reduced leptin synthesis in adipose tissue. To test this hypothesis without the confounding influence of parturition, we first examined the effects of undernutrition by using late lactating dairy cows fed 120 % of their nutrient requirements or restricted to 33 % of maintenance energy requirements. Plasma leptin was reduced within 24 h of feed restriction (fed vs restricted, 2.8 vs 2.2 ng/ml, $P < 0.001$), and was associated with increased plasma GH and decreased plasma insulin; complete food deprivation for a period of 48 h did not accentuate the reduction in the plasma concentration of leptin (fed vs fasted, 2.7 vs 2.0 ng/ml, $P < 0.05$). To determine if an elevation in GH is responsible for the fall in plasma leptin, late lactating cows in positive EB were treated for 4 consecutive days with excipient or recombinant bovine somatotropin (rbST, 40 mg/d), rbST treatment increased milk yield by 26 % ($P < 0.01$) but had no effect on plasma leptin. rbST also failed to alter plasma leptin when a similar experiment was performed during the third week of lactation when EB was negative. Finally, the effects of insulin were studied by performing euglycemic hyperinsulinemic clamps in mid-lactating dairy cows in positive EB. After 96 h of hyperinsulinemia, plasma leptin was increased significantly (basal vs hyperinsulinemia, 2.5 vs 3.4 ng/ml, $P < 0.001$). These data indicate that, in undernourished lactating dairy cows, reduced plasma insulin is partly responsible for the fall in plasma leptin, and that elevated plasma GH plays no role in this effect.

Key Words: Leptin, Growth Hormone, Insulin

780 Effect of sunflower seed inclusion on conjugated linoleic acid concentrations in milk fat of Holstein cows. D. B. Carlson*[1], M. S. Laubach[1], W. L. Keller[1], J. W. Schroeder[1], J. H. Herbein[2], and C. S. Park[1], [1]*North Dakota State University, Fargo, ND,* [2]*Virginia Polytechnic and State University, Blacksburg, VA.*

The objectives of this study were to investigate the effect of sunflower seed supplementation on conjugated linoleic acid (CLA) concentration in milk fat and to determine the level of sunflower seed supplementation that maximizes CLA concentration without negatively impacting milk yield. Lactating Holstein cows (n = 4) were stratified by parity, milk yield, and days in milk, and assigned to one of three dietary treatments in a completely randomized design. Treatments were: 1) 1% of dry matter (DM) as sunflower seeds (CON), 2) 6.5% of DM as sunflower seeds (MID), and 3) 11.4% of DM as sunflower seeds (HIGH). Sunflower seeds were rolled and directly blended into total mixed rations. The predominant fatty acids present in sunflower seeds were linoleic acid (74.04% of total oil) and oleic acid (15.45% of total oil). Cows were fed individually for a period of twelve wk following a one-wk adaptation period. Dry matter intake (DMI) and milk yield were measured daily. Milk and blood samples were collected, and body weight (BW) and a body condition score (BCS) were determined on d 0, 21, 42, 63, and 84. Data were analyzed using GLM procedures of SAS. Differences were considered significant at $P < 0.05$. DMI, milk yield, BW, BCS, and serum non-esterified fatty acids were not altered by treatment ($P > 0.05$). Serum glucose was higher ($P < 0.01$) in cows fed CON compared to those consuming MID and HIGH. *Cis-9*, *trans*-11 CLA concentration in milk fat was significantly increased ($P < 0.01$) in cows consuming MID and HIGH (8.0 and 7.0 mg/g of milk fat, respectively) compared to CON (4.3 mg/g of milk fat). Sunflower seed supplementation can increase CLA concentration in milk fat without affecting milk components and yield.

Key Words: Conjugated linoleic acid, Sunflower, Oilseed

Nonruminant Nutrition
Young Pig Nutrition and Management

781 Baby pig nutrition and management. V. W. Hays*, *University of Kentucky, Lexington.*

Producers and researchers knew about feeding young pigs before early weaning was introduced as a part of the management system. Death of the sow shortly after farrowing or failure to produce milk necessitated transfer of pigs to another sow or finding an alternative food supply. If the pigs did not receive colostral milk, mortality was very high. Those producers that had access to milk cows had found that cow's milk is a quite adequate diet for very young pigs. "Harris On the Pig" (1985) includes a trial by Miles of the Michigan Station in which pigs 2 weeks of age and 4.0 lb. body weight did very well on cow's milk. They gained 3.5 lb/pig during the first week. In the mid to late 1940s, researchers began using early weaned pigs (1 day of age and older) to study vitamin and other nutrient requirements. Serious interest in weaning at a very young age as a management system began in the early 1950s. In early studies, liquid or dry diets were based on the composition of sow's or cow's milk based on our knowledge of the performance of pigs on those diets. Much of the early work was published in Station publications, producer magazines or applied journals. "Baby Pigs Don't Need Their Mommies Any More", "Baby Pigs Have A Sweet Tooth" and "Pre-Starter 75" were among the titles. The age or weight at weaning still varies and should be determined by the degree of sanitation, the control of the environment, the complexity of the diet and the desired productivity level of the sow. As we changed the diets for economic reasons (less dependent on milk), we learned more and more about the quality and nutrient limitations of feed ingredients and the development of the pig's digestive system. Our knowledge of the nutrient requirements and utilization of various feedstuffs has been expanded greatly through the use of younger pigs.

Key Words: Baby pigs, Early weaning, Management

782 Dipeptide transport in the small intestinal brush broder membrane vesicles of the weaned pigs. J.G. Dai[1], D.F. Li*[1], X.S. Piao[1], J.R. Pan[1], H.L. Chen[1], and G.F. Yi[2], [1]*China Agricultural University,* [2]*University of Missouri-Columbia.*

Six crossbred Landrace x Large White x Beijing Black weaned pigs (age = 35d) were used in a series of experiments to investigate the transport of glycyl-L-proline (Gly-Pro) into brush border membrane vesicles (BBMV) of the small intestine. The BBMV were prepared from the small intestine using a magnesium chloride aggregation method. The membrane purity of the BBMV was determined routinely by assay of alkaline phosphatase, a marker enzyme for BBMV, and Na^+-K^+-ATPase, a marker enzyme for the basolateral membrane used to monitor the contamination of this membrane in BBMV. Results from the seven experiments indicated the following: Gly-Pro was not hydrolyzed in the small intestinal BBMV (P=0.25); transport of Gly-Pro in BBMV was optimized at an external pH of 4.5-5.5; Gly-Pro transport (20 min period) was greater at an external pH of 5.0 compared to that of a pH of 7.5 (P<0.05); at an external pH of 5.0, the presence of an inward proton gradient stimulated Gly-Pro transport (P<0.05); in the absence of a transmembrane proton gradient Gly-Pro transport was not different at an external pH of 5.0 as compared to a pH of 7.5; the K^+ diffusion potential (interior-negative) produced by valinomycin resulted in an increase in Gly-Pro transport both in the presence and absence of Na^+ (P<0.05); the H^+ diffusion potential (interior-positive) generated by protonophore Carbonyl cyanide p-(Tri-fluoromethoxy) phenylhydrazone (FCCP) decreased Gly-Pro transport (P<0.05); and that the uptake of Gly-Pro was due to transport directly into the intravesicular space rather than binding to BBMV. Collectively, these results suggest that dipeptide transport into the weaned pig small intestine is different from the transport of amino acids and glucose, in that Gly-Pro transport may be proton gradient-dependent and Na^+-independent.

Key Words: Pigs, Dipeptide, Small intestine

783 Effects of feeding supplemental milk replacer to piglets on pre-and post-weaning performance. M. E. Davis*[1], C. V. Maxwell[1], D. C. Brown[1], Z. B. Johnson[1], K. J. Touchette[2], and J. A. Coalson[2], [1]*University of Arkansas, Fayetteville,* [2]*Merrick's, Inc., Middleton, WI.*

Nineteen litters from two farrowing groups were allotted to two milk replacer treatments to assess the effects of milk replacer supplementation on pre- and post-weaning piglet performance. Litters were allotted to

treatments beginning at farrowing: 1) no milk replacer, and 2) milk replacer containing 18% solids. Milk replacer was provided ad libitum via an in-line system using a cup dispenser for each litter. At weaning, pigs within each treatment group were blocked into 8 weight groups, and 6 pigs from each block were assigned to a nursery pen. Pigs were fed a phase 1 diet from d 0 to 14 and a phase 2 diet from d 14 to 28. Pigs from the two lightest weight blocks were offered milk replacer for an additional 5 d after weaning. Average daily gain was greater from d 5 after birth to weaning (227 g vs. 285 g; $P \leq 0.05$), d 10 to weaning (223 g vs. 314 g; $P \leq 0.01$), and from birth to weaning (205 g vs. 254 g; $P \leq 0.06$) when pigs were provided milk replacer. Pig BW was greater at weaning (5.5 kg vs. 6.4 kg; $P \leq 0.08$) when pigs were fed milk replacer compared to the control pigs. From d 0 to 5 and d 0 to 14 post-weaning, pigs previously fed milk replacer had lower ($P \leq 0.05$) ADG than control pigs. Light weight (LW) pigs fed milk replacer for an additional 5 d after weaning had greater ADG (341 g vs. 153 g; $P \leq 0.01$) than heavy weight (HW) pigs without milk replacer. However, ADG decreased (210 g vs. 32 g, HW vs. LW, respectively; $P \leq 0.01$) during the subsequent 5 d after LW pigs were removed from milk replacer. The improvement in ADG of LW pigs from d 0 to 5 after weaning brought BW of HW and LW pigs closer together on d 5 after weaning (2.2 kg difference at weaning vs. 1.2 kg on d 5); however, this difference was lost by d 10 after weaning (2.1 kg difference) when milk replacer was removed from LW pigs. Supplementing pigs with milk replacer during the pre-weaning period improves ADG and weaning weight, while milk replacer supplemented to LW pigs for the initial 5 d after weaning improves ADG.

Key Words: Swine, Growth, Milk Substitutes

784 Gut integrity of piglets fed a diet in liquid and dry form. J.M.A.J. Verdonk[1], M.A.M. Spreeuwenberg*[2], G.C.M. Bakker[1], Z. Mroz[1], and M.W.A. Verstegen[3], [1]*ID TNO Animal Nutrition, Lelystad,* [2]*Nutreco, Boxmeer,* [3]*Wageningen University, the Netherlands*.

Effects of dietary form (liquid versus solid) on the gut integrity were studied with 30 weaned piglets (Yorkshire x [Dutch Landrace x Finnish Landrace]) of 7.3 kg initial BW. During 7-d postweaning period they were housed individually and fed a diet in two forms: 1) dry pelleted (group 1) and 2) liquid (group 2). The liquid diet was soaked with water (1:2.5, wt/vol). Daily rations were restricted to 0.5, 1.0 and 2.0 NE_m at weaning, d 2 and d 5, respectively. Gut samples were obtained from the proximal and mid jejunum of piglets euthanized at weaning (n = 6), on d 2 (n = 12) and on d 6 postweaning (n = 12) for comparing morphological parameters and permeability in Ussing chambers. Group 1 had significantly higher ($P < 0.05$) transcellular transport compared to group 2. Paracellular transport, the villous length and crypt depth were similar in both groups, although numerically longer villi (15%) and deeper crypts (7%) were in group 1. Crypt depth on d 2 was decreased and on d 6 increased numerically compared to d 0 (weaning). Crypt depth on d 6 was significantly increased compared to d 2 values. Villous length on d 2 decreased ($P < 0.05$) compared to d 0. On d 6 as compared to weaning, the liquid diet caused a further decrease of villous length, whereas in piglets fed the dry diet villi were partly restored to similar height as on d 0. Paracellular transport increased ($P < 0.05$) on d 2 and partially decreased on d 6 post weaning compared to d 0. The transcellular transport increased ($P < 0.05$) on d 2 and d 6 compared to day 0. These data imply that the mucosal integrity in weaned piglets fed restricted NE is affected by a weaning stress, as manifested by villous atrophy and increased paracellular permeability, irrespective of the dietary physical form.

Key Words: Piglets, Mucosal integrity, Physical form

785 Effect of segregated early weaning on growth performance and immune parameters of pigs. D. C. Brown*, C. V. Maxwell, M. E. Davis, and S. Singh, *University of Arkansas, Fayetteville*.

Growth performance and immune parameters were compared between pigs reared in on-site and off-site facilities. Crossbred pigs (N = 88) were weaned at 19 ± 2 days of age, allotted to one of two facilities based on initial BW (5.94 ± 0.07 kg on-site; 5.87 ± 0.07 kg off-site). Pigs in each group were divided into four weight groups, allotted into equal subgroups (2 or 3 pigs/pen), and stratified based on sex and litter. All pigs received common diets and were managed similarly. On d 1, 3, 11, and 24 post-weaning, one pig from each weight block was randomly sacrificed (n = 4 per facility) and blood was collected for differential cell counts, lymphocyte blastogenesis assay and cytokine profiles. Bile was collected for quantification of immunoglobin-A (IgA). During phase1, pigs reared in the off-site facility had greater ADG ($P \leq 0.01$) and ADFI ($P \leq 0.01$) and were heavier at 24 d post-weaning ($P \leq 0.05$) than pigs reared on-site (17.38 ± 0.35 kg vs. 15.85 ± 0.35 kg, respectively). Lymphocytes isolated from pigs from both facilities had a higher ($P \leq 0.01$) mitogen stimulation index on d 1 post-weaning compared to d 3, 11 and 24 post-weaning. Production of IgA and the percentage of eosophils from pigs at both locations were higher ($P \leq 0.05$) on 24 d post-weaning compared to other days sampled. On-site pigs had higher ($P \leq 0.05$) interleukin-4 (IL-4) production on d 1 post-weaning than on d 3, 11 and 24 post-weaning and higher IL-4 on d 1, 11 and 24 post-weaning than off-site pigs. Off-site pigs had higher ($P \leq 0.05$) IL-4 production on d 3 post-weaning than on d 1 and 11 post-weaning and higher IL-4 on d 11 and 24 post-weaning than on-site pigs; however, there were no differences in interleukin-2. The percentage of neutrophils increased ($P \leq 0.05$) in off-site pigs from d 1 through 3 post-weaning followed by an increase ($P \leq 0.05$) in lymphocytes on d 11. These data suggest that rearing weanling pigs in an off-site facility can improve growth performance, and that performance during the nursery period may be dependent on the immune status of the pig.

Key Words: Immune function, Nursery pigs, Growth

786 Pigs weaned from the sow at 10 d of age respond to dietary energy source. W. T. Oliver*[1], K. J. Touchette[2], J. A. Coalson[2], C. S. Whisnant[1], J. A. Brown[1], S. A. Mathews[1], J. Odle[1], and R. J. Harrell[1], [1]*North Carolina State University, Raleigh, NC,* [2]*Merrick's Inc., Union Center, WI*.

Previous research suggests the young pig does not respond to the energy density of manufactured liquid diets and that the sow does not supply adequate amounts of nutrients for optimal growth of neonatal pigs. Our objectives were: 1) to determine the effect of a high (25%, HF) or low (2%, LF) fat liquid diet on pig performance, and 2) to determine if dietary energy source alters plasma leptin. Two replicates of 60 pigs (n = 120; 60 males, 60 females), with an initial body weight of 4210 95 g, were weaned from the sow at 10 days of age and utilized in a randomized complete block design. Pigs were blocked by weight and gender, and then assigned to 1 of 6 pens (10 pigs/pen). Diets were formulated to provide a constant lysine:ME ratio and were fed for a duration of 9 days. Pigs gained 336 9 g/d, which resulted in an ending body weight of 7228 120 g, regardless of dietary treatment ($P > 0.15$). Pigs fed LF diet consumed approximately 17% greater dry feed/pen/day than the pigs fed the HF diet (2777 67 vs 2376 67 g/d, $P < 0.01$) throughout the 9-day experiment. Treatment differences in ADFI were not observed on d 5 or 6 of treatment ($P > 0.25$). Calculated ME intake did not differ between dietary treatments ($P > 0.20$), except on d 5 and 6 of treatment, where ME intake was higher in the pigs fed the HF diet ($P < 0.05$). Feed conversion (gain:feed) was 23% higher in HF compared to LF fed pigs ($P < 0.01$). Circulating leptin averaged 1.78 0.06 ng/mL, regardless of dietary treatment. Plasma urea nitrogen concentration was higher in HF pigs (11.0 0.6 mg/dL), compared to LF pigs (6.2 0.6 mg/dL, $P < 0.01$). These results suggest that young pigs respond to a lower energy density liquid diet with increased feed intake, without altering growth performance, utilizing a mechanism other than circulating leptin. However, economic advantages of dietary energy source will depend on the availability and costs of dietary ingredients.

Key Words: Swine, Energy source, Leptin

787 Effect of menhaden fish oil supplementation and starter diet complexity on the performance and immune response of nursery pigs. A. M. Gaines*[1], G. L. Allee[1], J. A. Carroll[2], J. W. Frank[1], D. C. Kendall[1], J. D. Spencer[1], and G. F. Yi[1], [1]*University of Missouri-Columbia,* [2]*Animal Physiology Research Unit, ARS-USDA*.

A trial using 64 weanling pigs (TR4 × PIC C22) was conducted to determine the effects of menhaden fish oil supplementation and diet complexity on performance and immune response of nursery pigs. Pigs (17 d and 6.27±1.16 kg) were weaned into a SEW facility and given free access to a complex diet for 7 days postweaning. At d0 (d7 postweaning), pigs were blocked by weight and allotted to 64 pens. Treatments (Trt) were arranged as a 2×2×2 factorial arrangement. Main effects included diet (complex vs. simple), oil (menhaden fish (MFO) vs. corn (CO)), and

immunogen (saline vs. lipopolysaccharide (LPS)). Experimental diets contained 6% oil (6% CO or 5% MFO + 1% CO) and were fed for 14 days. On d12, i.v. injections of either LPS (100 μg/kg) or saline were given, followed by blood collection at 30 min intervals for 6 hrs. After the immune challenge (d14), pigs were placed onto a common corn-soybean meal fortified diet and growth performance was evaluated until termination of the study (d28). Pigs were weighed and feed intakes recorded at 7, 14, and 28d. Prior to immune challenge (d12), there were differences in BW for pigs fed complex vs. simple diets ($P < 0.01$; 13.1 and 12.1 kg, respectively) and pigs fed CO vs. MFO diets ($P < 0.05$; 12.9 and 12.3 kg, respectively.) During the challenge period, for pigs treated with LPS there was a Time × Immunogen × Oil effect ($P < 0.04$) for serum cortisol with MFO fed pigs having lower serum cortisol as compared to CO fed pigs. Peak serum cortisol for LPS-treated pigs was 174.1 ng/ml at 3 hrs post-challenge for MFO fed pigs and 234.2 ng/ml at 4 hrs for CO fed pigs. At d14 & 28, there were no differences ($P > 0.05$) in BW, except for pigs challenged with LPS. This study suggests that by d7 postweaning, pigs can be placed on a simplified diet without affecting performance and that menhaden fish oil supplementation may provide immunological protection.

Key Words: Starter diet, Fish oil, Pigs

788 Effects of different fat sources in milk replacer on growth performance, body composition and plasma fatty acid profile in neonatal pigs. H. K. Kim*, Y. W. Shin, J. G. Kim, Y. H. Park, and K. Y. Whang, *Korea University, Seoul, Korea.*

An experiment was conducted to investigate the effects of various fat sources in milk replacer on growth performance, body composition and fatty acid profiles in plasma and whole body in neonatal pigs. A total of 58 neonatal crossbred pigs (Yorkshire × Landrace × Duroc) were assigned to six treatments at 5-day old. Pigs in each treatment were fed artificial milk replacers including six different fat sources. Milk intakes were the same among treatments and adjusted every day as pigs grew. Milk replacers were made of dried skim milk (62.8% DM), fat sources (35.5% DM), and emulsifiers (1.7% DM). Fat sources and inclusion rates in the milk replacer were 35.5% lard (LD), 17.8% lard (LLD), 35.5% palm oil (PAM), 35.5% canola oil (CAN), 35.5% coconut oil (CCN), and 35.5% olive oil (OLV). Pigs were weighed at day 0, day 10 and day 20 and average daily gain, average daily milk intake and milk efficiency were calculated. Four pigs were sacrificed for initial body and fatty acid compositions at day 0. Also, four or five pigs each treatment were sacrificed at day 10 and day 20 to measure body composition and plasma and body fatty acid compositions. Average daily gain, milk intake and milk efficiency in LLD were lower ($P < 0.05$) than other treatments for the entire experimental period. From day 0 to day 10, water, protein and ash gains were not different among treatments, but fat gain in LD (9.66 g/d) was higher ($P < 0.05$) than those in LLD (3.85 g/d), CAN (3.96 g/d), and OLV (5.49 g/d) but not different from those in PAM (6.23 g/d) and CCN (7.75 g/d). From day 10 to day 20, gains of all body components were not different among treatments. Fatty acid compositions in plasma and whole body were similar to fatty acid compositions of fat sources of milk replacer in each treatment. This experiment demonstrates that fat source in milk replacer does not alter the growth performance, but the absolute amount of fat consumption affects growth in suckling pigs. Also, the present study suggests that fat gain in the early stage of growth might be affected by fatty acid composition in milk.

Key Words: Pigs, Body composition, Fatty acids

789 Impact of glutamine, glutamate, and nucleotides on the growth performance and intestinal morphology of weaned piglets. G.F. Yi*[1], G.L. Allee[1], Y. Toride[2], J.L. Usry[3], and A.M. Gaines[1], [1]*University of Missouri-Columbia,* [2]*Ajinomoto Co., Inc.,* [3]*Ajinomoto Heartland Lysine, Inc.*

A total of 210 weaned barrows (4.81±0.3kg) at 17±2 days of age were used to evaluate the effects of glutamine (GLN), glutamic acid (GLU), or nucleotides (RNA) supplementation, individually or in combination on the growth performance and intestinal morphology of weaned piglets. Pigs were randomly allotted to one of the seven dietary treatments in a complete randomized block design, with six replicate pens per trt and five pigs per pen. The nursery rooms were cleaned but not disinfected after the last trial. Each pen of pigs had ′nose to nose′ contact with an older pig (about 22 kg) in an attempt to increase endemic pathogenic load. A corn-soy-lactose-fishmeal diet with no spray-dried plasma (SDP) served as a negative control (Trt 1). Trt 2 was fed a 3.5% SDP diet and served as a positive control. Trt 3 to 7 contained GLN, GLU, GLU+GLN mixture, GLU+ RNA mixture, or RNA diet, respectively. BW, ADG, ADFI and G:F were used to evaluate the growth performance weekly. Villus height (VH), crypt depth (CD) and VH:CD ratio (VCR) of duodenum, jejunum and ileum were used to compare the intestinal morphology of pigs at 7 days postweaning. From d 0 to 7, feeding the 3.5% SDP diet and the GLU+RNA mixture diet improved ADG of piglets compared to those fed the negative control diet, and those fed the GLN and the GLU diet ($P \leq 0.05$). Pigs fed the 3.5% SDP diet and those fed the GLU+RNA mixture diet tended to increase ADFI compared to pigs fed the GLU diet or the GLU+GLN mixture diet ($P \leq 0.10$). The first wk after weaning, feeding the 3.5% SDP, GLU+RNA mixture and RNA diet increased the VH of jejunum compared with the negative control diet ($P \leq 0.05$). The improved intestinal morphology of the pigs fed the 3.5% SDP and the GLU+RNA diet was in agreement with the increased ADG, while the improved jejunum VH of the pigs fed the RNA diet did not bring about a corresponding increase in ADG.

Key Words: Pigs, Glutamine, Intestinal morphology

790 Solutein^{TM} supplementation and growth of nursery piglets in commercial farms. Michel Vignola*, *Shur-Gain, a member of Maple Leaf Foods Inc., Saint-Romuald, Quebec, Canada.*

Two controlled field trials have been conducted in commercial facilities to measure the impacts of Solutein^{TM}, a source of soluble globulins. The first trial was conducted with 24 pens, 17 pigs/pen. Piglets weaned at 14-18 days of age were co-mingled from different sow operations with non stable status for PRRS. Twelve pens on one side of the room received Solutein^{TM} through water delivery system from d 0-4, 5-7 and 14-17 at 16, 7.3 and 11 g/p/d respectively. The control pigs (12 pens) received standard feeding program based on corn, soybean meal, plasma and whey. Live weight and feed intake were measured weekly. After 6 weeks, all pigs were individually weighed to determine variation of bodyweight by pen. Results were analysed as a randomised complete block design using Statistix^{TM}. Solutein^{TM} improved ADG during the first week (125 vs 88 g/d, $P < 0.001$) and numerically for the overall 6 week period (391 vs 370 g/d, $P < 0.10$). Feed intake was also improved with Solutein^{TM} the first week (137 vs 106 g/d, $P < 0.001$) and remained numerically improved each week without being significantly better ($P < 0.10$). For the entire period, feed intake was better for Solutein^{TM} fed pigs (544 vs 508 g/d, $P < 0.01$). Feed efficiency was not affected by treatment. End-weight was similar (21.81 vs 21.14 kg, $P = 0.28$) as was variation (13.56 vs 12.63 %, $P = 0.33$). Total mortality and culls was numerically reduced with Solutein^{TM} (2.94 vs 4.90 %, $P = 0.43$). A second trial was conducted with healthier (PRRS+ but stable) comingled pigs in two rooms. One room (18 pens, 17 pigs/pen) received Solutein# for d 0-4: 16g/p/d and a second room received standard program. Solutein^{TM} had no impact on ADG, ADFI, liveweight average (27.4 kg after 46 days) and variation (10.8%) but total mortality and culls was numerically reduced with Solutein^{TM} (0.98 vs 2.94 %, $P = 0.12$). Solutein^{TM} appeared to improve growth performances in health challenged pigs (PPRS+ non-stable) by improving feed intake and reducing the frequency of culls and mortality. Solutein^{TM} impacts could be different according to the PRRS status of recipient pigs.

Key Words: Piglets, Globulin protein

791 Weaner feed efficiency is determined by lower small intestine morphology. R. D. Slade* and H. M. Miller, *University of Leeds, Leeds, UK.*

Alterations to small intestine (SI) morphology following weaning are thought to influence pig growth performance. However, little information is available on the effect these changes have on feed efficiency (G:F). The objective of this study was to investigate the relationship between SI development and the efficiency of weaner growth. Twenty-four piglets (62.5% Large White, 25% Landrace, 12.5% Duroc) were weaned into individual mesh floor pens at 22 0.25 days of age (SEM) and 6.0 0.13kg liveweight. Piglets received a starter ration for 7 days (17.5 MJ DE/kg, 1.75% lysine) followed by a second stage ration (16.5 MJ DE/kg, 1.65% lysine). Diets were fed *ad libitum*. Individual feed intake and liveweight gain were recorded. Twelve pigs were killed for analysis on d7 following

weaning and 12 on d14. Mean crypt depth, villus height and villus diameter 100mm above the crypt villus interface were determined at points 25, 50 and 75% along the small intestine and crypt villus area estimated geometrically. Mean feed intake, weight gain and G:F were 175.2 13.5 g/d, 138.3 16.8 g/d and 0.71 0.07, respectively. Morphological measurements were similar throughout the tract and did not differ between d7 and d14 ($P > 0.05$). G:F was independent of villus and crypt dimensions at 25 and 50% positions ($P > 0.05$) and was poorly correlated with estimated crypt villus area for the same sites (linear, $R^2 = 0.18$, $P < 0.05$ and $R^2 = 0.13$, $P < 0.1$ respectively). At 75% G:F increased linearly with villus height ($R^2 = 0.27$, $P < 0.01$), villus diameter ($R^2 = 0.49$, $P < 0.01$) and crypt depth ($R^2 = 0.26$, $P < 0.05$) and quadratically with crypt villus area ($R^2 = 0.59$, $P < 0.001$). The relationships between feed efficiency and positional morphology were unaffected by days postweaning although regression coefficients and significances were improved at 14 compared to 7d. The results indicate that the distal SI plays a key role in determining piglet feed efficiency during the 2 weeks following weaning.

Key Words: Weaner, Gut morphology, Performance

792 Influence of litter size and creep feeding on preweaning gain and influence of preweaning growth on growth to slaughter in barrows.

John Klindt*, *USDA, ARS, U.S. Meat Animal Research Center.*

It has been advised that heavier weaning weights (Wnwt) are desired because pigs heavier at weaning attain market weights sooner. However, weaning ages have decreased and slaughter wts have increased, thus, Wnwt is a smaller proportion of the final wt. Herein, birth-to-weaning ADG (B-WADG) as a determinant of weight at a final age and yield of marketable pork was examined. Newborn pigs from 54 birth litters were crossfostered to create 47 assigned litters of 4 through 14 pigs/litter to create differences in B-WADG. Creep feed was offered from 5 d of age or for 2 d before weaning at 13 to 20 d. Data were obtained from 195 barrows slaughtered at an avg age of 170 d. Carcass dissection data were recorded. Analyses revealed a linear effect of assigned litter size ($P < 0.01$), linear effect of birth wt, kg ($P < 0.01$), and effect of birth dam ($P < 0.01$) on B-WADG, kg and Wnwt, kg. B-WADG and Wnwt were not influenced ($P > 0.71$) by creep feeding treatment. The importance of birth wt (Brwt), B-WADG, Wnwt, and Brwt plus B-WADG in determination of measures of postweaning growth and yield of marketable pork (sum of trimmed picnic, butt, loin, and ham) were examined by regression analysis. The initial models included the linear and quadratic effects of the independent variables. The models for wt at 170 d are presented below. In general, the R2s for other models ranked as for wt at 170 d. The results indicate positive relationships between B-WADG and measures of post-weaning growth and carcass yield, suggesting management practices that increase B-WADG may be advantageous in pork production. However, these data do not allow evaluation of costs and benefits of management changes that would increase B-WADG, and thus, increase postweaning growth rate.

Dependent var	Intercept	β (Brwt)	β (Brwt)^2	β (B-WADG)	β (Wnwt)	R^2
170 d wt, kg	54.8 ±15.1	59.3 ±18.9	-15.2 ±2.8	—	—	0.11
170 d wt, kg	98.3 ± 3.4	—	—	93.8 ±15.7	—	0.15
170 d wt, kg	82.5 ± 4.1	—	—	—	5.1 ±0.1	0.18
170 d wt, kg	47.7 ±14.4	50.5 ±17.9	-13.5 ±15.5	78.2 ±16.0	—	0.20

Key Words: Pigs, Weaning weight, Growth

793 Impact of pig weight at weaning. I. subsequent growth rate, feed conversion, and carcass composition.

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This study was conducted to determine the impact of high milk production on post-weaning growth of progeny. Three rearing strategies were used to produce piglet wean weights ranging from 4.1 to 8.6 kg. Litters of pigs were sow-reared until weaning (SR) (244), weaned at 2 d (2W) (228) or 14 d (14W) (226) of age. PIC C22 sows were randomly allocated to treatments based on parity. 2W and 14W groups were allowed *ad libitum* consumption of an acidified, medicated milk replacer using a semi-automated milk delivery system. Birth weights did not differ among treatments ($P > .05$). Litters were weaned from the sow or milk system at 19.5 ± 0.3 d of age. Pigs from 14W and 2W groups were 1.0 and 2.2 kg heavier respectively at 20 d of age compared to pigs from the SR group ($P < .05$). Pigs from the 14W group grew 35 g/d faster during the nursery period compared to pigs from the 2W group ($P < .05$). The ADG of SR pigs did not differ from the other two groups ($P > .05$). 14W pigs required 3.0 fewer d (164.7 d) to reach 125 kg compared to SR pigs ($P < .05$). SR and 14W pigs gained 936 and 932 g/d, respectively, during the finish period, which was 24 and 20 g/d faster than 2W pigs ($P < .05$). Feed conversion of SR pigs was 0.03 kg gain/kg feed better than 14W pigs (0.40, $P < .05$). Lean percent was 0.7% higher in carcasses from SR pigs (55.0%) compared to carcasses from 2W pigs ($P < .05$). Carcasses from SR pigs had 1.7 and 2.0 mm more Fat-O-Meater loin depth than 14W and 2W pigs respectively ($P < .05$). Adjusted weaning-to-estrus intervals for sows were 6.1, 8.1, and 13.8 d for the sows weaned at 19 d, 14 d, and 2 d of lactation, respectively ($P < .001$). We observed that a 1 kg increase in wean weight resulted in 8 kg at 140 d of age and that the sow is important to post-weaning piglet growth beyond the period of colostrum (SR *vs* 2W). This may involve facilitated development of the immune system, digestive system, or both.

Key Words: Pig wean weight, Milk supplement, Growth rate

794 Impact of pig weight at weaning. II. post-weaning growth and economic assessment of weights ranging from 4.1 to 8.6 kg.

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Six groups of pigs with mean 20-d wean weights of 4.6 (n = 41), 5.5 (n = 77), 6.4 (n = 112), 7.3 (n = 109), 8.2 (n = 77), and 9.5 kg (n = 41) were derived from sow reared (SR) litters or the combination of SR and milk supplement (19.5 ± 0.3 d of age). Pigs were allocated to pens of 15 (blocked by gender and weight) and fed by computerized Feed Intake Recording Equipment. Birth weight (BWT) averaged 1.43, 1.43, 1.49, 1.60, 1.71, and 1.85 kg for 4.6, 5.5, 6.4, 7.3, 8.2, and 9.5 kg groups, respectively. The estimate of the linear effect for BWT was 0.043 kg ($P < .001$). Growth rates in the nursery period for the 4.6, 5.5, 6.4, 7.3, 8.2, and 9.5 kg groups were 507, 530, 549, 579, 593, and 607 g/d with a linear estimate of 10.3 g/d ($P < .001$). Growth rates for combined nursery-finish periods were 752, 796, 804, 815, 825, and 831 g/d, respectively, with a linear estimate of 7.06 g/d ($P < .001$). Nursery-finish gain:feed ratio was similar, (0.41). Age at 125 kg averaged 176.8, 168.8, 167.8, 164.8, 162.9, and 160.9 d respectively. The linear estimate was -1.432 d ($P < .001$). Fat-O-Meter loin depths were 57.4, 58.1, 57.6, 56.4, 56.1, and 55.4 mm for the 4.6, 5.5, 6.4, 7.3, 8.2, and 9.5 kg weaning groups, respectively. Estimates of the linear effect were -0.24 mm ($P < .05$) for loin depth. Lean percent did not differ among groups. Return over feed for each weaning weight group was calculated assuming \$0.12/kg cost of finisher feed, \$1.32/kg carcass weight market price, and a premium of \$2.75/100 kg carcass weight for pigs with 54 to 56% lean. This resulted in a lean premium of \$2.22/pig. Carcass yield was assumed constant, 73.6%. Marginal revenue per pig produced was \$83.67 for the 4.6 kg group. This was \$5.13, \$7.24, \$8.67, \$10.88, and \$9.83 per pig less compared to the 5.5, 6.4, 7.3, 8.2, and 9.5 kg groups, respectively. This study illustrates the financial benefit of improved wean weight and provides important information when assessing management and selection strategies.

Key Words: Pig wean weight, Milk supplement, Growth rate

795 Influence of type of heat-processed cereal and oat hulls inclusion in the diet on nutrient digestibility and productive performance of young pigs.

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A trial was conducted to investigate the influence of substituting 30% of cooked corn by rice with or without the inclusion of 2.5% of cooked and expanded oat hulls on apparent fecal nutrient digestibility and performance of piglets weaned at 20 d. Each of the four treatments was replicated eight times. Diets were based on full-fat soybeans, fish meal, and milk products, and were fed from 20 to 40 d of age. Fecal nutrient

digestibility was determined at 33 d of age. At the end of the trial, piglets fed rice tended to grow faster (345 vs 315 g/d; P=0.08) but had same feed conversion than piglets fed corn. Adding oat hulls to the diet did not affect growth but improved feed conversion (1.51 vs 1.59 g/g; P<0.05). Apparent fecal digestibility of organic matter (76.0 vs 73.8%), crude protein (67.1 vs 62.8%), and gross energy (72.0 vs 69.0%) improved when oat hulls were included in the diet (P<0.01) but was not affected by the main cereal used. In a second trial we compared diets with 52% of heat-processed rice or corn and 0, 2, or 4% of cooked and expanded oat hulls. Each of the six treatments was replicated eight times and the trial lasted 20 d. At the end of the trial, average daily gain was greater for rice than for corn diets (315 vs 286 g/d; P<0.01) but feed conversion was not affected by the main cereal. Increasing the level of oat hulls did not affect performance from 20 to 29 d but improved feed conversion from 29 to 40 d of age (P<0.01). It is concluded that the inclusion of cooked rice in diets for piglets improves performance during the first 20 d after weaning. Also, the inclusion of a moderate amount of heat-processed oat hulls improves feed conversion from 29 to 40 d of age without modifying body weights at any age.

Key Words: Rice, Oat hulls, Piglets

796 The effect of the addition of a starter culture on the fermentation of liquid milled wheat. C. A. Moran*[1] and R. H. J. Scholten[2], [1]*Alltech Inc., Nicholasville, KY,* [2]*Beuker, Doetinchem, The Netherlands.*

A number of concerns have been raised about the fermentation of complete liquid feed diets as this may lead to protein fermentation products, palatability problems and reduced feed intake. An alternative strategy would be to ferment the carbohydrate fraction of the diet separately and combine it with the remainder of the diet immediately before feeding. The aim of this study was to examine the effects of a lactic acid bacteria inoculum on chemical and microbial composition during fermentation of Liquid Milled Wheat (LMW). In this study, LMW (210g DM kg^{-1}) was defined as whole grain wheat, hammer-milled through a 3mm sieve, mixed with water and steeped for 48 hours with mixing every two hours. Two treatments were assigned in triplicate to 45 L PVC storage tanks housed in a temperature-controlled room set at 24°±1°C. The control treatment (Con) received no starter culture whilst the other (SC) was inoculated (6 $\log_{10}$ cfu ml^{-1}) with a starter culture containing *Lactobacillus plantarum* and *Pediococcus pentosaceus*. Samples were removed at Time = 0, 24 and 48 h for chemical and microbiological analysis. Lactic and acetic acid concentrations were measured by capillary electrophoresis. Microbiological counts were determined from decimal dilutions of LMW samples in MRD and plated on MRS, MacConkey and Rose Bengal Chloramphenicol agar for lactic acid bacteria, coliforms and yeast, respectively. Data were analyzed by two-way ANOVA. The inclusion of the starter culture resulted in a lower coliform population (5.8 vs 6.7 $\log_{10}$ cfu ml^{-1}, $P < 0.001$) at the end of the 48h steeping period. However, lactic acid concentration, LAB numbers and pH were not different in Con and SC treatments after 48 h. Coliform inhibition in the SC treatment may have been due to the slightly elevated acetic acid concentration or other unknown anti-microbial fermentation products resulting from starter culture addition. These results indicate that the use of the LAB starter culture combination may prove beneficial during fermentation of LMW for liquid feeding applications.

Key Words: Fermented liquid feed, Liquid milled wheat, Lactic acid bacteria

Physiology
Reproduction

797 Evidence for uterine Effects on fetal Development in the Pig. S.C. Town*, J.L. Patterson, and G.R. Foxcroft, *Swine Research & Technology Centre,University of Alberta, Edmonton, Alberta, Canada, T6G 2P5.*

Even in a proportion of gilts, uterine crowding in early pregnancy has detrimental effects on placental development, with implications for fetal development and postnatal growth capacity. To study this phenomenon further, pregnant gilts (n = 23) underwent midline laparotomy at d30 of gestation to record embryo number in utero and ovulation rate. Subsequently, during farrowing, each piglet born was matched with its placenta using an umbilical tagging procedure and piglet birth weight and placental weight were recorded. Representative day-old piglets from each litter (n=45) were necropsied and brain:liver weight ratio was determined as a measure of intra-uterine growth retardation. In this group of gilts, number of embryos at d30 of gestation was strongly correlated to littersize at term (r^2 = 0.72; P < 0.0001). Although there was a strong positive correlation between placental weight at term and birth weight (r^2 = 0.76, P < 0.001), neither showed a strong inverse relationship to littersize born (r^2 = 0.12; P = 0.12; r^2 = 0.17; P = 0.05), suggesting that uterine capacity had only a moderate effect on intra-uterine development. However, as brain:liver weight ratio, an indicator of IUGR, showed a negative correlation with mean piglet birth weight (r^2 = -0.48; P < 0.001), and a positive correlation with litter size at term (r^2 = 0.35; P = 0.003), intra-uterine growth retardation, measured by changes in brain:liver weight ratio, appears to have been influenced by the intra-uterine environment to a greater extent than birth weight. The results of the current study indicate that even in the absence of extreme uterine crowding, a "brain sparing" effect occurs in lower birth weight neonates. Therefore, other aspects of fetal growth such as muscle fibre development, may also be affected.

Key Words: Swine, Uterus, Development

798 Estradiol benzoate (EB) delays new follicular wave emergence in a dose dependent manner after ablation of the dominant follicle in the ovaries of cattle. C.R. Burke*[12], M.L. Mussard[1], and M.L. Day[1], [1]*The Ohio State University, Columbus OH,* [2]*Dexcel Research Ltd, Hamilton, New Zealand.*

Estradiol benzoate (EB) induces atresia of the dominant follicle (DF) on the ovaries of cattle when progesterone is elevated. Reduction of estrogenic function in the DF occurs within 36 h, but emergence of the new follicular wave is typically observed 3 to 5 d after EB is administered. We tested the hypothesis that EB delays emergence of a new follicular wave in a dose dependent manner, independent of the status of the DF. At 6.4 ± .2 d after ovulation, all follicles ≥ 5 mm in diameter were aspirated in 26 postpartum cows, and animals immediately received 0, 1, 2 or 4 mg EB/500 kg BW by i.m. injection (n=6 or 7/group). Ovarian structures were monitored daily by ultrasonography from the d before aspiration to emergence of a new follicular wave. Blood samples were collected every 8 h to measure changes in concentrations of FSH. The time to peak FSH was defined as the interval from aspiration to the time of maximal FSH concentration. Time to peak FSH was 29.3 ± 4.0 h, 53.3 ± 4.5 h, 81.1 ± 15.5 h and 91.4 ± 8.2 h for the 0, 1, 2 or 4 mg EB treatments, respectively. Time to new follicular emergence was 1.5 ± .22 d, 3.3 ± .3 d, 4.0 ± .6 d and 4.4 ± .4 d, respectively. Peak FSH and new wave emergence occurred earlier (P<.05) in the 0 than in the 1, 2, or 4 mg EB treatments. These variables were similar among the 1 and 2 mg EB, and longer (P<.05) in the 4 mg EB when compared to the 0 or 1 mg EB treatments. The interval from peak FSH to new wave emergence was 15.7 ± 3.3 h and was not affected by treatment. Treatment with EB maintained the basal concentrations of FSH present during follicular dominance, and in a dose dependent manner, delayed the surge in FSH that stimulates new follicular development. These results show that the dose of EB, rather than the timing of atresia in the DF, determines the timing of new follicular emergence that follows treatment with EB.

Key Words: Estrous syncronization, Follicular development, Estradiol