

1563 Use of Prickly Pear forage in sheep diets. I. Mejia-Haro*¹, I.B. Camarillo-Solis¹, J. Mejia-Haro², and J.T. Frias-Hernandez², ¹CIGA ITA de Aguascalientes, Mexico, ²Universidad de Guanajuato, Mexico.

In Mexico, the use of grains in sheep diets is expensive, an alternative is the use of native forages in combination with grain byproducts. Prickly pear forage used in sheep diets may be useful. Prickly pear forage is found in native and cultivated arid and semiarid regions of Mexico. Although the protein and phosphorus content of this forage is low, the energy value is acceptable (2.6 Mcal/ kg of DE) and the calcium content and DMD are high. The objective of this study was to evaluate the inclusion of prickly pear forage in sheep diets. This study was carried out in the CIGA-ITA de Aguascalientes, Mexico in 2001. Twenty-four male sheep (BW 29.9 kg) of mixed crossed breed (Dorset, Suffolk and Rambouillet) were completely randomized and assigned to one of four treatments (inclusion of dehydrated Prickly pear in diet); T0, inclusion of 0% ; T20, 20%; T30, 30% and T40, 40%. The diets were formulated with 14 % of CP. Sheep were adapted to diets for 14 d, fed ad libitum during an experimental period of 62 d and weighed twice. Feed intake, feed efficiency and ADG were recorded. Feed samples were processed for DM, CP, NDF, ADF, and in situ DMD. Data were analyzed by ANOVA and Tukey tests by using the GLM procedure of SAS (1996). No significant differences ($P > .05$) were observed among treatments in ADG, the values were: T0 (222g), T20 (236 g), T30 (213 g), and T40 (253 g). Also no differences were found in values of DMD among treatments (T0,86%; T20,86%; T30,85%; T40,85%). The values of feed efficiency were: 4.6, 4.7, 5.7 and 4.6 for T0, T20, T30, and T40, respectively. In this study it was demonstrated that using 20, 30 and 40% of prickly pear in sheep diets the ADG obtained is similar to those using grains. It is important to consider the nutrient requirements of sheep for weight gain when prickly pear diets are fed although this forage most of the times is used for maintenance. Using diets with 20, 30 and 40% of prickly pear in sheep the average daily gains are like to those using grains.

Key Words: Forage, Diets, Sheep

1564 Effects of fibrolytic enzymes on degradation of Prickly pear forage (*Opuntia ficus-indica* L.(Mill)). M. A. Medina-Romo¹, C. R. Cruz-Vazquez¹, I. Mejia-Haro¹, G. Tirado-Estrada*¹, and G. D. Mendoza-Martinez², ¹CIGA ITA de Aguascalientes, Mexico, ²Colegio de Posgraduados, Texcoco, Mexico.

The objective of this study was to evaluate the effects of Prickly pear forage (PPF) treatment with exogenous fibrolytic enzymes (fibrozyme) on processes *in vitro* and *in situ* digestion and ruminal fermentation. Three experimental phases were conducted: Phase I. Previous digestion (pre-digestion; 24 h) and *in vitro* digestibility (48 h). Phase II. *In situ* digestibility (24 h). Phase III. Ruminal fermentation patterns. In phase I the effects of the level of the enzyme (E) were evaluated: 0 (control), 1.5 and 3 g /kg DM, with three application methods of the enzyme: 1) dry (DE); 2) dry + 250 ml of water (DE+W); 3) in a solution of 500 ml of water (SE). In Phase II, four E levels were used: 0, 1, 2 and 3 g /kg of DM, two treatment times of the PPF (0 h = T0 h and 24 h = T24 h), and two forage:concentrate ratios, one with 82:18 (DI), and the other with 73:27 (DII) (4x2x2). In Phase III, the effects of the four enzyme levels on digestibility were evaluated on six sampling times 0, 3, 6, 9, 12 and 24 h (4x6) after the application of the enzyme. During the pre-digestion phase the treatments affected neither the NDF nor the ADF disappearance. Treatments did not affect *in vitro* digestibility of DM (IVDMD). No effects were observed ($P > .05$) on the E levels on *in situ* DM digestibility and NDF, but DI surpassed to DII and T0 h surpassed to the T24 h in both variables ($P < .05$). The greatest concentrations of total VFA, acetate, propionate, and butyrate were obtained with 1 and 3 g of E at 3 and 9 h of sampling ($P < 0.05$). The highest concentrations of N-NH₄ were reached with 1 and 2 g of E at 3 h ($P < 0.05$). Results indicate that exogenous fibrolytic enzymes promote intra-ruminal changes in the fermentation process of PPF, but a more complete study is required.

Key Words: Fibrolytic enzymes, Forage, Prickly pear

Nonruminant Nutrition Antimicrobial Agents, Additives, and Fermentation Modulators

1565 Zinc oxide and avilamycin enhance pig performance. L. J. Broom¹, H. M. Miller*¹, K. G. Kerr¹, and P. Toplis², ¹University of Leeds, Leeds, UK, ²Primary Diets Ltd, Melmerby, UK.

Concern regarding antibiotic resistance and environmental pollution is likely to result in the elimination of antibiotic growth promoters (AGPs) and zinc oxide from EU pig diets. This experiment aimed to investigate what effect removing both avilamycin (AGP) and zinc oxide from the post-weaning diet would have on weaned piglet growth performance. Fifty two piglets (62.5% Large White, 25% Landrace, 12.5% Duroc) were weaned, at 21.2 ± 0.30 days of age (SEM) and 6.9 ± 0.16 kg BW, into commercial flatdeck accommodation. Six or 7 piglets were allocated to each pen (1.99 m²) on the basis of weight, litter and sex. Four pens were randomly allocated to one of 2 treatments. Treatments were: 1) Control - no supplementation, and 2) ZnO+ - supplemented with 0.31% ZnO and .004% avilamycin. Diets were formulated to contain 4,167 kcal DE/kg, 1.75% total lysine in Wk1, and 3,810 kcal DE/kg, 1.6% total lysine in Wk2 and 3. Thereafter, pigs received the same diets. Feed and water were provided *ad libitum*. From d20 pigs were housed in conventional grower-finisher accommodation. Piglets were weighed on d0, 20 and 118 post-weaning. Daily FI per pen was recorded from d0 to 20. Faecal samples were taken on d0 and 19 to determine total bacterial count. Data were analysed using the GLM procedure of Minitab 12.2. From d1-20, ZnO+ piglets ate more ($P < 0.01$), grew faster ($P < 0.001$) and had better FCR ($P < 0.05$) than Control piglets. ZnO+ piglets were heavier than Control pigs by d20 post-weaning (13.0 vs 11.7 kg, $P < 0.001$) and numerically heavier at slaughter (82.4 vs 79.3 kg). ZnO+ pigs had a lower total faecal bacterial count than the Control pigs on d19 (4.43×10^7 vs 1.69×10^8 colony forming units/g, $P < 0.05$). Omission of ZnO and avilamycin from the post-weaning diet reduced pig performance and increased days to slaughter at a specific weight.

Key Words: Zinc oxide, Avilamycin, Piglet growth

1566 Effect of dietary supplementation of probiotics (CalsporinTM) on sow and litter performance. Q. Yang*¹, S.K. Baidoo¹, R.D. Walker¹, T. Marubashi², and T. Imabayashi², ¹Southern Research and Outreach Center, University of Minnesota, MN 56093, ²Calpis USA Inc., Torrance, CA 90503.

The study was designed to determine the effects of dietary supplementation of CalsporinTM (probiotic) on sow, litter performance and microflora changes in the feces of sows. Fifty-two cross-bred sows were divided into 2 groups that were fed either a corn-soybean meal based diet or the basal diet supplemented with 0.1% Calsporin from d 80 of gestation until farrowing. After farrowing the concentration of Calsporin was reduced to 0.01% in lactation diets. The sows were on the same dietary treatments in lactation as in gestation. The sows were restricted fed (1%BW+500gms) and ad lib fed during lactation of a corn-soybean meal based diet. The results indicated that Calsporin had no effect ($P > 0.05$) on sow body weight changes and backfat thickness during gestation, litter size, average feed intake, and body weight changes during lactation. The total number of pigs born and weaned was not influenced by dietary treatment. The average daily gain (ADG) of piglets from sows fed Calsporin diet during gestation and lactation was 214.0g, which was significantly greater ($P < 0.05$) than 200.4g of the piglets from sows fed control diet. The number of Clostridium perfringens in the feces of Calsporin fed sows was less ($P < 0.05$) than in the feces of the control fed sows (6.13 log vs 7.13 log, CFU/g feces). The number of Bifidobacterium in the feces of Calsporin fed sows was higher ($P < 0.05$) than that of control the group fed sows (8.56 log vs 7.27 log, CFU/g feces). The number of total anaerobic bacteria in the feces of piglets from the sows fed Calsporin diet was less ($P < 0.058$) than in the feces of piglets from the sows fed control diet (9.54 log vs 10.22 log, CFU/g feces). In summary, Calsporin could improve body weight gain of the suckling piglets and increase the number of Bifidobacterium in sows during gestation and lactation.

Key Words: Sow and pigs, Probiotic, Performance and microflora

1567 Evaluation of CalsporinTM (Bacillus subtilis C-3102) on growth performance of nursery pigs. S.K. Baidoo¹, Q. Yang^{*1}, R.D. Walker¹, T. Marubashi², and T. Imabayashi², ¹*Southern Research and Outreach Center, University of Minnesota, MN 56093*, ²*Calpis USA Inc., Torrance, CA 90503*.

The objective of this study was to evaluate the use of CalsporinTM as an feed additive in the diets of nursery pigs. All diets for sows and piglets were not supplemented with antibiotic. Fifty-two cross-bred sows were allotted to two dietary treatments (1) basal corn-SBM diet; (2) diet 1 + 0.1% Calsporin based on body weight and parity from d 80 of gestation until farrowing. At farrowing, the dietary supplementation of Calsporin was reduced to 0.01%. A total of 144 pigs (BW of 5.5 kg and 21 d of age) were used in a 28-d growth assay. At weaning, treatments were arranged as a 2x2 factorial design with main effects of sows and nursery dietary supplementation. (1) basal-basal; (2) basal-Calsporin; (3) Calsporin-basal; (4) Calsporin-Calsporin with first treatments for sows and second treatment for piglets. For d 0 to 14, pigs in treatment 2 had increased (P<0.05) ADG than pigs in treatment 3 (Table 1). In conclusion, dietary supplementation of Calsporin to sow diets did not influence nursery pig performance, however, adding Calsporin to nursery diets at 100 mg/kg diet improved ADG of pigs.

Table 1. The effect of Calsporin on the Performance of weaned piglets

Sow		Sows fed control diet		Sows fed Calsporin diet	
Treatments					
Pig					
Treatments	Control	Calsporin	Control	Calsporin	P.
ADG					
(g, d 0-14)	127.2 ^{ab}	140.2 ^a	103.7 ^b	117.8 ^{ab}	<0.05
Feed/Gain	1.61	1.58	1.69	1.72	NS
ADG					
(g, d 14-28)	387.7 ^b	435.9 ^a	377.8 ^b	428.6 ^a	<0.05
Feed/Gain	1.56 ^a	1.48 ^b	1.59 ^a	1.50 ^{ab}	=0.05
ADG					
(g, d 0-28)	257.4 ^b	288.1 ^a	240.7 ^b	273.2 ^a	<0.05
Feed/Gain	1.58	1.53	1.63	1.60	NS

Note: Means with different superscript in each row are significant (P<0.05).

Key Words: Piglets, Probiotics, Performance

1568 Evaluation of germanium biotite as a substitute for antibiotics in growing pig diets. O. S. Kwon^{*1}, I. H. Kim¹, J. W. Hong¹, S. H. Lee¹, and Y. K. Jung², ¹*Department of Animal Resource & Science, Dankook University,* ²*Seobong Biobestech. Co., Ltd, Korea.*

This study was conducted to evaluate the effect of germanium biotite as a substitute for antibiotics in growing pigs. A total of 54 crossbred pigs (Landrace x Duroc x Yorkshire) initially 32.47±0.9kg BW were used in this experiment. Pigs were allocated into three treatments. Each treatment had three replicates with six pigs per replicate. This study was carried out for 35 days. The three treatments were negative control (NC: basal diet without antibiotic), positive control (PC: NC diet + 200ppm chlortetracycline) and GB0.3 (NC diet + germanium biotite 0.3%). ADG and ADFI for pigs fed PC and GB0.3 were higher (P<0.05) than for pigs fed NC. Pigs fed GB0.3 improved (P<0.05) gain/feed compared to NC treatment. DM and N digestibility were significantly different in PC and GB3.0 compared to NC (P<0.05). In conclusion, supplementation of germanium biotite 0.3% in diet has possibility as alternative substances of antibiotics in the diet of growing pigs.

Key Words: Pigs, Biotite, Antibiotics

1569 Effects of an in-feed antibiotic on the morphology of the porcine small intestine. V. Rayadurg^{*}, D.H. Zeman, M.B. Hildreth, and H.H. Stein, *South Dakota State University, Brookings, SD.*

The objective of the current experiment was to assess the effect of the antibiotic (carbadox) on the intestinal morphology. A total of 25 weaning piglets (DH x LYD) were used in the experiment. Pigs were weaned at 21 d and allotted to one of two treatment groups. A phase 1 diet was fed to appetite to the pigs during the entire experimental period. Pigs on treatment group 1 received this diet without any in-feed antibiotic.

Pigs on treatment group 2 received the diet with an antibiotic growth promoter (carbadox) included at 50 ppm. Small intestinal morphology and enterocyte mitotic index was assessed on the d of weaning (d 0), and on d 5 and d 10 of the experiment. Samples taken from the pigs included intestinal tissue obtained from 33%, 66%, and 100% of the length of the small intestine measured from the pyloric sphincter. Computerized morphometry and enterocyte mitotic index was performed on the intestinal sections. Results were analyzed using a three-way factorial analysis. For d 0, the mean villus height (VH) values were higher (P < 0.05) than for d 5 or d 10 regardless of the diet being fed post-weaning. Regardless of the site of sampling there was no effect of diet on VH. Within each diet, there was no difference (P > 0.05) between mean VH at site 33% and 66%. However, for both diets, VH at both these sites were higher (P < 0.05) than at site 100%. On d 0, site 100% had greater crypt depths (CD) than sites 33% and 66% (P < 0.05). For diet 1, the CD for site 66% at d 5 were greater than for the other two sites (P < 0.05). However, on d 10 site 100% had greater CD than site 66% (P < 0.05). For diet 2, CD were greater on d 10 regardless of sampling site. On d 5, pigs fed diet 1 had greater (P < 0.05) mean CD values at site 66% than pigs fed diet 2 (P < 0.05), but on d 10, pigs fed diet 2 had greater (P < 0.05) CD values than pigs fed diet 1. No effects of time, diet, or site were found for the mitotic index. Overall, the results of this experiment demonstrated that VH decreases after weaning while CD increases. An in-feed antibiotic such as carbadox can contribute to an amelioration of the increase in CD.

Key Words: Villus height, Crypt depth, Mitotic index

1570 Utilization of spray-dried egg protein containing specific egg yolk antibodies for weaned pigs. J. W. Hong^{*1}, I. H. Kim¹, O. S. Kwon¹, J. H. Kim², S. H. Lee¹, and J. M. Lee¹, ¹*Department of Animal Resource & Science, Dankook University,* ²*Agribands Purina Korea, Inc., Seoul, Koera.*

For the Exp. 1, thirty six Duroc x Yorkshire x Landrace pigs (6.55±0.10kg average initial BW and 21 d average age) were used in a 14-d growth assay to determine the effects of replacing spray-dried plasma protein (SDPP) with spray-dried egg protein containing specific egg yolk antibody (SDEP) on growth performance and nutrient digestibility in weaned pigs. Dietary treatments were 0, 3 or 6% SDEP contained 6, 3 or 0% SDPP, respectively. Through entire experimental period, ADG, ADFI and gain/feed tended to decrease as the concentration of SDEP in the diets was increased. However, there were not significant differences among the treatments. As the addition of SDEP in the diets was increased, apparent digestibilities of DM and N were decreased without significant differences. For the Exp. 2, thirty six Duroc x Yorkshire x Landrace pigs (2.63±0.04kg average initial BW and 10 d average age) were used in a 14-d growth assay to determine the effects of antibiotic replacement with SDEP on growth performance and digestibility in segregated early-weaned pigs. Dietary treatments included 1) CON (corn-dried whey-SBM based diet+0.08% antibiotic), 2) SDEP 0.5 (corn-dried whey-SBM based diet+0.5% SDEP), 3) SDEP 1.0 (corn-dried whey-SBM based diet+1.0% SDEP). ADG and gain/feed of pigs fed SDEP1.0 diet were higher than pigs fed CON diet without significant difference. Pigs fed the diet with SDEP 1.0 tended to have increased apparent digestibilities of DM and N on compared to pigs fed the CON diet without significant differences. In conclusion, the SDEP supplementation seemed to be partial replacing the SDPP portion of high nutrient dense diet and to be approximately 1.0% or more when the pigs fed the antibiotic-free diet for early-weaned pigs.

Key Words: Animal protein, Egg yolk antibody, Pigs

1571 Dietary effect of egg immunoglobulins containing anti-pathogenic antibodies to pre- and postweaning pigs on growth performance till market weight. C. Y. Liu^{*1}, B. J. Chang¹, G. Y. Lee¹, and Y. Kodama², ¹*Animal Technology Institute Taiwan, ROC,* ²*Immunology Research Institute, Japan.*

Two experiments were conducted to evaluate the effect of feeding egg immunoglobulins (Ig) containing anti-pathogenic antibodies to pre- and postweaning pigs on growth and subsequent performance till market weight. In Exp. I, 20 litters of 14-day old piglets (8 pigs/litter) were fed either a control or Ig supplemented diet, in which Ig was obtained from laying hens immunized with ETEC K88, K99, 987P, porcine rotavirus and PED virus, at 4.0% for 14 days before weaning and at 0.2% for 28 days after weaning. Diets supplemented with Ig significantly (P<.01)

increased ADG during both pre- (205 vs 226 g/d) and postweaning (375 vs 414 g/d) periods. Postweaning F/G was also improved by Ig (1.74 vs 1.64, $P < .05$). In Exp. II, 20 litters of preweaning piglets (14 days of age, 8 pigs/litter) were fed a diet with or without anti-EPEC K88 and K99 Ig antibodies at 0.5% for 14 days before weaning and at 0.035% for 28 days after weaning. Dietary Ig supplement improved ($P < .05$) ADG by 7.1% (269 vs 288 g/d) and 14.2% (393 vs 449 g/d) for pre- and postweaning period, respectively, as well as postweaning F/G (1.62 vs 1.47, $P < .01$). Subsequently, the growth performance (Exp. II) remained superior in Ig-fed group from 20 kg to market weight (ADG: 747 vs 801 g/d, $P < .01$; ADFI: 2242 vs 2323 g/d, $P > .05$; F/G: 3.00 vs 2.90, $P < .05$). Since less diarrhea and lower mortality were observed in Ig-fed young pigs, these results demonstrate that feeding anti-pathogenic antibodies to weaning pigs can protect pigs from infection and improve growth performance till growing-finishing phase.

Key Words: Pigs, Immunoglobulin, Performance

1572 Effects of dietary bacterial biodegradation velocity and electrolyte balance on nutrient digestibility, retention, and excretory patterns in finishing pigs. Z. Mroz^{*1}, A.J. Moeser², J.Th.M. van Diepen¹, and J. Kogut¹, ¹*Institute for Animal Science and Health, Lelystad, The Netherlands*, ²*North Carolina State University, Raleigh, NC, USA*.

Effects of dietary bacterial biodegradation velocity (BBV) and electrolyte balance (dEB=Na+K-Cl) were investigated with ten ileal cannulated pigs of 60 kg BW, according to a balanced row-column design. The BBV is a measure of dietary fermentative potential expressed in time (h) needed for a progressive anaerobic gas production (in vitro). Ten diets were formulated of barley, wheat, tapioca, soybean meal, corn products, soybean hulls, beet pulp, and K_2CO_3 to obtain two levels of dEB (180 and 360 mEq/kg), each with five BBV times (7.7, 9.2, 9.4, 10.6, and 12.1 h). Daily energy allowance ($2.4 \times ME_m$) was given in two wet meals (3 L of water per 9.2 MJ NE_g). No interactive effects of BBV and dEB were found, irrespective of the response parameter. Daily production of feces and urine was affected ($P < .05$) by BBV, and not by dEB. With a longer BBV time, more feces and less urine were excreted. Apparent digestibility (ileal/overall) of DM, OM, and CP diminished ($P < .05$) with increasing BBV time, whereas no effect of dEB (except for ash) was found. Body N retention was not affected by BBV, whereas it tended ($P = 0.068$) to be greater in pigs fed low dEB. Daily amounts of fecal N were greater ($P < .001$) with increasing BBV time, whereas urinary losses of N were similar. Reduced dEB tended to lower urinary N ($P = 0.082$), and to increase N retention ($P = 0.068$). Ratios of urinary to fecal N were affected by BBV ($P < .001$), and prolonging BBV time from 7.7 to 12.1 h resulted in "shifting" 28% of urinary N (easy degradable) into fecal bacterial N (less degradable). Thereby, a velocity of indoor ammonia volatilization could be slowed down.

Key Words: Pigs, Dietary fermentative velocity, Nutrient balance

1573 Effects of in-feed acidifiers for multiparous sows. Z. Mroz^{*1} and W. Krasucki², ¹*Institute for Animal Science and Health, Lelystad, The Netherlands*, ²*Agricultural University of Lublin, Lublin, Poland*.

Two in-feed acidifiers in graded doses were used for sows to study reproductive responses, nutrient digestion, and the inhibition of bacteriuria, lactation failure (PHS), and ammonia emission from manure. In Exp.1, 32 multiparous sows of 150 kg BW were fed a cereal-soybean meal-rapeseed meal-based diet with 0.0, 0.3, 0.6, and 0.9% of blended propionic and formic acids (1:3) over one reproductive cycle. In Exp. 2, 24 pregnant sows of 180 kg BW received a basal diet with Na-benzoate (0.0, 0.2, 0.4, and 0.8%) at free access to water. No PHS was noted in both experiments. In Exp. 1, sow's BW changes in pregnancy or litter size/weight at birth were similar ($P > .05$) among the groups. Lactating sows tended ($P < .01$) to increase milk production at greater ($P < .05$) contents of fat and PUFA (except for C18:3). Also, piglet's BW at weaning, and the ileal digestibilities of lysine, cystine, and histidine in lactation diets were improved ($P < .05$). In Exp. 2, voluntary feed intakes and growth rates were similar ($P > .05$) among the groups. Sodium-benzoate at the highest dose reduced ($P < .01$) urinary bacterial populations (from 10^6 at mating to less than 10^3 at farrowing), urine pH (by up to 2.2 units), and ammonia emission from manure (by up to

43.2%). These data imply that acidifiers for sows may inhibit periparturient hypogalactia syndrome, bacteriuria, and(or)ammonia emission from manure.

Key Words: Sows, Acidifiers, Bacteriuria

1574 The interaction between lactofeed level and soybean meal on growth performance of weanling pigs. J. V. O' Doherty^{*1}, C. S. Nolan¹, J. J. Callan¹, and P. McCarthy², ¹*University College Dublin, Ireland*, ²*Volac International, UK*.

A 3 x 2 factorial experiment was conducted to investigate the interaction between lactofeed 70 (LF70) (800 g/kg lactose, 200 g/kg soybean meal, Volac International, UK) levels and soybean meal inclusion (SBM) (9% and 22.5%) from d 0 to d 25 (starter period) after weaning on growth performance and diet digestibility. A common diet was fed from d 26 to d 38. Dietary treatments were established by substituting LF70 for extruded wheat and soybean meal for potato protein (PP) and soy protein concentrate (SPC). Digestible energy and amino acids were maintained by adjusting soy oil and synthetic amino acids. A total of 248 pigs (initially 7.3 kg and 25 +/- 4 d of age) were allotted randomly to 6 treatments containing (1) 0 LF70 with 4% PP and 4% SPC (2) 0 LF70 with 22.5% SBM (3) 17.5% LF70 with 4% PP and 4% SPC (4) 17.5% LF70 with 22.5% SBM (5) 35% LF70 with 4% PP and 4% SPC and (6) 35% LF70 with 22.5% SBM. There was an increase in average daily gain (ADG) (0.182 vs 0.292 vs 0.318 kg, sem 0.0089; $P < 0.001$), feed intake (0.413 vs 0.472 vs 0.489 kg, sem 0.0139; $P < 0.01$) and feed efficiency (FE) (2.12 vs 1.55 vs 1.49 kg, sem 0.057; $P < 0.001$) as the level of LF70 increased during the starter period. From d 26 to d 38, the pigs fed the starter diets containing 0% LF70 had an improved ADG ($P < 0.05$) and FE ($P < 0.001$) compared to the pigs fed 17.5 and 35% LF70. There was an increase in live weight (18.1 vs 20.2 vs 21.1 kg, sem 0.335; $P < 0.001$) at d 38 as the level of LF70 increased. There was an interaction between LF70 and SBM in the apparent digestibility of gross energy (GED) and nitrogen (ND). Pigs fed higher SBM diets had a higher GED ($P < 0.01$) at the 35% LF70 inclusion than pigs fed PP and SPC diets. However, there was no difference in GED at the 0 and 17.5% LF70 inclusion. Pigs fed higher SBM diets had a higher ND ($P < 0.05$) at the 35% LF70 inclusion than pigs fed PP and SPC diets. However, at 0 and 17.5% inclusion the pigs fed the higher SBM had a decreased ND ($P < 0.05$) compared to the pigs fed PP and SPC diets. In conclusion, the inclusion of LF70 increased ADG, feed intake and FE.

Key Words: Piglets, Lactofeed, Soybean

1575 Interaction between lactofeed level and antimicrobial growth promoters on growth performance of weanling pigs. J. V. O' Doherty^{*1}, C. S. Nolan¹, and P. McCarthy², ¹*University College Dublin*, ²*Volac International, UK*.

In experiment 1, 184 pigs (initially 8.85 kg and 28 +/- 2 d of age) were used in a 2 x 2 factorial arrangement of treatments to investigate the interaction between lactofeed (LF70) (800 g/kg lactose, 200 g/kg soy bean meal, Volac International, UK) level (17.5% and 35%) and avilamycin (0 and 200 ppm of maxus, Elanco Animal Health) inclusion in piglet starter diets. Pigs were fed starter diets from d 0 to d 22 and a transition diet was fed from d 23 to d 39. The inclusion level of LF70 in the transition diet was 7.5% and 15%. Pigs fed 35% LF70 had a higher ADG ($P < 0.05$) during the starter period than the pigs fed 17.5% LF70. Pigs fed medicated diets had a higher ADG ($P < 0.01$) and an improved feed efficiency (FE) ($P < 0.05$) compared to the non medicated fed pigs. There was an increase in feed intake (AFI) ($P < 0.05$) during the transition period with increasing levels of LF70. There was an improvement in FE during the transition period with the inclusion of maxus ($P < 0.005$). There was a significant interaction ($P < 0.01$) between LF70 and maxus for ADG during the transition period. The inclusion of maxus at 17.5% LF70 inclusion had no effect ($P > 0.05$) on ADG. However at 35% LF70 inclusion the pigs offered medicated diets had a higher ADG ($P < 0.001$) compared to non medicated diets. In experiment 2, 184 pigs (initially 8.85 kg and 28 +/- 2 d of age) were used in a 2 x 2 factorial to investigate the interaction between LF70 level (17.5% and 35%) and zinc oxide (ZnO) (0 and 3.1 kg/metric tonne) inclusion in piglet starter diets. The inclusion level of LF70 in the transition diet was 7.5% and 15% and ZnO was 2 kg/metric tonne. There was a significant increase ($P < 0.05$) in ADG and an improvement in FE with increasing levels of LF70 during the starter period. The inclusion of ZnO during the starter period resulted in an increase ($P < 0.05$) in ADG and FE compared to

no ZnO inclusion. Neither the inclusion of zinc oxide or LF70 had an effect ($P>0.05$) on performance during the transition period. In conclusion the supplementation of starter diets with increasing levels of LF70, ZnO and avilamycin resulted in increased ADG and improved FE.

Key Words: Pigs, Lactofeed, Avilamycin

1576 Effect of dietary soy isoflavone concentrations on pig growth and meat quality. T.S. Stahly* and T.R. Lutz, Iowa State University.

The effects of four concentrations of dietary soy isoflavones on growth and meat quality of pigs fed from 27 to 119 kg BW were evaluated. Twelve sets of four littermate pigs (6 sets of barrows, 6 sets of gilts) were individually penned and randomly allotted within the litter to a basal (corn-soy concentrate, about 24 ppm isoflavone) diet supplemented with 0, 1x, 2x or 3x ppm of soy isoflavones during each of three stages of growth. The 1x increment represented addition of 180, 120 and 80 ppm isoflavones on an aglycone basis, in stage 1, 2 and 3, respectively. Isoflavones were provided as a soy extract (Novasoy, ADM) which consisted of 21% genistein, 15% daidzein, and 4% glycitein. These isoflavone concentrations are representative of those in diets containing traditional soybean meal with zero, low, medium or high concentration of isoflavones. At 119 kg BW, pigs were slaughtered and carcass and ham composition, longissimus meat quality, and selected muscle weights were determined. Dietary isoflavone concentrations did not alter daily BW gain or gain/feed ratios during any of the three stages of growth. Estimated carcass fat-free lean and dissected ham muscle and fat tissue content also were not altered by isoflavone regimen. Weight of four red-fibered muscles were unaffected by isoflavone addition, while weight of three white-fibered muscles were ($P=.06$) reduced due mainly to the response of the biceps femoris muscle. Meat quality of the longissimus as reflected in ultimate pH, Hunter L, a, b values, and retail water loss percentage also was not affected by isoflavones. In these data, soy isoflavones at dietary concentrations below 240 ppm for finishing pigs did not alter carcass muscle content or meat quality.

Key Words: Pigs, Soy isoflavones, Growth

1577 Evaluation of chicory inulin extracts as feed additive for early-weaned pigs. G He*¹, S.K. Baidoo¹, Q. Yang¹, D. Golz², and B. Tungland³, ¹Southern Research and Outreach Center, University of Minnesota, MN 56093, ²Encore Technologies, MN 55305, ³Imperial Sensus, TX 77487.

This study was done to evaluate the effects of dietary inclusion of chicory inulin extract on the performance of early-weaned pigs. One hundred and eighty early-weaned (17-d old, 6.0 kg BW) crossbred pigs were allotted into five dietary treatments. The dietary treatments were (1) corn -soybean meal based diet - the basal diet, (2) basal diet + inulin in water, (3) basal diet + inulin in water and feed, (4) basal diet + inulin in feed and (5) basal diet + ASP 250 antibiotic in feed. Inulin supplemented diets fed to pigs in treatments 3 and 4 contained 0.5%, 0.2% and 0.1% inulin in phases 1 (wk 1), 2 (wk 2) and 3 (wk 3 and 4) respectively. Treatment 5 contained 0.25% ASP 250 in all three phases. Treatments 2 and 3 received inulin in water medicator (132 g/L) for 14 days and were maintained on their respective dietary treatments until d 28 of the study. The average daily gain (ADG) for the five dietary treatments was 192.7 g/d, 208.5 g/d, 203.9 g/d, 189.8 g/d, and 196.2 g/d, respectively. In phase 2, pigs fed inulin in feed or water tended to grow faster ($P<0.08$) than the control group (335.7 g/d, 355.1 g/d, 355.4 g/d, 374.1 g/d and 371.0 g/d for the respective five dietary treatments). Inulin in both water and feed did not ($P>0.05$) improve pig performance compared to pigs supplemented with inulin in water or feed only. In phase 3, pigs fed diets supplemented with antibiotics gained more ($P<0.05$) weight than other dietary treatment groups (476.5 g/d vs 399.9 g/d, 422.4 g/d, 402.7 g/d, and 425.5 g/d for treatments 1, 2, 3, and 4, respectively). In conclusion, supplementation of inulin in water or feed tended to improve average daily gain and feed conversion efficiency during the 28-d study.

Key Words: Inulin, Early-weaned pigs, Growth performance

1578 Milky flavor alone but not in combination with sweeteners improves preference at the dietary change from piglet prestarter to starter feeds. E. van Heugten*¹, E. Roura², and M. Gibson³, ¹North Carolina State University, Raleigh, NC, ²Lucta SA, Barcelona, Spain, ³Lucta USA Inc., Northbrook, IL.

Two flavors were assayed in a two double-choice (flavored vs. non-flavored) treatment design. The two flavors tested were both based on milky notes but flavor 1 had a sweetener added (289 ppm saccharine and 300 ppb neohesperidin dihydrochalcone in final feeds) and distinctive vanilla-coconut notes and flavor 2 had no sweetener added and distinctive vanilla-cheese notes. Pigs (5.92±0.01 kg BW) were weaned at 18 days of age, blocked by weight within gender and housed in 12 equally sized indoor nursery pens containing 3 barrows and 3 gilts. Pigs were simultaneously offered 2 identical feeders with the two diets (with and without flavor). Feeders within a pen were switched on a daily basis. Pigs had access to prestarter diets until the average feed consumption per pig for pens within a block had reached 2.27±0.11 kg of feed. At that point diets were changed to the starter feed until the average feed consumption per pig for all pens within a block had reached 9.07±0.45 kg of feed. During the prestarter phase, piglets showed initial neophobia to flavor 1 (30, 32, 31, 35, and 35 compared to the control set at an index of 100 ($P<0.05$) for 5, 4, 3, 2, and 1 d prior to the diet switch, respectively), while no preference or rejection ($P>0.10$) was shown for flavor 2 (66, 123, 89, 110, and 106 compared to the control). Up to 5 days following the diet change, piglets in treatment 1 showed equal preference for flavor 1 vs. the control (85, 61, 62, 72, and 82 compared to the control ($P>0.10$) for 1, 2, 3, 4, and 5 d following the diet change, respectively) while piglets in treatment 2 preferred flavor 2 over the control (190 ($P<0.10$), 156 (NS), 255 ($P<0.05$), 190 ($P<0.10$), and 223 ($P<0.05$)). It is concluded that in treatment comparison 1 control feed was preferred over a combination of flavor and sweeteners, except following the dietary change, while in treatment 2 flavor was preferred over the control particularly after the dietary change.

Key Words: Flavors, Sweeteners, Preference

1579 Interactive effects of diet complexity and a combination of flavor, acid and enzymes on growth of starter pigs. E. Roura*¹, M. Gibson², and J. Brennan³, ¹Lucta SA, Barcelona, Spain, ²Lucta USA, Northbrook IL, USA, ³Maple Leaf Foods Agresearch, Burford, ON Canada.

The effects of dietary supplement (Luctaplus[®] at 0 or 5 kg/tonne) and diet complexity were evaluated in a 2 x 2 factorial design with eight replicate blocks. The feed supplement consisted of a combination of a milky vanilla flavor, organic (citric and lactic among others) and inorganic acids (phosphoric), in addition to several enzyme activities, primarily protease and amylase. Complex and simple diets contained 5.0 or 2.5% plasma protein in phase 1 (week 1), 2.5 or 0% plasma protein in phase 2 (week 2) and 3.0 or 0% fish meal in phase 3 (week 3, 4). All diets contained 20% whey powder in phase 1 and 10% in phase 2. Simple and complex diets were isocaloric, were formulated to the same essential amino acid specifications (NRC, 1998) and contained 22 ppm lincomycin. A total of 192 pigs were weaned at approximately 21 days of age and randomly assigned to pens within block. There were four pens per block and six pigs per pen. Weekly bodyweight, feed intake and fecal consistency scores were recorded throughout a 28-day growth period. There were no significant main effects of treatment on bodyweight but there was a significant interaction effect on day 21 ($P<0.02$) and day 28 ($P<0.01$) bodyweight. Luctaplus[®] supplementation of simple diets significantly ($P<0.05$) increased final bodyweight from 14.5 to 15.3 kg which was not significantly different from that of pigs fed the complex unsupplemented diet (15.1 kg). There were no significant main effects of treatment on feed intake but there were significant interaction effects on feed intake for the day 7-14 ($P<0.02$), day 0-21 ($P<0.04$) and day 0-28 ($P<0.01$) periods. Luctaplus[®] increased ($P<0.05$; day 7-14) feed intake of pigs fed simple diets but reduced ($P<0.05$) overall intake of complex diets. There were no significant ($P>0.05$) main or interactive effects of treatment on feed efficiency and fecal scores. It is concluded that flavor, acid and enzyme supplementation of a simple diet resulted in growth performance and feed efficiency which were not significantly different from those of pigs fed a complex diet.

Key Words: Starter pig, Plasma protein, Flavor acid enzyme

1580 Effects of germanium biotite supplementation on the growth performance and serum characteristics in nursery pigs. O. S. Kwon^{*1}, I. H. Kim¹, J. W. Hong¹, S. H. Lee¹, and Y. K. Jung², ¹*Department of Animal Resource & Science, Dankook University, Cheonan,* ²*Seobong Biobestech. Co., Ltd, Korea.*

This study was conducted to determine the suitability of germanium biotite for a dietary supplement on growth performance, nitrogen digestibility and serum characteristics in nursery pigs. A total 60 crossed pigs (average 15.09±0.18kg BW, Landrace×Duroc×Yorkshire) were used in this experiment. Pigs were allocated into five treatments. Each treatment had three replicates with four pigs per replicate. This study was carried out for 28 days. The five treatments were control (Con: basal diet), GB0.1 (basal diet+germanium biotite 0.1%), GB0.3 (basal diet+germanium biotite 0.3%), GB0.6 (basal diet+germanium biotite 0.6%) and GB1.0 (basal diet+germanium biotite 1.0%). During 0 to 14 days, ADG, ADFI and Gain/feed were not significantly different among the treatments. During 14 to 28 days and overall experimental period, ADG and Gain/feed were not significantly different among the treatments. However, ADFI was significantly increased in GB0.6 treatment (P<0.05). DM and N digestibility were not significantly affected by treatments. In total-cholesterol, difference between d 0 and d 14 was decreased in GB3.0 treatment. However, there was no significant difference among the treatments. HDL-cholesterol was significantly increased in GB3.0 treatment compared to Con (P<0.05). LDL-cholesterol was significantly decreased in GB3.0 treatment with difference between d 0 and d 14 (P<0.05). IgG significantly increased to 86.6% in GB0.1 treatment compared to Con (P<0.05). In conclusion, the results obtained from this feeding trial suggest that below 0.6% supplementation for nursery pigs had improved immunostimulation and decreased cholesterol level in serum.

Key Words: Pigs, Biotite, Growth

1581 Dietary botanical product improves performance of nursery pigs. B. Z. de Rodas^{*}, B. L. Miller, R. Walker, D. A. Nelson, and J. Marin-Guzman, *Land O'Lakes, Webster City, Iowa/USA.*

Four experiments were conducted to determine the effect of a botanical product (BP) on the growth performance of nursery pigs fed diets with or without antibiotics (AB). The BP (Fresta, Delacon, Austria) was a mixture of essential oils, herbs, and spices. Treatments were replicated with six pens of three (Exp. 1 and 4) or five to six (Exp. 2 and 3) pigs each. All experiments were 35 days in length with experimental periods ranging from 7 to 11d, (Phase 1), 10 to 14 d (Phase 2), and 14 d (Phase 3). The diets for Phase 1, 2, and 3 contained 1.6, 1.3, and 1.2 % lysine, respectively. All Phase 1 diets contained Carbadox, while Phase 2 and 3 diets contained Chlortetracycline, Sulfathiazole and Penicillin. In Exp. 1 and 2, pigs (initial weight of 6.6 and 6.3 kg, respectively) were fed diets with 0 and 0.05% BP, with or without AB. In Exp. 1, BP improved overall ADG and F:G (P < 0.05). In Exp. 2, AB improved overall ADG (P < 0.01), ADFI (P < 0.05), and FG (P < 0.01). In Exp. 3, pigs with an average initial weight of 6.3 kg were fed a basal diet with 0.05% BP, the basal diet +AB, or the basal diet +BP and AB. For the overall 35 d experiment, the combination of both AB and BP improved (P < 0.05) ADG and F:G compared to the single additions of BP or AB. Pigs fed the basal diet +BP had improved (P < 0.05) F:G compared to pigs fed the basal diet +AB. In Exp. 4, pigs (initial weight of 6.6 kg) were fed a control diet containing AB with or without 0.05% BP for 35 d. The BP improved (P < 0.1) overall F:G. These data suggest that this BP improves the growth performance of nursery pigs. The observed improvement in growth performance of pigs fed BP appeared to be most evident during Phase 2 and 3.

Key Words: Nursery pigs, Botanicals, Antibiotics

1582 Effect of plant extracts and formic acid on the performance and gut microflora of early-weaned piglets. E. G. Manzanilla^{*1}, M. Martin¹, F. Baucells¹, J. F. Perez¹, C. Kamel², and J. Gasa¹, ¹*Universitat Autònoma de Barcelona,* ²*AXISS France, S.A.S. Archamps, France.*

Two hundred and forty early (20 ± 2.0 d) weaned piglets (6.0 ± 0.46 kg BW) were randomly distributed in 24 replicates and fed a milk by-products diet without additives during a pre-experimental period of 12d. After this adaptation, a 3×2 experimental design resulting from the

combination of three levels of XTRACTTM (0, 150 and 300 ppm), a commercial product based on plant extracts, with or without the addition of 0.5% formic acid was carried out. A single experimental diet (ME: 3.3 Mcal/Kg, CP: 19.46%, Lys: 1.29%) was formulated with 60% of cereals (corn, barley and wheat) and 31% of soybean products (meal and full fat). Voluntary consumption and weight gain were measured on a 22-day period. Finally 8 piglets per treatment were slaughtered and samples from ileum digesta were taken for determination of total purine bases concentration (PB) (as an index of microbial mass) and counts of *enterobacteria* and *lactobacilli* (log₁₀CFU/g fresh weight content). Feed intake (647.6 ± 95.6, g/d), ADG(425.8 ± 57.0, g/d) and OMD (87.1% ± 3.6) were unaffected by treatment. However, piglets fed the 0.5% formic acid plus 300 ppm XTRACTTM diet compared to piglets fed the 0.5% formic acid diet tended (P < 0.07) to have higher ADG (g/d) after 14 days (432.6 vs 391.4) and 21 days (447.1 vs 417.0). A F4 (K88) ETEC (enterotoxigenic E. coli) episode occurred and five casualties were registered (4 animals from the replicates without XTRACTTM (two with and two without formic acid) and one from the 150 ppm of XTRACTTM with formic acid). The PB (mmols/g DM) in ileal contents showed a significant decrease as a result of the inclusion of 300 ppm of XTRACTTM (10.84 and 10.34 vs 6.84, P < 0.01) for 0, 150 and 300 ppm of XTRACTTM, respectively. The inclusion of 300 ppm of XTRACTTM also promoted a decrease of *enterobacteria* counts (5.85 and 6.06 vs 5.44, P = 0.16) coupled with a significant increase in *lactobacilli* counts (7.59 and 7.72 vs 8.31, P < 0.05).

Key Words: Plant extracts, Weaned piglets, Lactobacilli

1583 Supplementation of diets with herbal extracts enhances growth performance in newly-weaned piglets. M. Radford^{*1}, E. Jeaurond¹, B. Schumann², M. Clunies², and C.F.M. de Lange¹, ¹*University of Guelph,* ²*Grand Valley Fortifiers, Cambridge, Ontario.*

Concerns about food safety and public health force the pork industry to find alternatives to in-feed antibiotics. The effects of feeding a herbal extract product (HE; containing cinnamon, thyme and oregano) on growth, fecal consistency score (on a scale of 1 to 2) and blood parameters (counts for total and various types of white blood cells) were evaluated in purebred Yorkshire piglets weaned at 16-19 days (d) of age over a three-week period. Dietary treatments were: 0% (CON), 0.25%, 0.5%, 0.75% inclusion level of HE and a medicated control (MED; 55 mg carbadox in finished feed). A total of 27 pens, each with 6 pigs, were utilized (5 pens per diet, 7 for MED). In week 1, ADG was improved (P < 0.05) when feeding 0.5% and 0.75% HE, as compared to feeding CON (25 and 26 vs -5 g/d, respectively; SEM 9), while it was intermediate (P > 0.10) for the other diets (17 and 1 g/d for MED and 0.25% HE, respectively). In week 1, gain:feed (G:F) was higher (P < 0.05) for 0.5% and 0.75% HE than for 0.25% HE (0.30 and 0.32 vs -0.41, SEM 0.41), while it was intermediate (P > 0.10) for the other diets. During weeks 2 and 3, no diet effects on ADG and G:F were observed (P > 0.10). At 21 d post-weaning, 0.5% HE resulted in higher (P < 0.05) BW as compared to CON (8.84 kg vs 7.99 kg, SEM 0.23). Results were intermediate (P > 0.10) for the other diets: 8.6 kg, 8.19 kg and 8.32 kg for MED, 0.25% and 0.75% HE, respectively. ADG during the first week following weaning and BW at 21 d post-weaning for 0.5% and 0.75% HE were similar (P > 0.10) to MED. On d 14, piglets fed 0.75% HE had an improved (P < 0.05) fecal consistency score over CON (1.23 vs 1.55; SEM 0.10). There were no meaningful differences (P > 0.10) between diets for the blood parameters. Supplementation of diets with HE enhanced ADG in week 1, BW at d 21 and fecal scores at d 14 post-weaning, although it did not influence other selected indicators of piglet health.

Key Words: Piglets, Herbal extract, Performance

1584 Fermentation and microbial kinetics along the large bowel of growing pigs (20-60 kg) fed on 25% of cornstarch and raw potatoe starch. D. Martínez-Puig, E. G. Manzanilla^{*}, J. F. Pérez, M. Anguita, J. Morales, and J. Gasa, *Universitat Autònoma de Barcelona, Barcelona/Spain.*

Twelve growing pigs (Landrace, initial BW 26 ± 3.6) were randomly distributed in two dietary experimental treatments based on ground barley (29%), soybean meal (33%) and purified starch (25%), obtained either from corn (Diet CS) or raw potatoe (Diet RPS). Diets were characterized by their different content in resistant starch (52 g/kg CS; 143 g/kg RPS), and offered twice daily at 90% of the predicted voluntary intake.

From day 24, urine was collected for a 3 d period, and a sample frozen until analysis of N. On day 38 after dietary presentation, animals were slaughtered, the whole gut excised, ligated and digesta samples obtained from the caecum, proximal-, medium- and distal- colon, and rectum. Digesta samples were analyzed for their content of volatile fatty acid (VFA) and purine bases (PB). Urinary nitrogen excretion tended ($P < 0.11$) to be higher with CS (20.5 g/d) than RPS (15.98 g/d). Fermentation parameters in the large bowel showed differences between experimental diets. With both diets, VFA concentration increased from ileum to proximal colon and decreased thereafter. However, higher VFA concentrations were observed in the proximal colon with RPS than CS (222.09 vs 162.14 mmol/g; $P < 0.01$). PB concentration linearly decreased from the proximal colon to rectum with CS, while PB concentration remained remarkably high back to the medium colon with RPS, decreasing thereafter (Diet \times location; $P < 0.001$). Therefore, higher PB concentrations ($P < 0.02$) were observed with RPS compared to CS in the digesta obtained from the medium colon (48.26 vs 30.46) and distal colon (38.00 vs 26.47). The results suggest that resistant starch consumption promote a higher excretion of microbial N in the faeces and a lower excretion of urinary N.

Key Words: Resistant starch, Swine, Fermentation

1585 Effect of carvacrol on indigenous *Enterobacteriaceae* levels and fermentation products in an in vitro cecal fermentation system. A. Piva^{*1}, C. Cervellati¹, J. E. Call², and J. B. Luchansky², ¹University of Bologna-Italy, ²United States Department of Agriculture, Agricultural Research Service, Wyndmoor, PA.

The inclusion of herbal extracts in feed to enhance animal well being is gaining increasing interest despite the variable results being described. We investigated the effect of carvacrol (CVC), the major essential oil found in oregano, on cecal fermentation and indigenous *Enterobacteriaceae*. The cecal contents of several pigs were collected within 20 minutes after slaughter, pooled, and transferred to fermentation vessels used in a batch culture system held at 39C. Four vessels were employed for each of the following two treatments: 1) control diet plus cecal contents (CTR), and 2) CTR added with CVC (2.66 mM). Gas production was recorded hourly and data were fitted by the Gompertz bacterial growth model ($r^2 > 0.98$). Ammonia levels were determined at 8 and 24h for each treatment. In addition, *Enterobacteriaceae* levels were determined at 8 and 24h by direct plating portions of each treatment onto Hektoen Enteric agar. During the initial 8h of fermentation, compared to the CTR, the CVC treatment displayed higher ammonia levels (+22%; $P < 0.05$), but there were no differences in ammonia levels between the two treatments at 24h. The maximum volume and rate of gas production were lower in CVC treatments compared to the control (-13 and -21%, respectively; $P < 0.05$). Indigenous *Enterobacteriaceae* levels were 8% (4.8 vs 5.2 log₁₀ CFU/ml; $P < 0.05$) and 24% (4.1 vs 5.4 log₁₀ CFU/ml; $P < 0.05$) lower in CVC treatment than in the control after 8 and 24h, respectively. These data establish the potential of CVC to reduce bacterial gas production and the levels of indigenous *Enterobacteriaceae* in a cecal fermentation.

Key Words: Carvacrol, *Enterobacteriaceae*, Swine

1586 High dose of carvacrol, and not oregano, controls swine cecal fermentation. A. Piva^{*}, C. Cervellati, G. Biagi, and G. Casadei, University of Bologna.

The increasing concern about antibiotic feed additives in farm animal nutrition has lead to explore natural strategies to increase food safety and maintain animal performances. In this in vitro study we investigated the ability of oregano and its major essential oil, carvacrol (CVC), to control swine cecal fermentation. Cecal inoculum was collected from pigs within 20 minutes from slaughter and the fermentation was carried out in a batch culture system and samples were collected for ammonia analysis after 0, 4, 8, and 24h. Gas production was recorded hourly and the data were fitted by the Gompertz bacterial growth model ($R^2 > 0.98$). Four vessels were employed for each of the following four treatments: 1) control diet (CTR), 2) CTR added with oregano (500 mg/kg), 3) CTR added with pure CVC at the concentration supplied by oregano (0.12mM), and 4) CTR added with CVC at the highest MIC recorded for *Escherichia coli* and *Salmonella* in our previous study (3.91mM). Only the latter concentration resulted in significant ($P < 0.05$) differences with a reduction of cecal ammonia over time (-34% at 4h, -28%, at 8h and -48% at 24h), and volume and velocity of gas production (-66% and

-73%, respectively; $P < 0.05$). Following this first trial, a second fermentation study was conducted to identify a dose-response and the minimal dose of CVC that could exert a statistical significant effect on cecal fermentation. Six two-fold dilutions of CVC from 3.91mM were investigated in quadruplicate. Only the 3.91mM dose reduced bacterial activity as shown by volume and rate of gas production (-54 and 57%, respectively; $P < 0.05$) and ammonia production (-11%; $P < 0.05$), whereas the 1.95 mM dose did not show any difference from CTR. These data substantiate the ability of a high dose of CVC to control cecal fermentation, whereas oregano at the tested dose was not effective.

Key Words: Oregano, Carvacrol, Swine

1587 In vitro fermentation characteristics of selected oligosaccharides using swine fecal inoculum. M. R. Smiricky^{*}, E. A. Flickinger, C. M. Grieshop, L. L. Bauer, and G. C. Fahey, Jr., University of Illinois at Urbana-Champaign.

Much of the negative perception concerning oligosaccharides (OS) in pig diets stems from potential depression in digestibility and the increase in gas production resulting from the fermentation of these substrates in the gut. The objective of this study was to compare the fermentation characteristics of selected OS sources: raffinose (R), stachyose (S), R+S combination (R/S), soy solubles (SS), glucooligosaccharides (Glu OS), short-chain fructooligosaccharides (scFOS), medium-chain FOS (mcFOS), long-chain FOS (lcFOS), granular and liquid transgalactooligosaccharides (g-TOS, l-TOS), mannanoligosaccharides (MOS), and xylooligosaccharides (XOS). Three healthy pigs (avg. initial BW = 25 kg) from an antibiotic-free herd served as sources of fecal inoculum. The donor pigs consumed a corn SBM-based diet during the study. Each substrate (115 mg) was fermented in vitro and samples were taken at 0, 2, 4, 8, 12, and 24 h, and pH change, and short chain fatty acid (SCFA) and gas productions determined. Bifidobacteria and lactobacillus populations were determined in the pig fecal inoculum and in the fermentation vessels after 4 and 12 h. Gas production at 12 h was similar for all FOS and TOS forms, SS, and XOS. Vessels containing R, S, and R+S resulted in the greatest ($P < 0.05$) gas production at 12 h for all substrates tested. The pH at 12 h for all FOS forms and XOS did not differ. The pH at 12 h in the vessels containing R, S, R+S was highest ($P < 0.05$) compared to all other substrates. However, the pH at 12 h for SS was much lower ($P < 0.05$) than for the pure soy OS and both TOS forms. Total SCFA production was similar for all FOS and TOS forms, GOS, and SS. However, total SCFA production was highest ($P < 0.05$) for XOS, S, and R+S and lowest ($P < 0.05$) for MOS and R. Vessels containing scFOS, mcFOS, S, and R+S had higher ($P < 0.05$) bifidobacteria concentrations than did those containing the other substrates, with the exception of g-TOS. All OS studied were readily fermentable, but varied in amount and type of SCFA produced. Furthermore, fermentation of pure soy OS resulted in more gas production and higher pH when compared to SS. The OS in the soy matrix appear to behave differently than their pure counterparts.

Key Words: Pigs, In vitro, Oligosaccharides

1588 Effects of elevated and reduced dietary N and S concentration upon growth and concentration of odor causing components in waste of finishing pigs. G. Apgar^{*}, K. Griswold, B. Jacobson, and J. Salazar, Southern Illinois University, Carbondale.

Crossbred finishing pigs (n = 95, initial wt 82 kg) were used to evaluate the effect of elevated or reduced dietary N and S concentrations on growth performance and odor components of waste. Feed and water were offered on an ad libitum basis. Pigs were weighed, feed intake recorded and efficiency calculated every 7 d. Diets contained altered N and S concentrations with chromic oxide as an indigestible marker. Lysine was equalized across dietary treatments and AA concentrations were balanced to support adequate growth. Random fecal samples were collected from each pen during each of the two dietary phases. Frozen fecal samples were subsampled, placed in diluent and analyzed on a mass spectrometer for known odorous compound concentrations. Growth performance did not differ among the treatments during either dietary treatment phase. During the first collection period, there was a significant N \times S interaction ($P < 0.039$), hexanoic acid decreased with lower S content in high N diets, but increased in diets containing reduced S content and lower N concentrations. 3-methylindole tended to respond in the same manner ($P < 0.075$). During the second collection period

there was a significant N x S interaction ($P < 0.036$) following the same pattern above for 4-methylphenol, and a tendency for this interaction to affect phenylacetic acid ($P < 0.092$). During the third collection period, phenol concentration was significantly altered by N ($P < 0.013$) and a N x S interaction ($P < 0.029$), with phenol increasing with reduced S content in the presence of elevated N, and decreasing with reduced S content in lower N diets. 3-methylindole tended to be affected by N ($P < 0.079$), while propanoic acid tended to be affected by S ($P < 0.092$). Reduction of N and S in swine finishing diets does not affect growth performance but can alter the concentration of components implicated in the odorous qualities of swine waste.

Key Words: Waste, Odor, Swine

1589 Effects of dietary supplementation of diatomaceous earth and zeolite on fecal excretion of major odor-causing compounds from growing-finishing pigs fed corn and soybean meal-based diets. Y. Gao, T. C. Rideout*, and M. Z. Fan, *University of Guelph*.

A trial was conducted to examine the effects of dietary supplementation of natural binding compounds, i.e., diatomaceous earth and zeolite, on fecal excretion of major odor-causing compounds in growing-finishing pigs. Six Yorkshire barrows, with an initial BW of 19 kg, were fed six diets according to a 6 x 6 Latin square design. The diets were corn and soybean meal-based, contained the same amount of CP and AA and differed in the source and level of binding compounds. Diet 1 had no binding compounds and served as the control; diets 2, 3 and 4 contained 1.2, 2.4 and 3.6% of diatomaceous earth; diets 5 and 6 contained 0.6 and 1.2% of zeolite. Ammonia and volatile sulfide contents were analyzed by spectrophotometric analysis, and other odor-causing compounds were determined by using a gas chromatography-mass spectrometer. Supplementing diatomaceous earth and zeolite did not affect the fecal excretion of ammonia, short-chain fatty acids, *p*-cresol or indole. However, adding diatomaceous earth at the levels of 2.4 and 3.6% (diets 3 and 4) decreased ($P = 0.07$ and 0.05) the fecal excretion of total volatile sulfides (2.98 and 2.87 vs. 4.52 g H₂S ·kg DMI) in comparison with the control diet. In conclusion, adding suitable levels of diatomaceous earth

in swine diets may effectively decrease volatile sulfide-associated odor and pollution to the environment.

Key Words: Diatomaceous earth and zeolite, Odor-causing compounds, Pigs

1590 Efficacy of various microbial urease inhibitors in controlling ammonia and volatile sulfide emission from swine manure slurry. T. C. Rideout* and M. Z. Fan, *University of Guelph, Guelph, Ontario*.

Three experiments were conducted to evaluate the effectiveness of the microbial urease inhibitors phenylphosphorodiamidate, N-(*n*-butyl)thiophosphoric triamide, and acetohydroxamic acid in reducing ammonia (NH₃) and volatile sulfide (in hydrogen sulfide unit, H₂S) emission from stored swine manure slurry. Liquid manure slurry was collected from the University of Guelph Arkell Swine Research Station and treated with six graded dosages (0.00, 0.40, 0.80, 1.20, 1.60, and 2.00 g/kg DM manure slurry) of the aforementioned urease inhibitors according to a completely randomized block design. Cumulative NH₃ and H₂S emission was measured over a 7-d period in an *in vitro* measurement system. Ammonia-nitrogen, urea-nitrogen, and volatile sulfide contents of the manure slurry were analyzed at the start and the end of the 7-d emission measurement. There were no differences ($P > 0.05$) in NH₃-N, urea-N, and H₂S contents in the manure slurry at the end of the 7-d emission measurements among the six dosages of the urease inhibitors. As urea hydrolysis in the manure slurry was complete at the start of the emission measurement, there were no differences ($P > 0.05$) in NH₃ emission rates in response to the addition of the urease inhibitors. However, the control groups appeared to have a lower rate of H₂S emission in comparison with the urease inhibitor-treated groups. While the results of this study suggest that the effectiveness of microbial urease inhibitors in controlling NH₃ emission from animal waste is strongly dependent on the time of application, more work is needed to clarify the dose-response relationship between urease inhibitors and volatile sulfide emission from swine manure slurry.

Key Words: Microbial urease inhibitors, Swine manure slurry, Ammonia and sulfide emission

Ruminant Nutrition Ruminal Fermentation

1591 Effects of barley grain particle size on dairy cow performance. G. R. Ghorbani*¹ and A. Moradai¹, ¹*Isfahan University of Technology*.

Six Holstein cows were used in a 3 x 3 replicated Latin square design to investigate the effect of different particle sizes of ground barley grain on lactation performance. Geometric mean diameters of the barley particles were 0.94, 1.93 and 2.9 mm for treatment 1, 2 and 3 respectively. Diets were only different in barley particle size and all cows received diets containing 40 percent corn silage and 60 percent concentrate (DM basis). About 50 percent of the concentrate was ground barley with different particle sizes. The differences among dry matter intake (DMI), milk fat percentage, milk total solid percentage, daily fat yield, dry matter digestibility, urine, and ruminal pH, daily body weight change, and fecal particle size distribution were not significant. Treatment 3 caused a decrease ($P < 0.05$) in milk protein percentage, daily milk yield, and fecal pH compared to treatment 1 and 2, but the differences between treatment 1 and 2 were not significant. With increasing barley particle size, fecal dry matter was increased and daily milk protein yield was decreased significantly ($P < 0.05$). Differences between treatments 1 and 2 or 2 and 3 for 4 percent FCM, 4 percent FCM/DMI daily, milk lactose yield, daily total solids yield and organic matter digestibility were not significant, but differences between treatments 1 and 3 for 4 percent FCM and 4 percent FCM/DMI were observed. The soluble fraction, the potential degradable fraction, the ruminal degradation rate and the effective degradability of dry matter increased linearly for treatments 1, 2 and 3, respectively. It is concluded that fine grinding of barley which is commonly used on dairy farms improved OM digestibility, milk yield, protein percentage and production and would be recommended for nutrition conditions similar to the present experiment.

Key Words: Barley, particle size, Dairy cow

1592 Determination of energy values and degradability characteristics of triticale varieties. Ulku Gursoy*¹ and Aydan Yilmaz, ¹*Ankara University Agriculture Faculty, Ankara, Turkey*.

The objective of this research was to investigate the rumen degradability characteristics and energy values of triticale varieties used in ruminant nutrition in Turkey. Three Anatolia Merinos rams (3 yr old and 70 kg live weight) fitted with ruminal cannulas were used. Animals were fed the same ration during the trial. To determine rumen degradability characteristics, triticale varieties were incubated in nylon bags for 2, 4, 8, 16, 24, and 48 h in the rumen. Degradability characteristics of DM (dry matter) and OM (organic matter) of feed samples were determined using the equations $P = a + b(1 - e^{-kt})$ and $Pe = a + bc / (c + k)e^{-kt}$ (McDonald 1981). Effective ruminal degradabilities (at an assumed passage rate of 0.05/h) of triticale varieties for DM and OM were: (Presto, Karma 2000, Tatlycak 97, and Tacettinbey) 76.37, 77.77; 67.97, 70.90; 76.87, 79.57; and 74.94, 77.47. Degradability (%) in 48 h were: 91.35, 91.35; 82.66, 84.19; 88.40, 89.82; and 87.36, 88.62 respectively. The enzyme technique (*in vitro*) was used to estimate energy values. The ME values (kcal/kg DM) of triticale varieties were 3079, 3012, 3065, and 3046, respectively. Differences for DM and OM (based on DM) effective degradabilities for Presto, Tatlycak, and Tacettinbey varieties were not significant ($P > 0.05$), but the Karma 2000 variety was lower ($P < 0.05$). When the same varieties were compared for ME values, the Presto and Tatlycak varieties did not differ ($P > 0.05$), but differences between the other varieties were significant ($P < 0.05$). *This research was summarized from the M.S. thesis of Ulku Gursoy, Ankara University Agriculture Faculty, Department of Feeds and Animal Nutrition.

Key Words: Varieties of Triticale, Nylon Bag Technique, Method of Cellulase, Degradability