179 Crystalline amino acid substitution for whey protein concentrate in the diets of weanling pigs. M. E. Davis[1]*, B. Z. de Rodas[2], C. V. Maxwell[1], B. J. Kerr[2], J. Chung[1], and E. Broekman[1], *[1]Oklahoma State University, Stillwater, [2]Nutri-Quest Inc., Chesterfield, MO.*

Two experiments were conducted to determine if similar performance could be obtained when crystalline amino acids (AA) were substituted for whey protein concentrate (WPC), and if AA addition to different basal diets would affect these results. In both experiments, treatment diets were fed during phase 1 (d 0 to 14), followed by common phase 2 (d 14 to 28) and phase 3 (d 28 to 42) diets. In Exp. 1, 120 pigs (21 d and 6.3 kg BW) in pens of 6 (4 pens/treatment) were fed one of 5 dietary treatments arranged as a 2×2 factorial with a negative control (NC). The NC contained 1.0% digestible Lys and was devoid of WPC. The factorially arranged treatments consisted of two dietary Lys levels (1.2 and 1.4% digestible Lys) with WPC or with WPC replaced by an ideal AA mixture. Increasing WPC improved ADG and G/F, whereas response decreased with increasing level of AA (interaction, P≤.05). In phase 2, pigs previously fed 1.2% digestible Lys had greater (P≤.05) ADG than those previously fed 1.4% digestible Lys. Blood urea N (d 14) increased as Lys levels increased in diets containing WPC, but decreased with increasing Lys levels in AA diets (interaction, P≤.01). In Exp. 2, 48 pigs (21 d and 6.3 kg BW) in pens of 4 (3 pens/treatment) were fed one of 4 dietary treatments arranged as a 2×2 factorial to determine if protein source in the basal diet affected response to AA addition. The treatments contained 1.4% digestible Lys and included two basal diets. Each basal diet was supplemented with WPC or AA to meet ideal requirements. When compared to pigs fed basal diet 2, ADG and G/F during phase 1 tended to be higher in pigs fed basal diet 1 when WPC was used as the amino acid source, but tended to be lower when supplemented with AA (interaction, P≤.08). These studies indicate that replacement of amino acids in WPC with AA results in reduced pig performance. Also, protein source in the basal diet appears to impact response to AA addition.

Key Words: Swine, Protein source, Amino Acids

180 Lysine requirement of phase 2 nursery pigs fed hard red winter wheat based diets. E.J.A.J. Broekman*, B. Z. de Rodas, W. G. Luce, C. V. Maxwell, and J. Chung, *Oklahoma State University, Stillwater.*

Two experiments involving 120 pigs (21 ± 3 d of age; 6.3 kg BW) were conducted to determine the dietary Lys requirement to maximize growth performance of phase 2 nursery pigs fed a hard red winter wheat (Karl variety)-soybean meal (SBM) diet. Pigs were blocked based on initial BW and penned in groups of five with 6 pens per treatment. All pigs were fed a common phase 1 diet for the first 10 d (Exp. 1) or 8 d (Exp. 2) following weaning. After phase 1, pens were assigned to one of four dietary treatments. Dietary treatments were 1.3, 1.4, 1.5 and 1.6% total Lys. Wheat (Exp. 1) and corn starch and sucrose (Exp. 2) were replaced by SBM to provide additional Lys levels. Experimental diets were fed for 28 d. From d 0 to 7 (phase 2), ADG and G/F increased linearly (P < .01) with increasing dietary Lys. Increasing dietary Lys improved ADG and G/F (linear, P < .01; quadratic, P < .05, respectively) from d 7 to 14. During d 14 to 28 ADG was improved (linear, P < .07) with increasing dietary Lys. Feed intake was not affected by treatment during any phase of the study. Blood urea N concentrations (d 14) increased (linear, P < .01) with increasing dietary Lys. These data suggest that the dietary Lys requirement for maximum performance of phase 2 nursery pigs fed a hard red winter wheat-SBM diet is at least 1.6% in week 1 with some indication of a reduction in requirement after d 7.

	Lys, %				
Item	1.3	1.4	1.5	1.6	SEM
d 0 to 7					
ADG, g[a]	306	352	343	384	13
G/F[a]	.74	.80	.88	.89	.03
d 7 to 14					
ADG, g[a]	438	476	520	523	23
G/F[b]	.66	.72	.80	.78	.02
d 14 to 28					
ADG, g[c]	591	596	597	639	16
G/F	.63	.68	.65	.67	.02

[a]Linear effect of increasing dietary Lys (P < .01).
[b]Quadratic effect of increasing dietary Lys (P < .05).
[c]Linear effect of increasing dietary Lys (P < .07).

Key Words: Pig, Wheat, Lysine

181 The response of 10-kg pigs to increasing levels of dietary lysine. D. Ragland*, T. R. Cline, and O. Adeola, *Purdue University, West Lafayette, IN.*

The purpose of the experiment was to assess the response of 10-kg pigs to diets containing increasing levels of dietary lysine when formulated on a digestible amino acid and ideal protein basis. The experiment consisted of a growth study and a nitrogen retention study. A basal diet which contained 4.8 g digestible lysine per kilogram and 3.6 Mcal DE was supplemented with 0, 2.0, 2.4, 3.6, 4.8 or 6.0 g of lysine per kilogram for a concentration of 4.8, 6.0, 7.2, 8.4, 9.6 or 10.8 g digestible lysine per kilogram of diet, respectively. Forty-eight crossbred pigs with an average body weight of 10 kg were blocked by weight and randomly assigned to the six experimental diets for a 28-d growth study. Increasing digestible lysine levels resulted in linear (P<.05) and quadratic (P<.05) responses in average daily gain (ADG) and feed efficiency (FE). Mean ADG and FE ranged from 287 to 549 g and 262 to 508 g/kg, respectively, for the six diets. A quadratic effect was observed for average feed intake (P<.05) and ranged from 1003 to 1275 g. Twenty-four crossbred pigs with an average body weight of 15 kg were blocked by weight, randomly assigned to the six experimental diets and maintained in metabolism crates for a 10-d nitrogen balance study. No treatment effects (P>.05) were observed for nitrogen absorption while a linear (P<.05) response was observed for nitrogen retention (NR) and ranged from 11.97 to 14.30 g/d for the six diets. No further improvement in nitrogen retention was observed beyond 7.2 g of digestible lysine per kilogram of diet. Analysis of the ADG and FE data using the broken-line method yielded a digestible lysine requirement of 7.2 and 7.1 g digestible lysine per kilogram of diet, respectively. Analysis of the NR data using the broken-line method estimated the requirement to be 7.8 g digestible lysine per kilogram of diet.

Key Words: Lysine, Digestible, Ideal protein, Nitrogen retention, Pigs

182 Effects of dietary protein and porcine somatotropin on whole empty body accretion rates of proximate components in pigs from 22 to 60 kg BW. W. A. Dozier, III*, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky, Lexington.*

The effects of PST and dietary protein (near-ideal blend of amino acids [AA] on whole empty body (WEB) percentages and accretion rates of chemical components in growing pigs were assessed. Forty pigs (22.5 kg BW) were individually penned and assigned to a 4× 2 factorial (4 diets±PST)(See JAS 75(Suppl.1):78,1997). A basal diet (1.50% lys) consisted of fortified corn-soybean meal with added lys (.33%), thr (.22%), met (.30%), and trp (.03%). In three additional diets, lys was reduced to 1.25, 1.00, and .75% by diluting the basal with starch, cellulose, and sand. PST was given at 2 mg/d (im). At 60 kg BW, the WEB (carcass, head, viscera, blood, nails, and hair) was ground and analyzed for protein, fat, water, and ash. Six additional pigs were processed for initial composition. The final WEB consisted of 73.4, 22.5, 3.6 and .3% carcass, head+viscera, blood, and hair+nails, respectively, and these components contained 75.7, 20.1, 3.1, and 1.2% of the WEB protein. PST increased (P<.001) daily accretion rates of WEB protein (143 vs 118 g/d), water (495 vs 417 g/d), and ash (24.1 vs 21.8 g/d), and reduced (P<.001) WEB fat (135 vs 186 g/d). Increasing the dietary lys increased (P<.01) the % and accretion of WEB protein, but the responses were greater in the PST-treated pigs (16.1, 17.2, 17.7, 17.8%; 114, 147, 156, 154 g/d) than in the controls (15.8, 15.8, 15.9, 15.9%; 117, 118, 117, 119 g/d)(PST x lys, P<.01). As dietary lys increased, the % and accretion of WEB fat decreased, but the responses were greater in the PST-treated pigs (20.3, 16.9, 16.1, 13.0%; 165, 144, 137, 91 g/d) than in the controls (23.3, 20.4, 22.3, 19.8%; 208, 175, 194, 165 g/d)(PST x lys, P<.09). These data indicate that PST influences WEB protein and fat percentages and accretion rates in growing pigs from 22 to 60 kg BW and the dietary requirement for a near-ideal blend of AA to achieve maximum WEB protein accretion is markedly increased by PST administration.

Key Words: Pigs, Somatotropin, Amino acids

183 Optimum ratio of total sulfur amino acids to lysine for late finishing gilts. T. A. Knowles*, L. L. Southern, and T. D. Bidner, *LSU Agricultural Center, Baton Rouge.*

An experiment was conducted to determine the optimum ratio of total sulfur amino acids (TSAA) to Lys for late finishing gilts. Sixty gilts were allotted to five treatments (ratios of TSAA:Lys) with four reps of three gilts each in a RCB design. Average initial and final BW were 74 and 110 kg. Gilts were fed diets formulated to contain .65% total Lys. The ratios of TSAA:Lys were: .35, .425, .50, .575, and .65. The diets consisted primarily of corn and corn starch, and all diets contained the concentration of corn of the diet with the lowest level of TSAA. With the exception of TSAA, diets met or exceeded an ideal amino acid pattern for all indispensable amino acids, and they were isonitrogenous and equal in electrolyte balance. There were no ($P>.10$) TSAA:Lys ratio effects for ADG, final BW, hot carcass weight, leaf fat weight, psoas muscle weight, tenth rib fat thickness, percentage muscle, carcass length, average backfat thickness, fat-free lean, lean gain, lean gain per day, and total fat. The ADFI decreased (linear, $P<.08$) as TSAA:Lys ratio increased. Also, gain:feed increased (linear, $P<.01$; quadratic, $P<.04$) as TSAA:Lys ratio increased. Total fat gain and fat gain per day decreased (linear, $P<.04$) as TSAA:Lys ratio increased. Also, there was a linear decrease ($P<.02$) and quadratic ($P<.01$) effect of TSAA:Lys ratio for serum urea-N (corrected for initial serum urea-N by covariance analysis). One-slope, broken-line regression models estimated required ratios of TSAA:Lys of .44, .40, .47, .45, .45, .45, .65, and .58 for serum urea-N, average daily gain, ADFI, gain:feed, fat-free lean, lean gain, total fat, and total fat gain, respectively. Thus, for growth and muscling traits of late finishing pigs, the optimum ratio of TSAA:Lys is lower than the current proposed ratio (.65), but to minimize fat accretion, the ratio is .58 to .65.

Key Words: Total sulfur amino acids, Lysine, Pigs

184 Plasma urea concentration can be used to identify protein requirements of group-penned finishing (60 to 105 kg) barrows and gilts fed corn-soybean meal diets. P. S. Miller*, H-Y. Chen, and A. J. Lewis, *University of Nebraska, Lincoln.*

One hundred twenty barrows and 120 gilts were used in a randomized complete block experiment designed to investigate the use of plasma urea concentration (PUC) as a method to identify protein requirements of group-penned finishing pigs. Treatments were arranged in a 2×4 factorial (two sexes and four dietary treatments). Barrows and gilts (initial BW = 61 kg) were penned separately, and each pen contained 10 pigs. Four corn-soybean meal diets were formulated to contain 9, 12, 15, or 18% CP. Each pen received the respective diet for the entire experiment (56 d). Pigs were weighed, pen feed intakes determined, and individual pig blood samples taken every 14 d. Barrows exhibited greater ($P < .05$) ADG and ADFI, but reduced ($P < .05$) ADG/ADFI compared to gilts. Average daily gain, ADFI, and ADG/ADFI responded quadratically ($P < .005$) to dietary protein concentration and were maximized at 15% CP. These performance criteria did not suggest different protein requirements for barrows and gilts (sex $\times$ protein-quadratic, $P > .25$). The quadratic regression of PUC vs time indicated that urea was conserved in barrows and gilts up to 12% and 15% CP, respectively. These data suggest that the CP requirement of barrows was between 12 and 15%, whereas for gilts the requirement was between 15 and 18%. Four additional data sets were created by randomly selecting PUC data for 2, 4, 6, or 8 pigs/pen. Comparisons of parameters (linear and quadratic coefficients) from the quadratic regressions of PUC vs time using the four data sets indicated that similar conclusions regarding the conservation of urea in barrows and gilts could be made by selecting as few as 4 pigs/pen. The response of PUC vs time was more sensitive than growth criteria in identifying differences in dietary protein requirements of group-penned barrows and gilts.

Key Words: Pigs, Urea, Growth

185 Digestible threonine requirement of growing and finishing pigs. M. Rademacher[1]*, L. Babinsky[2], and J. Tossenberger[2], *[1]Degussa AG, Germany and [2]Pannon Agricultural University, Hungary.*

The objective of these studies was to evaluate the effect of increasing dietary threonine (Thr) on the performance and carcass quality of growing (30-60 kg)and finishing (60-103 kg) pigs. Before starting the growth trial, ileal amino acid digestibilities of the basal grower and finisher diet were determined with pigs fitted with an ileo-caecal re-entrant cannula. In each trial, a basal diet was formulated and supplemented with four graded levels of L-threonine (0.31 to 0.47% ileal digestible Thr for grower pigs and 0.25 to 0.41% ileal digestible Thr for finisher pigs). The basal diet fed to grower pigs was based on wheat, barley, meat meal and soybean meal and formulated to contain 16.5% CP, 1.1% lysine (Lys) and 0.48% Thr. Finishing pigs were fed a basal diet based on wheat, barley and corn and formulated to contain 12% CP, 0.8% Lys and 0.36% Thr. Each diet was available on an ad libitum basis to 10 individually penned pigs (barrows:gilts, 1:1). The Thr requirement was estimated from weight gain and feed/gain ratio using a nonlinear regression procedure. Exponential response curves were fitted to the experimental data points and the tentative values for the Thr requirement was calculated at 90% of the asymptotic response. The daily weight gain and feed/gain ratio of growing pigs improved significantly ($p< .05$) with increases in Thr up to a dietary level of 0.41% ileal digestible Thr. With increases in dietary Thr, daily gain and feed/gain ratio for finishing pigs improved significantly ($p< .05$) up to a dietary level of 0.37% ileal digestible Thr. Based on exponential regression analysis, the Thr requirement for obtaining maximum weight gain and feed/gain ratio of growing pigs was calculated to be higher than the maximum level of 0.41% ileal digestible Thr tested in the experiment. The Thr requirement for optimizing daily gain was not maximized within the range of Thr fed to finishing pigs. For obtaining maximized feed/gain ratio of finishing pigs, the requirement was estimated to be 0.37% ileal digestible Thr. The carcass quality was not affected ($p> .05$) by dietary Thr level.

Key Words: Pigs, Threonine, Digestibility, Requirements, Amino Acids

186 Effects of cereal and microbial phytases on phytate-phosphorus utilization, intestinal phytase and alkaline phosphatase activity, and plasma glutathione peroxidase in growing pigs. Y. M. Han*, K. R. Roneker, and X. G. Lei, *Cornell University, Ithaca, NY.*

This experiment was to determine the effects of supplemental cereal or microbial phytase in the diets for young pigs on performance, phytate-phosphorus (P) utilization, intestinal phytase and alkaline phosphatase activities, and plasma glutathione peroxidase (GPX) activity. Forty weanling pigs (Hampshire $\times$ Yorkshire $\times$ Duroc, BW: 10.0 kg) were divided into five groups (four pens/group and two pigs/pen). Pigs in groups from 1 to 5 were fed a low-P (.39%), corn-soybean meal basal diet (BD), the BD plus .15% or .25% of inorganic P (calcium phosphate), the BD plus 15% of wheat middlings (455 units of cereal phytase/kg), and the BD plus *A. niger* phytase at 1,200 units/kg, respectively. During the eight-wk experiment, body weights were recorded and plasma samples were taken weekly from all of the individual pigs. At the end of the trial, one pig per pen was killed to collect the duodenum and ileum mucosa and metatarsal bones. Pigs fed the BD had lower ($P < .05$) ADG, ADFI, plasma inorganic P concentration, bone strength, and conformation and mobility score than pigs of the other four groups. Pigs fed the diet supplemented with cereal phytase had similar growth performance to those supplemented with inorganic P or microbial phytase. Pigs fed the two phytase-supplemented diets had similar plasma inorganic P concentrations, bone strength, and conformation and mobility scores. Activities of mucosal phytase and alkaline phosphatase in duodenum or ileum or GPX activity in plasma were not affected by the diets. Both supplemental cereal and microbial phytases were effective in improving dietary phytate-P utilization by growing pigs, but did not affect intestinal phytase and alkaline phosphatase expression or the antioxidative status of pigs.

Key Words: Pigs, Phytase, Wheat middlings

187 Phytase supplementation of low phosphorus growing-finishing pig diets. A. F. Harper*, Z. Zhang, and E. T. Kornegay, *Virginia Polytechnic Institute and State University, Blacksburg.*

Crossbred growing-finishing pigs were used in a study to assess the use of a microbial phytase (Natuphos®) in corn-soybean meal diets to improve phytate P bioavailability, and thus, reduce inorganic P supplementation and fecal P excretion. The treatments consisted of alterations of inorganic P inclusion rate and phytase inclusion rate in meal form diets that contained .42 % Ca during the grower phase (30 to 70 kg BW) and .37 % Ca during the finishing phase (70 to 107 kg BW). Dietary trt were: 1) .38/.33% total P, respectively for grower and finisher phases, and no phytase; 2) .42/.37% P and no phytase; 3) .46/.41% P and no phytase; 4) trt 1 plus 167 U/kg phytase; 5) trt 1 plus 333 U/kg phytase; 6) trt 1 plus 500 U/kg phytase. There were 16 replicate pens with 4 pigs/pen for trt 1 and 8 replicate pens with 4 pigs/pen for trt 2 - 6. Fecal collections were made for digestibility determination using chromic oxide as an indigestible marker. Pigs fed the low P control diet (trt 1) grew slower and less efficiently ($P < .01$) than pigs fed diets with added P or phytase. Growth rate linearly increased ($P < .01$) with increasing dietary P (876, 928 and 934 g/d for trt 1,2 and 3, respectively) and increasing phytase in the low P diet (876, 917, 929, 936 g/d for trt 1, 4, 5 and 6, respectively). Feed intake and gain/feed followed a similar pattern of increase with increasing dietary P or phytase, but the linear effect was not significant ($P < .05$). Increasing P or phytase also resulted in linear improvements ($P < .01$) in P digestibility coefficients (28.7, 33.9 and 39.5% for trt 1, 2 and 3, respectively and 28.7, 32.6, 37.4 and 41.3% for trt 1, 4, 5 and 6, respectively) but effects on Ca digestibility were not significant. Rib bone shear energy and ash as a percentage of dry bone also increased linearly ($P < .01$ to .08) with increasing dietary P or phytase. Using prediction equations with these data we estimated that 500 U/kg of phytase released .96 g of P for grower-finisher pig utilization and reduced fecal P excretion by 21%.

Key Words: Growing-finishing pigs, Phosphorus, Phytase

188 The efficiency of plant and microbial phytases for growing pigs. B. Schindler[1]*, H. J. Lantzsch[1], F. J. Schöner[2], H. K. Biesalski[1], R. Mosenthin[1], and W. Drochner[1], *[1]University of Hohenheim, Stuttgart and [2]BASF AG, Ludwigshafen, Germany.*

Enzymatic hydrolysis of phytates has been shown to improve the apparent absorption of phosphorus (P) in diets for pigs. As a result there is no or only limited need to supplement diets with P from inorganic feed phosphates. However, only very few studies have examined the question if and to what extent phytases of different origin can replace each other. The objective of the present study was to compare the effectiveness of phytases of plant (wheat, rye) and microbial origin (Aspergillus niger, Natuphos®5000, BASF). Using the slope-ratio technique the dose response relationship between phytase levels (0, 50, 100, 150, and 200 U/kg of diet, as fed) and the apparent P absorption was measured to determine comparative efficiency values. A total of 76 barrows (German Landrace, initial body weight 16 kg) were allocated to four dietary treatments (n = 19). Two basal diets composed of corn and phytase-inactivated wheat or rye were supplemented with either increasing amounts of the respective phytase-containing grains (diets 1 and 2) at the expense of phytase-inactivated grains or corresponding activities of microbial phytase (diets 3 and 4) at the expense of corn starch from the mineral/vitamin premix. Inactivation of the grain phytases was achieved by microwave treatment. The phytase-free wheat and rye control groups had 6 animals, each phytase-containing group 4 animals. Dietary P supply (0.37% DM) was below the requirement. The dietary levels of phytate-P and Ca were 0.25 and 0.53% DM, respectively. The pigs were housed individually in stainless steel metabolic crates and fed twice daily (80 g/kg $BW^{0.75}$). Following an adaption period of 10 d, feces and urine were collected quantitatively for 10 d. The dose response effects of wheat and rye phytases on apparent P absorption were similar ($P > .05$) when comparing the slopes of the regression lines of both diets. Compared with the plant phytases, supplementation of both basal diets with microbial phytase resulted in a significant ($P < .05$) 2.5 times higher P absorption. The higher effectiveness of microbial phytase may be caused by the broader pH spectrum and a lower inactivation rate during stomach passage resulting in a more effective phytate breakdown.

Key Words: Pigs, Phosphorus, Phytase

189 The effects of adding citric acid to a low phosphorus corn-soybean meal based diet with or without added microbial phytase for weanling pigs. J. S. Radcliffe*, Z. Zhang, and E. T. Kornegay, *Virginia Polytechnic Institute and State University, Blacksburg.*

After a 7 d adjustment, 96 weanling pigs (equal barrows and gilts) were used in a 4 wk experiment to investigate the effects of microbial phytase, citric acid, and their interactions on growth performance, Ca and P digestibility, and rib shear force and ash. A 19% CP corn-soybean meal based diet fortified with vitamins and minerals to meet or exceed NRC (1988) requirements (except Ca and P) was fed. Diets 1, 2, and 3 contained no added citric acid and 0, 250, and 500 U of Natuphos® phytase/kg of diet, respectively. Diets 4, 5, and 6 contained 2.0% citric acid and 0, 250, and 500 U of Natuphos® phytase/kg of diet, respectively. No additional P was added to the diets, maintaining the P level in all diets at 3.7 g/kg. Calcium was supplemented to all diets in the form of $CaCl_2$ to achieve a level of 4.3 g/kg. Calcium levels were kept low in order to maintain an optimal Ca to P ratio. Pig BW and pen feed intake were measured weekly and fecal collections were taken during wk 4. At the end of wk 4, all barrows (1 per pen) were killed following a 22 h fast, a 1 h refeeding period, and then a 2 h fast. Stomach contents were analyzed for pH and phytase activity and 10th ribs were taken for determination of bone shear force and ash content. Increasing levels of phytase in the diet (0, 250, and 500 U/kg) increased phytase activity in the stomach digesta ($P < .001$) and bone shear force ($P < .05$) and ash percent ($P < .001$). Adding citric acid to the diet decreased diet pH ($P < .001$), stomach digesta pH ($P < .05$), and the level of phytase activity ($P < .04$) in the stomach digesta. Growth performance was not affected by phytase or citric acid, and no clear interactions of phytase*acid were observed. This study demonstrates that the pH of stomach digesta can be lowered by adding citric acid, but that this may not affect the efficacy of microbial phytase.

Key Words: Phytase, Acid, Pigs

190 Determination of the contribution of an enzyme combination to the growth performance of pigs. M. D. Lindemann, J. L. Gentry*, H. J. Monegue, and G. L. Cromwell, *University of Kentucky, Lexington.*

A total of 120 crossbred pigs (60 barrows and 60 gilts; mean initial and final BW - 26 and 109 kg, respectively) were used to assess the effects of an enzyme combination on pig performance. The product (VegPro®) is a mixture of protease, cellulase, pentosanase, α-galactosidase, and amylase enzymes. Dietary treatments were structured as a 2×2 factorial of energy level (high vs low; corn-soybean meal ± 20% wheat midds) and enzyme inclusion (± VegPro® at .1%). Diets were formulated to meet or exceed NRC (1988) estimates while assuring that lysine was the first-limiting amino acid with a constant lysine:energy. Pigs were housed in 20 pens with gender equally distributed and had ad libitum access to feed and water. The addition of wheat midds decreased ADG (829 vs 758 g/d; $P < .01$), increased ADFI (2.36 vs 2.61 kg/d; $P < .05$), and increased F:G (2.85 vs 3.45; $P < .01$). Enzyme inclusion decreased ($P < .10$) F:G in the growing period (2.74 vs 2.53). Single degree-of-freedom comparisons for the effects of the enzyme indicated an increased ADG in the growing and total periods (771 vs 837 g/d and 799 vs 855 g/d, respectively; $P < .05$) and a decreased F:G in the growing period (2.57 vs 2.29; $P < .10$) for pigs fed the high energy diet. An experiment with weanling pigs followed in which 120 crossbred pigs (57 barrows and 63 gilts) averaging 21.4 d of age and 6.8 kg BW were assigned to complex diets with 0, .075, or .15% enzyme inclusion. Pigs were housed in 24 pens with gender equally distributed within a replicate. Pigs had ad libitum access to feed and water. For a 3 wk starter period, there were no effects ($P > .10$) observed for ADG and ADFI (362, 372, 379 g/d; 521, 521, 529 g/d, respectively, for 0, .075, and .15% enzyme inclusion), but a linear improvement ($P < .07$) occurred in F:G (1.45, 1.40, and 1.39, respectively). The results suggest that use of this enzyme combination may have potential for improving pig performance.

Key Words: Pigs, Performance, Enzymes

191 Effects of microbial (*A. niger*-phytase) and wheat-bran phytase activity on phosphorus availability. M. Morlacchini[2], G. Colombari[3], A. Prandini[1], C. Cerioli[1], and G. Piva[1]*, *[1]Istituto di Scienze degli Alimenti e della Nutrizione, Università Cattolica del Sacro Cuore, Via Emilia Parmense 84, Piacenza, [2]CERZOO, S.Bonico-Piacenza, and [3]Istituto Superiore Lattiero Caseario, Via Pilla 25, Mantova, Italy.*

Two trials has been carried out to evaluate the effects of pigs diets formulated to meet the available P requirements on growing-finishing pigs performance, P excretion, level of P in the bones and slaughtering parameters using microbial (*A. niger* var. Tieghem) or vegetable (wheat bran) phytase. 240 hybrid pigs D×(LW×L) and 240 hybrid pigs D×Y (in the 1st and 2nd trial, respectively) were fed from 45-50 to 160 kg l.w. with 4 diets. A basal diet (CTR), meeting total P requirements by using inorganic P source, was compared to 3 diets without inorganic P and meeting available P requirements: 1) basal diet supplemented with microbial phytase (700 U/kg feed) (PHY); 2) as treatment 1, but without microbial phytase addition (NEG); 3) wheat bran as source of phytase activity (1600 U/kg feed) (WB). Pigs were fed with wet diets (3:1 water:meal ratio); meal was at 9% of $l.w.^{0.75}$. ADG were lower with NEG diet vs CTR, PHY and WB diets only in the 1st trial from 56 to 112 days-old pigs ($P<.01$). No differences were found among treatment vs CTR in both trials for ham weight after seasoning and for Ca and P deposition in the bones. In both trials, NEG pigs had lower meat percentage ($P<.05$) and loin thickness ($P<.01$ and $P<.05$ in the 1st and 2nd trial, respectively) than CTR, PHY and WB pigs; in the 1st trial NEG pigs had more thoracic fat thickness vs CTR, NEG and WB pigs ($P<.05$). In the 1st trial, PHY diet increased inorganic P, Na, K, Zn, alkaline phosphatase plasma levels at 80, 120 and 160 kg l.w.. P balance data recorded in three periods (40-80, 80-120 and 120-160 kg l.w.) showed a reduction ($P<.05$) of P excretion for PHY and WB vs CTR pigs. Results show a positive effect of the diets formulated with available P requirement data on P excretion, deposition of P in the bones and carcass characteristics; wheat-bran phytase activity improves the release of phytate P as well as microbial phytase. Microbial phytase improves also the utilization of some micro-nutrients.

Key Words: Pigs, Phytase Activity, Phosphorus Availability

192 Effectiveness of a new phytase on the in vitro hydrolysis of phytate-phosphorus and the release of iron and zinc in feeds. Y. M. Han, C. Stahl*, W. A. House, and X. G. Lei, *Cornell University and USDA Plant, Soil, and Nutrition Laboratory, Ithaca, NY.*

We determined the effectiveness of a new phytase produced by a yeast expression system on the hydrolysis of phytate-phosphorus and the release of iron and zinc from commonly-used feeds. In Experiment I, samples of corn, soybean meal and wheat middlings were suspended into .2 M citrate buffer (pH 5.5) and incubated with phytase at 0, 100, 250, 500, or 1,000 units/kg for 4 h at 37°C. Supernatant of the hydrolysate was collected to measure inorganic phosphorus concentrations. Compared to controls, phytase released phytate-phosphorus from both corn and soybean meal ($P < .01$). The hydrolysis of phytate-phosphorus by phytase reached the plateau in corn at 250 units/kg and in soybean meal at 500 units/kg. There was no significant hydrolysis of phytate-phosphorus by phytase from wheat middlings. In Experiment II, samples of soybean meal were mixed with the citrate buffer and incubated with phytase at 0, 500, 750, 1,000, or 1,250 units/kg for 4 h at 37°C. Concentrations of iron and zinc in the supernatant of the hydrolysate were determined after phytate was separated. Phytase incubation resulted in an increase ($P < .05$) in the concentrations of free zinc and iron in the supernatant. Approximately 70% of the phytate bound iron or zinc was released from soybean meal at the highest phytase activity in the mixture. In conclusion, the phytase expressed in the yeast system effectively released phytate-phosphorus and(or) iron and zinc from corn and soybean meal.

Key Words: Phytase, Phosphorus, Zinc and Iron

193 Effects of cereal and microbial phytases on dietary lysine utilization by growing pigs. X. G. Lei*, Y. M. Han, D. A. Ross, D. H. Beermann, and K. R. Roneker, *Cornell University, Ithaca, NY.*

This experiment was to determine if supplemental cereal and microbial phytases improved utilization of dietary lysine as well as phytate-phosphorus (P) by growing pigs. Thirty pigs (Hampshire × Yorkshire × Duroc, BW: 12.0 kg) were allocated into five groups and housed individually in pens. Pigs in groups 1 and 2 were fed a low-P (.36%), corn-soybean meal basal diet (BD) supplemented with 15% of wheat middlings (455 units of cereal phytase/kg) and *A. niger* phytase at 1,200 units/kg, respectively. Pigs in groups 3, 4, and 5 were fed the BD supplemented with inorganic P (.15%) and with 0, .075, and .15% of L-lysine HCl, respectively. During the six-wk experiment, weekly body weight gains and daily feed consumption of individual pigs were recorded. Plasma samples of individual pigs were taken biweekly. At the end of the experiment, four pigs from each group were killed to determine carcass weight, fat depth, and loin area. There was no difference in ADG or ADFI among the five treatment groups. But, the pigs fed the lysine-supplemented diets had better feed use efficiency ($P < .04$) than those fed the diet added with cereal phytase. At wk 2 and 4, pigs fed the two phytase-supplemented diets had similar plasma inorganic P concentrations to those fed the lysine-supplemented diets. But, the pigs fed these two diets had higher plasma urea nitrogen concentration ($P < .01$) than the pigs fed the diet supplemented with .15% of lysine. Traits of carcass were not affected by the diets. In conclusion, supplemental cereal or microbial phytase seemed to have no effect on utilization of lysine in corn-soybean meal diets by growing pigs.

Key Words: Pigs, Phytase, Lysine

194 Comparison of pigs and broilers in their response to microbial phytase. A. W. Jongbloed[1]*, A. Ohman[2], J.T.M. van Diepen[1], J. D. van der Klis[1], I. Knap[2], and H.A.J. Versteegh[1], *[1]Institute for Animal Science and Health, Lelystad, The Netherlands and [2]Novo Nordisk A/S, Bagsvaerd, Denmark.*

Digestibility and absorption of P were measured with 216 weaned piglets from 10 to 23 kg BW, and 180 broilers from 14 to 28 d of age. Both species were fed two diets with supplementary microbial phytase (MP), i.e., 200 and 800 FTU/kg of diet. In addition, a third diet (a negative control for the piglets, and a positive control for the broilers) was used. The latter was the basal diet supplemented with .12% P from monocalcium phosphate (MCP). In order to feed the same amount of available P to the broilers, the amount of supplementary P from MCP was reduced by .07 and .12% using 200 and 800 FTU/kg of diet, respectively. Pen (pigs) and battery cage (broilers) were the experimental units. Per pen 7 piglets were used. At 24 d of age the number of broilers was standardized at 13 birds per cage. The three treatments were arranged according to a completely randomized block design (n=4). The animals were fed identical feeds consisting of corn, extracted soybean meal, and soybean oil as primary ingredients. Calcium content was .75%. The feeds were pelleted and offered ad libitum. The apparent digestibility of total P in piglets was evaluated in the fourth and fifth week of study. The apparent ileal absorption of P in broilers was assessed at d 28. Digestibility and absorption were evaluated from Cr ratios. The amount of generated P in pigs was the difference in amount of digestible P as compared with the negative control diet. For broilers the amount of generated P was calculated by taking into account the exchange of P from MCP. The broilers had a higher response to 200 FTU/kg of diet than the piglets, whereas the piglets and broilers had the same response at 800 FTU/kg of diet. It is concluded that the broilers have a higher response to low phytase levels than pigs in evaluating the efficacy of MP.

Key Words: Pigs, Broilers, Microbial Phytase

195 Requirement for apparent ileal digestible isoleucine of young pigs. N. P. Lenis and J.T.M. van Diepen, *Institute for Animal Science and Health, Lelystad, The Netherlands.*

The requirement for apparent ileal digestible isoleucine of starter pigs was investigated in a feeding experiment with 276 group-housed and ad libitum fed pigs in the live weight range 18-40 kg. Six dietary treatments were involved: a positive and negative control diet, containing, respectively, 178 and 162 g/kg crude protein and 5.0 and 3.8 g/kg ileal digestible isoleucine. To the negative control diet four additions of L-isoleucine (0.4, 0.8, 1.2 and 1.6 g/kg) were tested. Levels of all other essential amino acids were about the same for all diets and not limiting for maximum growth performance. Net energy level amounted 9.5 MJ/kg (14.2 MJ/kg DE). Individual daily gain and feed consumption per pen were recorded every week during the four week experiment. Of the basal diets apparent ileal digestibility of amino acids and apparent faecal digestibility of proximate components (for calculating dietary net energy content) were determined, using four ileal cannulated pigs. Apparent ileal digestibility was 82.8 and 82.0 for isoleucine and 88.7 and 89.4 % for lysine in the basal diets 1 and 2, respectively. From analysis of variance and regression analysis the requirement for apparent ileal digestible isoleucine of the pigs was found to be 5.1 g/kg for maximum weight gain and 5.5 g/kg for maximum efficiency of feed utilization. This is 57-60% relative to an apparent ileal digestible lysine level of 9.0 g/kg in a standard Dutch starter diet, containing 9.49 MJ/kg net energy. This knowledge may help to restrict oversupply of dietary protein and consequently to reduce nitrogen excretion by pigs.

Key Words: Pigs, Requirement, Isoleucine

196 Apparent digestibility of amino acids and balance of nitrogen and minerals as influenced by buffering capacity and organic acids in diets for growing swine. Z. Mroz, A. W. Jongbloed*, K. Partanen, J.T.M. van Diepen, P. A. Kemme, and J. Kogut, *Institute for Animal Science and Health, Lelystad, The Netherlands.*

The objective of this 2 × 4 factorial experiment carried out with eight SICV-cannulated swine of 30 kg initial BW was to evaluate the effects of dietary buffering capacity (BC, **H**igh vs **L**ow) and organic acids (no, formic, fumaric and n-butyric) on the apparent ileal digestibility (AID) of N/amino acids and nutrient balance. The organic acids were added to a corn-tapioca-soybean meal based diet in acid-equivalent doses, i.e., 300 meq/kg. To lower the BC, Ca-benzoate was added in an amount of 24 g/kg at the expense of limestone and corn starch. The pigs were fed twice daily at the level of 2.8 times their maintenance requirement (MR=418 kJ ME/$BW^{.75}$). Each experimental period lasted 14 d. After 5 d of adaptation, feces and urine were collected quantitatively for 5 d, and thereafter ileal digesta were collected twice for 12 h, with a 3-d interval in-between. Organic acids in the diet **H** (BC= 632 meq/kg) improved the AID of N and several essential and nonessential amino acids by 3 to 6%-units ($P<.05$). In the diet **L** (BC=578 meq/kg) the AID of N and amino acids was improved, although statistically significant differences were found for Arg, Ileu and Leu only. Organic acids had a positive effect on the balance (% of intake) of N ($P<.01$), Ca ($P<.05$) and total P ($P<.01$). Adding Ca-benzoate reduced P retention by .4 g/d ($P<.05$).

Key Words: Swine, Digestibility, Buffering Capacity, Organic Acids

197 Modeling amino acid requirements of preruminant calves. W.J.J. Gerrits[1,2]*, J. W. Schrama[1], and M.W.A. Verstegen[1], *[1]Wageningen Institute of Animal Sciences, The Netherlands and [2]TNO Nutrition and Food Research Institute, Wageningen, The Netherlands.*

Estimation of the requirements for amino acids (AAs) to achieve a certain production objective has been a key issue in (non)ruminant nutrition for many years. The production objective of many meat producers has shifted from maximizing production volume to the efficient conversion of nutrients into lean meat. Together with interactions between protein and other nutrients, this has urged an integrated approach to AA requirements. A mechanistic model was developed for preruminant calves. The model simulates the partitioning of nutrients from ingestion through intermediary metabolism to growth, consisting of fat, ash, protein and water, following kinetic principles described by Gill et al. (Nutr. Res. Rev. 1989, 2:181). Besides prediction of growth rate and -composition, the model can be used to quantify the corresponding AAs needed. The model includes protein (turnover) in hide, bone, viscera and muscle, adapting different AA profiles for these tissues. Furthermore, AA losses through oxidation, into the gastro-intestinal tract (endogenous, drained from the viscera pool) and through scurf losses (drained from the hide pool) are accounted for. Comparing simulated with experimentally derived AA requirements at similar N-retention shows agreement for most AAs for calves around 90 kg LW (Van Weerden & Huisman, J. Anim. Physiol. Anim. Nutr. 1985,53:232). For calves of around 230 kg LW, however, the model suggested requirements for lysine and for methionine + cystine slightly below the range covered by experiments of G.H. Tolman (unpublished data). This may explain the lack in response, found in these experiments. It is concluded that integrating AA metabolism into a whole-animal model is a useful step in quantifying the requirements. The predictive quality of the model can be improved when more data are available on tissue AA profiles, oxidation rates of individual AAs and protein turnover.

Key Words: Veal calves, Protein Metabolism, Amino Acid Requirements

198 Techniques for accessing optimal dosage in titration studies. J. R. Schwenke and R. D. Goodband, *Kansas State University, Manhattan.*

The purpose of a titration study is to determine an optimal dosage or requirement for a nutrient or therapeutic agent. A traditional approach to estimating the optimal dose is to characterize the response data through the use of a broken line (or spline) model. Our objective is to access a novel approach to determine optimal dosage when a broken line model does not accurately fit the data. We evaluated data from a recent study designed to determine the threonine requirement of 10 to 20 kg pigs (see Table below). Pigs were fed diets containing 1.10% digestible lysine and .44, .52, .60, .68 and .76% digestible threonine with six pens (observations) per treatment. First, data were characterized through several statistical models including: broken line, quadratic, and growth curve (i.e., Mitcherlich). Once the best model was determined, alternative techniques to determine the optimal dose were used. These techniques are based on: 1) the response slope, 2) potential loss in response, 3) change in slope, and 4) change in response. The techniques based on the slope of the dose response determine the minimal dose such that an increase in dose does not significantly increase the response. The potential loss in response is quantified by the area inscribed by the maximum response and the dose response curve. The technique based on change in response determines the minimal dose that is associated with the response not different than the maximum observed response. For example, the Mitcherlich growth curve best characterized the G/F response to increasing threonine. Based on this model, estimates of the threonine requirement were: response slope, .62%; potential loss, .50%; change in slope .67%; and change in response .55%. These techniques allow more flexibility to adequately characterize the dose response when the broken line model does not accurately characterize the response data, and thus, obtain a more reliable optimal dose based on the best fit model.

	Digestible Threonine, %				
Item	.44	.52	.60	.68	.76
G/F[a]	.54	.59	.60	.61	.62

[a]Threonine effect (quadratic, $P < .0554$), SEM = .015.

Key Words: Breakpoint analysis, Optimal dose, Statistics

199 Apparent ileal amino acid digestibility in wheat, cottonseed meal, fish meal, and meat meal in pigs. M. Cervantes[1]*, G. Revuelta[1], V. González[1], and M. Cuca[2], *[1]Universidad Aut. Baja California, Mexicali and [2]Colegio de Postgraduados, Montesillos.*

An experiment with eight pigs, average initial BW 30 kg, fitted with a simple T-cannula at the distal ileum, was conducted to determine the apparent ileal amino acid digestibility (IAAD) in wheat, cottonseed meal, fish meal, and meat meal. Four diets, each based on one of these dietary ingredients, were formulated. Chromic oxide was included as a digesta marker. The experiment was conducted as a two-period change over design; each period consisted of 10 d, 7 d adaptation followed by a 3 d digesta collection. The data were analyzed according to this design. The IAAD in wheat, cottonseed meal, fish meal, and meat meal were: lys, 62.7, 82.3, 83.9, 83.0; thr, 57.6, 81.2, 86.1, 81.1; met, 49.5, 78.5, 85.8 83.1; ile, 57.0, 82.1, 85.3, 82.6; phe, 63.3, 82.6, 85.2, 82.0; val, 52.3, 80.1, 85.4, 81.7; leu, 58.8, 81.7, 85.1 86.1; his, 56.5, 81.4, 85.1, 80.9; arg, 64.4, 74.1, 85.2, 79.1; tyr, 74.7, 85.4, 84.9, 84.2, respectively. The average amino acid digestibility in wheat (61%) was significantly lower (P<.01) than that in cottonseed meal (81%), meat meal (82%) and fish meal (85%). The digestibility of threonine, valine (P<.01), phenylalanine and arginine (P<.10) was lower in cottonseed meal as compared with that in fish meal. Threonine (P<.01), phenylalanine and valine (P<.10) were less digested in meat meal than in fish meal. Within ingredients, the digestibility of amino acids was closely related to the amino acid content. These results indicate that the digestibility of amino acids can be very different between ingredients, and that, formulating swine diets on the basis of total amino acid content, may cause a deficiency in some of the most limiting amino acids. Thus, these data suggest the need for formulating diets on the basis of available amino acids rather than total amino acid content.

Key Words: Amino acid, Digestibility, Pigs

200 Intestinal cannulation of growing pigs for pancreatic enzymes and amino acid digestibility studies. V. González, M. Cervantes*, J. González, S. Rodríguez, and L. Flores, *Universidad Autónoma de Baja California, Mexicali.*

This abstract describes the anatomical references and the insertion of two cannulas, one in duodenum and one in ileum, to study the concentration and activity of pancreatic enzymes, and the digestibility of amino acids in pigs. Six female crossbred pigs, 30 kg BW, from the Universidad A. de B. California swine herd were used. The pigs were fasted 24 h prior to the surgery. The left abdominal wall was clipped, shaved, and scrubbed with an iodine solution (2%) and prepared for surgery from the last rib to the coxal tuberous, and from the dorsal midline to the ventral midline. An incision was made at the center of this area beginning 12 cm from the dorsal midline, and from 5 cm from the last rib, and extended approximately 10 cm ventrally. The jejunum was visualized through the incision, and moved ventrally to expose the pancreas. Then, the duodenal-colical ligament which holds the mid-duodenum, colon and pancreas was localized, and a segment of duodenum, 10 cm caudally from the last pancreatic conduct, was exteriorized. The cannula was inserted at this segment, and exteriorized through a hole ~ 13 mm in diameter, and 2 cm dorsocraneally from the original incision. After this, the ileo-caecal junction was localized using the caecum as a guide, and a segment of the terminal ileum (10 cm from the junction) was exteriorized through the incision. The cannula was inserted at this point, and exteriorized through a hole made across the skin, muscle layers and peritoneum, 2 cm caudally from the original incision. Feed intake was used as a guide to animal recovery; all pigs recovered their original consumption within 5 d of the surgery. No surgery-related problems were observed, and no pig lost her cannulae during the 60-d study. The cannulation of both duodenum and ileum in the same pig is not a difficult procedure, and can be very useful to study the effect of diet manipulation on production, secretion, and activity of pancreatic enzymes, and the consequences over the amino acid digestibility.

Key Words: Intestinal cannulation, Digestion studies, Pigs

201 Effect of amino acid content of finisher diets on growth performance of pigs subjected to dietary restriction during the grower phase. L. I. Chiba*, H. W. Ivey, K. A. Cummins, B. E. Gamble, W. F. Owsley, M. W. Carroll, and P. J. Tyler, *Auburn University, AL.*

Sixty-four, individually-housed crossbred pigs were used to investigate the effect of lysine (Lys) content of finisher (F) diets on growth performance of pigs subjected to dietary restriction during the grower (G) phase. In each of the two trials, low- and high-Lys G diets (1.76 and 3.20 g Lys/Mcal DE, respectively) were assigned to 16 gilts and 16 castrated males (23 kg). At 50 kg, pigs were assigned to four F diets (1.76, 2.16, 2.56 and 2.96 g Lys/Mcal DE) in a 2 × 4 factorial arrangement of treatments after measuring ultrasound backfat (UBF). When pigs weighed 105 kg, UBF was measured before slaughter. Data from the two trials were combined. Pigs fed the high-Lys G diet grew faster (889 vs 776 g/d; $P < 0.001$), and had higher gain to feed ratio (G:F; 394 vs 329 g/kg; $P < 0.001$) and less UBF (11.7 vs 13.6 mm; $P < 0.001$) than those fed the low-Lys diet. The G diets had no effect on weight gain or G:F during the F phase, but pigs fed the high-Lys diet grew faster ($P < 0.01$) during the G-F phase than those fed the low-Lys diet (958 vs 880 g/d). Pigs fed the low-Lys diet had less UBF (20.5 vs 22.9 mm; $P < 0.01$) and larger carcass loin muscle area (LMA; 40.1 vs 36.8 cm^2; $P < 0.05$) than those fed the high-Lys G diet. Although weight gain was not affected by F diets, G:F improved (linear, $P < 0.05$) during the G-F phase (305, 306, 303 and 333 g/kg) as the Lys content increased. Similarly, carcass BF (27.4, 28.5, 25.9 and 24.7 mm) and lean accretion rate (329, 337, 353 and 352 g/d) improved (linear, $P < 0.05$) as the Lys content of F diets increased. Unlike previous research, depression of growth during the G phase through dietary restriction had adverse effects on the overall growth performance, but improved carcass quality of F pigs as indicated by less UBF and larger carcass LMA. Increasing the Lys content of F diets resulted in improved G:F and carcass quality of F pigs regardless of the G diets.

Key Words: Pigs, Amino Acid Restriction, Growth Performance

202 Increased amounts of fermentable carbohydrates in pigs increase the empty gut weight and reduce the energy balance. G.C.M. Bakker[1], R. A. Dekker[1], A. W. Jongbloed[1]*, and M.W.A. Verstegen[2], *[1]Institute for Animal Science and Health, Lelystad and [2]Agricultural University, Wageningen, The Netherlands.*

There is discrepancy in the efficiency of energy gain in pigs when comparing fermentable carbohydrates with starch. It was hypothesized that an increased weight of the gastrointestinal tract requires more energy, thus leaving less energy for growth. In the present study, 96 growing finishing pigs received similar amounts of calculated net energy during the entire growing finishing period (30 to 105 kg live weight). The pigs were assigned to 12 diets, differing in the source of energy. These diets were composed by isoenergetical exchange of maize starch from the control diet with purified cellulose (260 g/kg), with toasted soya bean hulls (270 g/kg) and with four amounts of animal fat (0, 30, 60 and 105 g/kg). The digestibilities were determined using a marker. The amount of retained energy in the pigs were determined using the comparative slaughter technique. In addition, weights of full and empty parts of the gastrointestinal tract were measured. Results showed a linear relationship between the weight of the empty hindgut at slaughter and the amount of fermented carbohydrates (DFERM) consumed during the entire growing finishing period (on average 100 days): empty hindgut (kg) = 1.32 + .023*DFERM (kg) (adj. R^2 = 44%; rsd = .308 kg; CV = 15.3%; P<.001 for both coefficients; n=92). The efficiency of utilization of energy from fermentable carbohydrates was calculated to be .43, while for starch this coefficient was .71. The value for starch corroborates with literature values. The relatively low value for fermentable carbohydrates was suggested to be due to an enhancing effect on maintenance requirement caused by the increased empty gut weight.

Key Words: Pigs, Fermentation, Energy balance

203 Effects of dietary chromium tripicolinate or chromium propionate on growth, plasma metabolites, glucose tolerance, and insulin sensitivity in pigs. J. O. Matthews*, L. L. Southern, J. M. Fernandez, A. M. Chapa, L. R. Gentry, and T. D. Bidner, *LSU Agricultural Center, Baton Rouge.*

An experiment was conducted to determine the effects of dietary Cr tripicolinate (CrPic) and Cr propionate (CrProp) on growth, plasma metabolites, glucose tolerance, and insulin sensitivity in pigs. Thirty-six barrows (12 per treatment; initial and final BW were 20.2 and 38.4 kg) were allotted to one of the following treatments: 1) corn-soybean meal basal (Control), 2) 1 + 200 ppb Cr as CrPic, or 3) 1 + 200 ppb Cr as CrProp. Growth performance data were collected for 28 d. Following the growth trial, 23 pigs (7, 8,and 8 pigs for treatments 1, 2, and 3, respectively) were fitted with jugular catheters and a glucose tolerance (IVGTT; 500 mg glucose/kg BW) and insulin challenge (IVICT; .1 IU of porcine insulin/kg BW) were conducted. Both CrPic and CrProp decreased ($P < .05$) ADG and average daily feed intake, but did not affect feed efficiency ($P > .10$). Fasting (14 to 16 h) plasma total cholesterol, urea N, insulin, and HDL:total cholesterol concentrations were not affected ($P > .10$) by either Cr source. Fasting plasma glucose tended ($P = .11$) to be higher in pigs fed CrPic than in control pigs. Fasting HDL cholesterol concentrations tended ($P = .12$) to be higher in pigs fed CrPic than in pigs fed CrProp. Pigs fed CrPic had decreased ($P < .02$) fasting plasma nonesterified fatty acid concentrations (NEFA) and pigs fed CrProp tended ($P = .12$) to have lower NEFA concentrations than control pigs. During the IVGTT, glucose and insulin kinetics were not affected by treatment ($P > .10$). During the IVICT, glucose clearance was increased ($P < .01$) in pigs fed CrProp and tended ($P = .12$) to be increased in pigs fed CrPic. Glucose half-life was decreased ($P < .03$) in pigs fed either CrPic or CrProp. Insulin kinetics were unaffected ($P > .10$) during the IVICT. Both sources of organic Cr affect glucose metabolism in pigs.

Key Words: Pigs, Chromium, Glucose clearance

204 Influence of dietary selenium source on growth performance, carcass, and meat quality characteristics in pigs. K. D. Miller[1]*, B. Wolter[1], F. K. McKeith[1], D. C. Mahan[2], and M. Ellis[1], *[1]University of Illinois, Urbana and [2]Ohio State University, Columbus.*

The study was conducted to evaluate effects of dietary inorganic and organic (Sel-Plex 50, Alltech, Inc.) selenium sources on growth, carcass, and meat quality characteristics in pigs. Forty-eight halothane carrier gilts were allocated to pens of four pigs on the basis of weight and pens were randomly assigned to selenium source. The study was carried out between 22.1 and 108.8 kg live weight. A three-phase feeding program was used with the crude protein and lysine contents being 19 and .12%, resp., up to 40 kg, 18.2 and 1.05%, resp., between 40 and 80 kg, and 16.5 and 0.9%, resp., from 80 kg to the end of the study. The dietary selenium concentration for both treatments was .15 %. Daily gain, daily feed intake, and gain:feed ratio were not different between treatments. Pigs fed the organic selenium source had less backfat opposite the last lumbar vertebra (1.16 vs 1.39 cm, sem = .007, $P = .04$) and larger longissimus area (42.8 vs 40.4 cm^2, sem = .80, $P = .03$). Other backfat depths and carcass measures were not different between the selenium sources. Meat quality was evaluated on a section of longissimus taken anterior to the last rib. There was no effect of selenium source on color, drip loss, cooking loss, and water holding capacity. This study suggests no effect of selenium source on growth or meat quality. However, the effects on backfat and longissimus area warrant further study.

Key Words: Selenium source, Swine, Meat quality

205 Effect of dietary zinc and copper amino acid complexes on growth performance of starter pigs. S. L. Hoover[1], T. L. Ward[2]*, G. M. Hill[1], and T. M. Fakler[3], *[1]Michigan Stage University, E. Lansing, [2]Consolidated Nutrition, L.C., Fort Wayne, IN, and [3]Zinpro Corp., Eden Prairie, MN.*

One-hundred seventy-five 19-day-old pigs (5 replicates of 5 pigs each; 6.3 kg BW) were randomly assigned to seven dietary treatments. The objective was to evaluate the individual addition and combination of two organic zinc (250 ppm) and copper (100 and 50 ppm in Stage 1 and 2, respectively) sources. The treatment diets evaluated were 1) Control (C), 2) C + copper lysine complex (CuPLEX™), 3) C + copper amino acid complex (Availa®Cu), 4) C + zinc methionine complex (ZINPRO™), 5) C + zinc amino acid complex (Availa®Zn), 6) C + CuPLEX™ + ZINPRO™, 7) C + Availa®Cu + Availa®Zn. All diets contained 250 and 160 ppm of zinc from zinc sulfate and 25 and 16 ppm of copper from copper sulfate in Stage 1 and 2, respectively. Stage 1 diets were fed for 13 d postweaning; Stage 2 diets were fed from d 13 to 33 postweaning. Copper lysine complex increased gain and feed intake in Stage 1 ($P < .05$), Stage 2 ($P = .10$), and the overall experiment ($P < .05$). Copper amino acid complex increased ($P < .05$) feed intake in Stage 1; but did not otherwise affect ($P > .05$) growth performance. Zinc methionine complex increased gain in Stage 1 ($P < .05$) but did not affect ($P > .05$) gain or feed intake in Stage 2 or the overall experiment. Zinc methionine complex increased ($P < .05$) gain/feed for the overall experiment. The effects of increased feed intake in Stage 1 from copper lysine complex and zinc methionine complex were not additive (copper lysine by zinc methionine, $P < .05$); no other interactions were present ($P > .05$). Zinc amino acid complex increased ($P < .05$) gain and feed intake in each phase of production but did not affect ($P > .05$) gain/feed. Pigs fed zinc amino acid complex were on average 2.4 kg heavier ($P < .05$) than pigs fed the control diet at the end of the 33 d experiment. These data support the use of organic zinc and copper supplementation in the form of amino acid complexes to improve the growth performance of starter pigs.

Key Words: Pigs, Zinc, Copper

206 The impact of organic and inorganic sources of zinc supplementation on intestinal metallothionein concentration in the nursery pig. M. S. Carlson[1]*, S. L. Hoover[1], G. M. Hill[1], J. E. Link[1], and T. L. Ward[2], *[1]Michigan State University, E. Lansing, [2]Consolidated Nutrition L.C., Fort Wayne, IN.*

Growth performance parameters of nursery pigs have been intensively studied during pharmacological zinc (Zn) supplementation yet the mode of growth promotion is unknown. Zinc supplementation may stimulate the induction of the protein metallothionein (MT), which has a role in metal detoxification and zinc homeostasis. The objective was to determine if MT concentration in the intestinal mucosa is affected by organic and inorganic Zn sources. Twelve barrows (19 d of age and 6.68 kg) were allotted by litter to one of four dietary treatments as follows: 1) basal (Control) 2) basal + 250 ppm Zn methionine complex (ZnMet) 3) basal + 250 ppm Zn amino acid complex (ZnAA) and 4) basal + 3000 ppm Zn oxide (ZnO). After 20 d, pigs were sacrificed and a 15 cm duodenum section (posterior to the pylorus) was excised, rinsed and scraped to obtain mucosal cells. Following centrifugation, mucosal cell homogenate was applied to a Sephadex G-75 column to separate proteins. Fractions containing the MT protein were analyzed for copper (Cu) and Zn concentrations by atomic absorption spectrophotometry. Mucosal cell homogenate was analyzed for MT using a non-radioactive silver (Ag^+) binding assay measuring Ag^+ by atomic absorption spectrophotometry. Zinc concentrations in the MT fractions of ZnO fed pigs were higher ($P = .02$) compared to control, ZnMet and ZnAA (.792 vs .027, .022 and .029 μg/ml), respectively. Copper concentrations in MT fractions were not affected ($P > .05$) by dietary treatment. Intestinal mucosal cell MT concentrations were higher ($P = .02$) in control and ZnO fed pigs compared to ZnMet and ZnAA (98.04 and 116.01 μg/g vs 56.6 and 71.31 μg/g), respectively. Therefore, it appears that intestinal MT responds differently to organic and inorganic forms of Zn.

Key Words: Metallothionein, Zinc sources, Nursery pig

207 Relative bioavailability of phosphorus sources with different solubilities in neutral ammonium citrate (NAC) for young pigs. E. T. Kornegay* and J. S. Radcliffe, *Virginia Polytechnic Institute and State University, Blacksburg.*

Six commercially used feed phosphate sources that varied in solubility in NAC were fed in a 5-wk test (n=96, initial BW 7.5 kg) to determine the relative bioavailability of P and to investigate the relationship between relative bioavailability of P and solubility of P source in NAC. The six P sources, monocalcium phosphate (MCAP), dicalcium phosphate (DCAP), high NAC defluorinated phosphate (HDFP), medium-high NAC defluorinated phosphate (MHDFP), medium NAC defluorinated phosphate (MDFP), and low NAC defluorinated phosphate (LDFP), were added at a level of .15% to a low P (.35% P, no added inorganic P) basal 20% CP (1.25% lysine) diet. The low P diet served as a negative control. The diets were formulated to contain .6% Ca (1.2:1 Ca:total P ratio for all except the basal diet, 1.7:1 Ca:P ratio). Early weaned PIC pigs were given a 10 d adjustment before dietary treatments were started. Apparent digestion coefficients for P were calculated using the indicator method (chromic oxide) using pen fecal samples collected during wk 4 and 5. All pigs were killed at the end of the test for collection of tenth ribs which were used in the determination of shear force and ash percentage. Daily gain, tenth rib shear force and ash percentage, and fecal P digestibility responses for all P sources were larger ($P < .05$) than responses for pigs fed the basal diet; however, differences among P sources were not significant ($P > .10$) for any of the response criteria. The mean ratio technique was used to compare the response criteria for MCAP (given a value of 100) to the responses of the other test P sources. Calculated relative bioavailability estimates averaged across the four response criteria were 95.1, 105.3, 100.3, 99.5 and 101.7%, respectively, for DCAP, HDFP, MHDFP, MDFP and LDFP. In summary, all commercial phosphate sources had similar relative bioavailability estimates, and a relationship between solubility in NAC and bioavailability could not be discerned.

Key Words: Phosphorus bioavailability, Solubility, Pigs

208 Relative bioavailability of organic Zn sources for chicks. J. Cao*, S. Godoy, P. R. Henry, L. P. Liu, R. D. Miles, and C. B. Ammerman, *University of Florida, Gainesville.*

A total of 432 1-d-old Avian broiler chicks was used to estimate the relative bioavailability of two supplemental organic Zn sources based on tissue Zn concentration and tissue metallothionein (MT) content. Dietary treatments included the unsupplemented basal corn-soybean meal diet (59 mg/kg Zn, DM basis) or the basal supplemented with 200, 400, or 600 mg/kg added Zn as reagent grade $ZnSO_4 \cdot 7H_2O$ or with 200 and 400 mg/kg added Zn as commercially available organic Zn-amino acid (ZnAA) and Zn-proteinate (ZnPro). At either 1, 2, or 3 wk of age, chicks were weighed individually, and feed consumption was recorded per pen. Three chicks from each pen were killed and intestine, intestinal mucosal cells, and right tibia were collected for Zn analysis. Liver and intestinal mucosal cells were analyzed for MT content. There were no differences ($P>0.05$) in feed intake among sources and Zn levels at 1 wk. Feed intake was greater ($P<0.05$) for birds fed 400 mg/kg Zn for both ZnAA and ZnPro at 2 and 3 wk, and for birds fed 200 mg/kg Zn from ZnAA at 2 wk, due to feed intake being slightly decreased with increasing $ZnSO_4$ at later experimental periods. Relative bioavailability was determined by slope ratio comparisons from multiple linear regression of tissue Zn concentration (mg/kg DM basis) and MT content (μg/g fresh tissue) on total daily Zn intake (mg). Bone Zn at 1 wk and mucosal Zn at 3 wk had the best fit to a linear model. Tissue MT content was not a good indicator of bioavailability in this study. The relative bioavailability values of the two organic sources were not different from that of $ZnSO_4$ ($P>0.05$). Based on mucosal Zn concentration, zinc from ZnPro (133%) tended to be more available than that from ZnAA (76%) at 3 wk ($P<0.05$).

Key Words: Zinc, Bioavailability, Chick

209 Evaluation of excretion and retention of zinc from inorganic and organic sources in diets fed to weanling pigs. S. L. Hoover[1]*, M. S. Carlson[1], G. M. Hill[1], J. E. Link[1], T. L. Ward[2], and T. M. Fakler[3], *[1]Michigan State University, E. Lansing, [2]Consolidated Nutrition L.C., Fort Wayne, IN, and [3]Zinpro Corp., Eden Praire, MN.*

Nursery diets commonly contain high concentrations of zinc (Zn) yet, the environmental impact is unknown. Therefore, the use of lower concentrations of organic forms of zinc were compared to inorganic forms. Twelve PIC barrows (19 d of age; 6.68 kg) were allotted to four dietary treatments: a basal (control), basal + 250 ppm Zn methionine complex-ZINPRO™ (ZnMet), basal + 250 ppm Zn amino acid complex-Availa®Zn (ZnAA), and basal + 3000 ppm Zn oxide (ZnO). Pigs housed in individual stainless steel metabolism cages were bled at d 0 and d 20 for plasma iron (Fe), copper (Cu), and Zn concentrations. Feces, orts, and urine were collected for 5 d following a 14 d adjustment period. On d 20, pigs were killed, liver and kidney were collected for atomic absorption analysis. At d 20, plasma Zn was greatest ($P < .01$) for pigs fed ZnO; there were no differences in plasma Fe or Cu concentrations. Pigs fed ZnO had the highest ($P < .01$) Zn accumulation (231.8 and 1166.2 μg/g) in kidney and liver respectively, and highest renal Cu. Zn retention was negative for control pigs and positive for pigs fed ZnMet, ZnAA or ZnO. Zn retention from ZnAA was 42.5% greater than for ZnMet at the same dietary Zn concentration. Pigs fed ZnO excreted the most ($P < .01$) Zn in urine and feces (3.01 μg/ml and 1022.13 μg/g, respectively). Significantly more Cu was excreted in urine from pigs fed ZnO and ZnAA than control or ZnMet. Results suggest that due to the similarity in Zn balance between dietary treatments, Zn from ZnO is contributing a greater amount of Zn in feces and urine that is not utilized.

Key Words: Zinc, Weanling pigs, Organic zinc

210 Effect of inorganic phosphorus withdrawal on absorption and retention of phosphorus and bone traits in finishing pigs. C.P.A. van de Ligt*, M. D. Lindemann, and G. L. Cromwell, *University of Kentucky, Lexington.*

Four sets of three littermate barrows (n=12; initial and final BW - 50 and 110 kg) were used to determine P balance in finishing pigs when inorganic P was withdrawn from the diet. The study involved two diets: a .65% lysine, corn-soybean meal fortified diet with (NORM) or without dicalcium phosphate (LO). NORM was formulated to a Ca/P % of .50/.40 (NRC, 1988), while LO was formulated to .35/.30. The Ca level in LO was reduced to keep the Ca/P ratio similar. Littermates were assigned to three treatments (T): T1 was fed NORM throughout, T2 changed from NORM to LO at 70 kg BW, T3 was fed LO throughout. A 5-d balance period was conducted at 70 kg (immediately following the diet switch on T2) and at 100 kg with a feed allowance during the collection periods of 3.0 and 2.4 % of BW, respectively. During Period 1, apparent P absorption was lower for pigs in T2 ($P < .05$; 35.6, 23.0, 31.2 % for T1, T2, T3, respectively) as was P retention ($P < .05$; 34.6, 22.3, 30.5 %). Daily P retention for Period 1 was 3.20, 1.53, and 2.13 g ($P < .05$). No differences ($P > .10$) among treatments were seen in Period 2 for absorption or retention of P as a % of intake. However, pigs in T2 had numerically increased P absorption (28.5, 30.9, 25.9 %) and P retention from the diet (24.8, 30.1, 25.1 % of intake). Daily P retention for Period 2 was 2.42, 2.19, and 1.93 g ($P > .10$). At 110 kg, carcass length was shorter the longer the period of P withdrawal ($P < .05$; 82.5, 81.5, 79.4 cm) with loin muscle area exhibiting a similar relationship ($P > .10$; 43.1, 39.5, 36.4 cm^2). Average metacarpal and metatarsal breaking strength was greater ($P < .05$) for T1 than T2 and T3 (145, 117, 105 kg) as was avg metacarpal and metatarsal ash ($P < .05$; 60.2, 57.3, 58.1 %). Pigs did not exhibit any obvious detrimental effects in this study, suggesting that some inorganic P can be deleted from the finishing diet for a period of time although P absorption, retention, and bone breaking strength will be negatively affected.

Key Words: Pigs, Phosphorus, Nutrient balance

211 Influence of dietary calcium salts and electrolyte balance on the urinary pH, slurry pH and ammonia volatilization from slurry of growing-finishing pigs. T. T. Canh[1,3]*, A.J.A. Aarnink[1], Z. Mroz[2], and A. W. Jongbloed[2], *[1]DLO-Institute of Agricultural and Environmental Engineering (IMAG-DLO), Wageningen, [2]Institute for Animal Science and Health (ID-DLO), Lelystad, and [3]Wageningen Agricultural University, The Netherlands.*

This study investigated the effect of dietary electrolyte balance (dEB; calculated as meq Na + K – Cl), and level and source of Ca-salts on the pH of urine and slurry, and on the ammonia emission from slurry of growing-finishing pigs. Ninety gilts of about 40 kg were randomly allotted to 16 diets in five replications. Two basal diets were used (diets A and B). Diet A had a high dEB (320 meq/kg DM) and diet B a low dEB (100 meq/kg DM). Each basal diet, containing 4 g/kg Ca, was supplemented with one of the four Ca-salts ($CaCO_3$, $CaSO_4$, Ca-benzoate or $CaCl_2$) to increase Ca content by 3 or 6 g per kg of diet. Faeces and urine were collected quantitatively on metabolism cages and mixed to slurry. From a subsample of this slurry the pH and the ammonia emission were measured in a laboratory set up. Generally, the pH of and the ammonia emission from the slurry were lower at the lower dEB-level, but there was an interaction effect with the Ca-salt added. The dietary Ca-salts significantly influenced the pH of and the ammonia emission from the slurry. The pH was highest for the diet with $CaCO_3$ and lowest for the diet with Ca-benzoate. On average, ammonia emission was reduced by 30%, 54% and 33% when $CaCO_3$ in the diet was replaced by $CaCl_2$, Ca-benzoate or $CaSO_4$ respectively ($P < 0.001$). It is concluded that ammonia emission can be reduced considerably when the Ca-salts $CaSO_4$ or $CaCl_2$ are added to the diet instead of $CaCO_3$. The most profound effect is achieved when $CaCO_3$ is replaced by Ca-benzoate.

Key Words: Pigs, Diet, Ammonia

212 Effect of dietary chromium supplementation on plasma glucosekinetics in barrows and gilts. X. F. Guan*, J. L. Snow, P. Ku , J. Burton, and N. L. Trottier, *Michigan State University, East Lansing.*

Twenty pigs (BW of 48.32±.96 kg) were used to test the effect of dietary chromium (Cr) supplementation on plasma glucose kinetics. Pigs were fed either a control diet (C) or a diet containing 200 ppb Cr (CR) for a 3-wk period after which six barrows (C, n=3; CR, n=3) and six gilts (C, n=3; CR, n=3) were selected and fitted with a jugular vein catheter. Glucose was administered via the catheter as a 50% dextrose solution following an overnight fast. The dextrose dose was .5g/kg of BW with an infusion rate of 10 g/min. Blood samples were collected at post-infusion times 0, 5, 10, 15, 20, 30, 45, 60, and 90 min. There was no difference ($P > .1$) in ADG, ADFI and gain/feed between C and CR. Fasting and peak plasma glucose concentrations (mg/dL) were not different ($P > .1$) in both barrows (C vs CR, for fasting and peak values: 90.9± 9.1 vs 91.7± 9.1 and 286.0± 9.1 vs 265± 9.1, respectively) and gilts (C vs CR, for fasting and peak values: 95.9± 10.3 vs 99.2± 10.3, 330.6± 10.3 vs 332.2± 10.3, respectively). Plasma glucose concentrations were lower ($P < .001$) for barrows in CR compared to C at post-infusion times 5, 10, 15, and 20 min, and lower ($P < .1$) for gilts in CR at post-infusion times 5 and 10 min. Glucose disappearance rate (k) was higher ($P < .05$) and glucose disappearance half-life ($t_{1/2}$) lower ($P < .05$) for barrows in CR compared to C (C vs CR, for k and $t_{1/2}$: .06± .01 vs .10± .01 mg/(dL·min), and 11.58± .92 vs 7.63± .92 min, respectively). There was no difference ($P > .1$) in k and $t_{1/2\alpha}$ for gilts between C and CR (C vs CR, for k and $t_{1/2}$: .07± .01 vs .08± .01 mg/(dL·min), and 10.78± 1.63 vs 9.03± 1.63 min, respectively). The fractional utilization rate of glucose (FUR) was higher ($P < .05$) for barrows in CR (9.53± .97 %/min) compared to C (5.99± .97%/min). No difference ($P > .1$) in FUR for gilts was found between C and CR (7.17± 1.33 vs 7.45± 1.33 %/min). This study indicates that dietary Cr increases glucose tolerance by increasing k and decreasing $t_{1/2}$ in barrows, but has no effect on k and $t_{1/2}$ in gilts.

Key Words: Chromium, Glucose Tolerance, Pig

213 Apparent and true ileal digestibilities of amino acids in newly-weaned piglets fed diets with protease-treated soybean meal. W. R.Caine, W. C.Sauer[1], S. Tamminga[2], M.W.A. Verstegen[2], and H. Schulze[3], *[1]University of Alberta, Edmonton, [2]Wageningen Agricultural University, The Netherlands, and [3]Finnfeeds International Limited, Wiltshire, United Kingdom.*

Apparent and true ileal digestibilities of amino acids were determined in piglets fed corn starch-based diets with untreated or protease-treated soybean meal. Twelve piglets, fitted with a modified post valve T-caecum cannula on d 14, 15 and 16 after birth, were weaned on d 20 and fed one of four diets according to a two period balanced change-over design. Treatments consisted of soybean meal which was untreated (SBM), incubated (1:2 wt/vol distilled water adjusted to pH 4.5, for 16 h at 50°C; CI-SBM), sprayed with protease (supplied at 1μL/g soybean meal; PS-SBM) and incubated, as previously described, with protease (supplied at 1μL/g soybean meal; PI-SBM). Each period consisted of 5 d adaptation followed by collection of digesta (total of 24 h) on d 6 and 7. On d 9, guanidinated meals were fed followed by a 24 h continuous collection of digesta. Apparent CP digestibilities (%) were similar ($P > .05$) at 70.4, 72.4, 65.2 and 70.3 for SBM, CI-SBM, PS-SBM and PI-SBM, respectively. Corresponding amino acid digestibilities were also similar ($P > .05$), ranging from 62.5, 67.5, 57.9 and 65.0 for alanine to 83.5, 83.4, 78.7 and 84.7 for arginine. True digestibilities were usually similar ($P > .05$) between SBM, CI-SBM and PS-SBM ranging from 82.7, 81.8 and 84.3 for glutamate + glutamine to 100.3, 97.8 and 98.3 for histidine, respectively. True digestibilities for PI-SBM were lower ($P < .05$) compared with the other treatments due to losses of amino acids from soybean meal during guanidination. With the exception of methionine pooled apparent digestibilities were lower ($P < .05$)for Period 1 (7 d after weaning) compared with Period 2 (16 d after weaning). True digestibilities were similar ($P > .05$) for both periods. In conclusion, protease treatment of soybean meal had no effect on apparent and true ileal digestibilities of amino acids in newly-weaned piglets.

Key Words: Pigs, Protease, Digestibility

214 Effect of micronization on energy, starch and amino acid digestibility in hulless barley for young pigs. S. X. Huang[1]*, W. C. Sauer[1], M. Pickard[2], and S. Li[1], *[1]University of Alberta, Edmonton and [2]InfraReady Products Limited, Saskatoon*, Canada.

Studies were carried out to determine the effect of micronization on energy, starch and amino acid digestibilities in hulless barley. Six pigs (Canabrid × Camborough) were weaned at 21 d of age and fitted with a simple T-cannula at the distal ileum on d 23 or 24. The pigs were fed one of three diets consisting of hulless barley and soybean meal (HB + SBM), micronized hulless barley and soybean meal (MHB + SBM) and corn starch and soybean meal (C + SBM) according to repeated Latin square design. The pigs were fed three times daily, equal amounts at 8-h intervals. The diets were supplied at a rate of 5% (wt/wt) of body weight. The average body weight of the pigs was 9.3 kg at the start and 15.9 kg at the conclusion of the experiment. Feces were collected for 48 h on d 6 and 7 and ileal digesta for 24 h on d 8 and 9. Chromic oxide was used as digestibility marker. The apparent ileal amino acid digestibilities in HB and MHB were determined with the difference method. The apparent digestibilities of the indispensable amino acids were higher in MHB than HB and ranged from 5.3 to 10.0 percentage units. Of the indispensable amino acids, the differences were significant ($P < .05$) for arginine, histidine, isoleucine, leucine, phenylalanine and valine. Micronization of HB improved ($P < .05$) the ileal digestibility of starch from 79.0 to 97.3%. Micronization resulted in an increase in the digestion and absorption of energy in the small intestine and a decrease in microbial fermentation of energy in the large intestine. This shift in the disappearance of energy from the large to the small intestine should also result in an improvement in the efficiency of energy utilization, These studies show a positive effect of micronization on the digestibilities of energy and amino acids in young pigs fed HB.

Key Words: Micronization, Barley, Pigs

215 Response of nutrient and energy digestibility to feeding diets containing low and high levels of soybean trypsin inhibitors in growing pigs. S. Li*, W. C. Sauer, and S. X. Huang, *University of Alberta, Edmonton, Canada.*

Studies were carried out to determine the effect of dietary soybean trypsin inhibitor(SBTI) content on nutrient and energy digestibilities in growing pigs. Six barrows, average initial body weight (BW) 47.8±4.0 kg, were fitted with a simple T-cannula at the distal ileum and fed two diets according to a crossover design. Two corn starch-based diets were formulated to contain 20% CP from either raw Nutrisoy (food grade defatted soy flour) or autoclaved Nutrisoy. The contents of SBTI in the raw and autoclaved Nutrisoy diets were 13.4 and 3.0 g/kg, respectively. The experiment consisted of 2 periods of 14 days each. The average BW at the beginning of the first and second experimental periods were 53.3±3.7 and 61.0±5.1 kg, respectively. The average BW at the conclusion of the experiment was 71.8±7.6 kg. The ileal digestibilities of DM, OM, energy, CP and amino acids were higher ($P < .01$) in pigs fed the autoclaved Nutrisoy diet. The energy digestibility increased from 66.0 to 77.9%; the CP digestibility from 37.4 to 77.1%. Of the indispensable amino acids, the increases ranged from 27.0 (methionine) to 49.2 (leucine) percentage units. Of the dispensable amino acids, the increases ranged from 30.2 (aspartic acid) to 50.8 (tyrosine) percentage units. The fecal digestibilities of all parameters measured were also higher ($P < .01$) in pigs fed the autoclaved Nutrisoy diet. Furthermore, there was a higher ($P < .01$) net disappearance (g/kg DM intake) of DM, OM, CP, Energy and amino acids in the large intestine of pigs fed the raw Nutrisoy diet. In conclusion, feeding diets containing high levels of SBTI decreased both ileal and fecal digestibilities of all parameters measured. The formation of SBTI-enzyme complexes is likely responsible for the reduction in protein digestion and amino acid absorption.

Key Words: Pigs, Trypsin inhibitors, Digestibility

216 Extruded hulless barley for swine and reductions in manure production and pollution. C. S. Darroch*, C. McPherson, A. Ceigelski, and F. X. Aherne, *University of Alberta, Edmonton, Alberta, Canada.*

The objectives of the study were to determine, using ileal cannulated barrows, the digestibility of nutrients in Condor hulless barley subjected to extrusion, acidification and enzyme supplementation; and to determine manure output in pigs fed raw or processed hulled and hulless barleys. In trial one, 25 kg batches of hulless barley were extruded in a twin-screw extruder at three temperature levels; with water, 0.1 or 2 M acetate buffer, and after pretreatment with single enzymes (α-amylase, β-glucanase, phytase) or an enzyme mixture. Increasing extruder barrel temperature increased ($P<0.001$) hulless barley product temperature and increased ($P<0.001$) the degree to starch cooking. Addition of 2.0 M acetate buffer during extrusion increased ($P<0.001$) hulless barley product temperature and increased ($P<0.01$) degree of starch cooking. Enzyme supplementation tended to increase ($P=0.10$) the degree of starch cooking. There were significant interaction effects between extruder temperature level and buffer treatments. In the second trial, hulled barley, hulless barley, extruded hulless barley, acidified (0.1 M buffer) enzyme-supplemented extruded hulless barley, acidified (2 M buffer) extruded hulless barley, and acidified (2 M buffer) enzyme-supplemented extruded hulless barley were fed to six ileal-cannulated barrows in a 6×6 Latin square design to determine ileal and fecal nutrient digestibilities and manure output. Extrusion of hulless barley reduced dry matter (DM) fecal output by 25.6% ($P<0.05$) and 47.4% ($P<0.05$) when compared to raw ground hulless barley and hulled barley, respectively. Ileal and fecal digestibility coefficients for DM, crude protein (CP), amino acids (AA) and energy (GE) were higher ($P<0.05$) for raw hulless barley when compared to hulled barley. Extrusion of hulless barley increased ($P<0.05$) GE digestibility and tended ($P>0.05$) to increase DM, CP and AA digestibility. Acidification of Condor barley with a 2 M acetate buffer tended to increase ($P>0.05$) ileal nutrient digestibility coefficients and increased ($P<0.05$) fecal DM, CP and GE digestibility coefficients. Enzyme supplementation decreased ($P<0.05$) ileal and fecal DM, CP and GE digestibility coefficients when compared to extruded and acidified hulless barley, and had variable effects on AA digestibility coefficients. Replacing hulled barley in pig diets with raw or processed Condor hulless barley improved nutrient digestibilities and reduced fecal DM output.

Key Words: Swine, Hulless Barley, Extrusion, Nutrient Digestibility

217 Comparative digestibilities of amino acids in growing pigs and sows. H. H. Stein* and R. A. Easter, *University of Illinois, Urbana.*

An experiment involving twelve growing barrows (initial body weight: 56+/-5 kg) and 12 sows was conducted with the objective to test the hypothesis that values for apparent ileal amino acid digestibilities obtained in growing pigs are also representative of amino acid digestibilities in sows. Pigs and sows were prepared with simple T-cannulas inserted in the terminal ileum, and apparent ileal amino acid digestibilities were measured in three cereal grains (corn, wheat, and barley) and three protein ingredients (soybean meal, cannola meal, and meat and bone meal). Chromium oxide was included in each diet as an indigestible marker and digestibilities estimated using marker concentrations. Sows were sampled in gestation as well as in lactation. Digestibility values for each feed ingredient were obtained from six growing pigs, six gestating sows and six lactating sows. Growing pigs and lactating sows were allowed ad libitum access to the diets, whereas gestating sows were restricted to 2 kg of feed per day fed in two equal meals. The results from the experiment showed that disappearance of indispensable as well as dispensable amino acids prior to the terminal ileum was significantly higher ($p<0.05$) in lactating sows compared to gestating sows and growing pigs. Gestating sows tended to have higher digestibilities than growing pigs for the indispensable amino acids ($p = 0.1$), whereas no difference existed for dispensable amino acid digestibilities ($p>0.1$). On average of the six feed ingredients, the apparent ileal digestibilities of indispensable amino acids were 76.3±1.16, 73.0±1.12, and 70.4±1.11, and apparent ileal digestibilities of dispensable amino acids were 65.4±2.24, 58.9±2.17, and 57.9±2.13 in lactating sows, gestating sows and growing pigs, respectively. In conclusion, results from this experiment indicate that apparent ileal amino acid digestibilities in pigs are affected by the physiological stage of the animal. Therefore, values obtained with one group of animals are not always representative of other groups.

Key Words: Amino acid digestibility, Sows

218 Effect of volatile fatty acid inclusion in drinking water on ileal microflora concentrations and performance in the weanling pig. R. J. Vickers*, S. E. Chattin, and A. G. Mathew, *University of Tennessee, Knoxville.*

In a series of three 17 d replicate trials, a total of 36 ileal cannulated pigs were used to determine the effects of volatile fatty acid (VFA)inclusion in drinking water on ileal microflora, water intake, and feed intake. All pigs were weaned at 21 days of age and assigned to one of three treatments including: T1)ad libitum access to water, T2)ad libitum access to water containing acetate(50mM), propionate(5mM), and butyrate (3mM), and T3)ad libitum access to water containing acetate(25mM), propionate(2.5mM), and butyrate(1.5mM). Individual water intake was measured daily and feed intake was measured twice weekly. All pigs were individually caged in an environmentally controlled room with ad libitum access to a phase starter diet. Ileal samples were collected twice weekly and digesta were analyzed for total *E. coli*, streptococci, and lactobacilli. Neither water nor feed intake differed between treatments ($P>.10$)($P>.08$)respectively. No differences ($P>.10$) were observed in microflora concentrations between treatments. Average ileal *E. coli* concentrations of 6.23, 5.87, and 6.15, streptococci concentrations of 7.55, 7.39, and 7.34, and lactobacilli concentrations of 7.32, 7.49, and 7.15 $\log_{10}$ CFU/g were observed for T1, T2, and T3 pigs respectively. Day effects ($P<.001$) were observed for *E. coli*, streptococci, and lactobacilli. Results indicate that VFA inclusion in drinking water had no significant effect on ileal microflora, water intake, or feed intake in weanling pigs.

Key Words: Volatile Fatty Acid, Microbial flora, Pigs

219 Menhaden fish meal (MFM) in Phase 1 and 2 diets for weanling pigs. T. L. Veum, D. W. Bollinger, and M. R. Ellersieck, *University of Missouri, Columbia.*

Crossbred weanling pigs (total n = 288) averaging 5.8 kg BW and 3 wk of age were used in two trials to evaluate the effect of MFM in Phase (P) 1 (day 0-14) and P2 (day 14-28) diets on pig growth performance. Four P1 MFM treatments were created by replacing corn and soybean meal on a total lysine (tL) basis with 0, 2.5, 5.0 or 7.5% MFM. The two P2 treatments were 2.5 or 5.0% MFM, allotted across all P1 treatments. P1 diets contained 4% spray dried animal plasma (AP), 25% spray dried whey (DW), 1.55% tL, .48% methionine (M) and 3.37 Mcal of ME/kg. P2 diets contained 0% AP, 15% DW, 2% spray dried animal blood cells, 1.45% tL, .44 M and 3.39 Mcal of ME/kg. Lard was used to equalize ME across treatments. Pens of pigs were the experimental units. There were no P1 × P2 interactions and no MFM treatment effects in P1 ($P > .4$ to .9) for ADFI, ADG or gain:feed (G:F) ratio. However, the 5% MFM treatment in P1 increased ($P < .05$) ADFI and ADG in P2, and increased ($P < .08$) ADG overall, compared to 0 and 2.5% MFM, whereas 7.5% MFM was not different from the other treatments. For P2, G:F ratio was higher ($P < .05$) for 2.5% MFM compared to 5.0% MFM. During week four, ADG and G:F ratio were higher ($P < .05$) for 2.5% MFM compared to 5.0% MFM. There were no overall P2 treatment effects ($P > .2$ to .5). In conclusion, there was a MFM treatment carry-over effect from P1 to P2, where 5% MFM in P1 improved pig growth performance in P2 when the P2 diet contained MFM.

Key Words: Swine, Performance, Weaning, Menhaden fish meal

220 Whey protein concentrate vs crystalline amino acids as a amino acid source for segregated early weaned pigs. B. Z. de Rodas[1]*, C. V. Maxwell[1], B. J. Kerr[2], M. E. Davis[1], E. Broekman[1], and J. Chung[1], *[1]Oklahoma State University, Stillwater and [2]Nutri-Quest, Inc., Chesterfield, MO.*

A total of 80 pigs (13 d of age and 4.7 kg BW) were used to evaluate the efficacy of whey protein concentrate (WPC) or a mixture of crystalline amino acids (AA) at two Lys levels on performance and blood urea N (BUN) of segregated early weaned (SEW) pigs. Pigs were housed in an off-site nursery with 4 pigs per pen and 4 pens per treatment and were assigned to five dietary treatments arranged as a 2 x 2 factorial with a negative control (NC; 1.12% digestible Lys and no WPC). The factorially arranged treatments consisted of two Lys levels (1.40 and 1.68 % digestible Lys) with WPC as a source of amino acids or the WPC component replaced by an ideal mixture of AA. The Lys levels were achieved by increasing the amount of WPC or AA. Experimental diets were fed from d 0 to 14 postweaning, then all pigs were fed a common transition diet from d 14 to 28, and a common phase 2 diet from d 28 to 42. From d 0 to 14, pigs fed the NC diet had lower ($P < .01$) ADG and G:F than pigs receiving WPC, and lower ADG ($P < .09$) and G:F ($P < .01$) than pigs receiving the AA diets. Pigs given the diets containing WPC during d 0 to 14 had greater gains ($P < .05$) than those receiving the AA diets. Gain:feed increased with increasing Lys level in the WPC diets, but decreased with increasing Lys level in the AA diets during d 0 to 14 (interaction, $P < .05$). For the entire 42-d experiment ADG and G:F of pigs fed diets containing WPC were greater ($P < .05$) than for pigs fed the NC diet. Pigs fed the WPC diets had greater ($P < .05$) G:F than pigs fed the AA diets. There was an increase in BUN concentrations (d 14) with increasing Lys levels in the WPC diets, but a decrease in BUN with increasing Lys levels in the AA diets (interaction, $P < .05$). These data indicate that adding AA to the diet of SEW pigs improved performance when compared to pigs fed a low protein NC diet, but did not produce equivalent performance when compared to pigs fed WPC.

Key Words: Swine, Protein Source, Amino Acids

221 The interactive effects between diet complexity, zinc oxide, and feed grade antibiotic on performance of segregated early weaned pigs. P. R. O'Quinn, J. R. Bergstrom*, J. L. Nelssen, M. D. Tokach, S. S. Dritz, and R. D. Goodband, *Kansas State University, Manhattan.*

A 27 d growth trial was conducted with 320 segregated early weaned (SEW) barrows (initially 4.5 kg BW and 12 to 15 d of age) to evaluate the interactive effects between diet complexity, zinc oxide, and feed grade antibiotic. Pigs were randomly allotted on the basis of initial weight to one of eight dietary treatments with five pigs per pen and eight replications per treatment. The experimental diets were fed in meal form in three phases (d 0 to 5, d 5 to 10, and d 10 to 20 postweaning, respectively). Treatments consisted of a 2 × 2 × 2 factorial arrangement with main effects of diet complexity, added zinc oxide, and feed grade antibiotic. For the remainder of the trial (d 20 to 27), a common diet not containing antibiotic or zinc oxide was fed to all pigs. The simple diets were corn-soybean meal based, while the complex diets contained dried whey, lactose, fish meal, spray-dried blood meal, and spray-dried animal plasma. The amounts of specialty products in the complex diets were decreased as pig weights increased. There were no interactions ($P > .05$) of main effects when measured over the entire trial. For the overall trial, pigs fed complex diets, regardless of zinc oxide or antibiotic, grew faster ($P < .01$) and ate more feed ($P < .01$) than did pigs fed the simple diets. Pigs fed diets containing antibiotic had better ADG ($P = .01$) and ADFI ($P = .06$) than did pigs fed diets without antibiotic. Similar results were observed for pigs fed diets containing zinc oxide (ADG, $P = .02$, and ADFI, $P = .07$). However, feed efficiency was not affected ($P > .10$) by treatment over the entire trial. The responses to antibiotic occurred in the latter half of the growth trial, while the responses to zinc oxide occurred primarily during the first 10 d of the experiment. These data indicate that both zinc oxide and antibiotic are beneficial in the diets of SEW pigs.

Key Words: SEW pigs, Antibiotic, Zinc oxide

222 Growth performance, apparent nutrient digestibility, blood chemistry, and body composition of artificially reared neonatal pigs receiving goat or cow milk. A. C. Murry[1]*, S. Gelaye[2], J. Casey[1], T. Foutz[1], A. Grider[1], and B. Kouakou[2], *[1]The University of Georgia, Athens and [2]Ft. Valley State University, Ft. Valley, GA.*

There is increased interest in the nutritive value of goat milk and its suitability as an alternative milk substitute for human infants experiencing allergic responses to cow milk. A total of 22 crossbred intact male Yorkshire × Hampshire × Duroc pigs, 72-h old, were used to compare the effect of goat or cow milk on weight gain, apparent nutrient digestibility, body composition, and blood chemistry. Pigs were allowed to receive colostrum from their dams prior to initiation of the study. They were housed separately in stainless steel metabolism cages. Fresh, nonfortified, goat milk was obtained from Ft. Valley Goat Research and Extension Center, and cow milk from The University of Georgia Dairy Research Farm. Pigs were randomly divided into two groups and assigned to receive pasteurized goat or cow milk at a predetermined level of 250 ml/kg BW per day for 28 d. A robotic-based semiautomatic feeding system was used to dispense the milk to each pig at 60 min intervals. Blood was taken by jugular puncture at 72 h, d 7, 14, 21, and 28. A balance trial was conducted during the last four days of the experiment. Body composition was determined on d 28, using dual energy x-ray absorptiometry (DXA; QDR-2000/W, Hologic Inc., Walthman, MA). Type of milk did not affect ($P>.05$) weight gain, percent body fat, lean body mass, bone mineral content, or serum concentration of Zn, Na, and K. Apparent digestibility of DM, or retention of N, energy, Zn, Na, and K was not affected ($P> .05$) by type of milk. Red blood cell and white blood cell (monocyte and eosinophil) counts were not affected ($P>.05$) by type of milk. However, white blood cell (lymphocyte and neutrophil) count was higher ($P<.02$) in pigs fed cow milk compared to those fed goat milk ($13.95*10^8$/L vs. $6.55*10^8$/L and $8.81*10^8$/L vs. $4.71*10^8$/L, respectively). This study suggests that baby pigs performed well when fed both goat and cow milk. However, future studies will focus on identifying factors associated with an increase in white blood cell count.

Key Words: Pigs, Goat milk, Cow milk

223 Effect of endotoxin on trace minerals and immunological parameters in weanling pigs. S. Mandali*, B. Z. de Rodas, C. V. Maxwell, A. B. Arquitt, and B. J. Stoecker, *Oklahoma State University, Stillwater.*

Two experiments were conducted to determine the minimum dose of lipopolysaccharide (LPS; from E. coli 0111: B_4) required to produce an immune response in early weaned pigs (13 d of age). Effects of level of LPS on plasma Fe and Zn were also investigated. After weaning, pigs were housed in an off site nursery in individual pens for 7 d. In Exp.1, 20 pigs (5 Kg BW) 7 d postweaning were fasted 4 h and injected i.p. with a .9% saline solution containing 0, .25, .50, 25 or 50 μg LPS/kg BW. Blood samples were collected and body temperature (BT) was recorded at 0, 3, and 6 h postinjection (PI). Pigs injected with LPS had higher ($P < .10$) BT than pigs in the control group (CG). There was a greater ($P < .05$) drop in plasma Fe from 0 to 6 h in pigs injected with LPS than in pigs in the CG. Plasma Zn decreased ($P < .05$) from 0 to 6 h only in pigs injected with LPS at 25 or 50 μg/kg BW. In Exp. 2, twelve 4-h fasted pigs (5 kg BW) 7 d postweaning were injected i.p. with a saline solution containing 0, 12.5 or 25 μg LPS/kg BW. Blood samples were collected and BT recorded at 0, 1.5 and 3 h PI. At 1.5 and 3 h PI, pigs injected with 25 μg LPS/kg BW had higher ($P < .05$) BT than control pigs and pigs injected with 12.5 μg LPS/kg BW. Similarly at 3 h, pigs injected with 12.5 μg LPS/kg BW had higher ($P < .05$) BT than pigs in the CG. At 1.5 h PI, pigs injected with 25 μg LPS/kg BW had greater ($P < .01$) tumour necrosis factor alpha (TNFα) concentrations than pigs injected with 12.5 μg/kg BW or those injected with saline. Tumour necrosis factor increased at 1.5 h and then decreased at 3 h in pigs injected with 12.5 or 25 μg LPS/kg BW ($P < .05$ and $P < .0001$, respectively). However, no change was observed in pigs in the CG. There was no time or treatment effect on plasma Fe or Zn. Endotoxin elevated TNFα by 1.5 h, but plasma Fe and Zn did not decline significantly until 6 h indicating that variable time periods are required to alter parameters classified as acute phase responses.

Key Words: Pigs, Endotoxin, Acute Phase Response

224 Effect of the addition of *Tenebrio molitor* to starter diets on the performance of weaned pigs. B. P. Gamboa, A. G. Borbolla*, J. Ramos-Elorduy, and G. Villar, *Universidad Nacional Autonoma de Mexico, Mexico City.*

The objective of this study was to evaluate the performance of weaned pigs under a diet containing the larvae of the insect *Tenebrio molitor*. Eighteen, 21±3 days old pigs were randomly assigned to three different treatment groups. Group 1 received a milo-soybean base diet (C), the second group received a diet containing 8% of dried *T. molitor* (T), and pigs in the third treatment group were fed a diet containing 8% spray-dried porcine plasma (PP). All diets were formulated to have the same levels of energy (3.3 Mcal), protein (20%), and lysine (1.3%). Diets were fed for 22 days after weaning. The performance parameters ADG, ADFI and F/G were measured twice weekly for each treatment group. The data was grouped by treatments and statistically analyzed using a random design. Throughout the feeding trial, total weight gain (kg) was not different ($P>.05$) in pigs that received the T or PP diets (9.44 vs. 10.54), with both values being greater ($P<.05$) than the one observed in the C group (7.96). Pigs fed the T diet had bigger ($P<.05$) gains at 5, 8 and 15 days when compared with pigs fed the C diet. Although not significant, pigs receiving the diets containing T or PP had better ADG (kg) than pigs fed the C diet (0.429, 0.479, and 0.362, respectively). ADFI was greater in pigs fed PP, followed by pigs receiving the T and C diets (0.762, 0.714, and 0.686 kg, respectively), although no difference ($P>.05$) among treatment groups was found. Feed efficiency between pigs fed the PP diet was better ($P<.05$) than the one observed in the C group (1.59 vs. 1.90). In the T group, F/G was greater (1.67) than in the C group, and lower than the PP group, although they were not significantly different. These results support our hypothesis that the addition of *Tenebrio molitor* to starter diets can give similar performance to the one observed when feeding pigs with a more expensive protein such as porcine plasma. Larvae protein may be a good alternative protein source for use in the pork industry.

Key Words: Weaned pigs, *Tenebrio molitor*, Pig performance

225 Effect of source and level of added chromium on starter pig growth performance. P. R. O'Quinn[1]*, J. L. Nelssen[1], M. D. Tokach[1], R. D. Goodband[1], R. E. Musser[1], K. Q. Owen[2], and S. A. Blum[2], *[1]Kansas State University, Manhattan and [2]Lonza Inc., Fair Lawn, NJ.*

A 35 d growth trial was conducted with 180 weanling pigs (initially 5.7 kg BW and 17 to 21 d of age) to evaluate the effects of source and level of added chromium (Cr) on growth performance and immune status. Pigs were randomly allotted by weight, equalized for gender, and assigned to one of six dietary treatments with six pigs per pen and five replications per treatment. The dietary treatments consisted of a basal diet, and the basal diet plus 50, 100, 200, or 400 ppb Cr from chromium nicotinate (CrNic) or 200 ppb Cr from chromium picolinate (CrPic). The corn-soybean meal-dried whey based diets were fed in meal form in two phases (d 0 to 14 and d 14 to 35 postweaning, respectively). On d 28 postweaning, two randomly selected pigs per pen were bled for haptoglobin concentrations. No treatment differences ($P > .10$) were observed for this test of immune status. No effect of treatment ($P > .10$) was observed on ADG, ADFI, or feed efficiency (G/F) during any of the time periods. Overall ADG, ADFI, and G/F is given below.

		CrNic (ppb)				CrPic (ppb)	
Item	Control	50	100	200	400	200	CV
ADG, kg	.48	.49	.49	.47	.50	.50	7.23
ADFI, kg	.70	.70	.70	.69	.70	.71	7.87
G/F	.68	.70	.69	.69	.70	.70	4.18

In summary, these data show neither beneficial results from added Cr nor differences in Cr source on either growth performance or immune status of weanling pigs.

Key Words: Starter pigs, Chromium, Growth performance

226 Four trial summary-The effect of tylosin phosphate (TYLAN™) on the performance of growing and finishing swine when fed for the control of porcine proliferative enteropathies (PPE) in commercial swine herds. G. Moore, A. Zimmermann, and L. Watkins*, *Elanco Animal Health, A Division of Eli Lilly & Co., Greenfield, IN.*

The objective was to evaluate the performance of growing and finishing swine fed Tylan™ for the control of PPE (Ileitis) during periods of clinical disease in commercial herds. Four trials were conducted in three geographical locations in herds with a history of Ileitis. All pigs were given a nonmedicated feed for at least three days prior to receiving medicated feeds which began approximately seven days before the anticipated onset of Ileitis. Both barrows and gilts (N=321) were administered Tylan™ in the feed at either 0 or 110 ppm for 21 days. Basic corn-soy meal diets were fed *ad libitum*. A randomized complete block design was used to place the pigs in three location blocks of two treatment pens per block for a total of six pens per trial. The pen was the experimental unit. The pigs were stratified by weight and sex and then randomly assigned to pens. Pen density within a facility was the same and density between facilities varied from 22 to 30 pigs per pen. Initial starting pig weights ranged from 11.57 to 23.66 kg. Daily gain and daily feed intake were significantly improved ($P<0.031$ and $P<0.016$ respectively) compared to 0 ppm Tylan™. Feed to gain was also improved ($P<0.056$) by feeding 110 ppm of Tylan™ as compared with non-medicated pigs.

Tylosin ppm	Expt. units	DG (kg)	DFI (kg)	F/G
0	12	.37	1.10	2.91
110	12	.46	1.21	2.65
P-value		0.031	0.016	0.056

Key Words: Swine, Ileitis, TYLAN™

227 Ten trial summary-the effect of tilmicosin phosphate (PULMOTIL™) on the performance of growing and finishing swine when fed for the control of pneumonia caused by *Actinobacillosis pleuropneumoniae* (App) and *Pasteurella multocia* (Pm) in commercial swine herds. G. Moore, R. Basson, L. Tonkinson, and L. Watkins*, *Elanco Animal Health, A Division of Eli Lilly & Co., Greenfield, IN.*

The objective was to evaluate the performance of growing and finishing swine fed Pulmotil™ for control of pneumonia attributable to App and Pm during periods of clinical disease in commercial herds. Ten trials were conducted in seven geographical locations in herds with a history of pneumonia caused by App and Pm. All pigs were given a nonmedicated feed for at least three days prior to receiving medicated feeds which began approximately seven days before the anticipated onset of pneumonia. Both barrows and gilts (N=1,150) were administered Pulmotil™ in the feed at either 0, 200, or 400 ppm for 21 days. Basic corn-soy meal diets were fed *ad libitum*. A randomized complete block design was used to place the pigs in two location blocks of three treatment pens per block for a total of six pens per trial. The pen was the experimental unit. The pigs were stratified by weight and sex and then randomly assigned to pens. Pen density within a facility was the same and density between facilities varied from 15 to 30 pigs per pen. Initial starting pig weights ranged from 13.6 to 75 kg. Daily gain, daily feed intake, and feed to gain were significantly improved ($P<0.0001$) by feeding 200 or 400 ppm of Pulmotil™, compared with non-medicated pigs.

Pulmotil™ ppm	Expt. units	Pig deaths/ pig numbers	DG (kg)	DFI (kg)	F/G
0	20	10/383	.47[a]	1.40[a]	2.97[a]
200	20	0/384	.66[b]	1.67[b]	2.51[b]
400	20	0/383	.65[b]	1.66[b]	2.52[b]

[a,b]Means within a column without a common superscript differ ($P < 0.0001$).

Key Words: Swine, Pneumonia, PULMOTIL™

228 Utilization of distillers dried grains with solubles (DDGS) in phase fed growing and finishing swine. E. L. Hansen*, G. W. Libal, D. N. Peters, and C. R. Hamilton, *South Dakota State University, Brookings.*

Four trials evaluated the use of DDGS in diets formulated for barrows and gilts for growth periods from 20-36, 36-59, 59-86 and 86-113 kg. The first treatment in each trial was a corn soybean meal diet balanced for threonine (THR), and supplemented with lysine (LYS). The second and third treatments, respectively, were diets with maximum levels of DDGS to meet the requirement for tryptophan (TRP) and methionine (MET), respectively. A fourth treatment had added MET to test the hypothesis that MET was less available in DDGS than original estimates. Crystalline LYS, THR and TRP were added to meet the digestible ideal protein ratio for each sex for each growth phase. From 20-36 kg, a depression in performance occurred for pigs fed the diet balanced for MET. Level of performance improved when MET was supplemented. Performance was equal for pigs receiving the first three diets for both sexes for the last three growth phases, but supplemental MET caused depressed feed intake and poorer performance. DDGS is a suitable feed ingredient for growing pigs. Availability of MET in DDGS appeared to be close to published values based upon pig performance.

		Diet 1	Diet 2	Diet 3	Diet 4	P	SD
ADG, kg		.71[b]	.72[b]	.67[a]	.71[b]	=.06	.025
G/F	20 to 36 kg	.45	.47	.46	.48	NS	.015
PUN, mg/dl		11.64[a]	12.25[a]	7.62[b]	7.77[b]	<.01	.976
ADG, kg		.81	.84	.83	.79	NS	.040
G/F	36 to 59 kg	.36[bc]	.38[a]	.38[ab]	.36[c]	<.05	.014
PUN, mg/dl		10.83[b]	12.71[a]	8.99[c]	9.53[c]	<.01	.616
ADG, kg		.89[a]	.88[a]	.85[a]	.81[b]	<.05	.031
G/F	59 to 86 kg	.32[a]	.32[a]	.31[a]	.29[b]	<.05	.012
PUN, mg/dl		11.59[ac]	13.19[a]	9.42[b]	10.86[bc]	<.05	1.39
ADG, kg		.95	.91	.94	.90	NS	.053
G/F	86 to 113 kg	.28[a]	.29[a]	.29[a]	.26[b]	<.05	.014
PUN, mg/dl		11.38[c]	13.55[a]	12.90[ab]	12.14[bc]	=.08	1.20

Key Words: Growing finishing swine, Digestible amino acids, Distillers dried grains with solubles

229 Effects of pelleting and fat supplementation on growth performance of growing-finishing pigs. E. van Heugten*, T. C. Schell, C. R. Risley, and J. A. Valancius, *Wayne Feed Division, Continental Grain Company, Chicago, IL.*

Two separate studies were conducted to determine the effect of pelleting and fat supplementation on performance of grower pigs (n=346) and finisher pigs (n=327). In each study, pigs were allotted by BW to one of four treatments (5 replicates/treatment) arranged in a 2 × 2 factorial randomized complete block design. Factors were: 1) diet form (meal or pellet), and 2) fat supplementation (0 or 5% added choice white grease). Corn-soybean meal based diets contained the following levels of ME for the 0 and 5% fat diets, respectively: 3260 and 3475 kcal/kg (grower); 3320 and 3535 kcal/kg (finisher). The lysine to ME ratio was kept constant (3.3 and 2.6 g/Mcal for grower and finisher diets, respectively). Methionine, threonine, and tryptophan levels were kept at a minimum constant ratio to lysine. In the grower study, pelleting improved ADG (746 vs 722 g/d, $P < .02$), reduced ADFI (1508 vs 1556 g/d, $P < .03$), improved G/F (.496 vs .467, $P < .03$), and efficiency of energy utilization (ADG/ME, 147 vs 138 g/Mcal, $P < .001$) in pigs. The improvement in G/F and ADG/ME due to pelleting tended ($P < .07$) to be greater in pigs fed diets without fat (8.5%) compared to pigs fed fat-added diets (4.5%). Addition of fat reduced intake (1467 vs 1597, $P < .001$) and improved G/F (.499 vs .463, $P < .001$). In the finisher study, pelleting reduced ADG (938 vs 984, $P < .02$) and ADFI (2537 vs 2848, $P < .001$), but improved G/F (.371 vs .346, $P < .001$) and ADG/ME (108 vs 101, $P < .001$), regardless of dietary fat level. Addition of fat improved ADG (982 vs 940, $P < .02$), reduced ADFI (2637 vs 2748, $P < .04$) and improved G/F (.374 vs .343, $P < .001$) and ADG/ME (106 vs 103, $P < .01$). Pelleting and fat addition had similar effects on feed intake and therefore nutrient levels in pelleted diets may need to be adjusted to maintain total daily nutrient intake and pig growth performance.

Key Words: Pigs, Pellets, Energy

230 Effects of added L-Carnitine during lactation on performance of first parity sows. R. E. Musser[1], R. D. Goodband[1]*, M. D. Tokach[1], J. L. Nelssen[1], K. Q. Owen[2], and S. A. Blum[2], *[1]Kansas State University, Manhattan and [2]Lonza Inc., Fair Lawn, NJ.*

A total of 107 first parity sows was used to determine the effects of added L-Carnitine in the lactation diet on sow and litter performance. Sows were fed a lactation diet that contained 1.0% lysine, .95% Ca, .85% P, with or without 50 ppm added L-Carnitine. No differences ($P > .10$) were observed for total number of pigs born, born live, stillborn, and mummies per litter. No differences ($P > .10$) were observed in number of pigs per litter on d 2, pigs weaned per litter, or pig survival. For the analysis of litter weight gain, litter weight at birth was used as a covariate. No differences ($P > .10$)were observed in litter weaning weights (41.65 vs 42.73 kg, control and added L-Carnitine, respectively). No differences ($P > .10$)in sow weight change or last rib fat depth change were observed. During the first week of lactation, ADFI was lower for gilts fed added L-Carnitine compared with control sows(4.32 vs 4.65 kg/d respectively; $P = .05$). No differences were observed in ADFI during week 2, or overall. Feeding added L-Carnitine at 50 ppm in lactation numerically tended ($P = .15$) to decrease the days to estrus(8.70 vs 6.85 days). The addition of L-Carnitine to the lactation diet had little effect on the performance of the first parity sow. However, a decrease in feed intake during the first week of lactation, and a tendency for fewer days to estrus were observed.

Key Words: L-Carnitine, Sows

231 Effect of dietary tea polyphenols on putrefactive metabolites in swine waste and pig performance. T. L. Veum, D. W. Bollinger, J. H. Porter, and D. M. Sievers, *University of Missouri, Columbia.*

Thirty two crossbred barrows averaging 37 kg BW were used in a 27 day experiment to determine the effect of tea polyphenols on pig performance and putrefactive metabolites in swine waste. Pigs were allotted to treatment by litter and weight and placed in individual pens. A 14% CP corn-soybean meal basal diet was supplemented with 0, .1, .2 and .3% of a commercial tea polyphenol product (Polyphenol G®, Mitsui Norin Co., Fujieda City, Japan). Diets were fed to appetite three times daily. Chromic oxide was added to the diet at .05% as a nondigestible indicator. Fresh fecal grab samples and total urine collections were made twice daily from days 22 to 26 of the experiment. There were no tea polyphenol treatment effects ($P > .9$) and no linear, quadratic or cubic responses ($P > .5$ to .9) to tea polyphenol concentrations for daily feed intake, daily gain or gain:feed ratio. There were no tea polyphenol treatment effects ($P > .1$ to .9) for any of the fecal and urinary metabolites measured (Phenol, p-cresol, 4-ethylphenol, indole, skatole and ammonia). There were linear declines in the mg of 4-ethylphenol excreted per day in feces ($P < .04$) and urine ($P < .08$) from 0 to .2% tea polyphenols, with no further decline at .3%. There were no tea polyphenol linear or quadratic responses ($P > .1$ to .9) for the other metabolites measured (mg/d) in feces and urine. In conclusion, tea polyphenols did not significantly reduce the fecal and urinary metabolites measured and did not improve pig performance. (Partially funded by the National Pork Producers Council, Des Moines, IA).

Key Words: Tea polyphenols, Swine, Odor, Performance

232 Dietary vitamin A, E, C needs of pigs experiencing a low or high level of antigen exposure. T. S. Stahly*, D. R. Cook, and R. C. Ewan, *Iowa State University, Ames.*

Fourteen sets of five littermate pigs were utilized to evaluate the impact of dietary concentration of vitamins A, E, and C on growth from 9.5 to 25.2 kg BW in pigs experiencing a low or high level of chronic antigen exposure (AE) thus immune system activation. Pigs from a single genetic strain and source were either administered ceftiofur and ampicillin on d 1, 3, 5, 8, 11 d of age, weaned (12–14 d) and placed in a sanitized facility isolated from other pigs (low AE) or not administered antimicrobials, weaned and placed in a nonsanitized facility occupied with older pigs (high AE). Dams of the pigs received a corn-soybean meal diet devoid of supplemental vitamins A, E, C from d 60 of pregnancy through lactation. Post-weaning, pigs were individually penned and self-fed a basal diet containing 25% of the estimated requirement (NRC, 1988) for 5–10 kg pigs for vitamins A and E and 8 mg/kg of vitamin C. All other vitamins were supplied at a minimum of 600% of NRC. At 9.5 ± 1.2 kg, pigs within a litter were randomly allotted to the basal diet supplemented with vitamins A, E, C equivalent to 0, 100, 200, 300, and 400% of NRC (2 mg of C added per 1 IU of E). Low AE pigs had lower serum alpha-1 glycoprotein concentrations (466 vs 726 μg/ml) and gained BW faster and more efficiently than high AE pigs. As dietary concentrations of A, E, C (V) increased, daily gains increased quadratically but the magnitude of the response differed between AE groups. Gain:feed ratios were not altered by diet.

		Dietary A, E, C, % NRC					Probability		
Criteria	Antigen exposure	25	125	225	325	425	AE	V	AE × V
Daily gain, g	Low	613	635	633	622	648	.01	.03	.05
	High	548	560	636	578	554			
Gain/feed, g/kg	Low	744	729	700	708	718	.03	.23	.40
	High	694	683	701	667	684			

Key Words: Pigs, Antigen exposure, Vitamins

233 Segregated early weaning: effect of raising pigs on-site and off-site with and without vaccinations on performance and economics. M. S. Edmonds[1]*, B. E. Arentson[1], W. A. Nipper[1], and D. L. Froe, II[2], *[1]Kent Feeds, Inc., Muscatine, IA and [2]Pfizer North American Animal Health Division, Inc., Lee's Summit, MO.*

Four, 5-week nursery trials (984 weanling pigs, PIC line 405 × Camborough 15) evaluated the effects of allotting littermates (with and without vaccinations) to both on- and off-site nursery facilities. Pigs were weaned between 14 and 19 days of age and housed six per pen. Sows were vaccinated with FarrowSure B-PRV® and TGE Neo-Vac® 7. Both the on-site (> 10 year old) and off-site (located 800 m away, 1 year old) nurseries were cleaned and disinfected, and all-in/all-out management procedures were utilized. All pigs were fed standard commercial medicated starter diets that exceeded NRC recommendations. In trial 1, a 2 × 3 factorial (on-site vs off-site; no injection, placebo (saline) or vaccination with PleuroGuard 4®) was utilized (216 pigs). Pigs housed off-site had improved ($P < .05$) ADG (9.6%) and ADFI (9.0%) compared to those raised on-site. Trial 2 (216 pigs) was a 2 × 2 factorial (on-site vs off-site; with or without PleuroGuard 4). Pigs raised off-site had greater ($P < .05$) ADG (7.0%) and ADFI (14.9%) but poorer ($P < .05$) G/F (6.9%) and cost per kg of gain (6.8%) than those on-site. Trial 3 utilized 336 pigs in the same design as trial 2. An improvement ($P < .05$) in ADFI (8.7%) occurred for those pigs housed off-site compared to on-site. Pigs raised off-site had reduced ($P < .05$) G/F (4.7%) and higher cost per kg of gain (5.8%) compared to those housed on-site. In trial 4, a 2 × 2 factorial design (on-site vs off-site; with or without PleuroGuard 4 and Respi-Sure®) utilized 216 pigs. Pigs raised off-site had increased ADFI (6.6%) but reduced G/F (4.8%) and greater cost per kg of gain (5.2%) than those housed on-site ($P < .05$). Mycoplasma titers were increased ($P < .05$) for those pigs that were vaccinated. No significant performance differences occurred from injecting pigs with vaccines in trials 1-4. These data suggest that nursery pigs raised on-site have reduced ADG and ADFI but improved G/F compared to those off-site.

Key Words: Pigs, Segregated Early Weaning, Vaccinations

234 A bioassay used to identify the active fraction of spray-dried plasma. J. A. Godfredson-Kisic[1] and D. E. Johnson[2], *[1]DuCoa, Highland, Illinois and [2]Colorado State University, Fort Collins.*

A bioassay has been developed using mice to study effects of spray-dried porcine plasma (SDPP) in diets of young pigs. Our objective was to use the bioassay to identify active protein fractions of SDPP. Male mice (n=100), 21 days of age were assigned to one of five treatments. The control diet consisted of dry skim milk (DSM). The other diets had 8% SDPP, 4% fibrinogen, 4% globulins, or 4% albumin. Diets were formulated on an equal lysine basis.During week 1, average weekly gain (AWG) of mice fed SDPP and globulin was greater than ($P<0.001$) all other mice. Gain to feed (G/F) was also greater than mice on the fibrinogen ($P<0.06$), albumin and control diets ($P<0.001$). On week 2, mice fed control, albumin and fibrinogen diets, exhibited compensatory gain. By week 3 all mice had higher AWG ($P<0.01$) than control mice. Our results suggest the globulin fraction is responsible for improved growth.

d 0 to 7	Control	SDPP	FIBRINOGEN	GLOBULIN	ALBUMIN
AWG[1]	5.37 ± 0.43[a]	8.12 ± 0.60[b]	5.96 ± 0.33[a]	7.69 ± 0.47[b]	3.67 ± 0.39[c]
AWFI[2]	20.78 ± 0.25[a]	21.79 ± 0.66[a]	20.97 ± 1.40[a]	19.00 ± 0.50[a]	19.49 ± 1.46[a]
G/F	0.26 ± 0.02[a]	0.38 ± 0.03[b]	0.30 ± 0.03[a]	0.41 ± 0.02[b]	0.19 ± 0.02[c]
d 7 to 14					
AWG[1]	8.50 ± 0.56[a]	6.13 ± 0.52[b]	8.26 ± 0.53[a]	6.70 ± 0.16[b]	8.37 ± 0.33[a]
AWFI[2]	27.14 ± 1.36[a]	26.72 ± 2.02[a]	28.55 ± 1.17[ab]	31.46 ± 1.44[b]	31.92 ± 0.72[b]
G/F	0.32 ± 0.03[a]	0.23 ± 0.02[b]	0.29 ± 0.01[a]	0.22 ± 0.01[b]	0.26 ± 0.01[a]
d 14 to 21	3.27 ± 0.18[a]	3.92 ± 0.16[b]	3.94 ± 0.17[b]	3.97 ± 0.18[b]	4.16 ± 0.18[b]
AWG[1]AWFI[2]	25.70 ± 2.18[a]	22.02 ± 7.20[a]	23.10 ± 0.64[a]	23.33 ± 3.06[a]	23.76 ± 1.25[a]
G/F	0.14 ± 0.02[a]	0.18 ± 0.01[a]	0.20 ± 0.03[a]	0.18 ± 0.01[a]	0.17 ± 0.01[a]

[1]AWG, [2]AWFI: Average weekly gain, and feed intake in grams per mouse.
[abc]Values with different letters are significantly different.

Key Words: Plasma, Protein, Mice, Growth

235 Impact of water quality on weanling pig performance under commercial farm conditions. J. F. Patience*, N. Possberg, and D. A. Gillis, *Prairie Swine Centre Inc., Saskatoon, Canada.*

Concerns about the impact of water quality on pig performance are common in many parts of North America. Of chief concern, with respect to inorganic contaminants, is very high levels of sulphates and associated mineral cations, primarily sodium and magnesium. Studies conducted at various research facilities have revealed a high tolerance by the pig for such minerals. Yet, concerns from the industry persist. Two experiments were carried out at a 1200 sow farm which operated a reverse osmosis unit on-site to treat drinking water; this provided an ideal opportunity to investigate the issue of water quality under farm conditions. In experiment one, a total of 258 barrows, weaned at ~21 days of age, were assigned onto one of two water treatments: control water (C) obtained directly from the well and containing 3,086 mg total dissolved solids/L, 1,634 mg sulphate/L and 7.2 mg iron/L, or water treated by reverse osmosis (RO) containing 15 mg sulphate/L, 193 mg total dissolved solids/L and 0.4 mg iron/L. While nursing the sow, all piglets had access to the RO water. Pig performance was monitored for the 35 days immediately following weaning. Blood samples were collected from 20 pigs per treatment on days 3, 7, 14, 21, and 28 postweaning. Although diarrhoea was more prevalent in the pigs on the C water, there were no differences ($P>0.05$) in average daily gain (444 [C] vs. 428 [RO] g/d), average daily feed (676 vs. 646 g/d) or feed efficiency (0.661 vs. 0.663). Similarly, there were no differences in plasma mineral levels due to water source. A second experiment, using 246 barrows also weaned at approximately 21 days of age, compared the two water sources. No differences in performance were observed. Similar to the results obtained under research institution conditions, weanling pig performance was unaffected by water quality. Care must be taken to not assume that osmotically-induced diarrhoea is automatically associated with poor animal performance.

Key Words: Swine, Water Quality

236 Effect of chromium picolinate on cell-mediated and humoral immunity in dogs. K. L. Keeling[1]*, J. W. Spears[1], T. T. Brown, Jr.[1], E. B. Kegley[1], M. G. Hayek[2], and G. D. Sunvold[2], *[1]North Carolina State University, Raleigh and [2]The Iams Co., Lewisburg, OH.*

Twenty-four female Beagle dogs (2 to 4 years old) were used to assess the effect of supplemental chromium (Cr)on immune responses. Treatments consisted of 0 (control), .3 or .6 mg added Cr (from Cr picolinate) per kg diet. Dogs were fed experimental diets for 45 d prior to any immunological measurements. Humoral immunity was determined by measuring specific antibody responses following administration of sheep red blood cells and a *Borrelia burgdorferi* vaccine on d 40. Blood samples were collected on d 0, 7, 14, 21, and 28 following antigen administration for antibody titer determination. Serum titers to sheep red blood cells measured by a microtiter hemagglutination method tended to be slightly decreased on d 7 for the Cr treatments (linear contrast $P=.04$) but showed no significant differences at the other timepoints. Antibody titers against *Borrelia burgdorferi* measured by an ELISA procedure showed no significant differences among treatments. In vitro cell-mediated immunity assessed using a lymphocyte blastogenic assay showed a quadratic response ($P<.10$) to dietary Cr with dogs supplemented with .3 mg Cr/kg diet tending to have lower blastogenic responses. In vivo cell-mediated immunity was measured on d 60 by determining the dogs response to an intradermal injection of phytohemagglutinin. Skinfold thickness was then measured at 0, 4, 24, and 48 hr after injection but revealed no significant differences among treatments. Results suggest that dietary Cr may affect immune response of dogs.

Key Words: Chromium, Dogs, Immunity

237 Effect of chlortetracycline (CTC) fed continually at low levels or in a high level "pulse" program in grower and finisher diets on gain variability and performance in lean genotype, high health pigs. G. Gourley[1]* and T. Wolff[2], *[1]Swine Graphics Enterprises, Webster City, IA and [2]Hoffmann-La Roche, St. Charles, MO.*

The objective of this study was to evaluate the effect of CTC on weight gain variation and performance in high health, lean genotype pigs when administered continually at 110 mg/kg of complete feed in grower diets followed by 55 mg/kg of complete feed in finisher diets vs. CTC 'pulsed' at a 22 mg/kg BW level for approximately 1 wk out of every 4 wk vs. nonmedicated controls. Single-sourced pigs (n = 576), averaging 28 kg each, were randomized by weight and sex to 24 pens (24 pigs/pen). Pigs were separate sex fed corn-soy meal diets in a 5-phase feeding program, with gilts receiving lysine ranging from 1% to 0.64% and barrows from 1% to 0.55%. CTC fed continually at low levels reduced the SD ($P = .012$) and CV ($P = .021$) of liveweight distribution at the end of the finisher period compared to nonmedicated controls. Overall, both CTC treatments improved ADG ($P = .009$ for continual and $P = .07$ for pulse) over nonmedicated controls. Neither CTC treatment program impacted carcass characteristics and meat quality. In summary, CTC fed continually at low levels in grower-finisher diets reduced weight gain variation, and both the CTC low level continual and high level pulse programs positively impacted performance in high health, lean genotype pigs.

Item	CTC Level 0	110/55 mg/kg	22 mg/kg BW	CV
Grower-Finisher (Day 0–110, 28–117 kg)				
ADG, kg	.80^{ae}	.83^{bf}	.81^{abf}	2.4
ADFI, kg	2.31	2.37	2.33	2.6
F/G	2.90	2.85	2.86	3.3
End weight at Day 110, kg^{h}				
SD	11.2^{c}	8.4^{d}	10.0^{cd}	23.4
CV	9.8^{c}	7.1^{d}	8.7^{cd}	26.7

^{a,b}($P < .01$).
^{c,d}($P < .05$).
^{e,f,g}($P < .10$).
^{h}Variation among pigs within pens.

Key Words: Pigs, Chlortetracycline, CTC

238 Variability in mixing efficiency and in laboratory analysis of diets at 25 experiment stations. NCR-42 and S-145 Regional Committees (presented by G. L. Cromwell), *University of Kentucky, Lexington.*

An experiment involving 25 stations in the North-Central and Southern Regions was conducted to assess uniformity in diet mixing among stations and to assess the variability among station labs in chemical analysis of diets. A fortified corn-soybean meal diet was mixed at each station using a common diet formula (except for vitamin-trace mineral additions). The diet was calculated to have 14% CP, .65% Ca, .50% P and 100 ppm added Zn (~125 ppm total Zn). Following mixing, samples were collected from the initial 45 kg of feed discharged from the mixer, after 25%, 50%, and 75% was discharged, and from the final 45 kg of discharged feed. The 5 samples were sent to a central location and distributed to 3 other stations, selected at random, for analysis of CP, Ca, P, and Zn (i.e., each lab analyzed 5 samples from 3 other stations). In addition, 2 commercial labs and 2 experiment station labs analyzed all 25 mixed diets. Overall analyses of the 5 samples were, respectively, CP: 13.4, 13.6, 13.4, 13.5, 13.4% ($P<.06$); Ca: .66, .67, .67, .66, .67%; P: .50, .51, .51, .50, .50%; and Zn: 115, 116, 112, 113, 120 ppm ($P<.001$). Diets were not uniformly mixed at all stations (station × sample; $P<.02$ for Ca, $P<.001$ for CP, P, and Zn). Among stations, the range of the 5 samples, averaged for CP, Ca, P, and Zn, varied from ±1.1% (i.e., 98.9 to 101.1% of the mean) to ±12.9%, with an overall average of ±5.2% (94.8 to 105.2%). Based on the labs that analyzed all diets, station mixed diets ranged from 11.8 to 14.6% CP, .52 to .73% Ca, .47 to .58% P and 71 to 182 ppm Zn. The CV among station diets for CP, Ca, P, and Zn were 4.6, 10.4, 4.5, and 17.8%, and among station labs were 4.4, 15,4, 11.5, and 16.3%, respectively. The results suggest that uniformity of diet mixes varies among experiment stations, that some stations miss their targeted levels of nutrients (especially Zn), and that the variability among experiment station labs in analysis of dietary Ca, P and Zn is quite large.

Key Words: Pigs, Feed mixing, Chemical analysis

239 The effects of poultry fat and choice white grease on longissimus muscle quality. J. J. Engel*, J. W. Smith, II, R. D. Goodband, J. A. Unruh, M. D. Tokach, and J. L. Nelssen, *Kansas State University, Manhattan.*

Eighty-four crossbred gilts (initially 60.3 kg) were used in a growth assay to evaluate the effects of added fat in finishing pig diets on growth performance and carcass characteristics. Poultry fat (PF) or choice white grease (CWG) were added at 2, 4, and 6% to a corn-soybean meal based control diet. Pigs were blocked by weight and ancestry and allotted to one of the seven dietary treatments. The diets were fed in a meal form with a constant lysine:calorie ratio of 2.26 g lysine/Mcal ME. Pigs were slaughtered at 109 kg to evaluate pH and quality traits of the longissimus muscle. Increasing CWG tended (quadratic, P < .10) to improve visual color score. Pigs fed CWG tended (P = .10) to have greater visual firmness scores than pigs fed PF. Neither fat source or fat level affected the visual marbling score, 24 or 48 h drip loss. Increasing CWG decreased Hunter L* values and hue angle (quadratic P < .05 and .10, respectively) and increased the a*:b* ratio (quadratic P < .05). These data indicate that dietary PF or CWG had no adverse effects on longissimus quality.

		Poultry fat, %			Choice White Grease, %			
	Control	2	4	6	2	4	6	CV
Drip loss, 24 h %	2.26	2.94	2.41	3.60	3.19	2.34	2.88	64.2
Drip loss, 48 h %	3.91	4.58	3.67	4.81	4.98	3.94	4.57	54.6
Visual color[a]	2.50	2.46	2.46	2.45	2.57	2.67	2.34	16.1
Visual firmness[b]	2.86	2.66	2.81	2.66	2.83	3.02	2.80	16.2
Visual marbling	2.61	2.40	2.53	2.20	2.44	2.56	2.33	26.4
Hunter L*[c]	51.54	51.58	50.64	52.06	50.65	49.50	52.24	5.8
Hunter a*	11.45	11.52	11.85	13.00	12.10	11.00	11.19	18.4
Hunter b*	7.99	8.09	7.95	8.94	8.02	7.30	7.92	22.8

[a]CWG quadratic, P < .10.
[b]PF vs CWG, P = .10.
[c]CWG quadratic, P < .05.

240 The effects of poultry fat and choice white grease on finishing pig growth performance and carcass characteristics. J. W. Smith, II*, J. Engle, R. D. Goodband, J. A. Unruh, M. D. Tokach, and J. L. Nelssen, *Kansas State University, Manhattan.*

Eighty-four crossbred gilts (initially 60.3 kg) were used in a growth assay to evaluate the effects of added fat in finishing pig diets on growth performance and carcass characteristics. Poultry fat (PF) or choice white grease (CWG) were added at 2, 4, and 6% to a corn-soybean meal based control diet. Pigs were blocked by weight and ancestry and allotted to one of the seven dietary treatments. The diets were fed in a meal form with a constant lysine:calorie ratio of 2.26 g lysine/Mcal ME. Pigs were slaughtered when mean block weight averaged 109 kg to collect standard carcass measurements. Average daily gain was not affected (P > .10) by either fat source or level. Increasing CWG decreased ADFI (quadratic, P < .10). Feed efficiency was improved in pigs fed increasing PF or CWG (linear, P < .10 and .01, respectively). Dietary additions of PF or CWG did not affect (P > .10) longissimus muscle area (LMA) or tenth rib fat depth. These data suggest that added PF or CWG improves feed efficiency of finishing pigs without affecting carcass leanness.

		Poultry Fat, %			Choice White Grease, %			
Item	Control	2	4	6	2	4	6	CV
ADG, g	0.92	0.93	0.93	0.94	0.96	0.98	0.94	5.6
ADFI, g[a]	3.07	3.04	3.07	2.88	3.23	3.05	2.87	7.4
g:f[bc]	.30	.31	.31	.33	.30	.31	.33	6.2
LMA, CM^2	42.83	42.31	39.80	43.15	44.31	41.99	43.99	11.4
10 rib BF, cm	2.01	2.03	1.98	1.93	1.88	2.06	1.98	18.6
Lean, %	54.47	53.75	53.95	54.35	54.87	53.50	54.73	5.1

[a]CWG quadratic, *P*< .10.
[b]PF linear, *P* < .10.
[c]CWG linear *P* < .01.

241 Recycled cafeteria food waste as a feed for swine and its influence upon growth, digestibility and meat quality. M. L. Westendorf* and Z. C. Dong, *Rutgers, The State University of New Jersey, New Brunswick.*

This project was designed to compare growth, meat quality and diet digestibility when pigs were fed cafeteria food waste (FW) or a corn/soybean meal (CSM) diet. The first experiment utilized fifty crossbred pigs randomly assigned to four diets. During the growing phase pigs fed a CSM diet gained significantly faster (P<.05) than pigs fed FW or FW plus an energy supplement. However, two groups fed energy supplements (at 25% or 50% of the intake of the CSM diet) gained faster (P<.05) than pigs fed FW alone (.61 and .65 kg/d vs .46 kg/d, respectively). In the finishing phase the addition of an energy supplement at 50% of the level of CSM intake resulted in gains (.90 kg/d vs .99 kg/d) similar to the CSM diet (P>.05). Six pigs were selected from both the CSM and FW diets and fed to finishing weight. The pigs were slaughtered and pork loins removed for flavor and texture analysis. A 65 member consumer panel rated the meat quality from FW pigs as acceptable and the flavor comparable to the CSM pigs (P>.05). The panel preferred the texture of the pork from FW pigs (P<.05). A nutrient digestibility and nitrogen balance experiment was conducted using eight growing barrows and compared FW with the same CSM growing diet fed earlier. Dry matter digestibility was similar for the two diets (P>.05). However, protein digestibility was higher (P<.05) in the FW diet than the CSM diet (88.2% vs 84.3%). Although rates of nitrogen retention were not different between FW and CSM diets (56.0% vs 55.2%; P>.05), nitrogen balance was greater for pigs receiving the CSM diet (266.0 g/pig vs 220.3 g/pig; P<.05). This can be attributed to greater dry matter intake (1.7 kg/d vs 1.4 kg/d) in the CSM pigs (P<.05). These results indicate that food waste has nutritive value and may be useful in swine diets.

Key Words: Food waste, Swine, Digestibility

242 Comparison of soybean meal sources for growing swine. R. A. Swick[1]* and S. Srinongkote[2], *[1]American Soybean Assn, Singapore and [2]Bangkok Animal Research Farm.*

A feeding study was conducted to performance economics of pigs fed soybean meals (SBM) from India-NDH (non-dehulled), Brazil-NDH (non-dehulled) and U.S.-DH (dehulled). Least cost diets were formulated using prevailing ingredient prices from Thailand. Measured crude protein (CP) and fiber (as is basis) for SBMs and prices (USD/MT) were for India: 47.2%, 6.2%, and $250, respectively; Brazil: 44.7%, 5.7%, and $250, respectively; U.S.: 46.4%, 3.1%, and $275, respectively. Diets were calculated to contain 3200 kcal/kg ME, 18.1% CP, and 1.10% lysine. NDH-SBM was assigned ME of 3220 and DH-SBM either 3220 or 3380 kcal/kg. Diet costs (USD/MT) were: Indian: $290.03, Brazil: $293.28, U.S.: $301.37 (3220 ME SBM), and U.S.: $297.54 (3380 ME SBM). A total of 96 crossbred pigs (LW × Lndr × Du) were fed using a randomized design and pens of equal mixed sex. FCR favored U.S. meal over Indian meal (P < .05). Although U.S. DH-SBM was $25.00/MT more expensive than NDH-SBM, feed cost per kg gain was lowest with U.S. SBM assigned the highest ME content, followed by U.S. meal assigned lower ME, India SBM and then Brazil SBM. Results indicate superior quality of U.S. DH-SBM over other sources for swine and DH-SBM should be assigned a higher ME than NDH-SBM.

Source	India	Brazil	U.S.	U.S.
Assigned ME kcal/kg	3220	3220	3220	3380
14.6–14.7 kg start				
Gain, kg	4.450	15.829	16.067	16.192
ADG, kg	.452	.495	.502	.506
FCR	2.27[a]	2.22[ab]	2.12[b]	2.11[b]
Feed cost/gain, $/kg	.662	.650	.637	.626

[ab]P < .05.

Key Words: SBM, Dehulled, Swine

243 The effect of six different wheat cultivars of similar bushel weight on growth performance of young pigs. H. Schulze*, A. N. Pearce, and S. P. Rose, *Finnfeeds International Ltd., Marlborough, UK and Harper Adams College, Newport, UK.*

The present trial compared growth performance of young pigs offered diets containing various wheat varieties of similar bushel weight to establish whether variation in voluntary feed intake (VFI) and growth could be explained by chemical and physical properties of the wheat or the whole diet. Seventy-two pigs (34 days of age, average initial weight 9.6 kg) were assigned to six dietary treatments with two pigs per pen in a randomised block design. The pelleted diets contained 65% wheat, 13% fishmeal, 10% dehulled soya and 10% fat/wheat feed blend and were formulated to provide 3540 kcal DE/kg and 1.46 % total lysine. Titanium dioxide (1%) was added to the diet as an indigestible marker. Voluntary feed intake (VFI) and growth rate were measured over a 21-day period. Voluntary feed intake differed by 15% leading to an 18% difference in growth rate. Digestible energy of the diet (DE-Diet) varied by 4% or 138 kcal/kg. There was no significant ($P > 0.05$) correlation between DE-Diet and growth rate of the pigs. There was, however, a significant ($P < 0.05$) negative linear relationship between water holding capacity of the diet, measured by the filter method (WHC-FF) and VFI ($r^2 = 0.61$) and daily DE intake ($r^2 = 0.75$). Bushel weight as a measurement of wheat quality only gave limited information about performance of the pigs. Water holding capacity of the feed, as a predictor of VFI, could have important implications when feeding pigs on ad libitum regimes. Water holding capacity of the diet is known to be influenced by the dietary fiber content and its properties.

Variety	lbs/ bushel	WHC-FF	ADG	g/dVFI	g/d FCR	DE-Diet kcal/kg
Hussar	62.4	1.92	488	636	1.31	3365
Hunter	61.6	1.85	470	608	1.30	3363
Brigadier	60.9	2.04	457	609	1.34	3246
Beaver	60.6	2.22	435	558	1.29	3308
Dynamo	60.6	1.92	419	614	1.49	3298
Riband	60.5	2.07	415	554	1.38	3384
SEM			20	22	0.063	21.5

Key Words: Pig, Wheat quality, Performance

244 Soy protein concentrate as a replacement for menhaden fish meal in commercial diets for channel catfish production in ponds. G. J. Burtle*, G. L. Newton, and S. R. Ghate, *University of Georgia, Tifton.*

Soy protein concentrate was evaluated as a component of channel catfish feed for production of catfish in earthen ponds. Nine ponds 0.1 ha in area were stocked with 2,724 catfish fingerlings (36.4 g/ fish) each. Three diets were fed to triplicate ponds for a 6 month period during which time the ponds were harvested on 5 dates separated by one month intervals. These average weights of harvested catfish were between 200 and 300 g, the preferred market weight in the South Atlantic states. Two diets containing 8% or 16% soy protein concentrate (70% crude protein) were compared to a third containing 8% menhaden fish meal. All diets were formulated to contain 32.5±.06% crude protein and 2,756±20 kcal DE/kg. The diet containing 16% soy protein also contained 0.25% lecithin. Addition of soy protein concentrate caused several changes in feed processing conditions including warmer barrel temperature, faster feeding rate, and more water added to the extruder barrel resulting in a lower motor amperage for 8% soy protein concentrate versus 8% menhaden fish meal. However, 16% soy protein concentrate required more motor amperage than either of the other two diets. Channel catfish weight gain averaged 6,839 kg/ha and was not different among treatments ($P = 0.05$). Feed efficiency (G/F) averaged 0.84 and was not different among treatments ($P = 0.05$). Fish meal containing diets have previously been reported to produce greater channel catfish weight gain than soybean meal-corn based diets. Based on this study, soy protein concentrate may be substituted on a weight basis for menhaden fish meal in channel catfish diets with similar performance.

Key Words: Channel Catfish, Soy Protein Concentrate, Menhaden Fish Meal

245 Effect of β-hydroxy-β-methyl butyrate on the physiological response to exercise and conditioning in horses. L. Sandberg*, P. Miller, and J. C. Fuller, Jr., *Iowa State University, Ames.*

β-hydroxy-β-methyl butyrate (HMB) is a leucine metabolite that has been shown to enhance muscle strength and endurance. This study evaluated the physiological responses of exercising horses fed HMB. Five geldings were fed a control supplement containing ground limestone and 5 geldings were fed the same supplement substituting HMB (@ approx. 1g CaHMB/45.5 kg BW) for the limestone. The horses were exercised 4×/week on a high-speed treadmill for 12 weeks; the first 6 weeks consisted of light to moderate work followed by 6 weeks of high intensity work. All horses performed an standard exercise test (SET) prior to conditioning with repeated SET at 6 weeks and 12 weeks. The SET consisted of 10 mins at a heart rate (HR) of 160, 2 mins @ HR 200, 10 mins @ HR 160, 2 mins @ HR 200, and a 60 min recovery period. Conditioning allowed another 10 min of exercise @ HR of 160 immediately prior to recovery, at the 6 and 12 week SET. Conditioning resulted in requiring a greater ($P<.001$) velocity to maintain a given heart rate. HMB treatment did not ($P>.05$) effect velocity. Conditioning ($P<.0001$) decreased ($P<.001$) plasma triglyceride (TG) concentrations and HMB treatment decreased TG even more ($P<.001$). Glucose concentration increased ($P<.0001$) during each SET and in response to conditioning. HMB treatment even further increased ($P<.01$) the blood glucose concentration. Plasma lactate concentration decreased ($P<.0001$) with conditioning; however, with HMB treatment the decrease was less at 6 and 12 weeks ($P<.04$ and $P<.001$). Aerobic conditioning increased oxidative metabolism but the addition of anaerobic training during the last 6 weeks did not effect lactate levels. HMB supplementation also increased hemoglobin and hematocrit. Despite higher plasma lactate in HMB supplemented horses, HMB appeared to increase oxygen carrying capacity. In conclusion, HMB treatment combined with conditioning appeared to be of benefit to the performance horse.

Key Words: Horse, β-hydroxy-β-methyl butyrate, Exercise

246 High oil corn and normal corn diets for growing finishing pigs. S. B. Sevilla, M. A. Esnaola, and R. Castillo, *Zamorano, Panamerican School of Agriculture, Tegucigalpa, Honduras.*

Normal yellow corn (NYC) containing 3.6% oil and 8.5% CP and high oil corn (HOC) containing 8.8% oil and 9.3% CP were compare as source of energy for growing swine. Sixty-four pigs averaging 27 kg and three moths of age were divided into 16 pens according to body weight and sex (two gilts and two barrows). Pens were randomly assigned to the following four treatments: 1. NYC- soybean Control diet; 2. HOC- soybean diet; 3. HOC diet plus 250 ppm. of CuSO4; 4. HOC diet plus wheatings and molasses with the same level of DE as the Control diet. Diets were isonitrogenous and formulated to contain 15% CP and .75% lysine up to 50 kg and 13%CP and .6% lysine up to 100 kg liveweight. Daily gains (g/d) from groups 1 to 4 for the whole period of the experiment were: 688, 697, 728 and 654, respectively. Diet 3 showed a 5.8% higher daily gains tendency ($P=.06$), than Control diet. Diet 4, despite its being similar to that of the Control diet in DE, showed a 4.9% reduction on daily gains. Daily intakes and gain:feed ratio were not significantly different among diets. The results of back fat and loin area were also not significantly affected by treatments. These results showed that HOC despite of having 5.2% more fat than the NYC only produce small improvements on daily gains with little effect on other parameters including such carcass measurements as back-fat and loin area. From these results is concluded that if the price of one tonne of HOC corn is 10 to 20%higher than NYC, it is doubtful that the swine producer will benefit from its use in growing-finishing diets.

Key Words: Swine, Energy sources, High oil corn

247 Effect of plasma, lactose and soy protein source in phase I diets on nursery pig performance. H. Liu*, K. J. Touchette, G. L. Allee, and M. D. Newcomb, *University of Missouri, Columbia.*

One hundred and twenty-eight weaned pigs (18± 2 d and 5.99 kg) were used to evaluate the effect of plasma protein, lactose, and soy protein sources in phase I starter diets on nursery performance. Pigs were weaned to an on-site nursery and were allotted by weight in a RCB to a 2×2×2 factorial arrangement with two levels of plasma (0 and 7%), two levels of lactose (0 and 30%), and two soy protein sources: soybean meal (SBM) and extruded soy protein concentrate (ESPC). Phase I diets were fed for 14 days and were formulated to contain 1.56% lysine and 0.86 sulfur amino acids. All diets contained 1.75% spray dried blood meal. Common phase II and phase III diets were fed from d 14 to 28 and d 28 to 39 respectively. Plasma increased (P<.05) ADG and ADFI in phase I , but plasma had no effect on pig weight at d 39 of the experiment. No lactose by soy protein source interaction was observed. Lactose increased (P<.01) ADG and ADFI in phase I, with no effect on subsequent performance. Pigs fed lactose in phase I maintained their weight advantage at d 39 postweaning (P<.1). There were soy protein source by plasma interactions in ADG (P<.05) and ADFI (P<.1) in phase I. When there was plasma in the diet, pigs fed diets containing SBM had higher ADG (P<.1) and ADFI (P<.05) than pigs fed ESPC. When there was no plasma in the diet, there was no difference in ADG and ADFI between pigs fed SBM and pigs fed ESPC. In phase II and phase III, there was no difference in ADG, ADFI or feed efficiency between the groups of pigs which received SBM or ESPC in phase I. These results suggest that both plasma and lactose improved phase I pig performance and SBM can be used as the major protein source in phase I diets with no detrimental effects on performance, if there is plasma in the diet.

Key Words: Weaned pigs, Plasma, Lactose, Soy protein

248 Impact of feed intake and spray-dried plasma on nursery performance and intestinal morphology of weaned pigs. K. J. Touchette*, G. L. Allee, M. D. Newcomb, L. W. Pace, and M. R. Ellersieck, *University of Missouri, Columbia.*

A study was conducted to determine if spray-dried plasma improves nursery performance by increasing ADFI and to determine the effects of diet and ADFI on intestinal morphology. Forty-three pigs weaned at 14-17 d were used in a RCBD and allotted to one of eight treatments. Flexible gastric cannulas were placed in 34 pigs. Pigs were fed one of two diets, 0 or 7% plasma. Both diets were formulated to contain equal digestible essential amino acids and ME. Treatments used were (1) plasma diet fed ad lib., (2) plasma diet fed ad lib., (3) no plasma diet fed ad lib., (4) plasma diet fed to trt. 3, (5) no plasma diet fed to trt. 2, (6) plasma diet fed 120% of trt. 2, (7) no plasma diet fed 120% of trt. 2 and (8) plasma diet fed 80% of trt. 2. Cannulas were not placed in pigs on trt. 1 and 8. All feed intakes were adjusted daily to metabolic body weight ($kg^{.75}$). Pigs that did not voluntarily consume the treatment defined amount were fed via the cannula over a 12 hour period. At the end of the 11 day study all pigs were killed and small intestine samples were collected to measure villus height and crypt depth. There was no effect of cannula on ADG or intestinal morphology. Pigs fed plasma ad lib. had a higher ADFI, ADG and G/F (P<.05) and had longer villi (P<.001) and a higher villus:crypt ratio (VCR, P<.01) than pigs fed no plasma ad lib. For pigs on the plasma diet fed to the no plasma ad lib. level there were no effects on ADG or intestinal morphology. For pigs on the no plasma diet fed to the plasma ad lib. level there was no effect on ADG, however the pigs fed the no plasma diet had shorter villi, deeper crypts and a lower VCR (P<.01). Increasing ADFI of the no plasma diet improved ADG (P<.05) however it did not affect intestinal morphology. Decreasing ADFI of the plasma diet reduced ADG and villus height (P<.05) with no differences in crypt depth or VCR. These data show that increasing ADFI of the no plasma diet improves performance to the plasma level; however intestinal morphology is dependent on diet and to a lesser degree on feed intake.

Key Words: Intestinal morphology, Weaned pigs, Plasma

249 Effect of spray-dried plasma and fructooligosaccharide on nursery performance and small intestinal morphology of weaned pigs. J. D. Spencer*, K. J. Touchette, H. Liu, G. L. Allee, M. D. Newcomb, M. S. Kerley, and L. W. Pace, *University of Missouri, Columbia.*

A study was conducted to evaluate the effect of spray-dried plasma and fructooligosaccharide (FOS) on early nursery pig performance and small intestinal morphology. A total of 96 weaned pigs (18 d and 6.1 kg) were allotted by weight in a RCBD (4 pigs/pen) to a 2×2 factorial arrangement with two levels of plasma (0 and 3.5%) and two levels of FOS (0 and .1%). Diets were fed for 14 days and were formulated to contain 1.56% lysine and 0.86% sulfur amino acids. All diets contained 1.75% spray-dried blood meal, 15% lactose, and 5% added fat. On day 10, one pig from each pen was killed and small intestinal samples of approximately 2-3 cm in length were collected. At each of the three sites (duodenum, jejunum, and ileum) ten villi and the respective crypt depths were measured. In the first week postweaning, dietary inclusion of plasma increased ADFI (P<.05) with no effects on ADG or feed efficiency, while inclusion of FOS did not affect pig performance. In the second week, plasma increased ADG (P<.05) and ADFI (P=.08) with no effect on feed efficiency, while FOS did not affect pig performance. Diet had no effect on crypt depth. Both plasma and FOS increased villus height (P<.01). Pigs fed FOS had a higher villus:crypt ratio (VCR, P<.07). A plasma by small intestine site interaction was shown for VCR (P=.05). Plasma did not effect VCR in the duodenum, but VCR was increased in the jejunum (P <.001) and ileum (P <.05). These data show that plasma improves ADFI and ADG in early nursery performance, and both plasma and FOS increase villus height and villus:crypt ratio in the small intestine.

Key Words: Plasma, Fructooligosaccharide, Intestinal morphology

250 Added L-Carnitine fed during gestating increases birth weight of pigs. R. E. Musser[1]*, R. D. Goodband[1], K. Q. Owen[2], S. A. Blum[2], M. D. Tokach[1], and J. L. Nelssen[1], *[1]Kansas State University, Manhattan and [2]Lonza Inc., Fair Lawn, NJ.*

A total of 307 sows was used to determine the effects of adding 50 ppm of L-Carnitine in gestation and lactation diet on sow and litter performance. The control diet, (1.83 kg/d), contained .65% lysine, .95% Ca and .85% P. The experimental diet consisted of 1.6 kg/d of the control diet with an additional top dressing of .23 kg of control diet that provided 50 ppm of L-Carnitine. Sows fed added L-Carnitine had greater BW (55.5 vs 46.6 kg; P =.0001) and last rib fat depth (2.6 vs 1.7 mm; P =.0160) gain in gestation than control sows. Addition of 50 ppm L-Carnitine in gestation increased both total litter (15.5 vs 14.6 kg; P =.0354) and pig (1.58 vs 1.49 kg; P =.0008) birth weight. No differences were found in the variation in birth weights between dietary treatments. Split-plot analysis was used to determine the overall treatment effect on litter weaning weights. Added L-Carnitine in gestation increased litter weaning weights (45.11 vs 41.35 kg, P =.023); however, no differences were observed from added L-Carnitine fed during lactation. Added L-Carnitine in gestation increased sow IGF-I concentration on d 60 (71.3 vs 38.0 ng/ml, P =.0071)and d 90 (33.0 vs 25.0 ng/ml, P =.0390). Feeding L-Carnitine through gestation increased sow BW and last rib fat depth, and increased litter birth and weaning weights.

Key Words: L-Carnitine, Gestation, Birth weight

251 Effects of tannin on porcine jejunal brush border membrane-bound enzyme activities. M. Z. Fan*, O. Adeola, and E. K. Asem, *Purdue University, West Lafayette.*

Effects of hydrolysable tannin on the activities of porcine jejunal enterocyte brush border membrane-bound alkaline phosphatase (*EC* 3.1.3.1), aminopeptidase N (*EC* 3.4.11.2), and sucrase (*EC* 3.2.1.48) were examined. Jejunal mucosa was scraped from three 26-kg pigs and enterocyte brush border membrane vesicles, with an average enrichment of 21-fold in sucrase specific activity, were prepared by Mg^{2+}–precipitation and differential centrifugation. The brush border membrane vesicles were treated with tannin by mixing 100 uL (1 mg protein) batches of vesicle suspension with 20 uL of vesicle resuspension buffers containing increasing amounts of the tannin to achieve the treatment concentration gradients (0, .05, .10, .25, .50, 1.00, and 2.50%). The mixture (120 uL) was incubated at 4°C for 60 min and was then diluted to contain .25 mg protein/mL prior to enzyme assays. *P*-Nitrophenyl phosphate (2 *mM*), L-alanine-*P*-nitroanilide hydrochloride (28 *mM*), and sucrose (28 *mM*) were respectively used in alkaline phosphatase, aminopeptidase N, and sucrase assays (37°C). All enzyme assays were conducted under the conditions of linear enzyme reaction. Inhibition kinetics were analyzed according to *Michaelis-Menten* equation. As a percentage fraction of the control (no tannin), the maximal inhibition of enzyme activity (I_{max}) was 24.4% for alkaline phosphatase, 54.8% for aminopeptidase N, and 61.2% for sucrase ($P < .05$). These results imply that the adverse effects of extractable polyphenols in feeds on the digestive utilization of dietary carbohydrates and proteins in the pig are partly due to their direct interference with the normal functions of the small intestinal brush border membrane-bound digestive enzymes.

Key Words: Tannin, Jejunal brush border enzymes, Pigs

252 Growth performance and digestive and metabolic responses of gilts penned individually or in groups. R. S. Gomez*, P. S. Miller, H. Y. Chen, and A. J. Lewis, *University of Nebraska, Lincoln.*

Two experiments were conducted to identify factors involved in the growth retardation of pigs housed in groups. In each experiment, 60 gilts were allotted to two treatments in a randomized complete block design. Twelve gilts were penned individually with one feeder, one waterer and a space allowance of 1.5 m^2/pen. Forty eight gilts were divided into12 groups of four and penned together with four feeders, four waterers and a space allowance of 6 m^2/pen. In Exp. 1 there were 60 growing gilts (initial and final BW of 17.9 and 50.8 kg, respectively) and in Exp. 2 there were 60 finishing gilts (initial and final BW of 46 kg 118.3 kg, respectively). In Exp. 1, there was a trend ($P < .10$) for greater ADG, final BW, and average backfat thickness for gilts penned individually. Apparent digestibilities of DM and CP tended ($P < .10$) to be greater and plasma concentrations of nonesterified fatty acids (NEFA) were greater ($P < .05$) for gilts penned individually. Plasma concentrations of urea and glucose were similar between treatments. In Exp. 2, ADG was greater ($P < .05$) and there was a trend ($P < .10$) for greater ADFI, final BW, loin weight, and primal cut weight for gilts penned individually. Apparent digestibilities of DM, CP, and energy, and the plasma concentrations of urea, glucose and NEFA were similar for both treatments. The growth retardation of group-penned growing gilts was related to reductions in the apparent digestibilities of DM and CP and increases in plasma concentrations of NEFA. However, in finishing gilts, growth retardation was not related either to changes in digestive processes or plasma metabolite concentrations.

Key Words: Gilts, Growth retardation, Groups

253 The effect of wheat quality measured by extract-viscosity and dietary addition of feed enzymes on performance of young pigs. G. Dusel, H. Schulze*, H. Kluge, O. Simon, and H. Jeroch, *Martin-Luther-Universität Halle-Wittenberg, Halle, Germany, Finnfeeds International Ltd., Marlborough, UK, and Freie Universität Berlin, Berlin, Germany.*

Viscosity is closely related to the soluble arabinoxylan content of wheat and is a major antinutritive factor in poultry. The present trial investigated the effect of wheat quality measured by extract-viscosity and dietary addition of feed enzymes on performance of young pigs. Seventy-two pigs (average initial weight 10.3 kg) were assigned to four dietary treatments (W I, wheat A = 1.3 mPas extract viscosity; W II, wheat B = 3.3 mPas extract viscosity; W II + xylanase; W II + xylanase + protease) with two pigs per pen in a randomised block design. The pelleted diets contained 40% wheat A or B, 20% barley, 20% rye, 10% soybean meal and 7% fishmeal. Voluntary feed intake (VFI) and growth rates were measured over a 35-day period. Extract-viscosity of the meal and pelleted W I and W II diet was significantly ($P < 0.05$) different. Addition of feed enzymes significantly ($P < 0.05$) reduced extract-viscosity compared with diet W II. The pelleting process increased extract-viscosity of the diets. Feeding diet W II numerically reduced growth rate and feed efficiency by 9% and 4%, respectively, compared with diet W I. Addition of dietary feed enzyme, either xylanase or xylanase + protease, significantly ($P < 0.05$) improved growth rate and feed efficiency compared with diet W II. Wheat extract-viscosity has important implications on performance parameters of young pigs. Dietary feed enzyme supplementation, xylanase and xylanase + protease, are able to reduce the antinutritive effects of soluble dietary fiber and increase pig performance.

Diet	Visc. Meal mPas	Visc. Pellet mPas	ADG g/d	VFI g/d	FCR
W I	11.2a	35.5b	388ab	717	1.85b
W II	30.2c	71.1a	354b	727	1.92b
W II + Xyl	18.7b	38.3b	462a	766	1.66a
W II + Xyl + Prot	18.9b	36.2b	480a	794	1.65a

a,b,c ($P<0.05$)

Key Words: Pig, Wheat quality, Performance

254 The influence of weaning on intestinal glycoproteins in pigs. M. I. Pestova*, R. E. Clift, and A. G. Mathew. *The University of Tennessee, Knoxville.*

Cannulated pigs were used to determine the correlation between weaning and the variability of intestinal glycoprotein content. This study identified two endogenous glycoproteins present in varying amounts in the ileal contents of 17 to 24 day old pigs before and after weaning. Intestinal samples were collected on the day of weaning and seven days postweaning through a cannula implanted in the proximal ileum. Water soluble proteins were electrophoresed by sodium dodecyl sulfate-polyacrilamide-gel electrophoresis (SDS-PAGE) and stained with coomassie blue and a periodic acid-Schiff stain specific for glycoproteins. Proteins were fractionated on a Bio – Gel A – 0.5 size exclusion column and fractions were collected. Further purification was accomplished by preparative SDS – PAGE and electroelution. Electrophoresis of water soluble proteins from ileal contents taken before weaning showed a band that stained positive for glycoprotein with a molecular weight of about 150 kDa. This protein stained intensely with coomassie blue and diminished in the electrophoresis pattern seven days after weaning. Another band was observed indicating a protein with a high molecular weight that did not penetrate the gel. This protein stained positive for glycoprotein but did not stain with coomassie blue. The high molecular weight and staining pattern of this second protein are consistent with mucin. An increasing concentration of mucin was observed from pre- to postweaning when samples were standardized for total protein. Analysis of the mucin, using agarose electrophoresis, indicated changes in structure as well as concentration of this component from pre- to postweaning. Based on this and other preliminary findings, we believe weaning and the transition to a solid diet result in changes in enteric microbes that impact on glycoprotein and mucin production and/or degradation.

Key Words: Pig, Weaning, Intestine, Glycoprotein, Mucin