use of antibiotics. In Exp 1, 144 pigs, weaned at 23.4±0.3 d of age, were fed three diets: negative control (NC) without antibiotics, positive control (PC) with carbadox (50 mg/kg), or a test diet (PEP) with 0.1% PEP (Biomin Inc). PEP contains a blend of essential oils and prebiotics. Each treatment had 6 replicate with 8 pigs per replicate. Pigs were fed experimental diets for 5 wks based on 3 phase feeding program with 1.51, 1.36, and 1.15% lysine for each phase. Pigs had free access to feed and water. Feed intake and weight gain were measured weekly. In Exp 2, 192 pigs, weaned at 19.2±0.3 d of age, were fed three diets: NC, PC, or a test diet (PBT) with 0.02% PEP and 0.4% Biotronic (Biomin Inc.) for the phase 1 (2 wks, 1.47% lysine) and 0.01% PEP and 0.2% Biotronic for the phase 2 (3 wks, 1.21% lysine). Biotronic contains phosphoric acid, lactic acid, sorbic acid, and citric acid. All other methods were identical to Exp 1. In Exp 1, ADG of PC was greater (P<.05) than NC during the entire period, whereas ADG of PEP did not differ (P>.05) from NC or PC. ADFI and gain:feed did not differ among the treatments during the entire period. Pigs in PC had higher (P<.05) diarrhea score (harder stools) than NC, whereas PEP did not differ from NC or PC. In Exp 2, there was no difference (P>.05) in ADG, ADFI, and gain:feed among the treatments. Diarrhea score was higher (P<.05) in PC than in NC and that of PBT did not differ from PC or NC. Collectively, when phytobiotics with or without organic acids were supplemented to nursery pig diets, the growth performance of pigs did not differ from antibiotics fed pigs nor from no antibiotics fed pigs during 5 week nursery period. Further research is needed to evaluate if phytobiotics improve growth and immune status of pigs under stress or sub-clinical challenges.

Key Words: Phytobiotics, Organic acids, Nursery pigs

180 Assessment of growth performance and nutrient balance of early-weaned pigs fed diets containing spray dried corn distillers solubles by-products, carbadox, and porcine plasma.

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Barrows (n = 63; 17-d of age) were used in a 10-d growth performance and nutrient balance trial. Pigs were housed in individual stainless steel metabolism crates to determine energy and N balance. Dietary treatments included: control diet (NC), NC + 15% condensed distillers solubles (DS), NC + 7.5% yeast cream (YC), NC + 15% residual solubles (RS), NC + 55 ppm carbadox (AB), NC + 6% porcine plasma (PP), and NC + AB + PP (PC). All diets were formulated to 1.60% total lysine, 3440 kcal/kg of metabolizable energy, 0.87% Ca, and 0.80% P. Growth performance (ADG, ADFI, G:F) was determined during the first 10-d period in which pigs had ad libitum access to feed. After the initial 10-d period, pigs were weighed and their daily feeding level was standardized to 4% of their body weight, fed in two equal meals. After a 5-d acclimation period, total feces and urine were collected and analyzed to determine the effects of treatment on energy and N balance. Pigs fed the PP and PC diets tended to have higher ADG (P=0.10) and

had higher ADFI (P<0.05) compared to pigs fed the NC and DS diets, but G:F was not affected. Pigs fed the PP diet also had higher ADFI (P<0.05) compared to pigs fed the YC, RS, and AB diets. Daily fecal, urinary, and total N excretion was not affected by treatment. However, pigs fed the RS, AB, and PC diets tended to retain more N (P=0.10) compared to pigs fed the NC and YC diets. Urinary and fecal energy excretion was not affected by treatment. However, the YC and PP diets had lower digestible and metabolizable energy (P<0.05) compared to the DS and RS diets. Results from this study suggest that feeding diets containing distillers solubles by-products resulted in similar growth performance compared to pigs fed the negative control and carbadox diets, but poorer performance compared to pigs fed PP and PC diets. The high digestible and metabolizable energy value of the DS and RS diets, along with N retention, suggests that DS and RS are acceptable alternative ingredients in phase 1 nursery diets.

Key Words: distillers solubles, nutrient balance, early-weaned pigs

181 Effect of sex and slaughter weight on carcass measurements.

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The aim here was to examine the effect of sex and slaughter weight on carcass measurements in pigs of a lean genotype. Forty five single sex pairs of pigs (meatline Landrace sire on Landrace x Large White sows) were used in a 3 (sex) x 3 (slaughter weight) factorial design with 5 pairs per treatment. The experimental period was from weaning (mean = 26 d) to slaughter. Sexes were boar (B), castrate (C) and gilt (G) and the slaughter weights were 80, 100 and 120 kg liveweight. All pigs were fed the same diets based on wheat, barley and soybean meal ad libitum as dry pellets. Sex x slaughter weight interaction effects were not significant (P>0.05). Carcass length, leg length and ham circumference were 845, 832 and 836 mm (s.e. 3.3; P<0.05), 388, 383 and 383 mm (s.e. 2.5; P>0.05) and 712, 720 and 719 mm (s.e. 3.4; P>0.05) for B, C and G respectively. Weight of cold carcass, hind leg, shoulder, loin and belly were 77.7, 78.6 and 77.4 kg (s.e. 0.74; P>0.05); 9.30, 9.73 and 9.59 kg (s.e. 0.153; P>0.05); 5.48, 5.56 and 5.40 kg (s.e. 0.096; P>0.05); 6.39, 7.17 and 6.59 kg (s.e. 0.159; P<0.01) and 3.46, 3.67 and 3.47 kg (s.e. 0.060, P<0.05) for B, C and G respectively. Carcass length, leg length and ham circumference were 793, 837 and 884 mm (s.e. 3.3; P<0.01); 364, 385 and 405 mm (s.e. 2.5; P<0.01) and 672, 720 and 760 mm (s.e. 3.4; P<0.01) for slaughter weights of 80, 100 and 120 kg respectively. Weight of cold carcass, hind leg, shoulder, loin and belly were 63.1, 78.6 and 91.8 kg (s.e. 0.74; P<0.01); 7.88, 9.54 and 11.2 kg (s.e. 0.153; P<0.01); 4.56, 5.45 and 6.41 kg (s.e. 0.096; P<0.01); 5.40, 6.64 and 8.10 kg (s.e. 0.159; P<0.01) and 2.84, 3.56 and 4.19 kg (s.e. 0.060, P<0.01) for slaughter weights of 80, 100 and 120 kg respectively. Carcases were longer for boars than gilts or castrates and the four primal cuts were heavier for castrates than boars. All measurements increased sequentially as slaughter weight increased.

Key Words: Castration, Slaughter weight, Carcass

182 Yearling horse growth and development: acceptability and replacement value of field peas for oats.

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Forty-eight yearling growing horses (colts: n=18; fillies: n=30) averaging 349.9 kg were used in a two year study to evaluate acceptability and replacement value of field peas for oats in an 84d feeding study. Field peas replaced 0, 33.3 and 67.7% of the oats in a complete pelleted supplement that was divided into two feedings and fed twice daily at 8:00 a.m. and 2:00 p.m. Forage was a 15% CP hay pellet [60% alfalfa (*Medicago sativa*) and 40% bromegrass (*Bromus inermis*)]; DE value of 0.477 Mcal/kg. Oat grain(*Avena sativa*) was 13.3% CP with an energy value of 0.658 Mcal/kg. Field peas (*Pisum sativum*) contained 23.0% CP and had an energy value of 0.713 Mcal/kg. Experimental supplement DM, CP, LYS, NEg, ADF and NDF were 86.75%,19.81%, 0.85%, 0.245 Mcal/kg, 13.74%, 27.18%; 87.55%, 20.8%, 0.84%, 0.256 Mcal/kg, 12.30%, 24.83% and 88.49%, 21.13%, 0.86%, 0.267 Mcal/kg, 10.86%, 22.59% for 0, 33 and 67.7% field pea, respectively. Average 84d hay cube consumption was 5.23, 5.44 and 5.09 kg/d and experimental supplement consumption was 3.26, 3.05 and 2.86 kg/d for 0, 33.3 and 67.7% field pea replacement, respectively. Horses readily consumed all experimental pea replacement supplements without noticeable signs of digestive disorder. Growth measurements included body weight change and physical measurements for body length, hip and wither height, heart girth, forearm, cannon bone and gaskin muscle circumferences. Treatment means did not differ for final weight (P=0.395), ADG (P=0.419), body length (P=0.392), hip height (P=0.536), wither height (P=0.584) heart girth (P=0.414), forearm circ. (P=0.648), cannon bone circ. (P=0.255) and gaskin muscle (P=0.633). Results of this experiment suggest that field peas can replace up to 67.7% of the oats in yearling growing horse supplements without development of digestive disorders. In addition, due to the higher protein/energy content of field peas, 12.4% less supplement was needed to achieve a similar growth response.

Key Words: Equine, Yearling Development, Field Peas

183 Effect of dietary phosphorus and genetic background on growth performance and IGF-1 levels in young gilts.

S. Cutler*, L. Grapes, M. Rothschild, and C. Stahl, *Iowa State University.*

Costs associated with inorganic phosphorus (P) levels in animal diets have driven research to more accurately define requirements in order to minimize P excretion while maintaining growth rate. We examined the influence of 2 sire lines, selected primarily for either meat quality (MQ) or growth performance (GP), on P utilization by 36 young gilts (21d of age, 6.63 ± 0.78 kg) from 6 litters (3 pigs/litter) for each sire line. Pigs were allotted into three dietary treatment groups: P adequate (+P, 0.41% available P for 2 wks), P repletion (RP, 0.14% available P for wk 1, 0.41% available P for wk 2), or P deficient (-P, 0.14% available P for 2 wks). A significant reduction (P < .05) in ADG was seen in MQ sired -P pigs when compared with either RP or +P pigs, whereas this reduction was not seen in GP sired pigs. Both MQ and GP sired -P pigs had lower (P<.05) G:F than their siblings in either the +P or RP groups. Plasma inorganic P concentrations were reduced (P<.05) and plasma alkaline phosphatase activities elevated (P<.05) in P deficient groups at wk1 and 2. The RP group returned to normal levels after 1 wk on a P adequate diet. Total plasma IGF-1 concentrations were determined by RIA. Regardless of sire line pigs in the -P group had lower plasma IGF-1 concentrations (P<.05) than +P pigs. The depression of circulating IGF-1 levels in -P MQ sired animals was greater (P<.05) than that seen in GP sired animals. There were, however, no significant differences in the relative expression of IGF-1, IGFBP-2, and IGFBP-3 mRNA in liver tissue among any of the treatment groups as determined by real-time PCR. These results suggest that genetic background dramatically influences inorganic P requirements and that genotype specific P supplementation could reduce the environmental impact of swine production without detriment to performance.

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Key Words: Pigs, IGF-1, Phosphorus

184 Effects of intermittent ractopamine use on pig growth performance in late finishing.

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A total of 342 finishing pigs (PIC L 327 x L42; 228 barrows and 96 gilts; initially 67.55 ± 1.87 kg) were used in a 56 d feeding trial to determine effects of intermittent Ractopamine use on pig growth performance in late finishing. There were four experimental treatments with 11 or 12 pigs per pen and seven pens per treatment in a randomized complete block design. Diets were sorghum-soybean meal-based and formulated to contain 1.0% lysine with or without 10 ppm Ractopamine. Experimental treatments consisted of: 1) a control diet (no Ractopamine) fed for 56-d before marketing; 2) Ractopamine fed for the first 21-d and then control diet for the last 35-d; 3) Ractopamine fed for the first 21-d, then control for 14-d, then Ractopamine the last 21-d; and 4) control diet fed for the first 35-d then Ractopamine fed for the last 21-d before market. Pigs were weighed on d 21, 28, 35, 42, 49, and 56 to determine ADG, ADFI, and G:F. From d 0 to 21, pigs fed Ractopamine had increased (P<0.001) ADG and improved G:F compared to pigs fed the control diet (1.06 kg and 0.40 vs 0.96 kg and 0.37, respectively). However, from d 21 to 35 (when no Ractopamine was fed), control pigs had greater

(P<0.009) ADG than pigs previously fed Ractopamine (0.98 and 0.88 kg, respectively). During the last 21-d, and for the overall 56-d trial, pigs fed Ractopamine the last 21-d of the study or those fed Ractopamine from d 0 to 21 and then d 35 to 56, had greater (P<0.0004) ADG and improved (P<0.0001) G:F than control pigs or those fed Ractopamine from d 0 to 21 (1.02 kg and 0.34 vs 0.89 kg and 0.29 from d 35 to 56, respectively, and 1.00 kg and 0.36 vs 0.95 kg and 0.33 from d 0 to 56, respectively). These results indicate that feeding 10 ppm Ractopamine increases ADG and G:F. Furthermore, the response to Ractopamine appears to be similar among pigs fed Ractopamine for the first time and those fed Ractopamine intermittently.

Key Words: Ractopamine, Withdrawal, Finishing pig

185 Effects of a solid-state fermented phytase on growth performance and nutrient digestibility of growing pigs fed barley-soybean meal based diets.

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Previous reports from our lab found that the addition of a solid-state fermented (SSF) phytase complex to corn-soybean meal diets improved P digestibility, but had little effect on digestibility of other nutrients. This enzyme complex contains side-enzyme activities other than phytase that could improve the digestibility of other nutrients (i.e., DM, N, energy) in lower quality feedstuffs. Thus, an experiment utilizing 24 barrows (24.3 kg) was conducted to determine the effects of adding SSF phytase complex (Allzyme SSF; Alltech, Inc.) to low available P, barley-soybean meal diets on growth performance and nutrient digestibility in a 21-d study. Pigs were blocked by BW and allotted randomly to four dietary treatments (6 pigs/trt). Diet 1 was a fortified barley-soybean meal based diet (0.77% dig. Lys; 1.2:1 Ca:total P) adequate in all nutrients, except available P. This diet contained 0.42% total P (0.11% available P), all of which was provided by barley and soybean meal. Diets 2, 3, and 4 were as Diet 1 plus SSF phytase to provide 250, 500, and 1,000 phytase units (PU)/kg, respectively. Pigs were housed individually and diets were fed at 3.0 maintenance with *ad libitum* access to water. There was a 7-d period (d 14 - 21) for collection of feces and urine. The addition of SSF phytase complex improved (linear, P < 0.05) ADG and F:G. Digestibility of P and ash was dramatically improved (linear, P < 0.01) with addition of SSF phytase. The increase in P digestibility led to a 17% decrease in absolute P excretion for pigs fed 1,000 PU/kg. Digestibility of GE improved (linear, P < 0.01) with SSF phytase resulting in an approximate 75 kcal/kg increase in DE concentration of the diet for pigs fed 1,000 PU/kg. Also, SSF phytase improved (P < 0.05) DM, OM, and N digestibility. These results indicate that the addition of SSF phytase complex to low P, barley-soybean meal diets markedly improved nutrient digestibility of growing pigs.

Key Words: Pigs, Phytase, Digestibility

186 Inadequate diet mixing time greatly reduces nursery pig performance.

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While the importance of thoroughly mixing diets is often emphasized, little data is available to quantify the impact of adequate mixing on pig growth performance. Therefore, a 28 d trial was conducted to evaluate the effects of mixing time on growth performance of nursery pigs. A total of 180 weanling pigs (6.31± 0.84 kg BW, 21±3 d of age) were used with 6 pigs/pen and 6 pens/treatment. Experimental treatments consisted of mixing a diet for 0, 30, 60, 120 or 330 s in a horizontal ribbon mixer. Diets were fed in two phases (d 0 to 14 and d 14 to 28) with diets in both phases containing high levels of synthetic amino acids. Diets in phase 1 also contained 3.75% fish meal, 15% dried whey, and 2,500 ppm zinc from zinc oxide. Eight samples were collected from the mixer at the completion of the respective mixing time for each batch of feed to determine a CV. Each bag (22.5 kg) was labeled (first to last) and sampled to determine the degree of mixing that occurred as feed was conveyed from the mixer to the bagger. Mixer CV values were 178, 38, 26, 21, and 5% for phase 1 and 172, 79, 60, 48, and 26% for phase 2 as mixing time increased. Bag CV values were 26, 20, 16, 11, and 7% for phase 1 and 56, 45, 40, 33, and 12% for phase 2 as mixing time increased. Each pen was then assigned a bag of feed. Bags were distributed across pens within the specific treatments in the order they were filled. As needed, the next chronological bag of feed was used. Growth performance was linearly (P<0.01) improved in both phases. From d 0 to 28, increasing mix time increased (linear and quadratic, P< 0.01) ADG (331, 405, 407, 426, 463 g for 0, 30, 60, 120, and 330 s, respectively). Increasing mix time also increased G:F (linear P<0.01, quadratic P<0.10; 0.67, 0.72, 0.76, 0.75, 0.77 for 0, 30, 60, 120, and 330 s, respectively). With greater use of low inclusion ingredients such as synthetic amino acids in swine diets, these data clearly demonstrate that inadequate mixing reduces nursery pig performance.

Key Words: Growth, Mixing efficiency, Nursery pigs

187 Growth performance of nursery pigs fed yeast alone or in combination with in-feed antimicrobial.

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Weaned pigs (initial BW 6.08 kg) were used in a 28 d growth study to evaluate the effects of feeding the combination antibiotic neomycin and oxytetracycline (Neo-Terra), varied levels of *Saccharomyces cerevisiae* (BIOSAF) yeast (0.15% or 0.3%) and the combination of Neo-Terra and BIOSAF in nursery diets. Pigs were blocked by weight and sex, and assigned randomly within blocks to five treatments. There were seven pigs per pen and six pens per treatment. Phase 1 diets were fed from d 0-14, and Phase 2 diets were fed from d 15-28. The negative control diet contained no added antibiotic or yeast, and the positive control diet contained Neo-Terra. Two diets contained BIOSAF yeast at 0.15 or 0.3 %, and a fifth diet contained the combination of 0.15 % BIOSAF and Neo-Terra. Diets were formulated without growth promoting levels of copper sulfate or zinc oxide. Growth performance data including ADG, ADFI, and feed efficiency (G/F) were calculated. Overall, pigs fed the diet containing both Neo-Terra and 0.15% BIOSAF® had greater ADG and ADFI than pigs fed the control diet and pigs fed either level of BIOSAF® alone (P < 0.05). Furthermore, over the entire trial, pigs fed the diet containing both Neo-Terra and BIOSAF® tended to also have greater ADG and ADFI than pigs fed only Neo-Terra (P = 0.15). Pigs fed Neo-Terra had greater ADG and ADFI than pigs fed the control diet and the diet containing 0.15 % BIOSAF®, but both ADG and ADFI were similar between pigs fed Neo-Terra and pigs fed 0.3 % BIOSAF. In summary, whereas BIOSAF® fed alone did not significantly improve growth performance over that of control pigs, overall, pigs fed the diet including both Neo-Terra and 0.15 % BIOSAF® had a 16 % improvement in ADG compared to pigs fed the control diet, and a trend for an improvement in ADG compared to the diet containing Neo-Terra without added yeast. Thus, in nursery settings where Neo-Terra will be added, addition of 0.15% BIOSAF® to diets could enhance growth performance. Additional research will be required to determine definitively if a level at or close to 0.3% BIOSAF® can be added to nursery diets to approach growth performance observed with Neo-Terra.

Key Words: Antimicrobials, BIOSAF®, Nursery pigs

188 Effect of milk supplementation with a direct-fed microbial during lactation on subsequent nursery performance.

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A total of 216 pigs were evaluated to determine the effect of pre-weaning milk supplementation with or without a direct-fed microbial (*Lactobacillus brevis*; 1E1) on subsequent nursery performance. At birth, 34 litters received either: 1) no milk supplement, 2) milk supplement devoid of 1E1, or 3) milk supplement with 1E1. At weaning, pigs were blocked by BW within previous lactation treatment groups and allotted to 12 pens/treatment. During the nursery, pigs were fed common Phase 1 (d 0 to 14), Phase 2 (d 14 to 28), and Phase 3 (d 28 to 42) diets. One pig/litter/treatment was euthanized on d -10, d 0 (weaning), and d 5 post-weaning to obtain duodenum, jejunum, and ileum tissue samples for intestinal morphology measurements. On d -10, pigs provided milk supplement with or without 1E1 had longer (P<0.05) jejunal villi than unsupplemented pigs. Pigs provided milk with and without 1E1 had longer (P<0.05) duodenal villi and greater (P<0.05) villus area at weaning than unsupplemented pigs. Pig BW at weaning was greater (P<0.01) with 1E1 supplementation compared to unsupplemented pigs, whereas BW of pigs provided milk tended to be greater (P=0.06) than unsupplemented pigs. From d 0 to 5 after weaning, ADG was greater

(P=0.03) in pigs provided 1E1 compared to those provided only milk. From d 0 to 5 and d 5 to 10 after weaning, ADFI was greater (P<0.05) for pigs supplemented with 1E1 compared to pigs provided milk without 1E1. Pigs supplemented with milk, with or without 1E1, had lower (P<0.01) G:F than unsupplemented pigs during the overall Phase 1 period. Pig BW on d 5 (P=0.02) and d 10 (P=0.06) post-weaning was greater in pigs previously supplemented with 1E1 compared to unsupplemented pigs. This study indicates that milk supplementation with and without 1E1 results in beneficial changes to intestinal villi architecture during preweaning, and milk supplementation with 1E1 during lactation improves ADG and ADFI in the early postweaning period.

Key Words: Swine, Lactobacillus, Growth

189 Comparison of direct-fed microbials and antibiotic supplementation on gastrointestinal morphology of weanling pigs.

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Pigs (n=252) from 30 litters were evaluated to compare the effect of direct-fed microbials and antibiotic addition on gastrointestinal morphology of nursery pigs. At farrowing, pigs were provided milk supplement throughout lactation with or without the addition of *Lactobacillus brevis* (1E1). Treatments were continued during the nursery period, in which pigs administered 1E1 in lactation continued to receive 1E1 through the watering system. At the start of the nursery phase, pigs were arranged in a 2 × 3 factorial design, and fed one of three diets: a control, or the control supplemented with Bacillus (BAC), or antibiotic. On d 10, 20, and 38 after weaning, 12 pigs were euthanized, and gastrointestinal tissues were obtained for morphology measurements. Pigs provided 1E1 had a lower (P<0.05) villus height:crypt depth ratio (V:C) in the duodenum and the jejunum on d 38 after weaning compared to pigs not administered 1E1, whereas there were no differences in V:C in either tissue section between the 1E1 treatments on d 10 and d 20 after weaning (1E1 × day interaction, P<0.01). In the ileum, villus height was greater (P<0.05) in pigs fed antibiotic compared to pigs fed the control diet or BAC on d 10 after weaning, however, pigs fed BAC exhibited greater (P<0.05) ileal villus height on d 38 after weaning compared to the other dietary treatments (nursery diet × day interaction, P<0.01). In the duodenum, pigs receiving 1E1 displayed decreased (P<0.05) numbers of sulfated goblet cells but increased (P<0.05) numbers of acidic goblet cells in comparison to pigs that did not receive 1E1. Jejunal acidic goblet cells were more abundant (P<0.05) in pigs administered 1E1 compared to pigs not provided 1E1, whereas jejunal sulfated goblet cells were less abundant (P<0.05) when pigs were provided with 1E1. Pigs fed either BAC or antibiotic had lower (P<0.05) numbers of sulfated goblet cells in the duodenum than pigs fed the control diet. This study indicates that antibiotic and direct-fed microbial supplementation results in potentially beneficial alterations in gastrointestinal morphology.

Key Words: Swine, Lactobacillus, Small intestine

190 Comparison of direct-fed microbials and antibiotic supplementation on gastrointestinal microflora and immune characteristics of weanling pigs.

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Pigs (n=252) from 30 litters were evaluated to compare the effect of direct-fed microbials and antibiotic addition on the gastrointestinal microflora and innate immunity of nursery pigs. At farrowing, pigs were provided milk supplement during lactation with or without the addition of *Lactobacillus brevis* (1E1). Treatments were continued during the nursery period, in which pigs administered 1E1 in lactation continued to receive 1E1 through the watering system. At the start of the nursery phase, pigs were arranged in a 2 × 3 factorial design, and fed one of three diets: a control, or the control supplemented with *Bacillus* (BAC), or antibiotic. On d 10, 20, and 38 after weaning, 12 pigs were euthanized to obtain gastrointestinal tissues for coliform and *E. coli* enumeration. Prior to euthanization, a blood sample was collected to determine monocyte/macrophage (MAC) phagocytosis. In the duodenum, pigs administered 1E1 had higher (P<0.05) coliform counts on d 10 and lower (P=0.10) counts on d 20 compared to pigs that did not receive 1E1 (1E1 × day interaction, P<0.05). In the jejunum, pigs administered 1E1 had lower *E. coli* counts (P<0.05) on d 20, compared to pigs not administered 1E1, whereas the administration of 1E1 did not affect jejunal *E. coli* counts on d 10 or d 38 (1E1 × day interaction, P<0.05). Without 1E1 administration, pigs fed the control and BAC diets had a greater (P<0.09) percentage of phagocytic MAC than pigs fed the antibiotic diet. However, with 1E1 administration, pigs fed the BAC diet had a lower (P<0.05) percentage of phagocytic MAC than pigs fed the control diet, with the antibiotic response intermediate between the two. (1E1 × diet interaction, P<0.10). In addition, MAC from pigs fed the BAC diet were more (P<0.05) phagocytic than those from pigs fed antibiotic. This study indicates that antibiotic and direct-fed microbial addition results in beneficial alterations in gastrointestinal microflora and innate immune activity.

Key Words: Swine, Microbial flora, Phagocytosis

191 Evaluation of two direct fed microbials on the ability of pigs to resist an infection from *Salmonella* Typhimurium.

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Forty mixed gender finishing pigs (113 ± 2.1kg initial BW), were used in a disease challenge study to determine the effects of two direct fed microbials (DFM) on the ability of pigs to resist an infection from *Salmonella* Typhimurium. Pigs were fed one of three dietary treatments: corn-soybean meal control diet (C), C + a DFM added in the water (PROBIOS^{TM}), and C + 0.05% DFM included in the feed (BIOPLUS^{TM}). Ten of the 20 pigs fed C were not challenged with *S.* Typhimurium (NC), while the remaining 30 pigs received a 2 mL intranasal inoculation with 10^9 CFU/mL *S.* Typhimurium. Pigs challenged with *Salmonella* had higher (P < 0.05) fecal scores (1=firm stool; 5=profuse diarrhea) and increased fecal shedding of *Salmonella* on d 2, 3, 4, and 5 compared to NC. On d 9 and 12 fecal scores and fecal shedding were similar between the challenged and NC pigs. Serum haptoglobin (Hp) concentrations were higher (P<0.05) for pigs challenged with *Salmonella* (2640 μg/mL) compared to NC pigs (1743 μg/mL) on d 7, but were similar on d 0 (1057 vs. 910 μg/mL) and d 12 (1585 vs. 1367 μg/mL), respectively. There were no differences in serum α_1 acid glycoprotein (AGP), IgM or IgG concentrations between challenged and NC pigs. No tissue or digesta from the NC pigs tested positive for the presence of *Salmonella*, but tissues (3.196 log CFU/g) and digesta (log 2.09 CFU/mL) recovered from challenged pigs contained high levels of *Salmonella.* Among all challenged pigs, tonsils contained higher concentrations of *Salmonella* (4.885 log CFU/g) than the cecum, ileal-cecal lymph nodes, ileum, kidney, liver, mandibular lymph nodes, or spleen (P < 0.01). Seven challenged pigs died of salmonellosis. Fecal and tissue concentrations of *Salmonella* were similar among challenged pigs fed C, PROBIOS, and BIOPLUS diets. Serum Hp, AGP, IgG, and IgM concentrations were not affected by dietary treatment. The results indicate a successful disease challenge model, but no differences in incidence or severity of the infection was apparent among pigs fed either DFM compared to pigs fed the C diet.

Key Words: Salmonella, Direct fed microbials, Acute phase proteins

192 Efficacy of organic selenium (SelenoSource AF^{TM}) in grower-finisher diets: Effects on growth and carcass characteristics.

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This study was conducted to determine the efficacy of organic (SelenoSource AF^{TM}, Diamond V Mills, Inc.) and inorganic (sodium selenite) sources of selenium (Se) on growth performance and carcass quality in growing-finishing pigs. A total of 180 pigs at 34.4±0.06 kg were allotted to five dietary treatments: a negative control without added Se, three treatment diets with 0.1, 0.2 and 0.3 ppm of supplemental Se from an organic source, and a positive control with 0.3 ppm supplemental Se from an inorganic source. Each treatment had 6 pens (3 barrow and 3 gilt pens) with 6 pigs per pen-replicate. Pigs were fed the experimental diets from 34.4±0.06 kg and the diets were changed twice at 66.1±0.53 kg and 99.0±0.93 kg according to a three-phase grower-finisher program. Body weight and feed intake were measured at the end of each phase. When pigs reached 129.9±1.35 kg, they were transported to a local abattoir (Seaboard Farms, Guymon, OK) to obtain meat quality

data. No significant difference in terms of growth performance (ADG= 862.6±15.1 g) was observed among treatments. Lean percentages and loin weight from all treatments did not vary significantly. Loin color, pH, temperature, marbling, texture and firmness values were the same among treatments. However, backfat thickness of pigs with supplemental Se (23.2 mm) tended to be smaller (P=0.072) than that of pigs without supplemental Se (38.2 mm). Drip loss (%) of pigs fed the diets with Se supplementation (1.72%) tended to be lower (P=0.056) than that of pigs fed the diet without Se supplementation (2.41%). Drip loss (%) of pigs was reduced linearly (P=0.007) as level of organic selenium supplementation increased. Collectively, Se supplementation did not affect growth performance of pigs from 35 to 130 kg body weight. Pigs fed Se supplemented diets tended to have both lower backfat thickness and percentage drip loss. Organic Se was more efficient in reducing loin drip loss (%) than inorganic Se (1.42 vs. 1.88% drip loss, for organic and inorganic Se respectively, at 0.3 ppm supplementation).

Key Words: Selenium, Pigs, Carcass

193 Virginiamycin improves phosphorus digestibility in growing-finishing pigs.

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Two balance studies were conducted to evaluate the effects of virginiamycin (VIR) in combination with phytase on P digestibility in pigs. A total of 48 crossbred barrows were used. The initial weight was 66.3 kg in Study 1 and 55.5 kg in Study 2. In each study, a corn-soybean meal basal diet without supplemental P that met all other NRC (1998) nutrient requirements served as the control. Dietary treatments were: (1) basal, or the basal + (2) VIR, (3) phytase, and (4) VIR + phytase. The inclusion rate of VIR was 11 mg/kg and of phytase was 750 (Study 1) or 300 (Study 2) PU/kg of diet. Pigs were placed in individual metabolism crates for a 7-d adaptation followed by a 5-d collection period, and were fed their respective treatments at 3% of BW/d in two meals. Water was supplied ad libitum during non-feeding times. The beginning and end of the collection periods was marked by the addition of indigo carmine to the diet. In both studies, the anticipated improvements in Ca and P digestibility were observed with phytase (P<0.01). In both studies, VIR increased P digestibility over controls (P<0.03 for Study 1, and P<0.02 for Study 2). VIR did not increase P digestibility in the diet containing 750 PU (P=0.65) but VIR did improve P digestibility in the diet containing 300 PU (P<0.10). The results indicate that additive effects of VIR and phytase are dependent on the amount of phytase in the diet.

Effects of virginiamycin and phytase on digestibility (%)

	TRT:	1	2	3	4		P-values	
	VIR:	-	+	-	+	TRT	TRT	TRT
	Phytase:	-	-	+	+	2 vs 1	3 vs 1	4 vs 3
Study								
1	DM	91.6	92.1	91.8	92.3	0.24	0.65	0.35
	N	89.8	90.8	89.4	90.2	0.18	0.60	0.30
	P	34.6	39.3	61.9	61.0	0.03	<0.01	0.65
	Ca	59.5	61.7	71.3	68.8	0.24	<0.01	0.65
2	DM	89.7	90.1	90.0	90.3	0.39	0.43	0.32
	N	89.1	90.5	89.4	89.8	0.09	0.66	0.44
	P	30.7	37.9	49.3	52.4	0.02	<0.01	0.10
	Ca	50.1	53.9	61.9	64.2	0.30	<0.01	0.36

Key Words: Virginiamycin, Phosphorus, Phytase

194 The effect of phytase and dietary Ca:P ratio on the excretion of total and soluble phosphorus by weanling pigs.

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Phytase enzyme increases the bioavailability of phytate phosphorous, allowing swine diets to be formulated with less total phosphorous (tP), potentially reducing both diet cost and P excretion. Phytase efficacy may be decreased at wide dietary Ca:tP ratios. Moreover, it has been suggested that the environmental benefit is dependent on the solubility of the excreted P. Two studies were conducted to examine the effect of the Ca:tP ratio on phytase efficacy and the effect of phytase on the amount and form of P excreted. In Exp. 1, pigs (n=144; 6.52 ± 0.75 kg; 19.6 ± 2.7 d; mean ± sd) were housed in pens of 3 and fed corn-soybean meal diets (0.5% tP) supplemented with either 0, 250, 500, 1000 or 2000 FTU/kg phytase or dicalcium phosphate (positive control; 0.7% tP) for a 28-d growth trial followed by a 7-d metabolism experiment (n=36). In Exp. 2, pigs (n=36; 7.62 ± 0.81 kg; 28.6 ± 1.21 d) were assigned to one of 6 dietary treatments arranged as a 2 x 3 factorial (0 or 500 FTU phytase/kg; Ca:tP ratio, 1.1, 1.7, 2.3) for a 14-d metabolism trial. Diets were offered at 3x maintenance during both metabolism experiments. In Exp 1, phytase supplementation improved ADG and feed efficiency during d0-21 (P<0.05). Apparent digestibility of tP improved, and excretion of total and soluble inorganic P declined, with phytase supplementation (linear, P<0.05). The output of soluble inorganic P was 2.98 and 1.60 g/d on the positive control or the 1000 FTU phytase/kg diet, respectively. In Exp. 2, phytase decreased (P<0.05) total and soluble inorganic P output (tP, 1.43, 1.23 mg/d; soluble P, 1.05, 0.89 mg/d; 0 or 500 FTU/kg respectively). The decreased output of total and soluble P with phytase supplementation averaged 23% and 6.3% when Ca:tP ratios were 1.1 or 2.3 respectively (phytase by Ca:tP ratio interaction, P<0.05). Phytase decreases the excretion of total and soluble inorganic P when used in corn-soybean starter diets. This effect, however, is mitigated at Ca:tP ratios above 1.7.

Key Words: Swine, Phytase, Phosphorus

195 Effect of xylanase and (or) phytase supplementation on nutrient digestibility and growth performance of grower pigs fed wheat-based diets containing wheat millrun.

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Wheat millrun could be a higher value feed ingredient if the nutrients bound by arabinoxylans and phytate were made available for use by the pig through enzyme supplementation. The effects on energy and P digestibility, and growth performance of millrun inclusion level (L1, 20%; L2, 40%) xylanase supplementation (0 or 4,375 U/kg feed), and (or) phytase supplementation (0 or 500 FTU/kg feed) were investigated in a 2 x 2 x 2 factorial arrangement with a wheat-based control diet. Diets were formulated to 3.34 Mcal DE/kg and 2.8 g app. dig. lysine/Mcal DE and included 0.4% chromic oxide. Cannulated pigs (36.2±1.9 kg) were fed three diets at 3 x maintenance in subsequent periods for 6 observations per diet. Ileal digesta and fecal samples were each collected for 2 d. Ileal energy digestibility was affected by millrun inclusion (P<0.001), xylanase (P<0.01) and phytase (P<0.05). Total tract DE values were determined to be 3.72, 3.53 and 3.33 Mcal/kg DM respectively, for the control, L1 and L2 diets. Xylanase and phytase supplementation of L1 improved the total tract and ileal DE values to a level similar to the wheat control diet (P>0.10). Millrun addition reduced P digestibility linearly (P<0.05) and phytase and xylanase supplementation improved P digestibility (P<0.05). In contrast to digestibility data, performance data were less conclusive. Millrun inclusion reduced ADG linearly (P<0.001), but did not affect ADFI or G:F (P>0.10). Xylanase and phytase reduced ADFI (P<0.01), and phytase tended to reduce ADG (P<0.10). Enzyme supplementation did not affect final BW or G:F (P>0.10). Overall, millrun inclusion reduced nutrient digestibility and growth performance. Xylanase and phytase improved nutrient digestibility; however, the improved digestibility did not result in improved growth performance which may have been indicative of a nutrient imbalance.

Key Words: Wheat millrun, Xylanase, Pig

196 Tissue mineral compositions of two genotypes of pigs during the grower finisher period.

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Two genotypes of pigs with different lean gain potentials (280 vs. 350 g FFL/d) were evaluated for mineral compositions and mineral distribution in various tissues during the period from 18 to 127 kg BW. Both genotypes, equal distribution of gilts and barrows (n = 120 total) were housed at a single site and fed common diets during the nursery period. At 18 kg BW the pigs were moved to a complete confinement facility and split sex fed a corn-soybean mixture meeting or exceeding NRC (1998) amino acid and mineral requirements for each genotype for their lean gain potential. A total of six pigs for each treatment group were harvested initially and at approximately 27 kg intervals to 127 kg BW. The experiment was a 2 x 2 x 5 RCB design conducted in two replicates. Carcasses were split along the dorsal midline with the right side

dissected into three components. Loin and ham muscles were trimmed of fat where it was combined with the remaining carcass components. The empty viscera, organs, and head were combined. Each component was analyzed for its mineral content. The results demonstrated a linear increase ($P < 0.01$) in each of the four tissues macro- and micro- mineral contents from 18 to 127 kg BW. Pigs of higher lean gain potential had higher macro-mineral content in the loin and ham ($P < 0.01$), than pigs with the lower FFL/d. Tissue levels of macro-minerals in the lean genotype did not consistently differ in the viscera or remaining carcass component. With the exception of loin Ca, macro-mineral levels were higher ($P < 0.01$) in loin and ham tissues for gilts compared to barrows. These results suggest that pigs with a greater lean gain potential have greater body concentrations of minerals in the loin and ham when expressed on a wet tissue basis but not when expressed on a fat free basis.

Key Words: Body composition, Mineral, Pigs

197 The effect of copper and vitamin E on growth performance and tissue vitamin E of pigs.

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The objective of this study was to compare copper sources for their effects on pig growth performance and tissue accumulation of vitamin E. A total of 105 weaned pigs (15 litters of seven pigs, 5.9 ± 0.8 kg) were individually-fed one of seven experimental diets for a period of 21 d. A basal diet based on corn, soybean meal, dried whey, and fish meal was formulated to be nutritionally-adequate for 10-20 kg pigs (22.2% CP, 1.35% tdLys, 22 mg/kg supplemental DL-α-tocopheryl acetate). Experimental diets included the basal diet, and the basal diet supplemented with 50 and 100 mg/kg DL-α-tocopheryl acetate in the absence and presence of 250 mg/kg Cu from either tribasic copper chloride (CC, $Cu_2[OH]_3Cl$, Micronutrients, Indianapolis, IN) or feed-grade copper sulfate (CS, $CuSO_4 \cdot 5H_2O$). Diets were mixed 3 wk prior to the start of the trial and samples were taken for tocopherol analysis at d 0, 23, 28, 35, and 40 d post-manufacture. Neither copper nor copper source affected ($P > 0.10$) dietary vitamin E concentrations in complete feed mixtures. Vitamin E and copper supplementation increased ($P < 0.001$) both weight gain and feed intake of pigs over the 21-d assay period. There was an interaction between vitamin E dose (50 *vs* 100 mg/kg) and copper supplementation for both weight gain ($P < 0.10$) and gain/feed ratio ($P < 0.05$) such that increasing the dose of vitamin E improved performance of pigs fed CS-supplemented diets, but did not affect that of the pigs fed diets containing no Cu or CC. Copper chloride-supplemented pigs had 6.5% greater ($P < 0.01$) gain/feed ratios than CS-fed pigs. Vitamin E supplementation resulted in linear ($P < 0.001$) increases in final serum α-tocopherol (μg/g) and liver α-tocopherol (μg/g). Copper supplementation increased ($P < 0.01$) both measures, but there was no difference between the copper sources. Copper chloride supplementation produced greater gain/feed ratios than copper sulfate, but tissue vitamin E concentrations were not different between the copper sources.

Key Words: Vitamin E, Copper, Tribasic copper chloride

198 Future nutrient issues in formulating environmentally friendly diets.

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As our industry is challenged to provide diets that meet animal needs and protect the environment, we must look at two horizons. First is utilization of by-products from all sectors of agriculture. Currently, by-products of the packing industry can effectively cost into livestock feeds, but future regulations may limit their use and economic viability. Dairy plant wastes, bakery waste, and distillers dried grains can fit into nutritional plans for swine operations by replacing some minerals and carbohydrates. Swine producers have overlooked waste from vegetable and fruit production. While by-product energy, fiber, protein and ash content are known, minerals and their availability are unknown and can potentially vary depending on type, processing and region of production. The feeding of liquid whey by-products can be a common practice, but little research has been done to measure how much nutrition this product can replace in a typical corn-soy diet. In whole, the feed industry is very protective of safety margins and even more so when feeding by-products. So are we actually fairly balancing these by-product diets, or contributing to more nutrient output? NEPA now regulates manure P application to soils. The N issues facing our industry are well known, but what other culprits must we feed more carefully to protect our environment? The answers are in soil analysis and crop utilization of applied nutrients, not state and federal regulations. Soil type, climate and crops determine if high Zn concentration in soils is a problem. Selenium deficient areas need the Se excreted by livestock for pastures and crops, but areas with seleniferous soils do not. While much of the Fe in swine diets is not useful to the animal, does this cycling of Fe onto soils result in nutrient interactions that reduce the crops ability to meet its needs? Proper use of by-products and the development of more precise manure application regulations will continue to protect our environment.

Key Words: Nutrient management, Byproducts, Environment

199 Energy and nutrient digestibility in dried distillers grain with solubles by growing pigs.

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Three experiments were conducted to measure energy and nutrient digestibility in dried distillers grain with solubles (DDGS) by growing pigs. In Exp. 1, apparent (AID) and standardized (SID) ileal digestibility coefficients of CP and amino acids (AA) were determined in four samples of DDGS using growing pigs equipped with a T-cannula in the distal ileum. Exp. 2 was an energy balance experiment that aimed at measuring DE and ME concentrations in four samples of DDGS and in corn, using the difference method. In addition, the apparent total tract digestibility coefficients (ATTD) for DM, GE, P, ether extract, NDF, and ADF were also measured in this experiment. The four samples of DDGS used in Exp. 2 were identical to those used in Exp. 1. The AID and the SID of CP and AA in ten samples of DDGS were measured in Exp. 3 using procedures similar to those employed in Exp. 1. Results of the experiments indicated some variation among DDGS sources in the AID and SID for most AA in DDGS. The most variable SID were obtained for Lys and Trp, where values ranged from 44 to 78%, and from 46 to 80%, respectively. Methionine had the lowest variability for SID among the indispensable AA (74 to 89%), while values from 62 to 87%, 67 to 85%, and 66 to 84% were found for Thr, Ile, and Val, respectively. The average SID for Arg, His, Ile, Leu, Lys, Met, Phe, Thr, Trp, and Val in the 14 samples of DDGS were 79, 76, 73, 82, 60, 81, 79, 70, 73, and 72%, respectively. The four samples of DDGS that were used in Exp. 2 had average ATTD of DM, GE, P, ether extract, NDF, and ADF of 71, 75, 55, 76, 84, and 67%, respectively. Significant differences (P #8804 0.05) between samples of DDGS were found for ether extract, NDF, and ADF, but not for DM, GE, and P. The DE and ME concentration in the four samples of DDGS averaged 3,639 and 3,378 kcal per kg DM, respectively, and no significant differences between sources were observed. It is concluded that considerable variation in AID and SID for CP and AA among samples of DDGS exists. Future work should focus on identifying the reasons for this variation.

Key Words: Dried distillers grain with solubles, Pigs, Nutrient digestibility

200 Effects of dietary level of distiller's dried grains with solubles and fat on the growth performance of growing pigs.

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The effect of dietary level of distillers dried grains with solubles (DDGS) and fat was evaluated in growing pigs (n = 2,560) using a randomized block design with a 4 × 2 × 2 factorial arrangement of treatments. The study was carried out in two periods. In Period 1 (21.8 to 40.9 kg), a 4 X 2 factorial of DDGS level (0 vs 10 vs 20 vs 30%) and fat level (0 vs 3%) were evaluated. In Period 2 (40.9 to 59.8 kg), an additional factor of two levels of fat were compared (0 vs 6%). Diets were corn-soybean meal based, formulated on analyzed nutrient values for ingredients to similar digestible lysine:ME ratios and to meet or exceed NRC (1998) recommendations. There were no DDGS × fat level interactions. During Period 1, there was no effect of DDGS inclusion level on ADG or ADFI, however, including DDGS at 20 or 30% resulted in a small improvement ($P < 0.05$) in G:F compared to the 0% treatment. Adding 3% fat reduced ($P < 0.001$) ADFI and improved ($P < 0.001$) G:F, but had no impact on ADG. In Period 2, previous level of DDGS did not affect growth performance. However, feeding 3% compared to 0% added

fat in Period 1 reduced (P < 0.05) ADFI and tended (P = 0.08) to improve G:F in Period 2. In addition, feeding 6% compared to 0% added fat in Period 2 improved (P < 0.01) ADG and G:F and reduced (P < 0.001) ADFI. In conclusion, adding fat to the diet improved growth rate in the second period only and there was a suggestion of a carryover effect of dietary fat level between periods that merits further study. Also, DDGS can be included at up to 30% of the diet of growing pigs without detrimentally affecting growth performance.

Key Words: DDGS, Fat, Pigs

201 Evaluation of an optimum fat level for early and late finishing pigs.

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Three experiments were conducted at a commercial research site in order to evaluate the optimum fat level for early and late finishing pigs. In Exp. 1, a total of 1,365 gilts (TR-4 × C22; 51.09 ± 0.15 kg) were used in a completely randomized block design with 13 replicate pens/treatment. In Exp. 2, a total of 853 barrows (TR-4 × C22; 72.24 ± 0.19 kg) were used in a completely randomized block design with 8 replicate pens/treatment. In Exp. 3, a total of 871 gilts (TR-4 × C22; 69.34 ± 0.23 kg) were used in a completely randomized block design with 8 replicate pens/treatment. Pigs used in Exp. 1, 2, and 3 were allotted to one of five dietary treatments containing 0.0, 1.5, 3.0, 4.5 and 6.0% supplemental fat (choice white grease), respectively. Diets were formulated at a lysine:calorie ratio of 2.74 (Exp. 1) and 2.26 (Exp. 2 and 3) g true ileal digestible lysine/Mcal ME. In Exp. 1, fat supplementation increased (linear, P < 0.001) ADG (930, 930, 939, 957, and 971 g/d), decreased (linear, P = 0.02) ADFI (2,413, 2,377, 2,368, 2,359 and 2,341 g/d) and improved (linear, P < 0.001) G/F (0.386, 0.391, 0.398, 0.406, and 0.416). In Exp. 2, fat supplementation increased (linear, P < 0.01) ADG (1,102, 1,098, 1,111, 1,111, and 1,148 g/d), decreased (linear, P < 0.01; quadratic, P = 0.06) ADFI (3,447, 3,361, 3,316, 3,311, and 3,316 g/d) and improved (linear, P < 0.001) G/F (0.320, 0.327, 0.336, 0.337, and 0.346). In Exp. 3, fat supplementation increased (linear, P < 0.01) ADG (1,084, 1,107, 1,125, 1,152, and 1,143 g/d), and improved (linear, P < 0.001) G/F (0.351, 0.364, 0.374, 0.380, and 0.379). These data indicate that increasing the energy density of finishing pig diets results in linear improvements in growth performance. Based on linear regression analysis, for each one percentage unit increase in supplemental fat addition there are 0.78% and 1.30% improvements in ADG (r^2 = 0.91) and G/F (r^2 = 0.98), respectively, in early finishing pigs. Similarly, in late finishing pigs there are 0.80% and 1.29% improvements in ADG (r^2 = 0.99) and G/F (r^2 = 0.95), respectively.

Key Words: Pigs, Fat, Energy

202 Effect of sorting and added fat level on performance of grow-finish pigs reared in a commercial facility.

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A total of 1,032 pigs were individually weighed, fitted with electronic ear tags and sorted into ten, 2.25 kg BW categories. Pigs were then allotted to pens lighter and heavier then the barn mean or remixed to create a normal distribution around the mean. The initial weight was 26.8, 34.7, and 30.7 kg for light, heavy, and mixed pens, respectively. To complete the 2 3 factorial, pigs were fed corn-soybean meal diets with or without 6% choice white grease. Diets maintained equal lysine to calorie ratios. For the overall 109 d trial, there were no fat initial sort category interactions (P>0.15). Pigs fed 6% added fat tended (P<0.07) to have higher ADG (803 vs 785 g), had lower ADFI (P<0.01; 1.92 vs 2.08 kg), and improved G:F (P<0.01; 0.42 vs 0.38) compared with those fed no added fat. For initial sort category, regardless of diet, heavy pigs grew faster (P<0.01, 0.83, 0.76, and 0.79) and consumed more feed (P<0.01, 2.15, 1.88, and 1.99) than either the light or mixed pigs, respectively; however, light pigs were more efficient (P<0.01, 0.41, 0.39, and 0.40) than either heavy or mixed pigs. Adding fat to the diet did not affect backfat, fat-free lean, % lean, or loin depth. Initial sort category did not affect fat-free lean, % lean, or loin depth; however, light pigs had decreased backfat (P<0.04) compared with heavy or mixed pigs. Although growth and carcass data did not show interactions, differences in the financial response were evident in margin over feed cost (MOF). Heavy pigs had a higher (P<0.01) MOF than either light or mixed pigs ($106.86, $98.64, and $102.36). When comparing 0 and 6% added fat within initial sort category, adding 6% dietary fat decreased MOF for heavy ($107.90 vs $105.81) and mixed ($102.75 vs $101.97) pigs, but increased MOF for light pigs ($98.04 vs $99.23). This study indicates that the economics of dietary energy density may depend on weight category; however, more research is needed to verify this response.

Key Words: Dietary fat, Variation, Finishing pigs

203 Pig feed intake correction calculator using a Microsoft Excel macro.

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In most animal growth experiments, more than one animal is housed per pen. Occasionally, one animal shows a very different growth rate than its pen mates or even dies during the experiment. When this happens, if pen feed intake cannot be re-estimated for the calculation of average daily feed intake and feed conversion ratio, an observation will be lost from the data set. Because calculation of individual feed intake is relatively complicated, we developed a simple calculator for feed intake correction using a Microsoft Excel macro. The feed intake of each affected pen is partitioned into feed intake for maintenance and feed intake for growth for each animal within that pen. First, individual pig maintenance feed intake for the period is calculated using the NRC (1998) estimation of ME for maintenance. The equation is: Maintenance feed intake (kg) = 106 x (((Initial weight (kg) + Final weight (kg)) / 2)$^{0.75}$) x feeding days / ME per kg feed. Then, maintenance feed intake for all pigs in the pen is summed. The difference between this sum and the total pen feed intake is that which supported growth in the pen. Next, individual feed intake for growth is calculated by apportioning the remaining feed equally to each kg of gain within the pen. Finally, the estimated individual feed intake for the pig being removed from the pen is the sum of maintenance feed intake and growth feed intake for that pig; this feed intake estimate is subtracted from the original pen feed intake to leave the new pen feed intake for the remaining pigs. All the calculation procedures are included within the Excel macro. Potential error warnings are included in the macro to avoid accidental selection of the wrong pig for exclusion. An outlier confirmation procedure, which shows the difference of the outliers' growth from its pen mates, is also included in the macro. The current feed intake correction calculator is designed for swine growth research; however, it is also applicable for poultry and rodent growth trials with modifications to the energy requirement for maintenance value and the exponent for metabolic BW.

Key Words: Feed intake, Excel, Pigs

204 Effects of dietary organic and inorganic trace minerals at NRC or elevated levels on sow reproductive performance over four parities.

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The effects of trace mineral source and levels on sow reproductive performance was evaluated over four parities using 102 sows and 287 farrowings. The experiment was a 2 x 2 + 2 factorial, conducted in a Split-plot design with repeated measures. The first factor evaluated organic (Bio-Plex, Alltech Inc.) and inorganic sources of trace minerals (Cr, Cu, Fe, Mn, Se, and Zn) fed to developing gilts and sows. The second factor evaluated dietary mineral levels, with one level meeting NRC (1998) standards (NRC) and the second set at normal industry standards (IND, range of 150 to 240% increase). Gilts were initially fed one of the four dietary treatments at 30 kg BW. From breeding through parity four, two treatments added higher levels of Ca and P to the IND level (IND+CaP) for both mineral sources. Litters were equalized within 3 d postpartum. Gestation weight gains (P < 0.01) and backfat thicknesses (P < 0.01) were greater when sows were fed the NRC vs. the IND level. Sows fed the organic trace mineral source tended to farrow more total (P = 0.06) pigs (12.3 vs. 11.5) with heavier (P < 0.15) litter (19.5 vs. 18.6 kg) but not individual pig weights at birth. Litter daily gains from birth to weaning were greater when sows were fed the organic source (P < 0.05). Number of pigs born (total and live) was greater (P < 0.01) for sows fed the NRC vs. the IND and IND+CaP levels for both sources. Litter gains during the lactation period were greater when the NRC vs. the IND level was fed (P < 0.05). Sow lactation feed intake, litter size at birth, and litter growth rates increased linearly (P < 0.01) as parity advanced. No interactions (P > 0.15) occurred between trace mineral source and dietary level or between parity and dietary treatments. These

results demonstrate that feeding sows organic trace minerals resulted in more pigs born with greater litter gains during lactation. No advantage was recognized by feeding higher dietary trace mineral levels of either source over a four parity period.

Key Words: Sow, Trace minerals, Lactation

205 Prewean piglet survivability: Sel-Plex® verses sodium selenite as selenium source in sow diets.

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Effect of selenium (Se) source on litter performance was evaluated in a side-by-side comparison of Sel-Plex® (selenium enriched yeast, Alltech) with sodium selenite. Supplementation was given to supply 0.3 mg added Se/kg. All sows received sodium selenite until initiation of Se source treatments on day 80 of gestation. Groups of sows bred within a week were randomly assigned to treatment by parity. The trial encompassed 6 weeks of farrowings within a 3,400 sow farrow to wean facility. Litter data were analyzed from 380 sows per treatment. Females remained on their respective treatment through weaning. Gestation and lactation diets contained 12.5 and 18.3% CP, 0.6 and 1.1% Lys, 3236 and 3463 kcal/kg ME, respectively. All litters were equalized to same number of piglets within treatment on day of birth. Milk Se concentrations were determined from 3 sows per treatment per farrowing week; samples were collected during mid lactation. Milk Se concentrations were greater (P#88040.01) in Sel-Plex group than in sodium selenite group (0.111 ± .003 ppm vs 0.088 ± .003 ppm). Sows receiving Sel-Plex weaned more pigs (P#88040.01) and had a greater litter weaning weight (P#88040.01). Prewean mortality of Sel-Plex treatment was 9.76% compared to 11.30% for sodium selenite treatment. This study demonstrates that prewean piglet survivability can be enhanced when Sel-Plex replaces sodium selenite as a dietary selenium source.

	Sel-Plex	Sodium selenite	SE	P=
Parity	3.74	3.74	0.08	0.98
Born alive	10.65	10.44	0.12	0.37
Birth wt (kg)	1.50	1.54	0.01	0.07
Still born	0.81	0.87	0.04	0.46
Pigs weaned	9.61	9.26	0.05	0.001
Litter wean wt (kg)	53.15	51.07	0.44	0.01
Wean age (d)	16.5	17.1	0.07	0.001
Wean to service (d)	6.61	6.48	0.20	0.73

Key Words: Swine, Selenium, Prewean mortality

206 Postwean piglet survivability: Sel-Plex® verses sodium selenite as selenium source in sow and nursery phase diets.

J. Lampe[1], G. Gourley*[1], J. Sparks[2], and T. Stumpf[3], [1]*Swine Graphics Enterprises,* [2]*NutraBlend,* [3]*Alltech.*

Effect of selenium (Se) source on nursery performance was evaluated in a 2 X 2 factorial arrangement of treatment design. Main effects were Se source and production phase. Se source was Sel-Plex® (selenium enriched yeast, Alltech) compared to sodium selenite. Production phases were sow (Se source treatment initiated at d 80 of gestation and maintained through weaning) and nursery. Supplementation was given to supply 0.3 mg added Se/kg. One thousand pigs were weaned, 500 from sows fed Sel-Plex and 500 from sows fed sodium selenite as Se source. The weaned pigs were placed in a commercial nursery and penned in groups of 25 head (0.25 m^2/pig). There were 10 pens per treatment and treatments were blocked within the room. Pens of pigs and feeders were weighed at entry, d 7, 14, 21, 28 and 42 of the trial. Average weight of pigs at entry to the nursery was 5.31 ± 0.04 kg and was not different dependent on Se source of the sow (P#88050.39). Pigs were fed a 3-phase nutrition program during the 42 d nursery trial. No overall main effects (P#88050.17) were observed for end weight, ADG or ADFI; 21.91 ± 0.14 kg, 0.39 ± 0.01 kg and 0.46 ± 0.01kg, respectively. An influence of sow Se source was observed (P=0.10) with total pigs surviving nursery. Fewer dead and culls (no value pigs) were observed in the nursery when pigs were from Sel-Plex fed sows. Total mortality and culls in the nursery was 3.2% for those pigs weaned from sows receiving Sel-Plex compared to 5.4% for those pigs weaned from sows receiving sodium selenite treatment. This study suggests that in commercial production, piglet survivability in the nursery can be improved when Sel-Plex replaces sodium selenite as the dietary selenium source of the sow.

Sow:	Sel-Plex		Sodium selenite	
Nursery:	Sel-Plex	Sodium selenite	Sel-Plex	Sodium selenite
Pigs in	250	250	250	250
Pigs out	243	241	238	235
Deaths	0	1	3	3
Culls	7	8	9	12

Key Words: Swine, Selenium, Nursery mortality

207 Interactive effects of milk supplementation and parity on pre- and postweaning mortality and growth performance of piglets on a commercial farm.

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A total of 125 (Genetiporc) sows and 1325 piglets (PIC 327 × Genetiporc) were used on a commercial farm to evaluate the interactive effects of milk supplementation and parity on piglet growth performance and mortality pre- and postweaning. Sow and piglet diets were formulated to meet all minimal NRC requirements. Sows were grouped according to parity as follows: parity 1 = group 1, parities 2 and 3 = group 2, and all parities greater than 3 = group 3. Litters from sows within the same group were randomly allotted to either milk or no milk treatments. At 48 h post-parturition, milk supplementation was initiated and piglets were counted and weighed. All cross-fostering and litter processing occurred prior to 48 h. Mortalities, their weights, and date of occurrence were recorded daily for each litter. At d 14 to 18, each litter was weighed, counted, and weaned. At weaning piglets were transferred to an off-site nursery facility and allocated by previous treatment. Piglets were weighed and feed intake recorded on d 0, 7, 14 and at the end of the nursery period. The date of occurrence, respective treatment and weight of mortalities were recorded daily. Data indicated that milk supplementation increased (P<0.05) litter weaning weight from 52.5 to 55.0 kg. Postweaning there was no difference (P>0.05) in growth performance between milk and no milk; however, mortality was decreased (P<0.05) with milk supplementation (0.9% vs. 4.1%). Piglets reared by parity group three sows had superior (P < 0.05) growth performance than those of parity groups one and two. Overall, this experiment indicates that the use of milk supplementation during lactation improves piglet performance preweaning and decreases mortality postweaning.

Key Words: milk supplement, pigs, sows

208 Influence of WEANMOR+® fed to sows on urine pH, stillbirth rate and preweaning mortality.

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WEANMOR+® is a microencapsulated dry calcium chloride product. The Cl- ions have been hypothesized to improve the dietary cation/anion balance by counter-balancing the K+ ions in the diet, which would decrease blood and urine pH, and decrease stillbirth rates and preweaning mortality. A total of 239 sows (parities 1 to 10; PIC C-22) were randomly allotted to one of the two experimental treatments approximately 5 days prior to their expected farrowing date. Treatments were: 1) Control sows; and 2) Sows that received a single daily topdress of 25 g of WEANMOR+. Urine samples were collected on a subsample of 40 sows within 24 hours after sows completed farrowing for determination of urinary pH. Sows on WEANMOR+ were fed for an average of 5.7 days prior to farrowing. WEANMOR+ tended to lower (P < 0.06, 6.28 vs 6.75) urine pH, but did not influence total number of pigs born, mummies, fostered, died, or weaned (P < 0.35). However, there was a tendency for a parity group by stillborn interaction (P < 0.10) where feeding WEANMOR+ reduced the number of stillborn pigs in the parity 2 to 5 sows with numeric increase in stillborns when WEANMOR+ was fed to parity 6 and over sows (Table 1). In conclusion, topdressing the feed with WEANMOR+ from 5 days prior to farrowing until weaning did not influence sow productivity in this experiment. The interaction between parity group and treatment that indicated a potential benefit in parity 2 to 5 sows warrants further investigation.

Influence of WEANMOR+® on stillborn rate[a]

Item	Control	WEANMOR+®	SE
Number of Sows	18	22	
Parity 1	8	9	
Parity 2-5	72	78	
Parity 6+	38	33	
Number of stillborns			
Parity 1	0.57	0.61	0.50
Parity 2-5	1.37	0.91	0.18
Parity 6+	1.42	1.82	0.25

Parity P<0.01; Treatment P<0.98; Parity X Treatment P<0.10;

Key Words: Sows, Lactation, Electrolyte balance

209 Corn dried distillers grains with solubles in sow lactation diets.

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High concentrations of protein, lysine, fiber and P in corn dried distillers grains with solubles (DDGS) make it a good potential feedstuff for lactation diets. Previous reports indicated that P in DDGS was 85% available in grower pig diets and diets containing up to 15% DDGS did not decrease grow/finish pig feed consumption. Our objective was to determine if lactating sows could utilize dietary DDGS to maintain body weight and lactation performance while decreasing P excretion. Sows were assigned to treatment based on expected farrowing date and parity. Diets met or exceeded NRC and contained 1.2% lysine, 0.9% Ca and 0.84% P. Treatments were: (1) 15% DDGS supplying 17% of P, or (2) 5% beet pulp (BP) with P supplied by monocalcium phosphate. Sows were gradually adapted from a common gestation diet to their respective treatment lactation diets fed ad libitum post-farrowing. Each treatment included 9 primiparous and 21 (BP) or 22 (DDGS) multiparous sows. Litters were balanced with a minimum of 11 pigs by d 2 post-farrowing and sows and litters were weighed on d 2 and 18. Fecal grab samples were collected on d 7, 14 and 18 and analyzed for P concentration. Treatment did not influence lactation performance. Sows weaned 10.9 and 10.8 pigs with pig gain of 3.82 and 3.91 kg for BP and DDGS, respectively. Sows lost 6.18 (BP) and 8.04 kg (DDGS). Litter weight on d 18 was less within BP treatment for primiparous vs multiparous sows (P=0.008). There was no parity effect with the DDGS treatment. Fecal P concentration did not differ on d 7 or 18. However, on d 14 BP sows had greater fecal P concentration than DDGS sows (33.02 vs 28.13 mg/kg DM, P<0.02). Over the lactation period BP sows exhibited a quadratic increase (P=0.07) while DDGS sows exhibited a linear decrease (P=0.05) in fecal P concentration. Inclusion of 15% DDGS in a lactation diet will support sow performance while maintaining and perhaps reducing P excretion.

Key Words: Dried distillers grains, Sow lactation, Phosphorus

Odor and Nutrient Management

210 Impact of diet manipulation on nutrient excretion and air emissions - intensive studies.

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Control of nutrient excretion and air emissions has many factors including; diet, genetics, building design, manure storage system, and producer management. A series of experiments have been conducted looking at many of these factors. By modifying the diets, we are controlling the inputs and instituting source reductions. The two key nutrients that are currently regulated and most researched are N and P. Through the use of synthetic amino acids in diets, replacing intact protein sources, N intake is reduced 15 to 30%, with corresponding reductions in N excretion. Currently, these reductions are accomplished by supplementing amino acids, lysine, methionine, and threonine. From a research standpoint, the use of tryptophan, isoleucine and valine can be incorporated and push this N excretion reduction to as high as 40-45%. The key to maintaining pig growth performance and carcass characteristics with low N excretion diets is to maintain amino acid balances and net energy levels in the diets. The correct amino acid ratios are open for debate, while formulation method (total, apparent or true ileal digestible) is of less importance with U.S. corn-SBM based diets. All three amino acid formulation methods maintain similar ratios to lysine in the NRC (1998) for tryptophan (17-19%), methionine (26-28%), total sulfurs (56-59%), valine (67-69%), and isoluecine (54-56%), with more variable ratios for threonine (60-68%). Reducing excess N and the dietary intact proteins does decrease N and hydrogen sulfide emissions from the swine facility. Phosphorus reductions are best achieved by reducing excesses, balancing to the available P requirement, and utilizing the phytase enzyme. Excretion of P can be reduced by 20-35% using these techniques. Reductions of P can be as great as 50-60% with the use of developing technologies of low phytic acid grains in the swine diets. Diet can be the leading point source reduction for many nutrients and emissions in swine operations and requires great detail and attention to minimize the environmental impact of swine operations.

Key Words: Swine, Nutrition, Nutrient excretion

211 On-farm application of diet manipulation to reduce nutrient excretion.

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Reducing the amount of nutrients (nitrogen and phosphorus) excreted from swine production systems is potentially the greatest challenge to the future of our swine industry. It is well established that dietary manipulation is one of the most effective tools to reduce the environmental impact of pork production. However, adoption and implementation of nutritional concepts to reduce environmental impact is often slow by many in the industry. The use of on-farm studies has been a very effective procedure to gain acceptance and implementation of dietary manipulation to reduce nutrient excretion. Two large scale studies involving approximately 30,000 pigs were conducted to evaluate aggressive amino acid supplementation during the entire growing and finishing phase (25 to 125 kg). The experimental diets were fed in a five or six phase feeding program. The control diets contained approximately 0.15% L-lysine·HCl, throughout the entire grow-finish period while the aggressive amino acid supplementation program included greater additions of L-lysine·HCl and supplementation with L-methionine and L-threonine. Pigs fed the aggressive amino acid supplementation program had similar growth performance and carcass value, and a reduced cost of production. In addition, nitrogen excretion was reduced by the aggressive use of synthetic amino acids. In another on-farm trial, the use of low phytate corn and phytase enzyme demonstrated that phosphorus excretion could be reduced 20 to 50% without influencing growth performance or carcass value. The use of on-farm studies with key industry leaders is a very effective method to gain adoption and implementation of dietary strategies to reduce nutrient excretion from swine production operations.

Key Words: Pigs, Nitrogen, Phosphorus

212 Using growth models to predict nutrient requirements and excretions.

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The compositional growth and nutrient accretion of pigs can be predicted based on previous empty body chemical composition research data. Daily nutrient requirements can be predicted based upon digestibility of feedstuffs consumed and the efficiency in which the available nutrients are utilized. Genetic population-gender-farm specific essential amino acid requirements can be predicted by three methods: (1) the utilization of serial real-time predictions of empty body protein and fat-free lean mass, (2) the mean fat-free lean gain over the grow-finish period (NRC, 1998); and (3) conducting nutrition trials in which alternative essential amino acids are fed. Currently research is being conducted by several groups to model daily P accretion rates as related to measures of empty body lean or protein mass, bone mass and/or ash mass. Further research is needed to evaluate the accuracy of predicting P accretion rates of pigs as affected by gender, genetics and environmental conditions. For example, research has indicated that pigs of high health status and pigs fed ractopamine have increased rates of carcass muscle gain and increased ratios of carcass muscle lean gain to visceral organ or bone growth. The importance of bone breaking strength must also be taken into account. Bone breaking strength responds differently to

increasing dietary concentrations of P compared to measures of pig performance such as ADG and G:F. Models can also be used to predict the excretion of nutrients including N and P, and furthermore can predict the relative and actual amounts of fecal versus urinary excretion and soluble versus insoluble excretion of each nutrient. These nutrient utilization and excretion models can be used in production system-economic models that evaluate farm specific management-nutrition alternatives.

Key Words: Pig growth modeling, Nutrient excretion, Requirements

213 Economic impact of low nutrient excretion diets in pork production with policy implications.

K. Foster*, M. Echarnier, B. Richert, and A. Sutton, *Purdue University*.

A non-linear mathematical programming model was used to determine the expected management decisions of crop mix, pig diet selection, and herd size towards a profit maximization goal under nitrogen versus phosphorus-based regulations. The case study uses a hypothetical 600 sow farrow-to-finish Indiana hog farm growing corn, soybeans, and wheat on 607 hectares to draw implications concerning the cost of alternative diets and the potential impact of alternative diets in the face of a producer's ability to change cropping patterns and make alternative decisions about manure allocation over space and time. The nine diets considered in the analysis were formulated to meet NRC (1998) requirements and are briefly distinguished as follows: 1. Regular corn-soybean meal diet: 13.1% CP content, 0.5% Ca and 0.387% P; 2. Regular corn-soybean meal diet plus phytase: Diet 1 plus 500 phytase units/kg; 3. High available phosphorus corn: Diet 1 with HAP corn replacing regular corn; 4. HAP corn plus phytase: Diet 3 plus 500 phytase units/kg; 5. HAP Corn and HAP soybean meal plus phytase: Diet 4 with HAP soybean meal replacing regular soybean meal; 6. Reduced crude protein: 11.5% CP with the addition of 0.15% Lysine-HCL; 7. Environmentally friendly diet: 8.25% CP, 5% soybean hulls, HAP corn, 300 phytase units/kg, 0.40% lysine-HCL and 0.16% available phosphorus; 8. Ractopamine industrial diet: 16.1% Crude Protein, 18 ppm of ractopamine and 1.10% lysine; 9. Ractopamine experimental diet: 13.8% CP, 18 ppm of ractopamine and 1.10% lysine. Results suggest that the cost and optimality of low excretion diets depends heavily on the cost of specialized ingredients such as synthetic amino acids and low available phosphorus grain. Also, availability of land and custom application heavily influence the cost of regulations born by farms. The estimated cost to the producer, as a result of switching from N to P based land application, can range from virtually no additional cost to $21.74 per unit of pig production capacity.

Key Words: Economic model, Swine nutrition, Environment

214 Acceptance and impact of environmentally friendly diets in Europe.

M. W. A. Verstegen* and A. J. A. Aarnink, *Wageningen University*.

Animal production in Europe is undergoing big changes as a result of environmental regulations in the EU. In some countries these environmental changes were already initiated about 20 years ago. Surpluses of minerals and nitrogen coming from animal production facilities were correlated to changes in soil, water and air quality. These environmental quality changes were not accepted by the public. As a result research programs were initiated to study the impact of nutrition on the environment and also to search for possible solutions to develop diets which are more environmental friendly. Possible solutions include choices of feedstuffs, formulating diets closer to pig requirements and multiphase feeding have been extensively tested and some are widely used. Also additions to the diet such as enzymes and synthetic amino acids are commonly used now in pigs and poultry production. These procedures and additions are accepted in the farming community but cause more costly food production. In recent years focus in pork production is less on maximizing pork production and more on optimizing pork production. The development of other programs (ecological production) has also focused on quality of manure that is produced by using the diet to shift excretion of N from urine to feces. New developments of diets are aimed less on pig requirements and more on how the diets may affect other aspects of the animals such as behavior, health and odor production. The implementation and acceptance of practices based on research on a few developments in Europe with environmental diets will be discussed.

Key Words: Water, Soil air quality, Pork production

215 Effect of feeding a low nutrient excretion diet on pig growth performance and carcass characteristics in a commercial wean-finish setting.

R. Hinson*, D. Sholly, A. Yager, M. Walsh, K. Saddoris, L. Wilson, D. Kelly, J. Radcliffe, A. Sutton, A. Schinckel, and B. Richert, *Purdue University*.

Two hundred fifty-six pigs (Initial BW = 45.6 kg) were randomly selected within four 1,000 hd commercial wean-finish swine buildings to determine the effects of feeding a control (CTL) corn-SBM based diet or a low nutrient excretion (LNE) diet, with synthetic amino acids and phytase, on grow-finish pig growth, carcass characteristics, live ultrasound backfat (BF) and loin eye area (LEA), and manure characteristics. Two barns were fed CTL diets and two fed LNE diets. Six phases of each diet were fed during the study, with diets balanced on ideal amino acid ratios. Individual BW and ultrasound measurements were recorded at 2 or 3 wk intervals on 32 pigs/sex/barn. After 11 wk on test, 10 pigs/sex/barn were harvested to determine carcass characteristics. Initial BW did not differ (P>.05) between CTL and LNE trts (46.2 vs. 45.0 kg) and barrows or gilts (46.1vs. 45.1 kg), respectively. Grower ADG (wk 1-6) was greater (P<.02) for pigs fed CTL compared to LNE diets (935 vs. 902 g/d). Finisher ADG (wk 6-11; 772 vs. 772 g/d), and overall ADG (wk 0-11; 864 vs. 847 g/d) were not different (P>.05) for CTL vs. LNE diets, respectively. Barrows had greater overall ADG (P<.01; 891 vs. 819 g/d) than gilts. Final body weight did not differ (P>.05) between trts, while barrows were heavier (P<0.001) than gilts (111 vs. 105 kg). There were no significant (P>.05) differences in carcass characteristics between trts. Visceral mass was similar, however, blood wt (4.2 vs. 4.0 kg) was greater (P<.02) for CTL vs. LNE trts, respectively. Barrows had greater (P<.05) 10^{th} rib BF (24 vs. 21 mm), last rib BF, and marbling score (2.2 vs. 2.0) and less LEA (41 vs. 44 cm^2) and predicted fat free lean (48 vs. 50%) than gilts. In a commercial setting, feeding a LNE diet reduced grower performance but maintained finisher and overall performance, with no differences in carcass characteristics compared to a standard corn-SBM diet.

Key Words: Swine, Dietary crude protein, Growth

216 The effect of feeding low nutrient excretion diets with the addition of soybean hulls and non-sulfur trace minerals on growth performance and carcass characteristics in grow-finish pigs.

R. Hinson*, M. Walsh, A. Yager, D. Sholly, L. Wilson, J. Beagle, S. Pence, K. Saddoris, D. Kelly, S. Radcliffe, A. Schinckel, A. Sutton, and B. Richert, *Purdue University*.

Three hundred eighty-four pigs (Initial BW = 21.7 kg) were fed: 1) Control (CTL); 2) low nutrient excretion (LNE; reduced CP + synthetic amino acids, low phytic acid corn, and phytase); 3) LNE + soybean hulls (LNE+SH); and 4) LNE+SH + a non-sulfur TM premix (LNE+SH+NSTM) to determine the effects on growth performance, carcass characteristics, and manure composition. Pigs were blocked by BW, sex, and ancestry and randomly allotted to diets. Pigs were housed four/pen and in eight separate, identical, environmentally controlled rooms (2 rooms/diet). Diets were split sex, phase fed with two grower and one finisher diets. Pig BW and feed disappearance were recorded every 14 d. At week 12, 12 pigs/sex/trt were harvested for determination of carcass characteristics and dissection. There was a diet by sex interaction for grower ADG (P<.008). Barrows had a greater reduction in ADG than gilts when fed the LNE based diet compared to the CTL diet, but had a smaller reduction in ADG than gilts when fed the LNE+SH diet. Pigs fed the CTL diet had greater G:F (P<.001) than all other trts during the grower phase. There were no differences among trts (P>.05) in finisher phase ADG and G:F, but ADFI was higher (P<0.03) for CTL pigs. Pigs fed the CTL diet averaged 4.8 kg heavier final BW (P<.001) than all other trts. Overall, CTL pigs had greater ADG (P<.001) than all other trts: 840, 796, 773, and 778 g/d for CTL, LNE, LNE+SH, and LNE+SH+NSTM, respectively. There were no differences (P>.05) in overall ADFI, G:F, and carcass characteristics among diets. Overall, barrows had greater ADG, ADFI, greater fat depth, loin color and firmness scores, and less LEA and predicted %

fat free lean when compared to gilts (P<.05). Feeding LNE based diets reduced grower pig performance but maintained finisher performance and carcass characteristics compared to a standard corn-SBM diet.

Key Words: Swine, Nutrient excretion, Growth

217 The effect of feeding low nutrient excretion diets with the addition of soybean hulls and non-sulfur trace minerals on manure generation and composition from grow-finish swine. R. Hinson*, D. Kelly, M. Cobb, J. Radcliffe, A. Schinckel, A. Sutton, and B. Richert, *Purdue University*.

Three hundred eighty-four pigs (Initial BW = 21.7 kg) were fed: 1) Control (CTL); 2) low nutrient excretion (LNE; reduced CP + synthetic amino acids, low phytic acid corn, and phytase); 3) LNE + soybean hulls (LNE+SH); and 4) LNE+SH + a non-sulfur TM premix (LNE+SH+NSTM) to determine the effects on growth performance, carcass characteristics, and manure composition. Pigs were blocked by BW, sex, and ancestry and randomly allotted to diets. Pigs were housed four/pen and in eight separate, identical, environmentally controlled rooms with 2 manure pits/room and 2 rooms/trt. Diets were split sex, phase fed in two grower and one finisher diets. Manure depths and samples were taken at the conclusion of each dietary phase (every 4 wks). Manure samples were collected by light agitation and cup sampling through 2 man hole openings/pit. Manure was analyzed for DM, N, ammonium N, P, water soluble P, and K. Overall grow-finish manure generation did not differ (P>.05) among trts. There were no differences (P>.05) in DM excretion among trts with 140, 148, 171, and 151 g/d for CTL, LNE, LNE+SH, and LNE+SH+NSTM diets. Barrows excreted greater DM (P<.012) than gilts (168 vs. 137 g/d). There were diet by sex interactions for total N and P (P<.035) excretion. Barrow N excretion was reduced more by the LNE formulations than gilts (B: 30.1, 24.4, 22.5, and 20.6 g/d; G: 19.6, 19.5, 19.3, and 16.4 g/d) for CTL, LNE, LNE+SH, LNE+SH+NSTM diets, respectively. Barrow P excretion was also reduced to a greater extent by LNE diets (B: 5.50, 2.30, 2.15, and 1.91 g/d), than gilt P excretion was (3.57, 1.95, 1.94, and 1.77 g/d) for CTL, LNE, LNE+SH, LNE+SH+NSTM diets, respectively. The feeding of these LNE based diets reduced N excretion by an average of 18% and P excretion by 56% when compared to standard corn-soybean meal based diets.

Key Words: Swine, Nitrogen excretion, Phosphorus excretion

218 Effect of clinoptilolite zeolite on cattle performance and nitrogen mass balance. D. Sherwood*, G. Erickson, T. Klopfenstein, and D. Schulte, *University of Nebraska-Lincoln*.

Zeolite clay may be effective in reducing N losses from feedlots. A winter feedlot trial was conducted from November to April using 96 crossbred steer calves (336 ± 12 kg) to evaluate effects of adding zeolite clay at 1.2% of the diet on steer performance and N volatilization loss. Calves were stratified by weight and assigned randomly to 12 pens and one of two treatments. Treatments were 1) control diet with 0% zeolite clay or 2) treatment diet with 1.2% zeolite clay. Diets consisted of 62.5% high moisture corn, 25% wet corn gluten feed, 7.5% alfalfa hay and 5% supplement. Steer performance was calculated and carcass data were recorded. Nitrogen excretion was determined by the difference between N intake and individual steer N retention. Total N lost was calculated by subtracting soil corrected manure and runoff N from excreted N. Ammonia emissions were measured weekly during the last six weeks of the feeding period using wind tunnels and an acid trap for 30 minutes in each pen. There were no statistical differences in steer performance between control and zeolite treatments. There was no difference (P=0.30) in ADG gain between the control and zeolite steers (1.72 vs. 1.78 kg) or gain to feed (P=0.41) with the control and zeolite steers at 0.170 and 0.176. Nitrogen mass balance was not affected (P=0.90) by the addition of zeolite clay with 39.4 and 40.5% N lost in control and zeolite pens. There was no statistical difference (P=0.64) in manure composition of the control and zeolite pens with 19.9 and 19.4 kg of N being removed. Ammonia emissions were not different (P=0.33) between the control and zeolite pen treatments (11.7 and 20.6 mg/hd/d). This trial indicates that zeolite clay does not have a negative effect on steer performance. Nitrogen mass balance and ammonia emissions were not affected by the addition of zeolite clay, which could be due to cation exchange potential and the ability to adsorb N. The zeolite may be less effective in outdoor dirt pens than confinement conditions.

Key Words: Cattle, Zeolite Clay, Nitrogen Mass Balance

Billy Day Symposium

219 The status of swine in vitro embryo production. H. Funahashi*, *Okayama University*.

Recent progress in technologies for in-vitro production of porcine embryos has made possible the preparation of mature oocytes or zygotes, as materials for production of cloned and transgenic pigs. However, a high incidence of polyspermic penetration and a low developmental competence of oocytes matured and fertilized in vitro (IVM-IVF) remain as persistent obstacles in this research area. This presentation addresses recent advancements in overcoming problems in porcine IVM-IVF systems. Although techniques for producing oocytes for in vitro embryo production are developing, further effort is required. To improve the developmental competence of oocytes, step-wise IVM systems have been developed. Thus IVM with an initial phase that holds oocytes at the germinal vesicle (GV) stage and a second phase that induces GV break down (GVBD), have been developed. An increased concentration of cAMP in oocyte-cumulus complexes during the early period of IVM seems to induce the expression of LH receptors on cumulus cells and to improve developmental competence of the oocyte. Synchronization of meiotic progression of oocytes by using cycloheximide, butyrolactone-I or roscovitine may be effective to improve the competence for development. Modification of culture conditions during IVM and in vitro culture (IVC) for early development, for example by reducing oxidative stress, has improved the developmental competence of oocytes and has produced piglets following embryo transfer of blastocysts produced by IVF-IVC in chemically defined media. The incidence of polyspermic penetration into IVM-IVF oocytes has been reduced somewhat in some unique IVF systems, such as the ‘climbing-over-the-wall (COW)’ method, ‘straw IVF’ and ‘transient co-incubation method’, or by replacement of caffeine with other inducers of sperm capacitation. However, further efforts are required to improve the efficiency and quality of swine in vitro embyo production.

Key Words: In vitro fertilization, Oocyte maturation, Pig

220 Outlook for the preselection of sex in pigs. J. M. Vazquez*, I. Parrilla, J. Roca, and E. A. Martinez, *Dept. Animal Medicine and Surgery (Animal Reproduction), Veterinary Faculty, University of Murcia*.

Sex preselection in pigs can be performed by separating the X- from the Y-chromosome bearing sperm using flow cytometry and cell sorting. However, the application of this technology on pig farms may be limited, at least until the efficiency of the procedures is improved and the lack of effect on sperm DNA is established. The efficiency of this technology depends of the number of sex-sorted sperm produced per unit of time, the fertilizing ability of sorted sperm, the number of spermatozoa required per insemination and the percentage of piglets with the expected sex. High-speed cell sorters produce 15 million sorted spermatozoa/h but the sperm have a short lifespan, as a consequence of the stressful steps required for the procedure. Therefore it is desirable to deposit the spermatozoa closer to the site of fertilization and inseminate near the time of ovulation in order to achieve acceptable fertility. Non-surgical, deep intrauterine insemination(depositing the spermatozoa in the anterior third of the uterine horn), or laparoscopic insemination of spermatozoa into the oviduct can greatly reduce the number of sperm required/insemination. When used in combination with hormonal control of the time of ovulation, these insemination procedures have been useful tools for the insemination of sex-sorted spermatozoa

in pigs. As deeper inseminations are performed, the number of inseminated spermatozoa can be lower, thus allowing increased numbers of sows to be inseminated and more piglets with the expected sex to be produced with the same number of sex-sorted spermatozoa. Regarding damage to the sperm DNA, damage due to the use of the Hoechst 33342 and the ultraviolet laser beam are theoretically possible. However, the incidence of abnormalities among the offspring that have so far been produced with sorted spermatozoa is similar to the incidence among offspring produced by unsorted spermatozoa. Moreover, a recent report indicates no increase in the frequencies of mutagenic indexes in the offspring produced with sex-sorted spermatozoa. These results are encouraging for the application of this technology in the swine industry, particularly when applied in specialized breeding systems.
CDTI, Fundacion Seneca and CCTIC.

Key Words: Sex ratio, Flow cytometry, Flow sorting

221 Germ cell transplantation in the pig: Status and possibilities.

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Transplantation of germ cells from fertile donor mice to the testes of infertile recipient mice results in donor-derived spermatogenesis and transmission of the donor haplotype to the offspring of recipient animals. This technique provides a bioassay for stem cell potential and a powerful approach to study spermatogenesis. In the pig, germ cells cannot be delivered by the same technique as in rodents due to differences in testicular anatomy and physiology. Therefore, we combined ultrasound-guided cannulation of the rete testis with delivery of germ cells by gravity flow to transplant germ cells in pigs. Importantly, germ cell transplantation was successful between unrelated, immuno-competent pigs, whereas syngeneic or immuno-compromised recipients need to be used in rodents. The germ line stem cell is unique among the stem cells in an adult male body in that it is the only cell that divides and contributes genes to subsequent generations. Genetic manipulation of isolated stem cells and subsequent transplantation will result in the production of transgenic sperm. Transgenesis through the male germ line has tremendous potential in species where embryonic stem cell technology is not available and current options to generate transgenic animals are inefficient. Introduction of a genetic change prior to fertilization will circumvent current problems associated with manipulation of early embryos and developmental abnormalities associated with somatic cell nuclear transfer and reprogramming. Transgenic mice and rats have been generated by viral transduction of germ cells prior to transplantation. Use of an adeno-associated viral vector to introduce a transgene into porcine germ cells prior to transplantation has also shown promising results. Current research is directed toward improved protocols for isolation and culture of porcine male germ cells to increase efficiency of transgene transmission and to allow for gene targeting prior to germ cell transplantation. It is expected that germ cell transplantation will then provide a viable alternate approach to generate germ line transgenic pigs.
NIH 1 R01 RR17359-01

Key Words: Germ cell, Pig, Transplantation

222 Status of cloning in swine.

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Since the first report of the successful production of porcine somatic cell clones (2000), a large number of cloned pigs has been produced by various research groups. While cloning efficiency is improving continuously, considerable variation still exists from lab to lab in development to blastocyst, blastocyst quality, pregnancy rate, development to term and health status of the clones. This variation may be attributable to a multitude of factors. Here we report the production of cloned piglets using both short and long term culture and compare our pregnancy rates and cloning efficiency with data for in vitro fertilization/in vitro culture in pigs.
Additionally, data on reproductive performance of cloned boars and their genetic donors will be presented. Six hundred twenty five piglets were produced in this study including 358 sired by four cloned boars. Semen quality and fertility of cloned boars as well as the growth characteristics of the offspring were compared, including the following parameters: sperm concentration, total sperm count, percent total motility, percent progressive motility, number of head/tail abnormalities. Carcass and meat composition of cloned and control pigs will also be reviewed.

Key Words: Animal cloning, Male fertility, Pig

Physiology

223 Satellite cell proliferation and differentiation.

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Postnatal skeletal muscle growth is associated with increases in muscle DNA content. Since myofiber nuclei are incapable of DNA synthesis, increases in myofiber nuclei result from satellite cell proliferation, differentiation and fusion with adjacent myofibers. Satellite cell differentiation controls the production of new myonuclei, as well as the number of satellite cells that remain capable of proliferation. Regulation of satellite cell proliferation and differentiation is complex due to the plethora of growth factors, binding proteins, receptors, enzymes, signaling molecules and transcription factors that modulate these events. Cultured satellite cells have been extensively used to elucidate regulatory mechanisms that control satellite cell activity. Quantification of *in vivo* satellite cell activity requires the ability to distinguish satellite cells from non-myogenic cells present in skeletal muscle, coupled with measurement of cell proliferation or differentiation. We have used immunostaining for proliferating cell nuclear antigen (PCNA) and myogenin as indices of satellite cell proliferation and differentiation, respectively, in growing pigs and cattle. Satellite cells were isolated from semitendinosus muscles of pigs at 1, 7, 14 and 21 weeks of age and cattle weighing 200 to 500 kg. Positive staining for neural cell adhesion molecule (NCAM) distinguished satellite cells from non-myogenic cells. Greater than 73% of NCAM-positive cells were PCNA-positive in both species. Myogenin-positive porcine satellite cells decreased ($P<0.05$) from 30% in 1-week-old pigs to 14% in 7-week-old pigs and remained constant thereafter. The reduced proportion of myogenin-positive cells may reflect accelerated incorporation of myogenin-positive cells into myofibers, or a decrease in the proportion of differentiating satellite cells in older pigs. The latter would result in a larger satellite cell population, which appears to explain a faster rate of muscle DNA accumulation observed in pigs from 7 to 21 weeks of age compared with that of younger pigs.

Key Words: Satellite cell, Proliferation, Myogenin

224 Gene expression during skeletal muscle growth and development.

J. Reecy* and D. Moody, *Iowa State University*.

Skeletal muscles of mammalian species exhibit a remarkable ability to adapt to genetic, pharmacological, and physiological demands such as genotype, injury, and training. Within the past decade revolutionary techniques have been developed to provide remarkable insight into genome-wide gene expression. The objective of this presentation is to review recent findings that describe changes in gene expression associated with skeletal muscle growth, regeneration, and atrophy. Experiments designed to determine mRNA expression profiles in skeletal muscle have utilized both hybridization and sequencing based platforms, such as SAGE, microarray, expressed sequence tag data, and massively parallel signature sequencing. We will discuss examples of gene expression profiling experiments designed to evaluate the number of genes expressed in adult skeletal muscle, the effect of growth promoting stimuli, the effect of physical activity, and mechanisms underlying skeletal muscle regeneration. These results provide new information concerning changes in gene expression associated with skeletal muscle growth and development and provide candidate genes for hypothesis-based testing.
USDA-NRI, Iowa State University Agriculture Experimentation Station

Key Words: Skeletal Muscle, Gene expression, microarray

225 Manipulation of postnatal muscle mass by embryonic intervention.

J. Killefer*, *University of Illinois at Urbana-Champaign*.

Myogenesis provides many avenues for the enhancement of postnatal muscle growth. Several growth factors influence myoblast commitment, proliferation, migration, and differentiation. Myoblasts fuse and mature into muscle fibers under the control of growth factors and nutrient availability. Increased postnatal muscle mass may be achieved through augmentation of myogenic growth factors or maternal nutrition. Though severe maternal nutritional restriction is detrimental to postnatal growth of offspring, reports conflict regarding the effect of increased maternal nutrition. Studies that investigated similar time periods within gestation of swine were not consistent; some demonstrated increased muscle fiber number and others detected no effect of increased maternal nutrition. Furthermore, though increased maternal nutrition resulted in elevated levels of maternal insulin-like growth factor (IGF)-I, this was not reflected in circulating fetal IGF-I concentrations. Although data is limited, manipulation of embryonic growth factors may also alter postnatal muscle mass. Additionally, exposure to growth promotants during early gestation may improve postnatal growth and carcass characteristics of the offspring. Growth hormone (GH) administration to the dam during late gestation increased birth weight and myofiber number and improved weaning weight and feed efficiency, but slaughter weight and carcass composition were unchanged. Furthermore, in ovo administration of GH in chickens increased body weight of male broilers upon hatch. In ovo administration of recombinant human IGF-I increased live and muscle weights, and improved feed efficiency. Additionally, modulation of myostatin function may provide a means to impact postnatal muscle growth as loss of function myostatin mutations result in increased muscle fiber number and increased postnatal hypertrophy of muscle fibers perhaps through alterations in satellite cell activity. Though several means of manipulating postnatal muscle growth by embryonic intervention exist, further research is needed to determine their feasibility for use in animal agriculture.

Key Words: Embryo, Muscle, Myogenesis

226 Production of IGF-I and its effects on muscle development.

A. L. Grant*, *Purdue University*.

The objective of this invited presentation is to provide an overview of the production of insulin-like growth factor-I (IGF-I) isoforms in skeletal muscle during different physiological states and to describe some of the mechanisms by which IGF-I alters muscle phenotype. IGF-I has been demonstrated to have a variety of effects in skeletal muscle in vivo and on muscle cells in vitro. Among these effects is altered proliferation and differentiation of muscle cells, increased cell size, increased protein accretion, and altered energy metabolism that determines muscle fiber type. As a result of the many studies to investigate the cellular mechanisms by which IGF-I alters muscle phenotype, several isoforms of IGF-I have been identified. These isoforms are a result of alternative splicing of the IGF-I gene. The splice variants, including those expressed in muscle, produce peptides with varying functions. IGF-I gene expression and splicing is altered by physiological state and the IGF-I isoforms appear to be differentially regulated under some conditions. The changes in IGF-I expression that accompany changes in muscle phenotype in these different physiological states have led to attempts using IGF-I to enhance muscle growth in vivo, and to prevent the muscle atrophy that accompanies aging and disease. Systemic or local administration of IGF-I peptide to muscle, or over-expression of IGF-I in muscle, results in increased muscle growth through a variety of cellular mechanisms, including altered protein metabolism and increased muscle satellite cell recruitment. The importance of locally-produced IGF-I splice variants in inducing muscle growth has been demonstrated in experiments in which the IGF-I of hepatic origin is lacking. Results from recent studies suggest that the effects of IGF-I on muscle satellite cells are subpopulation-dependent and that the variable effects of IGF-I on muscle in different physiological states may be explained by the altered proportions of these subpopulations that are present. A better understanding of muscle development is needed if strategies using IGF-I are to be developed for effective enhancement of muscle growth and prevention of muscle wasting.

Key Words: IGF-I, Muscle, Growth

227 Expression of vascular endothelial growth factor (VEGF) mRNA Isoforms- 120 and 164 are coordinately expressed during corpus luteum regression but appear differentially regulated after the LH surge in the bovine preovulatory follicle.

R. Ten Broeck*, D. Clopton, R. Bott, and A. Cupp, *University of Nebraska-Lincoln*.

VEGF is expressed by granulosa cells prior to ovulation in the bovine follicle and accumulates within follicular fluid. VEGF is composed of eight exons and six splice variants which produce six protein isoforms- VEGF 205, 188, 164, 144, 120 and 110. The objective of the present study was to investigate if the two major VEGF isoforms, 120 and 164, were differentially regulated prior to ovulation in the bovine follicle. In the first trial, two injections of $PGF_{2\alpha}$ were administered 14 d apart and follicular aspirates were collected at 12, 18, 24, 30, 36, 48, 54, 60, 66 and 72 h (n= average of 8) after the second injection of $PGF_{2\alpha}$. There were greater amounts of both VEGF isoforms ($P < 0.01$) detected by real time PCR at 18 h compared to all other times evaluated. A subset of cows (n=12) were bled at two h intervals after the second injection of $PGF_{2\alpha}$ from 0 to 72 h to determine timing of the LH surge. The LH surge occurred in 50% of the cows between 54 and 72 h. Due to this variation, a second trial was conducted to determine VEGF mRNA isoform concentrations after an artificial LH surge was induced with GnRH. In this experiment, cows were synchronized with two injections of $PGF_{2\alpha}$ 14 d apart and an injection of GnRH 48 h later. Follicular aspirates were collected at 3, 6, 12, and 24 h after GnRH (n=average of 3). An increase in VEGF 120 mRNA expression ($P<0.05$) was detected at 3 h post GnRH compared to all other h by real time PCR. However, VEGF 164 mRNA expression was not different at any h after GnRH. The data from these experiments indicate that expression of both VEGF 120 and 164 mRNA isoforms were greater at 18 h after $PGF_{2\alpha}$ but only VEGF 120 isoform displayed an increase in expression after GnRH. Therefore, regulation of expression of VEGF isoforms may be different during corpus luteum regression and after the LH surge. The differential expression of VEGF isoforms in response to the LH surge suggests unique non-overlapping functions of VEGF 120 and 164 prior to ovulation in the bovine follicle.

Key Words: VEGF, Follicle, Bovine

228 Comparison of circulating concentrations of vascular endothelial growth factor (VEGF) between cows gestating single and twin calves.

S. Echternkamp*[1], K. Vonnahme[2], and S. Ford[2], [1]*USDA, ARS, U.S. Meat Animal Research Center,* [2]*University of Wyoming*.

Placental function and efficiency have been related to placental vascularity and to VEGF concentrations in maternal blood of several species. Thus, the objective of the present study was to determine whether increased placental development in cows gestating twins was associated with increased VEGF concentrations in the maternal blood. Cows from the MARC Twinner Population were diagnosed by ultrasonography, and confirmed at parturition, to be gestating single (n = 24) or twin (n = 17) fetuses. Jugular vein blood samples were collected at four time periods of gestation that corresponded with management operations within the herd; Period 1 = 55 d, Period 2 = 125 d, Period 3 = 190 d, and Period 4 = 235 d of gestation (range = ± 10 days). Means for VEGF concentrations (ng/mL) in the maternal blood are presented in Table 1. Concentrations of VEGF tended ($P = 0.06$) to be greater in maternal blood of cows gestating twin fetuses compared with cows gestating a single fetus. Concentrations of VEGF did not differ ($P > 0.10$) among the four time periods. Also, VEGF concentrations did not differ ($P > 0.10$) between cows gestating a single male (n = 11) vs. female (n = 13) fetus. The trend for VEGF concentrations to be greater in the blood of cows gestating twin fetuses may reflect increased placental size and/or function for twin pregnancies. However, the association between VEGF and type of pregnancy was insufficient to enable the use of VEGF concentrations to diagnose twin pregnancies.

Table 1. Comparison of VEGF concentrations between cows gestating single versus twin calves

Type of pregnancy	N	Time periods				
		One	Two	Three	Four	SEM
Single	24	1.27	1.18	1.24	1.21	0.10
Twin	17	1.53	1.52	1.42	1.44	0.12

Key Words: Maternal VEGF, Twins, Cattle

229 Evaluation of ovulation rate and ovarian phenotype in puberal heifers from a cattle population selected for multiple births. R. A. Cushman*, M. F. Allan, G. D. Snowder, R. M. Thallman, and S. E. Echternkamp, *USDA, ARS, U.S. Meat Animal Research Center*.

Long-term selection for increased ovulation rate (1984-2002) has resulted in a unique ovarian phenotype in the MARC Twinner cattle population. Ovulation rate and frequency of bilateral ovulations were examined in heifers (n = 3910) in this population. Bilateral ovulations (one CL on each ovary) were of interest because bilateral pregnancies result in decreased dystocia and increased calf survival in cows with twin pregnancies. Heifers (12-18 mos. of age) were evaluated by ovarian palpation per rectum for 7.6 ± 0.03 estrous cycles. Ovulation rate increased linearly at a rate of 0.026 CL per year, and currently averages 1.5 ± 0.04 CL per estrous cycle. Concurrent with the increase in ovulation rate, the frequency of triplet ovulations increased from 0% to 2.3 ± 0.8% ($P < 0.0001$). Ovulation rate of both the right and left ovary increased equally at a rate of 0.013 CL per year, and mean ovulation rate of the right ovary remained greater than mean ovulation rate of the left ovary throughout the study (0.66 vs. 0.55 ± 0.003 CL per estrous cycle, $P < 0.0001$). The proportion of bilateral ovulations averaged 54.5 ± 0.8%, a value greater than the predicted 49.5%. Because triplet pregnancies increase the incidence of inter-sex pregnancies and subsequent incidence of freemartins, selection pressure on ovulation rate may need to be adjusted in the MARC Twinner population. Based on the greater than expected proportion of bilateral ovulations in the population, this may be a trait that is beneficial for improving bovine reproductive efficiency and that may respond to selection. Understanding factors controlling the increased functional activity of the right ovary and bilateral ovulations may provide further insights into the mechanisms controlling follicle selection, and provide methods to improve reproductive management of cattle.

Key Words: Cattle, Ovulation rate, Ovarian phenotype

230 A 12 bp insertion/deletion (in/del) polymorphism in the secreted folate binding protein (sFBP) gene is associated with uterine capacity and ovulation rate in swine. J. L. Vallet*, B. A. Freking, K. A. Leymaster, and R. K. Christenson, *USDA, ARS, RLH U.S. Meat Animal Research Center*.

Secreted FBP is present in the uterus during early pregnancy. This protein increases two orders of magnitude during early gestation and plays a role in transport of folate to the conceptus. A comparison of the nucleotide sequence of the cDNA and gene for sFBP indicated a 12 bp difference in exon 1 of the gene. The 12 bp in/del polymorphism is within a set of 12 bp degenerate tandem repeats, creating either 2 or 3 repeats, which alters a possible RNA hairpin structure in this region. Our objective was to determine whether the in/del was associated with reproductive traits in swine. Gilts (n = 407) from the control, ovulation rate and uterine capacity selected lines at MARC were unilaterally hysterectomized-ovariectomized (UHO), mated, and killed at 105 days of gestation. Corpora lutea and live fetuses were counted for each gilt, a blood sample was collected from each fetus, and each fetus and placenta was weighed. A second group of intact gilts (n = 131) from the OR line was mated and farrowed. Numbers of fully formed piglets and piglets born alive were recorded. DNA was isolated from each gilt to determine genotype. Secreted FBP gene specific primers were developed and used to amplify the region surrounding the in/del, resulting in products of 169 (del) and 181 (in) bp, which were resolved on a 10% acrylamide gel. The in/del had no effects on fetal weight, placental weight or fetal hematocrit. Uterine capacity was greater ($P < 0.01$) for del/del (8.0 ± 0.5) than for in/in UHO gilts (6.8 ± 0.1), and in/del gilts were intermediate (7.2 ± 0.2). There were fewer ($P < 0.05$) CL for del/del (13.7 ± 0.6) than for in/in or in/del UHO gilts (15.2 ± 0.2 for both). No effects of genotype on litter size of intact gilts from the OR line were detected. These results indicate that the del allele of the sFBP gene is associated with increased uterine capacity and decreased ovulation rate, resulting in no net effect on litter size.

Key Words: Pregnancy, Fetus, Litter size

231 Physiological effects and semen quality changes in boars treated with $PGF_{2\alpha}$. A. de Grau*[1], A. Ruiz[2], M. Wilson[3], R. Friendship[2], J. Ward[1], and K. Rozeboom[3], [1]*Minitube Canada,* [2]*Univeristy of Guelph,* [3]*Minitube of America*.

Prostaglandin-$F_{2\alpha}$($PGF_{2\alpha}$) has been suggested to facilitate training of sexually active boars to mount artificial sows for semen collection. This use in boars is considered off-label. 32 boars from a university boar stud were treated with $PGF_{2\alpha}$ to determine: number of treatments required before mounting, side effects, minimum and maximum dose, testosterone levels, semen quality changes, and long-term effects post-treatment. Blood samples were taken after treatment to measure testosterone peak levels, time of onset, response, and duration. Semen collections were evaluated for volume, concentration, total number of cells, motility and progressive motility using SpermVision® at 1, 7, 14 and 21 days post treatment. Regression analysis was performed to analyze the data utilizing the backwards elimination in Statistix®. On average 1.6 treatments were required to jump the phantom sow within 8-10 minutes. Erytheema, pruritus, itching, fever, urination, and defication were observed at 5 mg, abdominal muscle spasms, tail movements, increased vocalization, salivation at 10 mg. One boar vomited at 20 mg, 10% of the boars showed increased irritability and aggression towards the dummy and collectors. Testosterone levels rose within 10 min, peaked in 30 min and waned in 60 min. Testosterone levels remain unchanged for boars with <20 nmol/L pre-treatment regardless of dose applied. The ejaculation volume increased (P<.001) but no effects in total sperm cells per ejaculate nor motilities at collection, 7, 14 or 21 days post-treatment (P>0.1). Administration of $PGF_{2\alpha}$ (Lutalyse®) has often been used to aid the libido and desire of the boar to jump during training. Boars with poor libido have a correlation with low testosterone blood levels, there is little effect of $PGF_{2\alpha}$ in these boars. Long term use of $PGF_{2\alpha}$ should be discouraged and is un-necessary and the product only should be used after a prescription is written by a licensed veterinarian.

Key Words: Boars, $PGF_{2\alpha}$, Training

232 A method for the estimation of energy metabolic rate by oxygen consumption of broilers at different temperatures. Q. M. Yang*[1,2], S. K. Baidoo[2], and Y. Z. Ma[1], [1]*Shandong Agricultural University,* [2]*University of Minnesota*.

ABSTRACT: The experiment was designed to estimate resting metabolic rate (RMR) and fasting metabolic rate (FMR) via the oxygen consumption of broilers at 6 weeks of age at different ambient temperatures. Five airtight glass desiccators were used as metabolic chambers with scaled oxygen supply systems. Forty Arco Abro broilers (20 male and 20 female) at 4 weeks of age were randomly divided into 5 groups with 8 birds each. The treatment temperatures were 12.2 ± 0.6°C, 19.2 ± 1.4°C, 23.2 ± 0.9°C, 27.4 ± 1.2°C and 31.3 ± 1.1°C respectively for the 5 groups. After 2 weeks acclimatization period, the broilers were randomly distributed to the oxygen consumption measurements for 5 times a week, 1 h for each time. Eight broilers were used for 48 h fasting trial at 23°C to measure the FMR, which allowed the estimation of FMR for other temperature treatments. The desiccators contained solid NaOH for absorbing carbon dioxide produced by bird at bottom and silica gel on the top for absorbing moisture. The results showed that the RMR and FMR were negatively correlated to temperatures at the range of 12.2 to 31.3°C (r= - 0.86, P < 0.01). At the temperatures of 12.2, 19.2, 23.2, 27.4 and 31.3°C, RMR were 761.5, 662.7, 579.9, 570.3 and 528.9 KJ/$Wkg^{0.75}$ .day and FMR were 528.5, 460.0, 402.5, 395.8 and 367.1 KJ/$Wkg^{0.75}$ .day, respectively. In conclusion, the results were comparable with literature references. The regression equations of RMR and FMR to ambient temperatures (T, °C) respectively were: RMR (KJ/$Wkg^{0.75}$ ·day)=1314.76-521.28 log T and FMR (KJ/$Wkg^{0.75}$ ·day)=930.92-376.13 log T

Key Words: Broiler, Oxygen consumption, Temperature

233 Estimation of undegradable intake protein digestibility in forages using a mobile nylon bag technique.

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Two ruminally and duodenally cannulated steers were used to estimate digestibility of undegradable intake protein of two forage types using a mobile bag technique. Forages evaluated were cool and warm season grasses with legumes from subirrigated meadows (MDW) and warm season grasses from upland range (RNG) of Nebraska Sandhills, collected from May to September. Passage rate (kp) was estimated using IVDMD. The kp was used to determine mean retention time (MRT = 1/kp) and a 10-hour passage lag was added to yield total mean retention time (TMRT). Undegradable intake protein (UIP) was determined using neutral detergent insoluble protein at 75% of TMRT. Total tract indigestible dietary protein (IDP) was determined by incubating samples ruminally for 0.75 TMRT, in a pepsin and HCL solution for three hours to simulate abomasal digestion, and followed by duodenal insertion. Digestibility of UIP (DUIP) was estimated using the formula: DUIP = 1 - (IDP / UIP). There was a significant forage x month interaction ($P < 0.01$) for UIP and IDP. For May, June, and July, UIP (% DM) was not different ($P > 0.30$) between MDW and RNG. The UIP (% DM) in August and September was lower ($P < 0.02$) for MDW than RNG. There were no differences ($P > 0.09$) in IDP (% DM) of MDW, from May to September, or of RNG, from May to July; however, there was a significant increase ($P < 0.01$) in IDP (% DM) of RNG in August and September. There was not a forage x month interaction ($P = 0.57$) for DUIP, but there was a significant effect of month ($P < 0.01$). Both MDW and RNG had a significant decrease ($P < 0.05$) in DUIP (%) from May to September. Using correct ruminal incubation times to yield accurate UIP is critical to determine the digestibility of UIP in forages. The UIP digestibility values of the forages tested were low.

Month:	May	June	July	August	September
	MDW;	MDW;	MDW;	MDW;	MDW;
Forage:	RNG	RNG	RNG	RNG	RNG
CP, % DM	13.7; 12.0	12.2; 9.7	12.8; 9.5	12.4; 9.3	8.4 ; 9.4
IVDMD, %[a]	70.2; 67.7	67.3; 63.6	59.0; 61.6	57.2; 55.8	50.4; 52.5
UIP, % DM[b]	1.63; 1.83	1.93; 1.91	1.63; 1.49	1.46; 2.09	1.24; 2.37
IDP, % DM[c]	0.90; 1.05	1.09; 1.21	1.12; 1.21	1.15; 1.72	1.09; 2.12
DUIP, %[d]	43.3; 40.2	43.0; 36.1	30.1; 21.2	16.1; 10.9	6.5 ; 13.1

[a]Forage x month p=0.02 [b]forage x month p<0.01
[c]forage x month p<0.01 [d]forage x month p=0.57,
[e]forage p=0.24, month p<0.01

Key Words: Digestion, Forage, Undegradable intake protein

234 Cultural energy analysis of lamb production in the feedlot or on pasture and in the feedlot.

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A terminal sire study to evaluate post-weaning growth and carcass traits of Texel, Suffolk and Columbia sired offspring was conducted to evaluate cultural energy analysis of lamb production in the feedlot or on pasture and in drylot. A total of 82 whiteface ewes were exposed to Texel, Suffolk or Columbia rams. Ewes were wintered outdoors on average quality alfalfa hay fed at a level to meet their NRC (1985) requirements and were not fed any concentrate during late gestation or lactation. After being treated for parasites, ewes were turned out in early May onto 6.07 ha of predominantly cool season grass pasture divided into five 1.21 ha paddocks. Ewes were rapidly rotated through paddocks initially to stagger grass growth. A total of 139 lambs were born with an average of 1.7 lambs per ewe and 100 lambs survived through weaning. A total of 82 lambs were used in the study and 18 lambs were sold after weaning. The lambs were weaned at 70 days of age and lambs were placed in one of two finishing programs: 1) lambs going direct to feedlot and 2) lambs first grazed on pasture followed by feedlot finishing. In the feedlot they were fed corn and pelleted protein supplement. Lambs on pasture grazed for 63 days and received 455 g of concentrate daily. For cultural energy analysis, pasture establishment and maintenance, feed in feedlot and other inputs were calculated and corresponding values for each input were obtained from the literature. Total cultural energy invested in ewes and lambs in the first program was higher than that of the second program ($P<0.01$). Energy inputs/kg live weight and/kg carcass were lower for the second program ($P<0.01$, $P>0.07$, respectively). The energy output ratio defined as the kcal input/kcal output was better for the second program than the first program ($P>0.07$). Results of the study show that grazing before feedlot finishing decreases cultural energy input and supports the concept of sustainable agriculture and energy conservation.

Key Words: Cultural energy, Sheep, Pasture

235 A low cost vacuum storage method can preserve high moisture, distiller's grains.

P. Walker*[1], K. Earing[2], and L. Mathews[1], [1]*Illinois State University,* [2]*University of Kentucky*.

Herd sizes of small scale beef cow-calf producers can be too few in number to utilize high moisture distiller's grains (DGS) as a protein-energy supplement prior to spoiling. The objective of this trial was to evaluate a vacuum ensiling method for longer term storage of high moisture distiller's grain. Freshly produced DGS (36.53±0.43% DM) were placed on .24mm thick white plastic silo cover in two rows containing either 49t or 63.6t. Each row was either 3.05m or 4.57m wide at the base and 22.86m long. Prior to covering each row with plastic and sealing the plastic at the base with ground limestone a 5.08cm diameter x 15.24m perforated tube was laid on each side of each DGS row and connected to a 5 HP, 45.4 l, 120 volt Shop Vac® (Williamsport, PA) vacuum. Each vacuum was turned on 3x:d for a 5 minute duration at 0800h, 1200h and 1600h. Samples of DGS were collected at 0d, 41d and 78d post-sealing and analyzed for DM, pH, acetic acid (AA), propionic acid (PA), butyric acid (BA) and lactic acid (LA). Initial DGS contained 36.18±0.48% DM, 4.6 pH, 0.45±0.07 mg/g AA, 0.09±0.04 mg/g PA, 0.05±0.03 mg/g BA and 1.01±0.34 mg/g LA (DM basis). At 41d DGS contained 36.04±0.7% DM, 4.35 pH, 0.53±0.04 mg/g AA, 0.07±0.02 mg/g PA, 0.04±0.01 mg/g BA and 0.56±0.08 mg/g LA (DM basis). At 78d DGS contained 34.92±0.38% DM, 4.18 pH, 0.06±0.01 mg/g AA, 0.03±0.01 mg/g PA, 0.02±0.01 mg/g BA and 0.05±0.01 mg/g LA (DM basis). Over the first 78d of storage VFA concentration decreased ($P<0.05$) 97.8%, 66.7%, 60.0% and 95.0% for AA, PA, BA and LA, respectively. Bag one was opened at 78d post-sealing and fed for 112d. Of the 63.6t DGS stored in bag one, 19.8% was considered spoiled and unfit for feeding. Bag two was opened on day 190 post-sealing and fed for 67d. Of the 49.0t DGS stored in bag two 27.6% was considered spoiled and unfit for feeding. This trial suggests vacuum storing can preserve DGS for prolonged periods but the vacuum procedure used did not ensile DGS.

Key Words: Vacuum storage, High moisture, Distiller's grains

236 Relationship of milk urea nitrogen and total nitrogen excretion from lactating cows.

S. W. Zhai* and J. X. Liu, *Institute of Dairy Science and Industry, College of Animal Science, Zhejiang University*.

The objective of this study was to assess the relationship between milk urea nitrogen (mg/dl) and total nitrogen excretion in urine and feces (g/d). Four multiparous cows were fed four different CP level diets (13.2%, 14.1%, 15.0% and 16.2%, DM basis). Diets were isocarloric. The experiment was designed as a 44 Latin square. Experimental periods were 2week in length, with d1 to 9 used for adjustment and d12 t o14 used for a total collection of urine and feces. Crude protein concentration had a significant effect on milk urea nitrogen ($P<0.05$), total nitrogen excretion (fecal + urinary nitrogen; $P<0.01$) and no effect on milk yield and composition ($P>0.05$). There was a linear increase in milk urea nitrogen and total nitrogen excretion with increasing CP level ($P<0.001$). The linear regression equation of total nitrogen excretion on MUN was Total N excretion (g/d) =11.47(±1.72)MUN(mg/dl) +151.01(±19.54). The results in our study suggested that MUN would be used a valuable tool to monitor the changes of dietary CP and predict the amount of nitrogen excreted into the environment.

Key Words: Protein level, Milk urea nitrogen, Total nitrogen excretion

237 Milk urea nitrogen response to a change in dietary crude protein for Chinese Holstein lactating cows.

S.W. Zhai* and J.X. Liu, *College of Animal Science Zhejiang university*.

The objective of this study was to assess the response of milk production and milk urea nitrogen concentration in Chinese Holstein lactating cows to the change in levels of dietary crude protein (CP). Twelve multiparous lactating cows were divided by days in milk and milk yield into four groups. Diets were formulated to contain four different CP levels (13.2, 14.1, 15.0 and 16.2%, DM basis) and to be isocarloric. Experiment was conducted as a 44 Latin Square design and each period consisted of 14 days, with d1 to 9 for adjustment and d12 to14 for a total collection of urine and feces. Crude protein concentration had a significant effect on milk urea nitrogen concentration ($P<0.01$), but little effect on milk yield and composition ($P>0.05$). There were strong correlation relationships between MUN to PUN ($P<0.001$), The regression equations of MUN on PUN was MUN (mg/dl)=0.78PUN (mg/dl)+1.22. The above results suggested that MUN might be more sensitive to the change in crude protein level and MUN could be used a valuable tool to monitor the intake of crude protein and avoid excess protein feeding.

Key Words: Crude protein level, Milk urea nitrogen, Chinese Holstein lactating cows

238 Combinations of distiller's grains, gluten feed, and soy hulls for growing cattle.

J. Sewell* and L. Berger, *University of Illinois*.

The objective of this trial was to evaluate co-products combinations compared to a program-fed corn based growing diet for feedlot cattle. Crossbred steers (n=400, 272.2 ± 6.80 kg) were allotted to one of 8 diets for 91 d. Dietary treatments were: equal co-product combinations (20-20-20%), high co-product combination (40-20%), or a 60% corn based diet fed at 1.8% of body weight. Co-products used included dry distiller's grains (DDG), corn gluten feed (CGF), and soy hulls (SH). A common diet was fed for the finishing phase (93 d). Orthogonal contrasts were performed for preplanned treatment comparisons. During the growing phase steers fed the co-product combinations had a higher ADG ($P < 0.05$) when compared to the program-fed control steers (1.21 kg/d vs. 1.09 kg/d). The ADG for the 40% DDG/20% SH or CGF steers were greater ($P<0.05$) when compared to the 40% CGF/20% DDG or SH (1.26 kg/d vs. 1.15 kg/d). The same trend followed for the 40% SH/20% DDG or CGF steers when compared to the 40% CGF/20% DDG or SH (1.21 kg/d vs. 1.15 kg/d). DMI were greater ($P<0.05$) for the 40% SH/20% DDG or CGF steers when compared to the 40% CGF/20% DDG or SH and 40% DDG/20% SH or CGF combination steers. Steers fed the corn diet had the lowest DMI due to the restricted intake. The 40% CGF/20% DDG or SH steers were more efficient when compared to 40% DDG/20% CGF or SH (.1342 vs. .1457, $P<0.05$). The 40% SH/20% DDG or CGF steers were more efficient when compared to the 40% DDG/20% CGF or SH (.1295 vs. .1457). PROC MIXED procedure in SAS was used to determine significant differences ($P<0.05$) for hot carcass weight (HCW), yield grade (YG), rib-eye area (REA), and back fat thickness (BF). HCW was greater for the 40% DDG/20% SH, 40% SH/20% DDG or CGF combinations when compared to the 40% CGF/20% SH steers. The 40% DDG/20% SH steers had higher YG ($P<0.05$) when compared to the 40% DDG/20% CGF steers (2.93 vs. 2.58). There were no significant differences for quality grade.

Key Words: Distiller's grains, Gluten feed, Soy hulls

239 The effect of vacuum stored high moisture distiller's grains as a protein and energy supplement for beef cows.

P. Walker*[1], K. Earing[2], and L. Mathews[1], [1]*Illinois State University*, [2]*University of Kentucky*.

Eighty multiparous beef cows in the third trimester were blocked by BSC and randomly allotted within block to 10 pens subject to variation in BW to evaluate vacuum stored high moisture corn distiller's grains (DGS) as a substitute for shelled corn (C) and soybean meal (S). Control cows (CNTL) were fed corn silage-C-S based diets according to NRC recommendations. DGS were initially included in treatment cow (TRT) diets to balance for CP but were increased as needed over the 182d feeding period to maintain cow BCS. This procedure resulted in TRT diets containing 2.7±0.3% higher ($P<0.05$) CP, comparing 14.0±0.5% vs. 11.3±0.6% CP for TRT vs. CNTL diets, respectively. The DGS contained 37.1±0.4% DM, 32.0±0.5% CP, 7.1±0.6% ether extract and 20.6±3.6% ADF. Mean ADFI (wet wt. basis) was 48.8±6.5 kg for CNTL and 50.0±7.0 kg for TRT. DGS represented 21.9±2.3% of DMI for TRT cows and C + S represented 25.3±4.6% of DMI for CNTL cows. No differences ($P>0.05$) were observed in cow BW, BCS changes, conception rates and estimated milk production, and in calf creep feed intake and end of trial calf weights. These data suggest diets containing DGS stored for up to 260d using a vacuum preservation method can result in similar beef cow performance compared to cows fed corn silage-shelled corn-soybean meal based diets.

Key Words: High moisture distiller's grains, Vacuum stored, Beef cows

240 Effects of feeding polyclonal antibody preparations against *Streptococcus bovis* or *Fusobacterium necrophorum* on target bacteria populations and pH of steers fed high-grain diets.

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Three factorial experiments were designed to test the efficacy of avian-derived polyclonal antibody preparations (PAP) against *Streptococcus bovis* (PAPSb) or *Fusobacterium necrophorum* (PAPFn) in reducing rumen counts of target bacteria in steers fed high-grain diets with or without feed additives (FA; 300 mg monensin/hd/d and 100 mg tylosin /hd/d). Sixteen rumen cannulated steers were fed a diet comprised of 83% corn grain, 12% corn silage and 5% supplement on DM basis. Diet supplied 1.39 Mcal NE_g/kg DM, 12.5% CP, 0.65% Ca, and 0.35% P. Polyclonal antibody preparations were top-dressed. In Experiment 1, feeding increasing doses of PAPSb reduced *S. bovis* counts in a cubic response ($P < 0.05$). Inclusion of FA had no effect ($P > 0.15$) on rumen *S. bovis* counts. Counts of *F. necrophorum* were reduced ($P < 0.05$) by feeding FA. Feeding PAPSb or FA alone had no effect ($P > 0.15$) on rumen *S. bovis* counts, but feeding PAPSb and FA reduced ($P < 0.05$) rumen *S. bovis* counts relative to feeding either FA alone (Experiment 2). Rumen pH was greater ($P < 0.05$) in steers fed PAPSb, FA or both. In Experiment 3, rumen *F. necrophorum* counts were reduced ($P < 0.05$) by feeding PAPFn, FA or both. When feeding PAPFn and FA together, counts of *F. necrophorum* were greater ($P < 0.05$) than when feeding FA alone. Counts of *S. bovis* or rumen pH were not affected ($P > 0.15$) by feeding PAPFn. Total anaerobic counts were not affected ($P > 0.15$) by feeding either PAP (Experiments 1 and 3). In conclusion, avian-derived PAP were effective in reducing rumen counts of target bacteria. Specificity of the PAP was demonstrated as they did not affect counts of other rumen bacteria measured. Thus, PAP against *S. bovis* or *F. necrophorum* could be effective in preventing the pathogenic situations associated with these bacteria, and perhaps enhance animal performance.

Key Words: *Streptococcus bovis*, *Fusobacterium necrophorum*, Antibodies

241 Effect of live bacterial inoculants on performance of lactating dairy cows.

J. W. West*, J. K. Bernard, G. H. Cross, and D. S. Trammell, *University of Georgia*.

Forty-eight lactating Holstein cows were used in a 10 week randomized block trial to determine the effect of supplemental live bacterial inoculants on intake, milk yield and composition, and on blood metabolites. Treatments were: control (C); B1 (*Propioni freudenreichi* and *Lactobacillus acidophilus* bacteria); B2 (B1 plus an additional *Lactobacillus acidophilus* strain). Bacterial inoculants were top-dressed on individually fed mixed rations offered ad libitum. Data were subjected to analysis of covariance using PROC MIXED procedures of SAS. Orthogonal contrasts were: C vs. supplemental bacterial inoculant treatments B1 and B2 (C vs. B), and treatments B1 vs. B2. Performance means for C, B1 and B2 and significance were: DMI, 25.5, 26.3, 26.3 kg/d; milk, 37.7, 39.6, 38.5 kg/d (C vs. B, $P < 0.08$); energy-corrected milk (ECM), 34.5, 36.8, 37.0 kg/d (C vs. B, $P < 0.03$), and gross efficiency of production (ECM/DMI): 1.34, 1.42, 1.41 kg/kg (C vs. B, $P < 0.03$). Milk fat content for C, B1, and B2 was 3.19, 3.23, 3.40%; milk protein content was 2.95, 2.94, 3.00%. Body weight change (kg) was not affected by treatment. Serum urea N for C, B1, and B2 were 22.62, 20.43, 21.66 mg/dl (C vs. B, $P < 0.01$; B1 vs. B2, $P < 0.08$); serum glucose was 64.73, 67.55, 65.52 mg/dl. Inoculants did not alter DMI. Yield of milk and ECM and the gross efficiency of production were improved by inoculants but no differences among the inoculant treatments were noted. Serum glucose

was not different but serum urea N was lower for inoculants. The live bacterial inoculants used in this study improved the yield of milk and the gross efficiency of high producing dairy cows.
Nutrition Physiology Corporation

Key Words: Lactation, Bacterial inoculants, Nutrition

242 Potential of Alimet® supplementation to improve growth and reproduction of beef heifers fed a forage diet.

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The importance of adequate growth rates by beef heifers to ensure reproductive success has been well documented. Supplementing rumen undegradable protein has been shown to enhance reproductive tract development in heifers. The response of reproductive tract growth due to consumption of rumen undegradable protein is believed to result from supply of limiting amino acids. Diets composed of cool-season grass and legume species will be essentially devoid of intact protein that is resistant to extensive hydrolysis by proteolytic microbes in the rumen. Thus, the absorbable amino acid available to the animal is essentially of microbial origin. Relative to the amino acid requirements of the heifer, the first limiting amino acid is predicted to be methionine. Alimet® feed supplement (Novus International, Inc.) has been shown to be nutritionally equivalent to methionine and has an approximate rumen escape percentage of 40. Therefore, an experiment was designed to determine the potential of Alimet® to increase growth and reproductive tract development in beef heifers fed a forage diet. Seventy-two heifers (init wt 374 kg) were randomly allotted to twelve pens. Heifers were offered ad libitum access to water and hay, and fed 2.3 kg of supplement daily. The supplement consisted of soyhulls with 0, 7.5, or 15 g of Alimet® added per head per day. The experiment was conducted over an 85 d period, with intermittent weights taken on day 30. Feeding Alimet® resulted in a linear increase ($P<0.12$) in ADG over the first 30 days and for heifers fed 15 g of Alimet® to have a greater reproductive tract score (4.5 vs 4.2 for heifers fed the 15 g Alimet and control treatments, respectively) at the end of the 85 day experiment. No negative effect on supplement consumption behavior was observed in supplements containing Alimet® compared to controls. No differences were noted among treatments in hay disappearance. Alimet® supplementation was effective in improving growth of young heifers and trended to improve reproductive tract scores.

Key Words: Amino acids

243 Effect of stocking rate and corn gluten feed supplementation on bred second-calf heifers grazing stockpiled tall fescue-red clover pastures during winter.

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A winter grazing experiment was conducted to evaluate the performance of bred 2-year old second- calf heifers grazing stockpiled forage at two stocking rates and two levels of supplementation during winter. Two 12.2-ha blocks containing 'Fawn' endophyte-free tall fescue-red clover were each divided into four pastures of 2.53 or 3.54 ha. Hay was harvested from the pastures in June and August of 2003 and N applied at 44.8 kg/ha to initiate stockpiling in August. On October 22, 2003, twenty four Angus-Simmental second-calf heifers were allotted by weight and body condition score (BCS) to strip graze for 147 d at 1.19 or 0.84 cow/ha and eight second-calf heifers were allotted to two drylots and fed tall fescue-red clover hay. Corn gluten feed was fed to maintain a mean BCS of 5 or 4.33 (9-point scale) for the high and low supplementation levels, respectively, or when weather prevented grazing. At the conclusion of winter feeding, animals grazing at the low stocking rate had greater ($P < 0.1$) BW than those grazing at the high stocking rate, and the BCS of grazing animals was 0.42 lower ($P < 0.05$) than animals maintained in the drylot. Mean initial forage yield was 3548 kg/ha and decreased 13.7 kg/ha/d in grazed areas of the pasture over 147 d. Mean seasonal concentrations of CP and IVDMD were greater ($P < 0.05$) in hay than stockpiled forage, while the concentration of ADF was greater ($P < 0.05$) in stockpiled forage. Animals in the drylot were fed 2702 kg DM /hd of hay, and the amount of corn gluten feed fed was 86.2, 8.7, 126.6, 7.7, and 2.3 kg DM/hd for the high stocking rate high supplementation, high stocking rate low supplementation, low stocking rate high supplementation, low stocking rate low supplementation, and drylot treatments respectively, with no treatment difference ($P > 0.1$) in amount of corn gluten feed fed.

Key Words: Stockpiled forage, Second-calf heifer, Winter grazing

244 Supplementation of grazing Holstein steers with dried distiller's grains in combination with monensin.

J. Lehmkuhler*, A. Crooks, and D. Undersander, *University of Wisconsin*.

Sixty Holstein steers rotationally grazed a mixed cool-season grass/legume forage base to study responses in performance when supplemented with dried distiller's grains with or without monensin. Treatments included non-supplemented control (CON), dried distiller's grains with solubles (DDG), DDG plus monensin (RDDG), and a mixture of ground corn, soybean meal and monensin (SBM) at similar levels of crude protein and ionophore as RDDG. Steers were randomly assigned to three grazing groups and treatments within each group. Steers receiving supplements were trained to Calan gates prior to pasture turnout. Twelve gates were placed within each grazing group to deliver supplements at a rate of 2 kg/hd/d. Supplementation was initiated after 53 d of grazing and continued for 88 d. Steers were implanted with a single Revalor G implant and administered an anthlementic twice during the grazing season. Intermittent weights were collected monthly and average daily gain was calculated for each period, overall, pre-supplement, and supplement periods. Forage samples were collected at weekly intervals, composited by month and analyzed for quality. Initial weights were not equal across treatments and performance responses were analyzed with initial weight as a covariant. During the first portion of the pre-supplement period, CON steers tended ($P<0.1$) to gain more rapidly than all other treatments. During the last two periods (64 d) of the supplementation period, DDG, RDDG and SBM posted greater ADG ($P<0.05$) than CON. Additionally during the last 64 d, RDDG resulted in greater ADG ($P<0.05$) in comparison to DDG with SBM being intermediate and similar ($P>0.05$) to both. Supplementation increased performance of grazing Holstein steers by approximately 25% to 40% resulting in a supplement conversion of 5.8, 6.8, and 9.0 kg supplement/kg gain over control (RDDG, SBM, and DDG, respectively). Offering dried distiller's grains with an ionophore resulted in performance similar to a corn/soybean mixture. An additive response was observed when an ionophore was offered with dried distiller's grains.
Badger State Ethanol for donation of dried distiller's grains.

Key Words: Cattle, Ethanol, Pasture

245 Effects of whole soybean supplementation and cow age on hay intake and digestion during late gestation.

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During late gestation, 24 spring calving beef cows were used to determine the effects of cow age class and whole soybean supplementation on hay intake and digestion. Days from last measured DMI to calving avg 19.2. A 2 x 3 factorial treatment design with two supplements and three cow age classifications was used. Cows were classified as 2-yr-, 3-yr-olds, or mature (avg = 8.0; range = 6 to 12 yr). Supplement treatments included: 1) 1.36 kg/d of whole raw soybeans (WSOB; DM, 2.38 kg/feeding); and 2) 1.56 kg/d of a soybean meal/hull supplement (POS; DM, 2.73 kg/feeding). Supplements were formulated to be isonitrogenous and isocaloric and fed on M, W, F, and Sat. Cows had ad libitum access to bermudagrass hay (CP = 8.3%, NDF = 75%, DM). Hay intake was measured directly and fecal output was estimated by analyzing fecal grab samples, hay, orts, and supplements for acid detergent insoluble ash. No cow age class x supplement interactions were significant for any intake or digestion measurements. Neither hay intake (1.63, % of BW) nor DMI (1.92, % of BW) were influenced by cow age class or supplement treatment. In addition, DM digestibility (54.23 %), NDF digestibility (55.18%), and digested DMI (1.04 kg/100 kg BW) were not influenced by cow age class or supplement treatment. This experiment suggests that whole raw soybeans can be used as a winter supplement without reducing DMI intake or fiber digestion. It also suggests that separate intake prediction equations are not needed for varying age classes of cows when intake is expressed as a percent of BW.

Effect of whole soybean supplementation and cow age on hay intake and digestion

Item	Hay intake, kg/ 100 kg BW	DMI, kg/ 100kg BW	DM Digesti-bility, %	NDF Digesti-bility, %	Digested DMI, kg/ 100 kg BW
POS	1.55	1.85	54.81	55.52	1.01
WSOB	1.71	1.98	53.44	54.58	1.05
P =	0.10	0.18	0.31	0.48	0.44
Two	1.59	1.90	53.02	53.64	1.01
Three	1.62	1.91	54.71	56.07	1.04
Mature	1.68	1.93	54.65	55.44	1.05
P =	0.69	0.96	0.53	0.34	0.80

Key Words: Beef cows, Whole Soybeans, Digestion

246 Metabolite fluxes across splanchnic tissues in response to varying dietary protein in mature ewes consuming low quality forage.

S. L. Archibeque*, H. C. Freetly, and C. L. Ferrell, *USDA-ARS; U.S. Meat Animal Research Center*.

We hypothesized that there would be nonlinear relationships between nutrient fluxes and dietary protein intake. Fourteen mature Dorsett ewes (72.3, SD 3.8 kg) were used to describe the responses of metabolite flux across the portal drained viscera (PDV) and total splanchnic tissues of mature ewes fed a low quality forage (brome hay and wheat straw) that was supplemented to provide adequate energy for maintenance, yet differing amounts of dietary protein (34 to 122 g/d). The ewes were fed twice daily and metabolite fluxes were observed for the 12 diurnal hours. There were no significant ($P > 0.15$) quadratic responses of metabolites to increased dietary protein intake. The PDV release of α-amino nitrogen did not increase linearly ($P = 0.16$) with increased protein intake, yet hepatic uptake of α-amino nitrogen did increase linearly ($P = 0.07$) with protein intake. Similarly, there was a positive relationship ($P < 0.01$) between PDV ammonia nitrogen release and dietary protein intake [(0.19 mmol$\times$h^{-1})$\times$g protein^{-1}]. This increase in ammonia absorption from the gut was accompanied by an increased ($P < 0.01$) uptake of ammonia nitrogen by the liver [(0.17 mmol$\times$h^{-1})$\times$g protein^{-1}] and an increase ($P < 0.01$) in hepatic urea nitrogen production [(0.16 mmol$\times$h^{-1})$\times$g protein^{-1}]. There was no change ($P > 0.19$) in total splanchnic or PDV urea nitrogen flux with increased dietary protein. Total splanchnic lactate release also had a positive linear relationship ($P = 0.03$) with increased dietary protein [(0.22 mmol$\times$h^{-1})$\times$g protein^{-1}]. While nutrient fluxes did respond to increased dietary protein as expected, we failed to prove our hypothesis that there were curvilinear responses in nutrient fluxes as dietary protein intake increased from 34 to 122 g/d in mature Dorsett ewes. However, we did demonstrate that over a very wide range of dietary nitrogen intake, that approximately 40% of each increased g of daily protein intake was converted to ammonia to be converted into urea and either recycled or excreted into the environment.

Key Words: Ewes, Protein, Nutrient flux

247 Moderately altering weight gain patterns of second parity cows through nutrition changes the time that feed resources are offered without any differences in production.

H. C. Freetly*, C. L. Ferrell, and T. G. Jenkins, *USDA-ARS; U.S. Meat Animal Research Center*.

We hypothesized that feed resources could be deferred from mid-gestation to either late gestation or early lactation without a decrease in fertility or weight of calf produced in second parity cows. One-hundred and one MARC III composite cows (1/4 Hereford, 1/4 Angus, 1/4 Red Poll, and 1/4 Pinzgauer) were divided into three treatments that consisted of three different feed presentation: M-M-M-M (n = 32), L-H-M-M (n = 33), and L-L-L-H (n = 36). Feed levels resulted in cows losing maternal BW (L), maintain maternal BW (M), or rapidly gain maternal BW (H) during four periods (Period 1: 112 to 201 d of gestation, Period 2: 202 d of gestation to parturition, Period 3: parturition through 27 d of lactation, Period 4: 28 d to ∼64 d of lactation). As bred and lactating heifers these cows had the same treatment designations except heifers were fed for Low (L), Medium (M), and High (H) rates of gain during four periods (Period 1: 94 to 186 d of gestation, Period 2: 187 d of gestation to parturition, Period 3: parturition through 27 d of lactation, Period 4: 28 d to ∼63 d of lactation). Total feed intake of L-H-M-M and M-M-M-M second parity cows did not differ ($P > 0.59$), but L-L-L-H cows ate less ($P < 0.002$). At parturition, body condition score (BCS; scale 1-9) of did not differ between M-M-M-M (4.6 $\pm$ 0.1) and L-H-M-M (4.4 $\pm$ 0.1) cows, but both treatments had higher BCS than the L-L-L-H (3.8 $\pm$ 0.1; $P < 0.001$) cows. The percentage of calves weaned (88 $\pm$ 3%; $P = 0.77$), weight of calf weaned (167 $\pm$ 5 kg; $P = 0.63$), BCS at breeding (4.5 $\pm$ 0.1; $P = 0.20$), or the percentage of cows expressing a corpus luteum at the start of next breeding season (80 $\pm$ 4; $P = 0.21$) did not differ among treatments. Our findings suggest that timing nutrient availability to second parity cows can be used to change the time that feed resources are used.

Key Words: Nutrition, Pregnancy, Lactation

248 Supplemental phosphorus removal for grazing Holstein steers.

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Two experiments were performed to determine the responses of removing phosphorus from the mineral supplement. In Experiment 1, 80 Holstein steers (280 kg) were randomly assigned to four grazing groups. Treatments were trace mineralized salt only (TM) or a 67:33 mixture of trace mineralized salt and dicalcium phosphate (TMDC). Steers were trained to use Calan gates. Within each pasture group, half of the steers had access to a gate supplying TMDC while the other 10 steers had the same key for the TM gate. Steers rotationally grazed a cool-season grass/legume mixture for 139d. Fecal bags were placed on three steers from each grazing group (n=12) over a four d period for estimation of forage DM intake and forage contribution to daily P intake. Analyzed pasture samples were approximately 10.1% Ash, 53% NDF, 31% ADF, 83% OM, 17.6% CP, 80% OMD, and provided 2.85 mg P/g DM. Experiment 2 consisted of 72 Holstein steers (296 kg) blocked into a light and heavy weight group randomly assigned to four pasture groups. Within each pasture group nine steers were assigned to the TM and nine to TMDC treatments as in Experiment 1. Steers were administered a single Ralgro implant at turnout and rotationally grazed the same forage base as Experiment 1 for 126 d. Analyzed pasture samples were 10.6% Ash, 55% NDF, 36% ADF, 81% OM, 17.8% CP, 79% OMD, and provided 2.73 mg P/g DM. In both experiments average forage availability was above 2100 kg DM/ha. Individual intake and P contribution from mineral mixture was calculated from measured group mineral intakes. Experiment 1 and 2 performance and mineral intake data were pooled for analysis. No significant differences (P<0.1) were detected for weight, average daily gain (TMDC=1.18 kg vs TM=1.20 kg), or mineral intake (TMDC=47.0 g/d vs TM=48.4 g/d). In Experiment 1, the mineral mixture provided 8% of the estimated daily phosphorus intake for TMDC steers. Supplemental phosphorus was not required for Holstein steers grazing mixed cool-season grass/legume pastures because the forage was providing phosphorus at 157% of recommended NRC levels.

Key Words: ruminant, phosphorus, supplement

249 Effect of Optaflexx on finishing steer performance, USDA Yield Grade, and USDA Quality Grade.

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Two thousand fifteen crossbred steers fed at a commercial feedyard in Larned, KS, were used to evaluate Optaflexx fed during the last 29 d prior to slaughter (total days fed = 94). Basal diets included 64.3% steam-flaked corn, 15.4% wet distiller's grain, 2.5% tallow, 5.5% haylage, 4% wheat middlings, 5.3% liquid supplement, and 3% dry supplement (DM basis). Feed additives, including Rumensin, Tylan, and Optaflexx, were added via a micro-ingredient machine. Treatments were control (CON; no Optaflexx) and Optaflexx (OPT; 200 mg/steer daily). Finishing diets were formulated (DM basis) to contain approximately 15% crude protein, 0.72% Ca, and 0.63% K, and were fed (3 times daily) using separate mixer trucks for each diet to prevent cross-contamination between treatments. At initial processing, cattle were sorted into treatment groups; initial BW were 518 and 524 $\pm$ 2 kg ($P = 0.13$) for CON and OPT, respectively. Data were analyzed using SAS GLM, with model effects of treatment and block, and pen as the experimental unit (8

pens/treatment). Compared with the CON diet, feeding OPT yielded increases in final live BW, hot carcass weight (HCW) adjusted final BW, live BW gain during Optaflexx feeding (43 vs 49 ± 1 kg for CON vs OPT, respectively), ADG, and gain efficiency during the Optaflexx period ($P < 0.05$). Optaflexx increased HCW and HCW gain (HCW gain = HCW - Initial BW*0.635; $P < 0.02$). CON steers had a greater percentage of USDA Yield Grade 2 carcasses ($P = 0.02$; 54.8 vs 49.6 ± 1.3%, respectively) and a lower percentage of Yield Grade 4 carcasses ($P = 0.05$; 1.7 vs 3.3 ± 0.5%, respectively) compared to OPT. Optaflexx had no effects ($P > 0.24$) on dressing percent or the proportion of carcasses grading USDA Choice (35.8 vs 36.3 ± 1.7% for CON and OPT, respectively). Feeding Optaflexx at 200 mg/d during the last 29 d prior to slaughter improved live BW gain 16% and HCW gain 17% without affecting quality grade.

Key Words: Optaflexx, Steers, Finishing

250 Relationship of feeding behavior to feed efficiency in crossbred Angus steers fed a no roughage diet.

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A study was conducted to determine the relationship between feed efficiency and feeding behavior of feedlot steers fed a no roughage diet. The hypothesis was that efficient and inefficient steers would not differ in feeding behavior. Crossbred Angus steers (n=40) were fed ad libitum and individual intakes were recorded by GrowSafe®. Recorded intakes were used to calculate residual feed intake (RFI), a measure of efficiency. RFI values were calculated 4 consecutive months, and from these data 17 steers were identified as efficient or inefficient. Average RFI values for the efficient (-0.83; n=9) and inefficient steers (0.78; n=8) as well as F:G differed ($p< 0.05$). Both groups gained at the same rate (1.5 kg/d) throughout the experiment, however average daily intake (7.40 kg vs. 8.94 kg) and average eating bouts/day (14.54 vs. 17.64 visits) differed ($p< 0.06$) with efficient steers consuming less feed and eating fewer times/day. Average grams eaten per minute (GPM) throughout the day did not differ ($p> 0.10$) between groups. Time of day eating bouts occurred was divided into eight periods (1,2,3,4,5,6,7 and 8). Each period was 3 hrs in length with period 1 occurring from 12-3a.m., and each remaining period following consecutively in 3-hr time blocks. Most consumption occurred in periods 3-7. Intakes by efficient and inefficient steers in periods 3,4 and 6 differed ($p< 0.10$). Total period intakes by efficient steers in periods 3,4 and 6 did not differ ($p> 0.10$), but were higher than the intakes in periods 5 and 7. Period intakes for inefficient steers were more variable. Period 6 intake was higher ($p< 0.05$) than the intakes for periods 3,4,5 and 7. Consumption by inefficient steers in periods 3 and 4 did not differ and were higher ($p< 0.10$) than consumption in periods 5 and 7. The amount consumed in period 5 was higher ($p< 0.10$) than period 7 consumption. Other than periods 2,3 and 4 there were no differences ($p>0.10$) in the GPM within period between groups, suggesting that capturing time spent eating at the bunk, combined with ADG data, could be used to identify efficient animals.

251 Degradable intake protein in finishing diets containing dried distiller's grains.

K. Vander Pol*, G. Erickson, and T. Klopfenstein, *University of Nebraska*.

Fifty-eight crossbred yearling heifers (BW = 383 ± 25 kg) were utilized in a completely randomized 2x2 factorial arrangement of treatments designed to evaluate the effects of finishing diets containing dried distiller's grains supplemented with degradable intake protein on feedlot performance and carcass characteristics. Dietary treatments contained 10 or 20% dried distiller's grains (DDG) replacing corn, with or without 0.80 or 0.63% urea (DM basis). Basal dietary ingredients consisted of dry-rolled corn, 5% ground smooth bromegrass hay, 5% molasses, and 4% dry supplement (DM basis). DIP balances (NRC, 1996) were -192 (10% DDG no urea), 58 (10% DDG + urea), -111 (20% DDG no urea) and 81 (20% DDG + urea) g/d, and all diets had positive metabolizable protein (MP) balances. Heifers were individually fed utilizing Calan electronic gates, implanted on d 26 with Revelor-H , and slaughtered on d 100 at a commercial abattoir. Further, an aliquot of blood was collected on d 28, 72, and 100, for subsequent blood urea nitrogen (BUN) analysis. No significant differences ($P > 0.05$) were observed for the main effects or interaction on any performance or carcass parameter, with sufficient performance being observed (DMI = 11.1 kg/d; ADG = 1.63 kg/d; G:F = 0.147 kg/kg). Within each sampling date, as well as the average of each heifer's BUN across all sampling dates, there were significant differences ($P < 0.05$) for the main effect of both level and urea. Heifers receiving urea had significantly higher ($P < 0.05$) BUN values than heifers not supplemented with urea. Similarly, heifers fed the 20% DDG diets had significantly higher ($P < 0.05$) BUN values than heifers receiving the 10% DDG diets. In addition, heifers on all treatments had significantly higher ($P < 0.05$) BUN values as time on feed increased. These data indicate excess MP (i.e., when DDG is included) in diets deficient in DIP is adequate enough to supply additional DIP needed in the rumen to maintain performance.

Key Words: Corn, Distiller's grains, Finishing cattle

252 Effects of supply of excess amino acids on methionine utilization by growing steers.

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Six ruminally cannulated Holstein steers (205 kg) were used in a 6x6 Latin square to study effects of excess N supply from supplemental AA on methionine (Met) utilization. All steers received a soyhull-based diet at 2.8 kg/d DM, ruminal infusions of 200 g/d acetate, 200 g/d propionate, and 50 g/d butyrate, abomasal infusion of 300 g/d glucose, as well as abomasal infusion of an AA mixture (238 g/d) containing glutamate, glycine, and all essential AA except Met. Treatments were abomasally infused and arranged as a 2x3 factorial with two levels of Met (0 or 4 g/d) and three AA supplements (no additional AA, control; 100 g/d nonessential AA + 100 g/d essential AA, NEAA+EAA; and 200 g/d essential AA, EAA). Periods were 6 d, with 2-d adaptations and 4 d for fecal and urine collection. Met increased ($P<0.05$) retained N from 17.3 to 26.3 g/d and decreased ($P<0.05$) urinary N from 66.1 to 57.3 g/d and urinary urea from 51.5 to 44.6 g/d. NEAA+EAA decreased N retention when no Met was supplemented, but numerically increased it when 4 g/d Met was supplemented. In contrast, EAA decreased retained N at both Met levels (Met x AA interaction, $P=0.11$). Supplementation with NEAA+EAA or EAA increased ($P<0.05$) plasma urea and urinary urea excretion regardless of supplemental Met. Serum insulin increased ($P<0.05$) with EAA or NEAA+EAA. Serum IGF-1 and plasma glucose were not affected by treatment. Excess N supply from EAA or NEAA+EAA decreased protein deposition by steers when no Met was supplemented, but, when 4 g/d Met was supplemented, excess N supply from EAA, but not from NEAA+EAA, reduced N retention. The lack of a consistent response for EAA and NEAA+EAA suggests that excess α-amino N may not be the primary factor influencing Met utilization. Rather, these observations may result from an AA imbalance induced by both AA supplements when no Met was supplemented, but only by EAA when 4 g/d Met was provided.
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Key Words: Amino Acids, Methionine, Utilization

253 Effect of intake restriction on diet digestion, ruminal fermentation, and passage rate by beef steers.

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British X steers (n = 12; BW = 445 + or - 56 kg) were used to evaluate the effects of intake restriction on diet digestion, ruminal fermentation, and passage rate in a completely random design. Treatments consisted of 2 diets that were formulated to promote a 1.6 kg ADG at intake levels corresponding to approximately 100% (AL) or 80% (IR) of ad libitum intake. Both diets delivered similar total NE and MP per day. The daily amount of feed offered to each treatment group was determined according to the previous 5-d average intake for steers on the AL treatment. Actual DMI during the trial, as a percent of average BW, was 1.94% for AL and 1.61% for IR (83% of AL). Digestion of DM by IR steers was greater ($P < 0.01$) than by AL steers (76.8 vs. 69.5%, respectively). Fluid dilution rate was similar ($P > 0.05$) between treatments; however, passage rate of Yb-labeled corn was more rapid ($P < 0.01$) in IR steers (11.2 %/h) than AL steers (4.4 %/h). Treatment effects on ruminal ammonia concentration and ruminal pH varied with sampling time (treatment x time interaction; $P = 0.01$). Steers on the IR treatment had greater (main effect; $P < 0.01$) total ruminal VFA concentration (106.9 mM) than AL steers (85.8 mM). The average molar proportion of acetate was higher (main effect; $P = 0.03$) in AL steers compared to IR steers (61 and 58%, respectively). Conversely, IR steers had a greater

(main effect; P = 0.03) average molar proportion of propionate than AL steers (27 and 24 %, respectively). Molar proportions of butyrate, isobutyrate, valerate, and isovalerate were not affected (P > 0.05) by diet. Steers limited to 80% of ad libitum DMI but not restricted in terms of NE or MP intakes had greater DMD, total ruminal VFA concentration, and particulate passage rate than steers fed ad libitum.

Key Words: Intake, Passage rate, Fermentation

254 Effects of intake restriction on energy balance and retention of N and P by beef steers. T. B. Schmidt*, K C Olson, M. L. Linville, J. H. Clark, C. A. Stahl, D. L. McNamara, G. K. Rentfrow, and E. P. Berg, *University of Missouri-Columbia*.

Twelve Angus X steers (BW = 440 + 21kg) were used to evaluate the effects of intake restriction on energy balance and retention of dietary N and P in a completely random design. Treatments consisted of 3 diets that were formulated to promote a 1.6 kg ADG at DMI levels corresponding to approximately 100% (**AL**), 90% (**IR90**), or 80% (**IR80**) of ad libitum DMI. All diets delivered similar total NE, MP, and P per day. The daily amount of feed offered to each treatment group was determined according to the previous 5-d average intake for steers on the AL treatment. Actual DM intakes during the trial, as a percent of average BW, were 2.55% for AL, 2.38% for IR90 (93% of AL), and 2.02% for IR80 (79% of AL). Fecal energy loss was greater (P < 0.01) for AL and IR90 steers compared to IR80 steers. Moreover, there was a trend for urinary energy loss by IR80 steers to be higher (P < 0.12) than that of AL and LF90 steers. Gross energy digestion by IR80 steers was greater (P < 0.01; 78.1%) than AL and IR90 steers (70.3 and 68.7%, respectively). Measured dietary ME of IR80 steers was 22% higher (P < 0.01; 3.53 Mcal/kg) than AL steers (2.89 Mcal/kg); IR90 steers measured ME was intermediate (2.99 Mcal/kg). Conversely, total ME intake was similar (P > 0.19) across treatments. Total fecal N (% of intake) of AL and IR90 steers was greater (P < 0.01) than IR80 steers; however, total fecal P (% of intake) was not different between treatments. Total urinary N (% of intake) of IR 80 steers was greater (P = 0.02) than that of AL and IR90 steers, whereas total urinary P (% of intake) was unaffected by treatment. Apparent retention of N (% of intake) by AL and IR90 steers tended to be greater (P = 0.06) than that of IR80 steers. There were no differences in apparent retention of P (% of intake) among treatments. Results were interpreted to indicate that steers limited to 80% of ad libitum DMI but not restricted in terms of NE or MP intakes had dietary ME density greater than that predicted by NRC models but total ME intakes similar to cattle fed ad libitum.

Key Words: Intake, energy metabolism, nutrient retention

255 Effects of concentrate level of diet and pen configuration on performance and prevalence of *Escherichia coli* O157 in finishing goats. J. T. Fox*, M. E. Corrigan, J. S. Drouillard, E. R. Loe, B. D. Depenbusch, and T. G. Nagaraja, *Kansas State University*.

Boer goat kids (n = 181; initial BW = 16.8 kg) from native pastures in southeast Kansas were transported to the KSU Beef Cattle Research Center and used in an experiment to evaluate growth performance and prevalence of *E. coli* O157 when fed diets containing 50, 70, or 90% dry-rolled corn based concentrate. Goats were blocked into heavy and light BW groups and randomly assigned, within block, to feedlot pens (4.3 m X 4.3 m) containing 15 or 16 animals each. A 2 x 3 factorial arrangement of treatments was used, with factors consisting of concentrate level and pen configuration. Goats were housed in pens with concrete floors, and a large concrete block (45 cm X 75 cm X 150 cm) was placed into the center of 6 of the 12 feedlot pens, thus providing two different pen configurations. Goats were fed ad libitum twice daily for 126 d. Fecal samples were collected on d 0, 20, 34, 55, 83, and 105 and analyzed for *E. coli* O157. Isolation and identification of *E. coli* O157 from fecal samples was by selective enrichment, followed by immunomagnetic separation and plating on cefixime, tellurite, sorbitol MacConkey Agar. Sorbitol-negative colonies that were positive for indole production, positive for agglutination for O157 antigen, and speciated by API test were classified as *E. coli* O157. ADG was greatest for goats fed 70% concentrate (quadratic effect, P < 0.05). DMI increased and gain:feed decreased linearly (P < 0.05) as the level of concentrate in the diet increased. Ten goats died or were euthanized due to the development of urolithiasis. Of these, 8 were fed the intermediate level of concentrate. Presence of the concrete block did not affect final BW, ADG, or gain:feed (P > 0.10), but DMI tended (P < 0.10) to be lower for goats that had access to concrete blocks in their pen. Prevalence of *E. coli* O157 across all treatments and sampling days was 4.6%, but no differences (P > 0.10) were apparent for the different pen configurations or diet concentrate levels.

Key Words: Finishing, Goats, *E. coli*

256 The effect of eicosapentaenoic acid and docosapentaenoic acid on vaccenic acid formation in cultures of mixed ruminal microorganisms. A. AbuGhazaleh* and B. Jacoboson, *Southern Illinois University, Carbondale*.

Previous study showed that docosahexaenoic acid (C22:6n3, DHA) was the active component in fish oil that promotes vaccenic acid accumulation when incubated with linoleic acid. The objective of this study was to determine whether eicosapentaenoic acid (C20:5n3; EPA) and docosapentaenoic acid C22:5n3; DPA), an omega-3 fatty acids in fish oil, can also promote vaccenic acid accumulation using cultures of mixed ruminal microorganisms. Treatments consisted of control (T1), control plus 30 mg of sunflower oil (T2), control plus 5 mg EPA (T3), control plus 5 mg EPA plus 25mg SFO (T4), control plus 5 mg DPA (T5), and control plus 5 mg DPA plus 25mg SFO (T6).Treatments were incubated in triplicate in 125-ml flasks, and 5 ml of culture contents was taken at 0 and 24 h for fatty acid analysis by gas-liquid chromatography. After 24 h of incubation, the level of vaccenic acid (10.5, 3.5, and 3.4 mg/culture) increased (P < 0.05) with T2, T3 and T5, respectively, compared with T1 (2.7 mg/culture) and was highest with T2. Combining EPA and DPA with sunflower oil (T4 and T6) resulted in no further increase (P > 0.05) in vaccenic acid (10.2, 10.1 mg/culture, respectively) compared with T2 (10.5 mg/culture) indicating that EPA and DPA are not the active components in fish oil that promote vaccenic acid accumulation. In DPA cultures, the level of C22:3, EPA, and C20:3 increased (P < 0.05) after 24 h of incubation which may indicate that the disappearance of DPA from cultures may have been caused in part by biohydrogenation of double bond and shortening of the carbon chain. The level of C20:3 in EPA cultures also increased (P < 0.05) after 24 h of incubation.

Key Words: Eicosapentaenoic acid, Docosapentaenoic acid, Vaccenic acid

257 Evaluation of performance and carcass quality of finishing beef with natural feeding practices in North Dakota. V. Anderson and J. Schoonmaker*, *North Dakota State University*.

One hundred twenty eight crossbred steers (initial BW 254.3 ± 18.6 kg) were used to determine the effect of natural feeding practices on steer performance, carcass characteristics and cost of production. Cattle were allotted by weight and source to one of 4 diets: a conventional 85% concentrate diet containing Rumensin® (Elanco, Greenfield, IN) at 0.017% of diet DM (C85), or 3 natural diets (85, 70, and 55% concentrate) containing Bovi-Sacc® (Alltech; Nicholasville, KY) at 0.27% of the diet DM (N85, N70, and N55; respectively). Cattle were fed in 16 open drylot pens (8 steers per pen; 4 pens per treatment), and were slaughtered when BW for the treatment was estimated to be 533.5 kg. Slaughter weight did not differ among treatments (P > 0.40). Steers fed the C85 and N85 diets spent the least (P < 0.01) amount of time in the feedlot (154 d), and gained the fastest (P < 0.01) overall (1.39 and 1.33 kg/d, respectively). Steers fed the N55 diet spent the most amount of time in the feedlot (210 d), and gained the slowest (1.03 kg/d) overall. Cattle fed the N70 diet spent an intermediate amount of time in the feedlot (180 d) and gained 1.14 kg/d. Steers fed the N55 diet consumed the most DM/d (P < 0.03) and were the least efficient (P < 0.01). Steers fed the N85 diet consumed the least DM/d. Cattle fed the N85 and C85 diets were the most efficient (P < 0.01). Hot carcass weight did not differ among treatments (P > 0.15). Marbling score tended to be (P = 0.06), and fat thickness was (P < 0.01) greater for cattle fed the C85 and N85 diets. Rib-eye area tended (P = 0.07) to be greatest for cattle fed the N85 diet and lowest for cattle fed the N55 diet. Yield grade tended (P = 0.06) to be greatest for cattle fed the C85 diet, and lowest for cattle fed the N70 diet. Cost per head per kg of gain was 0.79,0.83, 0.94, *and*0.98 for cattle fed the C85, N85, N70, and N55 diets, respectively. To profitably raise beef without antibiotics, producers need alternatives to keep their animals healthy. Bovi-Sacc was effective in the

85% concentrate diet; however a modest premium would be required to offset increased feed and yardage costs.

Key Words: Beef, Natural

258 Effect of corn hybrid on digestibility and ruminal fermentation. M. Luebbe*[1], G. Erickson[1], T. Klopfenstein[1], and W. Fithian[2], [1]*University of Nebraska-Lincoln,* [2]*J. C. Robinson Seed Co.*

Seven ruminally cannulated heifers (BW = 512 ± 11 kg) were used in a 7x7 Latin square to determine nutrient digestibility and ruminal fermentation of seven hybrids (H-8562, 1; H-9533, 2; H-9164, 3; 33P67, 4; 33B51, 5; H-9235, 6; and H-9230, 7) with different kernel characteristics. Dietary treatments were 68.5% corn hybrid, 20% wet corn gluten feed, 7.5% alfalfa, and 4% supplement. Results from a previous feedlot performance study indicate that hybrid 1 was the most efficient (G:F 0.185) with the softest kernel traits and 7 the least efficient (G:F 0.169) with the hardest kernel. Stenvert hardness tests of time to grind, % of soft height, and others were conducted. Hybrids 2, 3, 4, 5, and 6 were intermediate for kernel hardness and feed efficiency. In the current digestibility study, periods were 14 d, with a 9 d adaptation, and 5 d collection of feces, continuous pH, and intake. Ruminal fluid samples were taken on d 14 of each period at 0, 2, 4, 6, 8, 10, and 12 h post-feeding. There were no differences ($P > 0.20$) for intake behavior among hybrids. Heifers consumed an average of 9.8 kg DM in 7.2 meals with 600 minutes of total time spent eating. Total-tract OM and starch digestibilities were not different ($P > 0.10$) among hybrids and averaged 77.9% and 95.1%, respectively. pH measurements were not influenced ($P > 0.10$) by hybrid. Hybrid 7 had the lowest ($P < 0.01$) total VFA concentration, a lower ($P = 0.01$) propionate concentration, and the highest ($P < 0.01$) acetate: propionate ratio compared to other hybrids. Propionate production was not significantly correlated to feed efficiency but was related to physical measurements. Propionate production was correlated ($P < 0.05$) to the Stenvert time to grind ($r = -0.84$). Differences found in performance could be due to more propionate production in the rumen.

Key Words: Corn hybrid, Beef cattle, Rumen digestion

259 Selection of bactericidal peptides against *E. coli* O157:H7 by phage display technology. C. J. Fu*, F. J. Schmidt, and M. S. Kerley, *University of Missouri.*

Bactericidal peptides were selected from phage displayed f88-4/15-mers random peptide library against two strains of pathogen *E. coli* O157:H7 (isolated from a human clinic case and ground beef, PA 1 and PA 2). After 4 rounds of affinity selection, 40 phage clone (PC) bearing colonies from each pathogen selection were picked up, amplified, and purified (total 80 phage clones: PC 1 to 80). Each phage clone has a kind of recombinant 15-mers peptide sequence on its PVIII coat protein. These phage clones were used to test the inhibiting or killing effects against PA 1 and PA 2 on lawn agar plates. The results indicated that 5 out of 40 clones showed inhibiting or killing effects against PA 1 and 3 out of 40 showed inhibiting or killing effects against PA 2. Some of the clones can inhibit or kill both pathogens. From this experiment, functional clones were screened for their inhibiting or killing effects against PA 1 and PA 2. These clones will be sequenced to check their identities from each other and the DNA sequence that the peptide coded will be determined. These codes can then be used to produce potential bactericidal peptides that could be beneficial to animal and human health for pre- and post-harvest food safety application. We concluded from this study that the phage display technology can be used to discover novel bactericidal peptides against pathogenic bacteria.

Key Words: *E. coli* O157:H7, Peptide, Phage display

260 The effects of saponified fatty acids on ruminal fermentation. D. O. Alkire* and M. S. Kerley, *University of Missouri-Columbia.*

Five steers (430 kg), fitted with rumen fistulas and duodenal cannulae were used to determine the effects of saponified fatty acids on ruminal fermentation. A digestion study, designed to be a 5 x 5 Latin square, was conducted to evaluate five dietary treatments: 1) negative control (CON), no added fat; 2) positive control (SO), soybean oil; 3) calcium salts of soybean oil (CAS); 4) calcium salts of fish oil (CAF); and 5) magnesium salts of soybean oil (MGS). All fat supplements were fed to provide approximately 2 % EE of the total diet. All animals received a basal diet (1.3 % BW, 5.7 % EE) consisting of 89 % corn, 6.6 % fish meal, and sufficient minerals to meet or exceed NRC recommendations. Animals were fed twice daily (2.73 kg at 0800 and 2.73 kg at 2000) at restricted intakes. Periods consisted of seven days with samples taken on day five, six, and seven. There were no differences in dry matter or EE digestibility in the rumen or total tract ($p > 0.05$). Percent rumen dry matter digestibility was 76.8, 73.8, 73.8, 74.1, 72.9 for CON, SO, CAS, CAF, and MGS, respectively. Percent rumen and total tract EE digestibility was 69.4 and 95.6 for CON, 71.1 and 95.9 for SO, 67.8 and 95.0 for CAS, 74.2 and 96.4 for CAF, and 68.0 and 95.8 for MGS. The rumen ammonia and VFA concentrations, pH, and microbial efficiencies were similar ($p > 0.05$) among treatments. We concluded that the saponified fatty acids used in this trial did not adversely affect ruminal fermentation.

Key Words: Rumen protected fat, Beef cattle

261 Effect of housing, initial weight and season interaction on feedlot performance of steers. H. Koknaroglu[1], D. D. Loy[2], D. E. Wilson[2], M. P. Hoffman*[2], and J. D. Lawrence[2], [1]*Suleyman Demirel University,* [2]*Iowa State University.*

Close-out information generated by Iowa State University Feedlot Performance and Cost Monitoring program submitted from January 1988 through December 1997 by Iowa cattle producers to Iowa State University was examined to determine the effect of housing, initial weight and season interaction on beef steer performance. Close-out information consisting 1225 pens of steers included information on start and end date, cattle per pen, sex, housing type, days on feed, initial and sale weight, feed conversion (FC), proportion of concentrate, ADG, percent death loss, feed cost and total cost per cwt gain, breakeven sale price, non-feed variable cost, non-feed fixed cost and corn price. Daily dry matter intake (DMI) was not provided but was calculated as DMI = ADG x FC. Starting date on feed was used to assign pens to seasons. Since cattle were fed for an average of 160 days, overlapping of seasons occurred. Since cattle started on feed in spring were finished in end of summer they were exposed to warmer portion of the year and cattle started on feed in fall were finished in end of winter and they were exposed to colder portion of the year and cattle started on feed in summer and winter they were finished in end of fall and spring, respectively, and were exposed to cooler portions of the year. Steers weighing less than 318, between 318 and 363 and more than 363 kg were classified as light, intermediate and heavy cattle. Cattle housed outside with access to overhead shelter had higher ADG than those housed in confinement and in open lot in cool season ($P<.04$). In general, cattle in confinement had lower DMI than those housed outside with shelter and in open lot ($P<.02$) regardless of season. Lighter cattle had a higher ADG ($P<.05$) in warm season whereas heavier cattle had a lower ADG ($P>.10$) in warm season. Cold and warm seasons affected DMI of lighter and heavier cattle more, respectively. Heavier cattle housed in confinement had lower ADG than those housed outside with shelter and in open lot ($P<.02$). Heavier cattle were less efficient than lighter and intermediate cattle regardless of housing.

Key Words: Housing, Initial weight, Season

262 Influence of increasing ME intake on nutrient utilization by beef steers consuming alfalfa hay. P. E. F. Prohmann[2,1], E. S. Vanzant*[1], K. R. McLeod[1], D. L. Harmon[1], N. A. Elam[1], and W. G. Doig[1], [1]*University of Kentucky,* [2]*Universidade Estadual de Maringa.*

Eight Angus steers (407 kg), fitted with ruminal, duodenal, and ileal cannulas were used in two 4 x 4 Latin squares to study the effects of level of ME intake from alfalfa hay on nutrient utilization. Treatments consisted of alfalfa hay (17.3% CP, 52.8% NDF, 35.7% ADF; DM basis) fed at 0.105, 0.127, 0.151, and 0.174 Mcal ME/kg $BW^{0.75}$. Experimental periods were 35 d in length, with 21 d of adaptation, 7 d of urine and feces collection, 5 d of digesta collection and 2 d of rest. In addition, indigestible NDF (INDF) and ADF (IADF) were evaluated for use as internal markers, following a procedure that included acid/pepsin

pretreatment of hay and fecal samples and 7 days of *in situ* incubation. OM digestibility decreased linearly (P = .10) with increasing intake (67.2, 65.3, 65.9, and 64.5 ± .90%, respectively). However, energy digestibility (62.1%) and NDF digestibility (60.4%) were not affected (P #8805 .11 and P #8805 .32, respectively) by treatment. Retained N (10.9, 19.7, 21.9, and 24.0 ± 3.72 g/d, respectively) and total VFA concentrations (98.0, 99.6, 105.5, and 104.6 ± 2.71 mM, respectively) increased linearly (P #8804 .05) with intake. Molar proportions of acetate (68.6%), propionate (17.5%), butyrate (8.7%), and valerate (1.7%), and acetate:propionate (3.98) were not affected by treatment (P #8805 .12). Inverse relationships were observed between intake and molar proportions of isobutyrate (Linear; P = .07; 1.59, 1.51, 1.55, and 1.40 ± .06%) and isovalerate (Linear; P < .01; 2.06, 1.95, 1.90, and 1.80 ± .06%). Ruminal pH (6.72) was not affected (P = .70) by intake. Ruminal OM fill responded cubically (P < .01) whereas liquid fill increased linearly (P < .01) with intake. Recoveries of INDF and IADF were incomplete (73.6 and 72.9%, respectively) and were not affected (P #8805 .27) by treatment. Between ME intakes of .10 and .17 Mcal/kg $BW^{0.75}$, N retention increased linearly whereas OM digestibility and molar proportions of branched-chain VFA decreased linearly. These data provide the framework for our efforts to describe the relationship between forage ME intake and N assimilation from forage protein.

Key Words: Metabolizable Energy, Forage Protein, Digestibility

263 Fatty acid changes in the digestive tract of Holstein steers fed canola supplemented dairy lactation diets.

S. Bedgar*, J. Schroeder, M. Bauer, and W. Keller, *North Dakota State University*.

Fifteen cannulated Holstein steers averaging 399 ± 21.7 kg initial body weight (BW) were stratified by BW and assigned to treatments in a completely randomized design to evaluate the effects of feeding ground canola seed on change in fatty acid flow. Diets containing 0, 6.1, and 12.2% of the total ration dry matter (DM) as ground canola seed were offered ad libitum. Rations were formulated to represent high production lactation diets and were isonitrogenous and equivalent to 1.74 Mcal of net energy per kg of DM. The control diet was composed of corn silage, ground corn, alfalfa, soybeans, canola and blood meal, vitamins, minerals, and chromic oxide as an external marker. Corn grain and canola meal were reduced as ground canola seed (39.6% lipid, DM basis) was added to the diets. Steers were acclimated to treatment for 25 d prior to collections. Duodenal and ileal samples were taken to represent every 1.5 h in a 12 h period from d 29 through 31. Rumen fluid samples were taken at 0, 2, 4, 6, 8, 10, and 12 h post-feeding. Dacron^{TM} bags, each containing 5 g ground canola were incubated in the rumen for 0, 2, 4, 8, 12, 16, 24, 36, and 48 h. Inclusion of ground canola seed did not significantly affect DM intake. Intake of total fatty acids ($P < 0.001$) and long-chain fatty acids ($P < 0.001$) increased linearly with increasing canola in the diet. Flow of fatty acids increased to the duodenum ($P = 0.04$) and ileum ($P = 0.01$) and rate of oil disappearance decreased ($P = 0.03$) linearly as canola was added to the diet. Diets that contained 6.9% lipid with up to 4.2% added lipid from ground canola seed did not alter the rate, site, or extent of digestion of DM, organic matter, fiber, and crude protein. These data suggest that ground canola can be used as an ingredient to increase the flow of fatty acids to the small intestine without negatively affecting digestion and ruminal fermentation.

Key Words: Canola, Digestibility, Fatty acid

264 Influence of a concentrated live yeast as a supplement for newly received calves.

J. C. Silva* and L. W. Greene, *Texas Agricultural Experiment Station*.

An experiment was conducted to determine the influence of concentrated live yeast (P7) <Saccharomyces/i> <cerevisiae/i> on health and feedlot performance of newly received calves. Three hundred crossbreed calves from New Port, Tennessee, with an average initial shrunk BW of 206 kg were received at the Texas Agricultural Research and Experiment Station feedlot at Bushland, TX, in May 2004. Cattle traveled for approximately 19 hours by a standard double deck trailer. Upon arrival cattle were immediately sorted, randomly assigned to pens, fed alfalfa hay <ad/i> <libitum/i> and 1 kg/head of a high roughage diet. Animals were allowed to rest and co-mingle within their pen until the following day prior to processing. A high roughage diet (5.75 kg/d) consisting of 36% steam flaked corn, 59% roughage, and 5% protein/vitamin mineral supplement were daily fed at 0800 h. Dietary treatments consisted of a basil diet with and without P7. Animals assigned to yeast treatment, consumed 10 g/head/d of P7. The P7 was top-dressed on the control ration after feed was delivered to the feedbunk and mixed by hand. Processing animals on d 1 consisted of an assessment of overall health, individual identification, record of rectal temperature, individual body weight, and breed. This procedure included emasculation, dehorn, vaccination and treatment for internal and external parasites. Castrated animals received 20 cc of penicillin. Calves were closely observed daily at 0700 for clinical signs of disease. Sick calves (anorexic, empty flanks, cough, nasal/ocular discharge, physical weakness, diarrhea and depression) were clinically reviewed and therapeutically treated. P7 significantly increased performance ($P < 0.05$), DMI, ADG and tended to increase ($P = 0.10$) gain:feed ratio over that of control diet. Calves' health evaluated by days head in hospital and heads in hospital did not significantly differ ($P > 0.10$). These data suggested that P7 improved performance and may improve health status of newly received feedlot calves.

Key Words: Calves, Stress, Yeast

265 Selenium supplementation of dairy cattle: Responses to organic and inorganic forms of selenium.

S. Elliott*, G. Harrison, and K. Dawson, *Alltech Biotechnology, Inc*.

The 2001 edition of the NRC defines the selenium requirement for all classes of dairy cattle as 0.3 ppm. Moreover, the FDA has set the legal limit for supplemental Se to dairy cattle at no greater than 0.3 ppm. Continuing problems with dairy cows, especially mastitis and reproductive disorders, suggest that current practices of Se supplementation may not be adequate. This is particularly true in areas where cattle are fed grains and forages naturally low in Se. Given the legal limits on supplemental Se, improving the Se status of dairy cattle can be challenging. Formulating rations using feeds with higher Se content can boost Se status in dairy cattle. However, this approach would require a consistent source of high Se feedstuffs and constant monitoring of Se content. A more practical approach to improving Se status is through the supplementation of high selenium yeast. Published research has shown Se from selenium yeast to be more available than Se in inorganic salts and more effective in increasing both blood and milk Se levels. Field trial results with Sel-Plex (Alltech, Inc.) confirm earlier university work indicating that a 20 to 30% increase in whole blood Se and an 80 to 100% increase in milk Se levels can be associated with selenium yeast supplementation. Incorporation of seleno amino acids into body proteins may help maintain Se status in the cow, but also improves the Se status of calves at birth. Field data have also reported reductions in cases of mastitis and lower somatic cell counts when supplementation strategies using selenium yeast are used. Limited data are available regarding reproductive performance, but preliminary results indicate that selenium yeast supplementation strategies may decrease the incidence of retained placenta resulting in less metritis and improved pregnancy rates. Total replacement strategies using organic Se in selenium yeast may not only address concerns associated with more toxic inorganic selenium salts but may also be necessary to realize the full benefits of improved selenium status.

Key Words: Selenium yeast, Minerals, Dairy

266 Feeding an alpha-amylase enzyme preparation to improve the clycemic status and performance of transition dairy cows.

J. M. DeFrain*[1], A. R. Hippen[1], K. F. Kalscheur[1], and J. M. Tricarico[2], [1]*South Dakota State University,* [2]*Alltech, Inc*.

Twenty-four multiparous Holstein cows (759 ± 30 kg body weight) were used in a randomized complete block design to determine the impact of feeding an alpha-amylase enzyme preparation during the transition period on rumen fermentation, key metabolic indicators, and lactation performance. Cows were assigned to either a control diet (**CON**) or the control diet supplemented with alpha-amylase enzyme (662 FAU/g fungal alpha-amylase; **AMA**) at 0.1% of diet DM. Experimental diets were fed from 21 d before expected calving through 21 days in milk (**DIM**). From 22 to 70 DIM, all cows were fed a similar lactation cow diet. Milk composition was analyzed at 7, 14, and 21 DIM. Blood was sampled at 21, 14, 7, and 2 d prepartum and 2, 7, 14, 21, and 28 DIM whereas rumen fluid was sampled 21 and 7 d prepartum and at 7 DIM. Liver tissue was sampled via biopsy at 7 and 14 DIM. Average pre- and postpartum

DMI were 12.4 and 17.8 kg/d, respectively, and did not differ between treatments; however, from wk -3 to wk -1 prepartum DMI increased in cows fed CON by 1.5 kg/d and decreased 1.8 kg/d in cows fed AMA (P = 0.03). Milk production and, with the exception of milk fat percent, composition were not affected by dietary treatments. Milk from cows fed CON tended (P = 0.13) to have a greater milk fat percent (4.78 vs. 4.18). Treatment differences were undetected for concentrations of insulin in plasma and lipid and glycogen in liver tissue. Concentrations of glucose (P = 0.07) and betahydroxybutyrate (P = 0.11) tended to be greater in cows fed AMA relative to cows fed CON across all time points. Prepartum plasma nonesterfied fatty acid concentrations were greater ($P < 0.01$) in cows fed AMA, but were not different postpartum. Cows fed AMA tended (P = 0.14) to have greater proportions of rumen butyrate prepartum but not postpartum. A tendency (P = 0.11) for increases in circulating plasma energy metabolites, the sum of betahydroxybutyrate and glucose, may place amylase-supplemented cows at an energetic advantage over unsupplemented controls.

Key Words: Amylase, Betahydroxybutyrate, Transition dairy cow

267 Effects of level and processing field peas in growing and finishing diets.

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The optimum level of field peas in growing rations was the objective of a winter growing trial. The cattle used in the growing trial were later used in a finishing trial where the objective was to evaluate processing (coarse rolling versus whole) of the peas fed at two different levels (15% and 30%). In the growing trial, 206 calves were randomly assigned to 20 pens and four treatments. Peas were fed at 0%, 8.8%, 17.5%, and 26.3% of diet DM, with peas replacing corn. All diets contained 69% corn silage and 5% supplement. The performance results are in the following table. Although numerical differences were small DMI increased significantly (Linear P = 0.006) while ADG and G:F were not different (P > 0.10). In the finishing trial the cattle were allotted to five treatments and 20 pens. Peas were fed either whole or dry-rolled with 0%, 15%, or 30% replacing corn. All diets contained 18% corn silage and 8% supplement. Diets were formulated so protein was not limiting in any of the diets. There were no significant differences among performance data or carcass characteristics (P > 0 .10) in the finishing trial. Based on these trials, cattle fed peas, gain similarly to the cattle fed corn and produce similar carcasses.

Levels of Peas (DM%)

	0%	8.8%	17.5%	26.3%
DMI, kg	8.23	8.21	8.3	8.37
adg, kg/d	1.41	1.38	1.39	1.48
G:F	0.172	0.168	0.168	0.177

Key Words: Field peas, Processing, Beef cattle

268 The impact of ruminal butyrate production and plasma betahydroxybutyrate on the glycemic status of transition cows.

J. M. DeFrain*, A. R. Hippen, K. F. Kalscheur, and D. J. Schingoethe, *South Dakota State University.*

Twenty-four multiparous Holstein cows (775 ± 24 kg body weight; 3.4 ± 0.11 body condition score) were used in a randomized complete block design to determine the impact of increased butyrate proportions from ruminal fermentation of lactose on key metabolic indicators and lactation performance during the transition period of late gestation and early lactation. Cows were assigned to either a corn-based control diet (**CON**) or a diet containing lactose at 15.7% of diet DM (**LAC**) at the expense of corn. Experimental diets were fed from 21 d before expected calving through 21 DIM. From 22 to 70 DIM, all cows were fed a similar lactation cow diet. Energy density and CP were 1.62 and 1.68 Mcal/kg and 14.3 and 18.1% for pre- and postpartum diets, respectively. Pre- and postpartum DMI averaged 12.8 and 17.7 kg/d, respectively, and did not differ between treatments; however, cows fed LAC did not esperience a prepartum decrease in DMI. Milk yields were unaffected by dietary treatments and averaged 45.7 kg/d during the first 70 DIM increasing numerically for LAC after 21 DIM. Plasma glucose and insulin increased for LAC during the last week prepartum ($P < 0.05$), and nonesterified fatty acids and BHBA increased for LAC during the first week postpartum ($P < 0.05$). Feeding LAC increased the molar proportion of ruminal butyrate both pre- (11.3 vs. 9.2 ± 0.45%) and postpartum (13.0 vs. 10.3 ± 0.67%), which led to increased plasma BHBA (6.1 vs. 4.2 ± 0.3 and 14.6 vs. 8.3 ± 1.7 mg/dL). Liver lipid content decreased (8.6 vs. 14.7 ± 1.5% of wet weight) in cows fed LAC relative to those fed CON while liver glycogen was unaffected by dietary treatments. Results from this research demonstrated that substituting lactose for corn in diets of transition dairy cows increases the proportion of butyrate in the rumen and in turn increases concentrations of BHBA in plasma. This increased ketone body production did not impact carbohydrate status and was associated with decreased severity of hepatic lipidosis.

Key Words: Lactose, Betahydroxybutyrate, Transition dairy cow

269 Wet sorghum distiller's grains with solubles in flaked corn finishing diets for heifers.

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A finishing trial was conducted using 637 yearling heifers (initial BW = 385 kg) to identify the optimum level of wet sorghum distiller's grains with solubles (WDGS) in finishing diets containing steam-flaked corn. Treatments consisted of diets containing 0, 8, 16, 24, 32, or 40% WDGS (DM basis). Heifers were placed into dirt-surfaced feedlot pens (25 to 30 heifers per, 4 pens per treatment) and fed once daily for 58 days. Average daily gains during the 58-d finishing period were 1.27, 1.41, 1.38, 1.31, 1.22, and 1.16 kg/day for cattle fed 0, 8, 16, 24, 32, and 40% WDGS, respectively (quadratic effect, P < 0.01). Dry matter intake decreased linearly (P < 0.01) as the level of WDGS was increased. Gain efficiency responded quadratically (P < 0.01) to WDGS addition (0.147, 0.154, 0.162, 0.151, 0.144, 0.139 for cattle fed 0, 8, 16, 24, 32, 40% WDGS, respectively). Animal performance data were used to compute net energy gain (NEg) values for each diet, yielding estimates of 1.54, 1.58, 1.67, 1.57, 1.52, and 1.49 Mcal/kg for diets containing 0, 8, 16, 24, 32, and 40% WDGS, respectively (quadratic effect, P < 0.03). Ribeye area and the percentage of USDA Yield Grade 1 carcasses decreased, and the percentage of Yield Grade 3 carcasses increased as the proportion of WDGS in the diet increased (linear effect, P< 0.05). Average USDA yield grade increased linearly (P < 0.02) in response to increasing concentrations of WDGS, but grid-based carcass values were not significantly different across dietary treatments. Based on these data, the optimum concentration of WDGS in flaked corn finishing diets is between 8 and 16% of the ration DM. Flaked corn finishing diets containing as much as 24% WDGS yielded efficiencies equal or superior to diets containing no distiller's byproducts.

Key Words: Finishing, Distiller's grains with solubles, Steam-flaked corn

270 Degree of starch availability: An index to define relative starch digestion potential in corn based feeds.

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A laboratory method, degree of starch gelatinization (DSG), used by the food industry to assess relative differences in starch characteristics of human foods was modified for application to livestock feeds. Because physical form and DM content of starch are of critical importance to ruminants the DSG assay was modified to accommodate feeds that were not ground nor dried. In addition corn feeds such as corn silage and high moisture corn are fermented and the DSG procedure is based on enzymatic hydrolysis of starch to glucose therefore additional buffer control within the assay was required because enzyme activity is pH specific. The modified assay, degree of starch availability (DSA), was used to evaluate relative starch availabilities of corn based feeds which differed in particle size, dry matter content and endosperm type. The DSA assay was used to evaluate particle size (370, 500, 640, 1100, 3140 and 4000 um) of corn which is known to influence starch digestion in ruminants. As particle size increased the DSA, % of starch, significantly decreased. For each 100 um increase in particle size the DSA decreased ($r^2 = 0.98$) 2.68 percentage units. The DSA assay was also used to evaluate high moisture corns which differed in DM content. For each percentage unit increase in DM content of high moisture corn, DSA decreased ($r^2 = 0.76$) 2.00 percentage units. Finally corns differing in vitreous endosperm (0-100 %) were evaluated using the DSA assay and the DSA assay was able to determine relative differences in starch availability with DSA values approximately 20.0 percentage units higher (% of starch) for corns containing no vitreous endosperm as compared to corns containing 100.0 %

vitreous endosperm. While no corollaries exist between in vivo starch digestion and DSA the DSA assay has the potential to refine prediction of starch digestion characteristics in corn based feeds.

Key Words: Starch, Availability, Vitreous

271 Economics of wet distillers grains use in feedlot diets.

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A summary of current and past research trials utilizing different levels of wet distillers grains plus solubles (WDGS) in finishing diets indicate an increased energy value of WDGS compared to the corn replaced. Further, these data demonstrate that at higher levels of WDGS dietary inclusion, the energy advantage is less than that of lower inclusions (y = -0.96x + 167, where x = inclusion rate, % of DM), however, it still appears favorable. With WDGS typically priced at 90-95% of current corn price at the ethanol plant, the cost/unit of energy is much lower than that of corn; however, there are other factors that may affect the quantity utilized in feedlot diets. Factors that may inflate the price of WDGS compared to corn purchased within close proximity of a feedlot may be; demand for corn in close proximity to an ethanol plant may increase corn price, distance from plant to feedlot, shrink, and an overall increased cost in delivering feed to the bunk. Return from feeding WDGS ($/hd) is positive, and follows a quadratic pattern as level of WDGS in diet increased, with higher levels (30-40% DM) being more profitable than lower levels (10-20% DM). However, as distance from the ethanol plant increased up to 170 km, return ($/hd) was reduced significantly for all levels, and favored a lower level of inclusion (20-30% DM). Considering cost of feeding (mixing and delivering feed to bunk), incorporating WDGS in the diet increased feeding cost (for 100 d on feed) from $0.53/steer when WDGS was fed at 10% of DM, to $4.03/steer when fed at 50% of DM. Our data suggest that because of the higher energy value of WDGS compared to that of corn, it is economical to utilize WDGS at levels as high as 40% of DM. Further, the economic limitations of a higher inclusion rate of WDGS may be distance from plant, corn price at plant, and feed delivery costs. Overall, it is evident that producers need to examine more than just the price of WDGS, to make decisions on a dietary inclusion rate.

Key Words: Economics, Distiller's grains, Cattle

272 Impact of alfalfa hay neutral detergent fiber concentration and digestibility on Holstein dairy cow performance.

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The objective of this study was to determine the effect of alfalfa fiber concentration and digestibility on dairy cow performance by selecting four alfalfa hays representing two concentrations of neutral detergent fiber (NDF); each with a high and low in vitro 48-h NDF digestibility (NDFD). Twenty Holstein dairy cows, averaging 193 d in milk and 31 kg of milk/d were randomly assigned to four treatments composed of 95.8% treatment hay and 4.2% molasses (dry matter basis). Cows were transitioned from 76.5% forage: 23.5% concentrate diet to the treatment diets over a 20-d period. Treatment diets were fed for 11 d before data collection occurred from d 12 to 18. Low NDF hays had approximately four percentage units less fiber than high NDF hays. Within both NDF hay pairs, NDFD of the more digestible hay was about three percentage units greater. For cows fed the low NDF hays there was no difference in dry matter intake (DMI); however, between the high NDF hays those cows fed the high NDFD hay consumed more DM as compared to cows fed the low NDFD hay. Yield of 4% fat-corrected milk (FCM) was similar for all hays except for a reduction in FCM for the high NDF, high NDFD hay compared to the two low NDF hays. Milk fat, true protein and lactose content were not affected by hay NDFD or NDF. Although the alfalfa hays contributed 95% of dietary dry matter, the differences in fiber concentration and digestibility were insufficient to impact intake, or milk yield and composition.

Treatment[1]	**LH**	**LL**	**HH**	**HL**		
NDF	37.2	36.4	41.7	40.8		
NDFD	41.3	37.9	44.6	41.1		
Item					**P-value[2]**	**SE**
DMI, kg/d	17.4^{ab}	22.2^{a}	19.6^{a}	13.1^{b}	.03	2.6
FCM, kg/d	21.0^{a}	20.7^{a}	16.7^{b}	18.1^{ab}	.02	.97
Fat, %	3.7	3.8	3.7	3.8	NS	.23
True Protein, %	3.1	3.1	3.0	3.1	NS	.11
Lactose, %	4.5	4.6	4.5	4.5	NS	.09

[1] low NDF, high NDFD (LH); low NDF, low NDFD (LL); high NDF, high NDFD (HH); high NDF, low NDFD (HL), [2] NS = (P<.05)

Key Words: NDF, Alfalfa, Digestibility

Teaching and Career Development

273 Using online tools as supplements in large lecture classes.

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Course web pages and other online tools can enhance learning in large lecture classes. Such tools provide an additional mode of communication between instructor and student. Students that are uncomfortable asking questions in large lectures or meeting with faculty in person may prefer communication via e-mail, message boards or chat rooms. Written electronic communication is more schedule-friendly for both faculty and students, and may result in more in-depth and well posed questions and answers. Message boards allow all students in the course to access questions and answers initiated by others, reducing the time required for faculty to repeatedly answer the same question for multiple students. Pages of Internet links can guide students to relevant sites without searching. Some software packages allow students to access their scores online, enabling them to determine their current grade in the course independently. In addition, student access to posted grades provides a check against data entry errors and lost assignments. Course documents can be published online, allowing students to print only as needed. Online quizzes and exams may be utilized if appropriate proctoring is used. Concerns with use of such tools include security and privacy, especially if grades are accessed or assignments submitted online. Also, electronic communication may lessen the personal contact between faculty and students. Electronic communication may be more focused, but less likely to drift into other beneficial discussion. Furthermore, connection speed and downtime issues may create problems with use of this technology. Amount of faculty time needed to learn to use the technology and to maintain the tools varies with the software and the faculty member's computer experience. While online tools cannot, and should not, replace other forms of student/faculty interaction, they can be a useful addition that can make more effective use of students' and faculty members' time.

Key Words: Teaching, Internet, Students

274 Using web-based tools in small enrollment discussion-type classes.

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Interactive engagement of students with course material, the instructor and other students is key to in-depth learning. Our objective was to study the use of web-based tools to help students prepare for discussion as the primary mode of class time interaction for the semester. Students in a required upper level course in ruminant nutrition (n=18) and an elective course in environmental management of livestock operation (n=8) were surveyed (SU=survey) 3 wks into the semester and at the end of the semester (EV=evaluation). Aspects of the course that contributed to learning gains were evaluated with a modified Student Assessment of Learning Gains (http://www.wcer.wisc.edu/salgains/instructor/). Scores (S) were on a 1-to-5 Likert-type scale (1=Not at all and 5=A great deal) for the environmental course, but 1-to-10 for the nutrition course. Separate analyses of variance measured the impact of student standing (junior vs. senior vs. graduate student) and the change in

students perception during the semester (EV vs. SU). Electronic components of the environmental course that contributed positively to learning (S=4.1) included the transcription of lecture material (S= 4.5) and real-world case studies (S=4.3). Quick time movies of lecturer (broken down in 3-5 min. segments) and a test-your-knowledge quiz ranked lower (S=2.8 and 3.7, respectively). Students felt increasingly comfortable asking questions and their interest for the course increased during the semester (4.0 vs. 4.6, P = 0.03 and 3.6 vs. 4.4, P = 0.08 for SU and EV, respectively). For the nutrition course, however, students resented having to download reading material and did not find the test-your-knowledge quiz useful (S=5.6). Self-assessed learning gains averaged 9.0, 6.3 and 5.0 for graduate students, seniors and juniors, respectively (all P < 0.001). Returning to lecture was ranked low for the nutrition (S=5.8) and the environmental course (S=2.7). The success of web tools to prepare students for class discussion depends on careful integration with other course components, students maturity or motivation, and the establishment of positive group dynamic early in the semester.

Key Words: Undergraduate education, Web tools, Discussion

275 Using case study format to teach applied dairy herd evaluation.

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Applied Dairy Herd Evaluation (AnS 435) is a course designed to help students learn how to apply knowledge gained in the classroom to commercial farm situations. Each student works individually with a commercial dairy farm in a case-study format. Students, in consultation with the instructor, select their case-study farm within two constraints: they cannot select their home dairy farm; and the farm must be enrolled on DHI and process their records through Dairy Records Management Services. Students are taught how to: analyze DHI records and other on-farm records to identify potential problem areas which limit animal performance and/or farm profitability; evaluate on-farm rations and other nutrition-related factors which might limit animal performance; analyze milking procedures, housing, and other factors involved in assessing milk quality; analyze reproductive practices and genetic programs; evaluate cow comfort and facilities; evaluate replacement rearing program; evaluate manure handling and nutrient management; evaluate personnel management; develop practical recommendations based on their analyses of the above factors; evaluate the potential economic impact of their recommendations; and finally prioritize and communicate their recommendations to the management team of the farm. Students develop skills in information gathering, decision making, problem solving, and interpersonal communications. No tests or quizzes are given, however students have weekly homework assignments targeted at a specific aspect of the dairy operation and present their recommendations and economic analyses in a comprehensive report that is shared with the herd owner.

Key Words: case study, undergraduate, teaching

276 Workshops used to provide animal science teaching materials to high school educators.

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The purpose of this program is to provide ready-to-use teaching materials to agricultural and science high school educators. During the school year, we offer a three-hour workshop for each topic at each of four locations throughout Pennsylvania. Programs are also offered at summer teaching conferences. Participants receive reading lessons, lesson plans that meet the PA Department of Education academic standards, hands-on laboratory activities, and all written materials on a CD. The greatest proportion of costs for materials has been paid with resources from the PA Departments of Agriculture and Education. Workshops offered since 2001 include the following: meat processing, quality assurance in food production, environmental challenges of animal agriculture, evaluation of food animal products, veterinary skills, small animal care, agriculture and the carbon cycle, biotechnology, ruminology, and chemicals and antibiotics in food production. Of the 194 participants who completed evaluations, 97% indicated that workshops were well organized, 99% said the presenters were well prepared, 98% believed materials were effectively presented, 93% felt the pace of the workshops was appropriate, 92% of participants were generally pleased with the materials, and 94% indicated the materials were age appropriate. In a supplemental evaluation for selected workshops, participants scored the overall quality (1=poor7=excellent) and the likelihood of their using the materials in the classroom (1=will not use7=will definitely use). The respective scores for quality of materials and likelihood of using the materials were 5.7 and 6.0 for the chemical/antibiotic workshops, 6.7 and 6.4 for carbon cycle workshops, and 6.8 and 6.6 for biotechnology workshops. We conclude that this format is appropriate for providing technical information to agriculture and science teachers.

Key Words: Teacher, Training, Animal science

277 Encouraging reading beyond the curriculum.

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Students in genetics and reproductive physiology, Junior/Senior level courses with enrollments averaging 76 and 41, respectively, were encouraged to read popular science books for extra credit. The objectives of the readings were to reinforce basic class concepts by forming ties to everyday life, and to expose students to a genre that can provide information to prepare them as citizens to engage in the debate over current issues. To earn credit (3% of the course grade for each of up to three books), students had to demonstrate knowledge and understanding of each book during a 15 min discussion with the instructor. Discussions focused on questions designed to stimulate critical thinking about each books content. For example: "There is approximately 98% homology in DNA sequence between humans and chimpanzees; in aspects ranging from basic physiology to behavior, what makes us similar to, or conversely, different from the species that is our closest living relative?" The books for genetics were: The Double Helix, Genome, Voyage of the Beagle, and The Engineer in the Garden, and for reproductive physiology were: Clone, Lives of a Cell, Life Before Birth and A Time to be Born, and The Second Creation: Dolly and The Age of Biological Control. The numbers of students reading 0, 1, 2 and 3 books in years one and two were 24, 21, 6 and 10, and 26, 31, 21 and 12, respectively, in genetics, and 45, 7, 0 and 4, and 20, 1, 2 and 3, respectively, in reproductive physiology. Final grade did not affect the number of books read. Sixteen genetics students from the second year's class, eight that had participated in the extra credit reading and eight that had not, volunteered to be reexamined on material from the class. The reexamination was conducted three months after the end of the class. With first exam score fitted as a covariate (P<0.10) participation in the extra credit reading assignment did not affect score on the reexam; participants averaged 67% correct answers, nonparticipants averaged 59% (P=0.37). Comments on course evaluations indicated broad satisfaction with the assignments.

Key Words: Extra credit, Pedagogy, Reading

Undergraduate Student Paper Competition

278 Comparison of muscle mass and muscle cell characteristics at different stages of growth in lines of mice divergently selected for heat loss.

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Selection for high (MH) or low (ML) heat loss (kcal·kg$^{-0.75}$·d^{-1}) created lines of mice that differed greatly in heat loss and feed energy required for maintenance but not body mass. The objective of this study was to compare these lines for mass of two muscles and for physiological characteristics of one muscle across different ages of growth. The MH and ML selection lines had been replicated three times for a total of six lines. Animals used in this study included 12 male mice from each selection line in each of the three replicates at ages 3, 7, 11, and 15 wk. Muscle mass of the quadriceps and the gastrocnemius from both hind limbs along with body mass at the time of sacrifice were obtained. No significant difference exists at any age between lines for body mass (P > 0.35) or muscle mass of either the gastrocnemius (P > 0.34) or quadriceps (P > 0.16). Chemical analysis was done on the quadriceps of all replicates at 3 and 15 wk to determine DNA, RNA, and protein concentrations. Total protein (P < 0.01) and protein concentration (P = 0.09, mg protein/g of tissue) were greater at 15 wk than at 3 wk. DNA concentration (P < 0.09, ug DNA/g of tissue) was greater at 3

wk, and RNA concentration (μg RNA/g tissue) tended ($P < 0.14$) to also be greater in 3-wk animals. No significant differences ($P > 0.17$) between lines were found in either concentration or total-muscle data, and there was no line by age interaction. In addition, no differences in protein/DNA and RNA/protein ratios ($P > 0.21$) were present, indicating similar cell sizes and ability for protein synthesis, respectively, for MH and ML lines. Selection for heat loss, with its concomitant response in feed energy for maintenance, has not produced changes in muscle mass growth or muscle cell characteristics. Differences in feed energy required for maintenance of these lines are not explained by differences in muscle characteristics.

Key Words: Mice, Selection, Muscle Growth

279 The interaction of dietary CLA and fat source on triglyceride turnover in adipose tissue of mice.

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Dietary conjugated linoleic acid (CLA) causes rapid loss of body fat in mice. Previously, mice raised on coconut oil (CO) or fat free (FF) diets lost more body fat when supplemented with CLA than mice raised on a soy oil (SO) diet. This interaction may depend on fat source effect on rate of lipolysis. The objective was to determine if fat source-specific sensitivity to CLA-induced body fat loss is due to altered rates of lipolysis. Male mice (n=46) were blocked by litter at weaning (3 wk of age) and randomly allotted to SO, CO, or FF diets for 42 d. Half of each group was supplemented with 0.5 % CLA isomers for an additional 10 d. Body weight and feed intake were measured weekly. After 52 d the mice were killed. Liver, retroperitoneal (RP), and epididymal (EPI) fat pads were removed and weighed. Epididymal adipose explants were cultured for 3 h. Glycerol and NEFA release were determined as indicators of lipolysis. Basal and maximal lipolysis were measured in the presence of 0 or 10 μM isoproterenol, respectively. Fatty acid re-esterification was calculated as mol glycerol released (x 3) - mol NEFA released. β-hydroxybutyrate (BHB) in serum was determined as an indication of β-oxidation. Dietary CLA reduced feed intake by 15 % ($P < 0.05$) and EPI and RP fat pad weights by 14 and 58 %, respectively ($P < 0.01$). There were no changes in serum BHB, maximal glycerol and NEFA release, or in re-esterification of fatty acids. Fat source did not alter basal rates of glycerol or NEFA release in the absence of CLA. CLA increased ($P < 0.05$) lipolysis in mice fed CO or FF but not in mice fed SO (8.5 and 7.2 vs 3.8 μmol glycerol released g tissue^{-1}, respectively). Re-esterification of fatty acids was increased ($P < 0.05$) in mice fed CO vs. SO or FF and in mice fed CO+CLA or FF+CLA compared to those fed SO+CLA. Therefore we conclude that the increase in lipolysis in mice fed CO and FF diets with supplemented CLA may account for the increased body fat loss.

Key Words: Conjugated linoleic acid, Lipolysis, Body fat

280 Epithelial cells and immune signaling: Effect of pathogenic and non-pathogenic bacteria on polarized chemokine secretion from pig jejunal epithelial cells.

J. Allen*, K. Skjolaas-Wilson, and J. Minton, *Kansas State University*.

Salmonella enterica serovar Typhimurium (ST) and serovar Choleraesuis (SC) are important enteric pathogens in pigs. In previous studies, we found that SC did not stimulate interleukin-8 (IL-8) secretion in cultured swine jejunal epithelial cells, whereas ST provoked robust IL-8 secretion that was markedly polarized in the basolateral direction. SC is known as a swine host adapted pathogen that is likely to cause serious and often fatal systemic disease, whereas ST is more likely to cause self-limiting enteritis. The lack of IL-8 response by epithelial cells suggested to us that SC may have more success penetrating cells because it avoids provoking immune alarm signals and may behave more like a commensal or probiotic bacteria. The current experiment was designed to test whether the IL-8 secretory response to SC from cultured pig jejunal epithelial cells was similar to non-pathogenic bacteria. Cells were plated onto permeable membrane inserts in six-well culture plates and grown for 14 d. Then, cells were exposed on their apical surface to 10^8 CFU ST, SC, *Lactobacillus reuteri* (LR), or *Bacillus licheniformis* (BL). Bacteria were washed away after 1 h, and media containing gentamicin was added. Control wells received all wash and media changes, but were not exposed to bacteria. Media from the basolateral and apical compartments was removed at 1.5, 3, and 6 h after the initiation of bacterial exposure, and frozen for subsequent measurement of IL-8 by ELISA. None of the bacterial treatments stimulated IL-8 secretion above control wells at 1.5 or 3 h. However at 6 h, ST stimulated IL-8 secretion in both the apical and basolateral compartments greater than that of control wells or other bacterial treatments ($P < 0.001$). Furthermore, IL-8 was increased to a greater extent ($P < 0.001$) by ST in the basolateral than in the apical compartment at 6 h. Taken together, the data suggest that SC interacts with gut epithelial cells very similarly to non-pathogenic bacteria, but much differently than ST. This may contribute to the greater tendency for SC to produce sepsis in pigs than ST.

Key Words: Salmonella, Immunology, Epithelial cells

281 Effect of phosphorus intake on bone mineral status of feedlot cattle.

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Phosphorus is an important nutrient and if not adequately fed, performance may be hindered. However, high amounts of P in manure may cause eutrophication if entering surface water. A P requirement study was conducted to determine the optimum amount of P for growth and bone stores. The performance data were reported previously. The objective of this experiment was to determine the impact of P intake on bone mineral. The experiment used 60 crossbred heifers, with heifers assigned randomly to one of 5 treatments (12 heifers/treatment). Each group was fed the same base diet, varying only by the amount of supplemental monosodium phosphate. Dietary P fed was 0.10, 0.17, 0.24, 0.31, or 0.38% of DM. The diet consisted of 50% coarse brewers grits, 15% high moisture corn, 15% corn bran, 10% sorghum silage, 5% tallow, and 5% supplement. At slaughter, the metacarpal and first and second phalanx bones were removed from the right foreleg. All bones were scraped and autoclaved to remove tissue and fat, and subsequently ashed. Phalanx ash weights (entire bone) were 78.6, 84.8, 83.4, 90.3, and 88.4 g for the 0.10, 0.17, 0.24, 0.31, and 0.38% P, respectively. Phalanx ash weight increased linearly ($P<0.01$) as P intake increased with an $R^2=0.24$ ($P<0.01$). However, metacarpal bone ash weight was not influenced by P intake ($P>0.30$). A significant linear effect ($P<0.05$) of bone ash weight due to P intake was observed when all bones were combined. However, due to the effect of P intake on carcass weight, expressing total bone ash weights for all bones combined as a percent of carcass weight, any effect of P intake was removed. Conducting non-linear breakpoint analysis with phalanx bone ash suggests the P requirement is very close to the lowest P concentration fed at 0.109 $\pm$ 0.006% of diet DM. The phalanx bone data are similar to the requirement determined for ADG (0.115 $\pm$ 0.012%). These data suggest the P requirement for cattle are quite low even with bone stores as the criteria. In normal grain feeding situations, P supplementation is not necessary.

Key Words: Bone, Cattle, Phosphorus

282 Effect of age on antioxidant activity in muscle and identification of iron regulatory proteins in liver of cattle.

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The importance of antioxidants in prevention of cellular oxidative damage has been well established. The presence of unbound Fe increases the opportunity for oxidative damage to occur. Heme pigments are known to correlate with the Fe content of tissue. In cattle the concentration of myoglobin, the major heme protein in muscle, increases with age as evidenced by the dark red color of cull cow carcasses. Iron regulatory proteins (IRP) modulate cellular Fe homeostasis in rats, although their presence in cattle is unknown. Therefore, our research investigated if the high Fe load in older animals is associated with elevated antioxidant enzyme activity in muscle and if IRP are present in cattle. Liver tissue and five muscle tissues (longissimus [LD], infraspinatus [IN], teres major [TM], biceps femoris [BF], semitendinosus [ST]) were collected within 60 min of slaughter initiation from the carcasses of 2 cull Holstein cows (6 yr age) and 2 market steers (16 mo age). Samples for antioxidant activity determination were stored at -80°C, then were homogenized and analyzed for the antioxidants Catalase (CAT), CuZn-Superoxide Dismutase (SOD), and Glutathione Peroxidase (GPX). Samples for analysis of IRP were flash frozen in liquid N_2 then stored at -80°C for later analysis. The presence of IRP in liver was confirmed, not previously reported in cattle. Cull cows had greater hepatic Fe concentrations than steers (108.6 vs. 48.8 mg/kg), indicating increased Fe load in the cows. Cows

had greater enzyme activity than steers for (1) CAT in IN (0.095 vs. 0.023 k min^{-1} mg $protein^{-1}$; $P = 0.003$); (2) GPX in BF (0.040 vs. 0.029 U/mg protein; $P = 0.004$); and (3) SOD in BF (13.6 vs. 10.0 U/mg protein; $P = 0.002$), LD (11.9 vs. 8.0 U/mg protein; $P < 0.001$), and ST (11.6 vs. 7.1 U/mg protein; $P = 0.026$). Antioxidant activity was numerically greater in 8 additional enzyme/muscle assays. As hypothesized, antioxidant enzyme activity was greater in the muscle tissue of older cows compared with market steers, and IRP are detectable in these animals.

Key Words: Cattle, Antioxidants, IRP

283 Effect of pasteurization of colostrum on serum immunoglobulin concentrations and health of bull calves.

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Immunoglobulins (Ig) in colostrum provide passive immunity to neonatal dairy calves. Colostrum may be pasteurized to reduce the risk of calves consuming viable disease-causing pathogens, but pasteurization can damage colostral Ig. The objective was to determine if pasteurization of colostrum using a batch pasteurizer affected serum Ig concentrations, health and growth rate of calves. Colostrum of high quality (#880550 mg/mL Ig) was divided in half, and one half was pasteurized for 30 min at 61 °C and cooled. Colostrum was stored at -20 °C and thawed in a water bath prior to use. Bull calves were alternately assigned to one of two treatments by date of birth and fed either unpasteurized (U; n=10) or pasteurized (P; n=11) colostrum. Starting body weight did not differ between treatments. Calves were fed 2 L of colostrum within 6 h after birth and another 2 L of colostrum within 12 h after birth. After 24 h of age, all calves were fed 2 L of milk replacer twice daily and managed similarly according to standard farm procedures. Blood samples were obtained at 48 to 60 h of age for measurement of serum IgG concentrations using a radial immunodiffusion assay. Body weight gain and health indicators were measured from 1 through 10 d of age. Data were analyzed using the GLM procedure of SAS. P colostrum decreased serum IgG concentrations by 20% compared to U colostrum (19.1 mg/mL versus 23.9 mg/mL; $P < 0.06$). Body weight at 10 d of age did not differ between calves fed P or U colostrum (47.8 versus 47.7 kg; $P > 0.66$). Calves fed P colostrum had similar daily rectal temperatures to calves fed U colostrum (39.2 versus 39.1 °C; $P > 0.39$). Fecal scores averaged 3.3 (on a scale of 1 to 5) for 1 through 10 d of age and did not differ by treatment ($P > 0.69$). P colostrum also did not affect ease of breathing of calves. We conclude that pasteurization did not decrease Ig concentration in high-quality colostrum to a degree that produced detectable adverse effects on calf health.

Key Words: Colostrum, Pasteurization, Health

284 Effect of weaning age and commingling on behavior of pigs in a wean-to-finish facility.

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To determine the effect of weaning age and commingling on behavior, pigs from one farrowing group of gilts bred to farrow pigs that would be either 14 or 21 d of age at weaning, were divided into older and younger age groups (108 pigs/group), blocked by BW, and penned 12 pigs/pen in a wean-to-finish facility. At the end of the nursery phase, one-half of the pigs in each pen were removed and commingled within each age group for the growing/finishing phase, whereas the other half of the pigs remained in their original pens. Pigs were fed common nursery and growing/finishing diets, and behavior was monitored during the nursery period on d 0 (weaning), 7, 14, and 27 post-weaning, and during the growing/finishing phase on d 35 (after commingling following the nursery phase), 38, 44, and 65 post-weaning. Four pens per treatment during the nursery phase, and two pens per treatment during growing/finishing phase were monitored. The frequency of times aggressive behaviors were observed was greater ($P < 0.05$) at weaning (d 0) than on any other observation day during the nursery period. Younger pigs spent less ($P < 0.05$) time resting on the day of weaning, and more ($P < 0.05$) time active during the overall nursery phase. During the growing/finishing period, pigs weaned at 14 d of age that remained unmixed spent a greater ($P < 0.05$) percentage of time engaged in feeding behavior on d 35 after weaning than 21 d-old pigs that were unmixed, or commingled pigs regardless of age. On d 65 after weaning, pigs weaned at 21 d of age and mixed and pigs weaned at 14 d of age and unmixed spent a greater ($P < 0.05$) percentage of time engaged in feeding behavior than pigs in the other treatments (weaning age × commingling × day interaction, $P < 0.05$). The results of this study indicate that weaning age had little long-term effect on behavior after weaning, and the interactive effects of weaning age and commingling after the nursery phase should be further explored.

Key Words: Swine, Behavior, Weaning

285 Lactose and specialty protein sources influence flow ability of starter diets.

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High levels of lactose and specialty protein products are often included in nursery pig diets to stimulate feed intake and improve growth performance. However, these ingredients, unless pelleted, frequently increase the incidence of bridging in bins and feeders. Therefore, our objective was to evaluate the effects of lactose products and specialty protein ingredients on angle of repose. Angle of repose is the maximum angle in which a pile of ingredient retains its slope. A large angle of repose represents a steeper slope and poorer flow ability. A 70:30 corn-soybean meal blend served as the base to which all specialty ingredients were added. In Exp. 1, we evaluated six lactose sources. Three sources were fine powdered whey permeates. The other sources were a coarse ground whey permeate, edible grade spray-dried whey, and a crystalline lactose source. Lactose sources were added at 0, 5, 10, 20, and 30% to the corn-soybean meal blend. Angle of repose was then measured on these mixtures as well as the individual lactose sources. There was a lactose source ï level interaction (P<0.0001). Increasing lactose source decreased angle of repose; however, the coarse whey permeate had the greatest improvement in angle of repose. In Exp. 2, we evaluated five specialty protein ingredients: spray-dried animal plasma (powdered or granulated), spray-dried blood cells (powdered or granulated), and select Menhaden fish meal. Specialty protein sources were added at 0, 2.5, 5, 7.5, and 10% to the corn-soybean meal blend. There was a specialty protein source ï level interaction (P<0.0001). As powdered animal plasma and blood cells increased, angle of repose increased, resulting in poorer flow ability. With the addition of granulated animal plasma and blood cells, angle of repose decreased indicating better flow ability. Increasing fish meal did not influence angle of repose. These data confirm that greater flow ability is observed with granulated or coarser lactose or specialty protein sources.

Key Words: Lactose, Flow ability, Specialty protein

286 Inhibition of methanogenesis in free living vs. protozoa-associated ruminal methanogens.

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Compounds designed to inhibit 4-(β-D-ribofuranosyl)aminobenzene-5′-phosphate synthase should decrease methane production in ruminal cultures. Some methanogens may be resistant to inhibition because of their association with ruminal protozoa. The objectives were to determine whether: 1) para-aminobenzoate analogs can eliminate ruminal methanogenesis in vitro; and 2) protozoa-associated methanogens differ in sensitivity to these compounds compared to free living methanogens. In experiment 1, cultures inoculated with total ruminal fluid were incubated anaerobically at 37 C for 22 h with increasing concentrations (0 to 5.0 mM) of two potential methanogenesis inhibitors (compounds X and Y; n = 4/dose). Methane concentrations in the headspace were determined by gas chromatography. In experiment 2, cultures were inoculated with either protozoa-associated methanogens (obtained by centrifugation) or with free living methanogens (600 x g ruminal fluid supernate). In quadruplicate, each type of culture was treated with a 1.0 mM concentration of each compound. In cultures inoculated with total ruminal fluid, compound X decreased ($P < 0.05$) methane production by 56, 85, 92, and 100% at concentrations of 0.5, 1.0, 2.5, and 5.0 mM, respectively. Compound Y decreased ($P < 0.05$) methane production by 19, 99 and 99% at concentrations of 0.1, 1.0 and 2.5 mM, respectively. Compounds X and Y decreased ($P < 0.05$) methane production by protozoa-associated methanogens (86 and 99%, respectively)

and by free living methanogens (100 and 99%, respectively). In a subsequent repetition, compound X decreased ($P < 0.05$) methane production by protozoa-associated and free living methanogens by only 45 and 54%, respectively. We conclude that these para-aminobenzoate analogs can inhibit both protozoa-associated and free living methanogens but protozoa-associated may be less sensitive.

Key Words: methane, rumen, protozoa

287 Economics of early and traditional weaning on cow performance and bull and steer calf performance. M. Bartlett*, E. Koch, M. Dikeman, J. Brethour, T. Marston, and J. Unruh, *Kansas State University*.

Commercial cow/calf pairs were used to determine the effects of calf weaning age on cow body weight, body condition score, reproductive efficiency, and calf livability. In addition, calf performance was investigated, including rate and cost of gain, feed efficiency, subcutaneous fat, marbling deposition, 12th rib Warner-Bratzler shear force, and carcass value. We expected that a production system utilizing bulls for meat production would be maximized with early weaning. This study was conducted with 103 male progeny (52 steers; 51 bulls) of Angus-based cows. The treatments were: 1) early-weaned bulls (EWB), 2) early-weaned steers (EWS), 3) traditional-weaned bulls (TWB), and 4) traditional-weaned steers (TWS). The EW calves were weaned at an average age of 115 d. The TW calves were weaned at an average age of 218 d. Ultrasound technology was used to evaluate back fat to determine the slaughter end points. The first slaughter date was when the average back fat of all steers measured 1 cm, and the second when the average back fat of all the bulls measured 1 cm. A random half of each treatment was slaughtered at these two endpoints. We found an advantage with the EW treatment. The EW treatment increased the value of the cow and calf compared to the TW treatment. At a weaning age of 218 d, the EW cows averaged a full body condition higher than cows in TW treatments. The EW calves had a gain advantage of 29 kg at 241 d, and an economic advantage of $20 per head over the TW treatments. During the feeding/finishing phase of this experiment, the TW calves had higher gains due to compensatory gain, and lower death loss. Final net carcass value was highest in EWS, and lowest in TWB. The EWB exhibited a lower feed efficiency than expected, lower carcass merit, and decreased tenderness as compared with steer treatments. Our results do not support the use of EWB for meat production. The EWS had the greatest economic advantage. This advantage could be increased, as better techniques for managing the EWS are developed to minimize death loss, and optimize slaughter endpoint.

Key Words: Beef, Early weaning, Economics