

novo synthesis was reduced by both the fish oil and safflower oil treatments. While there no significant changes in the lipogenic enzymes, it is possible that the changes to de novo synthesis were not large enough to be measured. Overall, the results demonstrate that there was significant potential to alter milk fat composition.

**Key Words:** CLA, Lipogenesis, Milk Fat Depression

**716 Role of stage of lactation in the regulation of fatty acid synthesis in the dairy cow.** N.S. Beswick and J.J. Kennelly\*, *University of Alberta, Edmonton, AB, Canada.*

Our objective was to determine the influence of stage of lactation on fatty acid synthesis in adipose tissue and the mammary gland of the dairy cow. We examined four multiparous animals at four time points in their lactation corresponding to early (35+7d), mid (110+1d), and late lactation (270+1d), along with 30 d into the dry period. Mammary and adipose tissue biopsies were collected at each of these time points. We measured four key lipogenic enzymes: acetyl-CoA carboxylase (ACC), fatty acid synthase (FAS), lipoprotein lipase (LpL), and stearoyl-CoA desaturase (SCD). We hypothesized that the enzymes would decrease in abundance or activity in the mammary gland and would increase in adipose tissue over the course of the lactation. We analysed the mRNA abundance of LpL and SCD, and the protein abundance and activity of ACC and FAS. The mRNA abundance of LpL in the mammary gland was not significantly affected. However, in adipose tissue this value was significantly higher in the dry period than in early lactation ( $p < 0.01$ ). With SCD, the mid lactation value for mammary gland was highest and was significantly higher than that of the dry value ( $p < 0.01$ ). In adipose tissue, the mRNA abundance was highest in late lactation and was significantly higher than in early lactation ( $p < 0.01$ ). Acetyl-CoA carboxylase activity was unaffected by stage of lactation in the mammary gland, but protein abundance was significantly higher in early lactation than in the dry period ( $p < 0.05$ ). In adipose tissue, protein abundance was not significantly influenced, but was significantly higher in the late and dry period than in the early period ( $p < 0.05$ ). Fatty acid synthase activity demonstrated no significant effect due to stage of lactation, but this was more likely a result of the very high SEM of the activity assay. Adipose protein abundance was significantly lower in early lactation than in the dry period. Milk yield and the percentage of its components were not affected by stage of lactation. However, fatty acid composition analysis revealed that de novo synthesis of fatty acids was lower during early lactation than mid and late lactation. In conclusion, we demonstrated that stage of lactation is significant in the regulation of lipogenesis in the dairy cow.

**Key Words:** Stage of lactation, lipogenesis

**717 The effect of abomasal amino acid imbalances on milk composition in lactating dairy cattle.** T.L. Weekes\* and J.P. Cant, *University of Guelph, Ontario, Canada.*

Milk production responses to rumen-protected methionine and lysine supplementation of dairy rations suggest that cows often experience an amino acid imbalance. The purpose of this experiment was to define the milk composition response to an intentionally large amino acid imbalance. The experimental design consisted of a 6x6 latin square balanced for carry-over effects. Each period was five days in length. All cows were fed a diet formulated to have 8.0% crude protein and 1.6 Mcal/Kg  $NE_L$ . The six isotonic solutions infused abomasally at 8 L/d for 5 days were: 1) 3.0% saline; 2) 15% free amino acids having the profile of milk protein as a positive control; 3) positive control minus methionine; 4)

minus lysine; 5) minus histidine; 6) minus leucine, isoleucine, and valine. The amino acid infusions were calculated to provide approximately one-third of the total duodenal amino acid flow. Milk protein yield was increased from 585 g/d on the saline control to 698 g/d with infusion of the complete amino acid solution. Removal of lysine, methionine, and histidine each reduced protein yield back to control levels; branched-chain amino acid removal had no effect. Milk fat yield was increased significantly from 728 g/d on the saline control to 986 and 1048 g/d on the lysine and histidine imbalances, respectively. Likewise, milk fat percentages increased from 3.4% with saline to 4.6% with the lysine imbalance and 5.3% with the histidine imbalance. Protein:fat ratios were .58 and .50 on these two treatments relative to .84 on the control. A post-ruminal essential amino acid imbalance decreases milk protein percentage and yield and causes a pronounced increase in milk fat secretion. Histidine removal caused the greatest imbalance effect, followed by lysine then methionine. Effects on milk composition of the amino acid infusate without branched-chain amino acids were the same as those for the positive control. Branched-chain amino acids do not limit milk synthesis.

**Key Words:** Amino Acid Imbalance, Milk Composition

**718 The effect of long-term supplementation of conjugated linoleic acid (CLA) to dairy cows grazing tropical pasture.** S. R. Medeiros<sup>1</sup>, D. E. Oliveira<sup>1</sup>, L.J.M. Aroeira<sup>2</sup>, M. A. McGuire<sup>3</sup>, D. E. Bauman<sup>4</sup>, and D.P.D. Lanna<sup>\*1</sup>, <sup>1</sup>ESALQ, São Paulo, Brazil, <sup>2</sup>CNPGL-EMBRAPA, Minas Gerais, Brazil, <sup>3</sup>University of Idaho, Moscow, <sup>4</sup>Cornell University, Ithaca, NY.

The objective of this study was to evaluate the effects of long-term treatment with CLA on lactating cows. Twenty Zebu X Holstein cows were rotationally grazed during the summer on stargrass (*Cynodon nlenfuensis* var. *nlenfuensis*) plus 4kg/d of a high-protein supplement formulated with corn, soybean meal, wheat middlings and fishmeal to provide 110% of estimated metabolizable protein requirements. Supplement was fed from the 4th to the 9th week of lactation, twice a day, and each treatment ( $n=10$ ) received either 150g/head/day of Megalac (Control) or the same amount of a Ca-protected CLA mixture (60% CLA, Church & Dwight). Below are the averages for the 4th to the 9th week of lactation. Milk production was unchanged, despite a small increase in CLA treated cows. As a result, the differences observed in yields of milk constituents are in accordance with their contents in milk. CLA decreased milk fat content by 25% and yield by 21%. This effect was observed within two days of treatment when cows were with less than 30 days in milk, which may be related to the source of substrates for fat synthesis in the mammary gland of these low producing cows. Protected CLA greatly increased protein content and yield (+13%). Because milk production was unchanged while energy secretion decrease ( $P < 0.05$ ) these results suggest Control cows could achieve their potential energy output under the conditions of this experiment.

	Control	CLA	Probability	CV(%)
Milk Yield, kg/day	16,6	17,0	0.516	8,9
Milk Fat, %	2,80	2,11	0.001	12,1
Milk Protein, %	2,79	3,07	0.025	7,9
Milk Lactose, %	4,62	4,50	0.239	4,7
Milk Solids, %	10,87	10,43	0.138	5,8
Milk Fat, g/day	458	361	0.025	19,7
Milk Protein, g/day	457	517	0.031	11,0
Milk Lactose, g/day	795	766	0.407	9,4
Milk Total Solids, g/day	1783	1769	0.901	12,8
Log SSC	5,18	5,70	0.477	19,8
Body Condition Score	3,5	3,5	0.867	7,5

**NONRUMINANT NUTRITION**

**719 Effects of level of phytase on ileal digestibility of calcium, phosphorus, crude protein, and amino acids in dehulled soybean meal.** S.L. Traylor\*<sup>1</sup>, G.L. Cromwell<sup>1</sup>, M.S. Plunkett<sup>1</sup>, M.D. Lindemann<sup>1</sup>, and D.A. Knabe<sup>2</sup>, <sup>1</sup>University of Kentucky, Lexington, <sup>2</sup>Texas A&M University, College Station.

Ileal-cannulated pigs were used to assess dietary levels of phytase (Natuphos; BASF, Mt. Olive, NJ) on the apparent and true digestibility of Ca, P, CP, and amino acids in dehulled soybean meal (SBM) analyzing .39% Ca, .70% P, 48.8% CP, and 3.17% lysine. T-cannulas were

surgically placed in the terminal ileum of 14 pigs (25 kg BW). Following a 14-d recovery, four diets consisting of 30.5% SBM, starch, minerals and vitamins (.50% Ca, .40% P, 14.6% CP, .95% lysine) with 0, 500, 1,000, or 1,500 units of phytase/kg were fed. A casein-starch diet low in CP (4.4%), Ca (.03%), and P (.05%) was used to estimate endogenous Ca, P, CP, and amino acids. Two additional diets (data not shown) were included as part of a larger coordinated study.  $Cr_2O_3$  (.5%) was used as an indicator. The seven diets were fed at .09 kg/kg BW<sup>.75</sup> daily during seven periods in a 7 x 7 replicated Latin square (14 observations/diet). Apparent ileal digestibility of Ca and P tended to increase

quadratically with increasing level of phytase (Ca: 64, 68, 69, 69%, ns; P: 50, 64, 67, 70%,  $P < .01$ ). Apparent digestibility of CP and most of the amino acids increased slightly with 500 units/kg of phytase, but not at the higher levels (CP: 82.5, 83.4, 80.9, 82.2%; lys: 89.9, 90.7, 88.8, 89.7%; thr: 80.5, 81.3, 78.7, 79.8%; trp: 89.3, 90.9, 87.7, 88.9%; met: 90.2, 90.6, 89.0, 89.4%; cubic,  $P < .05$  to  $P < .10$ ). True digestibility of Ca, P, CP, and amino acids followed similar trends (e.g., Ca: 69, 73, 75, 75%; P: 54, 69, 71, 74%; CP: 89.8, 90.8, 88.2, 89.6%; lys: 93.2, 94.0, 92.1, 93.0%). The results indicate that phytase had little effect on the apparent or true digestibility of amino acids in SBM, except for a slight numerical improvement from 500 units/kg of phytase (mean of .8 of a percentage point for the 10 essential amino acids). Phytase increased the apparent and true digestibility of Ca and P in SBM diets, with most of the improvement at the 500 units/kg level of phytase.

**Key Words:** Pigs, Soybean Meal, Digestibility

**720 The effects of phytase supplementation to growing-finishing diets containing wheat middlings.** N. Bekiaras\*<sup>1</sup> and G. Appar<sup>1</sup>, <sup>1</sup>*Southern Illinois University, Carbondale.*

An experiment was conducted using 54 crossbred pigs (initial wt 28.3 +/- 0.98 kg) to evaluate the efficacy of phytase addition to grower-finisher diets containing wheat middlings. There were 3 dietary phases during the experiment, 2 grower diets, fed during wk 1-2 and 3-4, respectively and a finishing diet fed during wk 5-7. Pigs were randomly allotted to either a control ration or a ration lacking inorganic phosphorus source with 500 FTU/kg phytase added. The phase 1 diet contained 4% wheat middlings, phase 2 contained 9%, and the phase 3 diet 10%. Chromic oxide was added to all diets as an indigestible marker for determination of nutrient digestibility. Pigs were weighed, feed intake measured and feed efficiency calculated every 2 wk. Random fecal samples, pooled by pen, were obtained during two 7-d collection periods during dietary phases 2 and 3, and analyzed for DM, Ca, P, Cu and Zn concentrations. Digestibility estimates were calculated by use of the indicator method. Treatments did not affect ( $P > .10$ ) ADG or ADFI. Gain to feed ratios were greater for control animals than phytase supplemented pigs during phase 2 ( $P < .05$ ), however the ratios did not differ at any other point during the trial. Dry matter digestibility was not different during phase 2, but was higher for pigs fed diets supplemented with phytase during phase 3 ( $P < .01$ ). Digestibility of Ca was similar during phase 2, but was higher in pigs fed phytase during phase 3 ( $P < .01$ ). Phosphorus digestibility was greater for pigs fed phytase supplemented diets during both phase 2 ( $P < .05$ ) and phase 3 ( $P < .01$ ). Although digestibility estimates for Cu and Zn differed between treatments, the data were unreliable and excluded from further analyses. Phytase addition to diets containing wheat middlings enabled growing-finishing pigs to have growth performance comparable to pigs fed diets containing wheat middlings with inorganic P. The addition of phytase resulted in lower concentrations of Ca and P in the excrement, presumably due to increases in absorption and utilization.

**Key Words:** Phytase, Pigs, Indirect digestibility

**721 Use of phytase to improve nutrient digestibility in growing finishing pigs fed diets containing cottonseed meal.** M. J. Azain, R. D. Jones, A. Phositimpagul, M. A. Froetschel, and H. E. Amos, *University of Georgia, Athens.*

Cottonseed meal (CSM) represents a potential substitute for soybean meal (SBM) as a protein source in swine and poultry rations. While CSM at 41% crude protein (CP) compares favorably to the crude protein content of SBM (49% CP), its amino acid profile and availability, as well as its energy content and presence of gossypol have limited its use. The objective of this work was to determine if phytic acid played a role in the reduced nutrient availability in diets formulated to contain 20% CSM. In a preliminary study, it was determined that the performance of pigs (50-105 kg) fed diets with CSM that were formulated on an available nutrient basis was equivalent to that of pigs fed corn-soybean meal based diets. In a second study, diets containing 20% CSM with adequate and marginal dietary phosphorus (DP), with and without 600 U of phytase (PT) were fed in two phases (45-75 kg, 75-105 kg). Diets were formulated to contain 0.61% and 0.48% available lysine in Phase I and II respectively. Total lysine was 0.93 and 0.68 % in these diets. The goal was to determine if phytase would indirectly increase protein or energy digestibility through its action on phytic acid. Growth performance was not different between diets. The lack of a difference is

likely accounted for by the failure to sufficiently reduce available nutrients to challenge the pigs. However, there were significant differences in digestibility. Digestibility was determined using chromic oxide as a marker at the mid point of each diet phase. In phase I, DP had no effect, but PT addition improved protein ( $P < 0.01$ ) and energy ( $P < 0.001$ ) digestibility. There was a DT x PT interaction ( $P < 0.05$ ) on protein digestibility that was due to improved PT action in the adequate DP diet vs. the marginal. Both DP ( $P < 0.001$ ) and PT ( $P < 0.001$ ) improved phosphorous digestibility and there was an interaction ( $P < 0.001$ ). The effects of treatment on digestibility were less evident in the Phase II diets, but trends ( $P < 0.20$ ) for improved protein and energy digestibility were noted. These results indicate that phytase addition to CSM containing diets improves macronutrient and phosphorous availability. The support of the Georgia Cotton Commission, BASF and the Southern Cotton Oil Company is gratefully acknowledged.

**Key Words:** Cottonseed meal, Digestibility, Pig

**722 Comparison of two genetically modified phytase sources fed to grower pigs.** B. C. Robbins\*<sup>1</sup>, J. S. Radcliffe<sup>1</sup>, T. L. Veum<sup>2</sup>, J. P. Rice<sup>1</sup>, and E. T. Kornegay<sup>1</sup>, <sup>1</sup>*Virginia Polytechnic Institute and State University*, <sup>2</sup>*University of Missouri, Columbia.*

Two hundred fifty-six crossbred pigs were used in a 6-wk experiment to compare the efficiency of two genetically modified phytases supplemented to grower pig diets. At an average initial weight of 28 kg, pigs were randomly allotted to eight dietary treatments. There were eight replicate pens of each diet, with two barrows and two gilts per pen. All diets were corn-soybean meal based and were fed in mash form. Diet 1 served as the positive control diet containing adequate levels of P and Ca (NRC, 1998). Diet 2 served as the negative control, having no added inorganic P (.35% P, .40% Ca). Diets 3, 4, and 5 consisted of diet 2 plus 250, 500, or 1,000 U/kg of source A phytase, respectively. Diets 6, 7, and 8 consisted of diet 2 plus 250, 500, or 1,000 U/kg of source B phytase, respectively. Individual BW and pen feed consumption were recorded bi-weekly. Pigs had ad libitum access to feed and water. During the last week of the 6-wk test, pen fecal samples were collected from each pen twice daily on three different days. At the end of wk 6, two barrows in each pen were slaughtered for collection of third metacarpals. The addition of source A or B phytase increased ADG ( $P < .01$ ), metacarpal shear force ( $P < .001$ ) and ash ( $P < .001$ ), and Ca ( $P < .05$ ) and P ( $P < .001$ ) digestibility. Differences in the efficacy of source A and B phytase were observed for ADG ( $P < .01$ ), and metacarpal shear force ( $P < .05$ ) and ash ( $P < .001$ ). Pigs fed diets supplemented with the source A phytase had larger improvements in ADG compared to pigs fed diets supplemented with source B phytase. However, bone parameters responded more favorably when source B phytase was fed. The P equivalency values of both phytase sources, based on phytase and P equations for ADG, P digestibility, metacarpal shear force and ash, showed that 500 U of phytase/kg of diet from either source can replace approximately .09% P from inorganic phosphate.

**Key Words:** pigs, phytase, digestibility

**723 The effects of microbial phytase on mineral, amino acid, and energy digestibilities in grow-finish pigs fitted with steered ileo-cecal valve cannulas and fed corn-wheat-soybean meal, corn-wheat-canola, or corn-sorghum-soybean meal based diets.** J. S. Radcliffe\*, R. S. Pleasant, and E. T. Kornegay, *Virginia Polytechnic Institute and State University, Blacksburg.*

Twelve crossbred barrows fitted with steered ileo-cecal valve cannulas, used in a paired 6 x 6 Latin square design, were fed corn-wheat-soybean meal (CWS), corn-wheat-canola (CWC), or corn-sorghum-soybean meal (CSS) based diets with or without 500 U of added phytase/kg of diet. Each 14-d period consisted of a 7-d adjustment followed by a 3-d total collection, a 12-h ileal digesta collection, a 3-d readjustment, and a second 12-h ileal digesta collection. Pigs were individually housed in metabolic pens (1.2m x 1.2m). Pigs had ad libitum access to water and feed was supplied at a level of 9% of metabolic BW ( $BW^{.75}$ ). The addition of microbial phytase to all diet types improved the apparent total tract digestibility (ATTD) of P ( $P < .001$ ) and the apparent ileal digestibility (AID) of P ( $P < .001$ ), Asp, Thr, Ser, Ala, Tyr, Phe, Lys, and Arg ( $P < .001-.05$ ), and tended to improve Gly AID ( $P < .1$ ). Amino acid AID were improved an average of 1.47 percentage units. Pigs fed CWC based diets had lower ( $P < .001$ ) ATTD of P, DM, and energy, compared

to pigs fed CWS or CSS based diets. Phosphorus ATTD was higher for pigs fed CWS based diets compared to pigs fed CSS based diets. Pigs fed the CWS based diets had higher ( $P < .001$ ) AID of all amino acids measured compared to pigs fed CWC or CSS based diets. The AID of Glu, Pro, Gly, Cys, Met, and His were lower ( $P < .001$ ) for pigs fed the CSS based diets compared to the CWC based diets. An interaction of phytase and diet type was observed for the ATTD of Ca ( $P < .02$ ) and the AID of Ca ( $P < .1$ ), Met ( $P < .05$ ), and Val ( $P < .01$ ). The AID and ATTD of Ca were improved in all diet types by the addition of phytase, but the magnitude of the response was greater in the CSS based diets. The AID of Met and Val was improved when phytase was added to the CWS and CWC based diets, but decreased when phytase was added to the CSS based diet.

**Key Words:** pigs, phytase, amino acids

**724** The effects of microbial phytase on mineral, amino acid, and energy digestibilities in grow-finish pigs fitted with SICV cannulas and fed corn-soybean meal, corn-soybean meal-wheat midds, or corn-soybean meal-meat and bone meal based diets. J. P. Rice\*, J. S. Radcliffe, B. C. Robbins, R. S. Pleasant, and E. T. Kornegay, *Virginia Polytechnic Institute and State University, Blacksburg.*

Twelve crossbred barrows fitted with steered ileo-cecal valve (SICV) cannulas were used in a paired 6 x 6 Latin square design to test the effects of added phytase on mineral, amino acid, and energy digestibilities. Pigs had ad libitum access to water and feed was supplied at 9% of metabolic body weight ( $BW^{.75}$ ) in two daily feedings. Pigs were fed corn-soybean meal (CS), corn-soybean meal-wheat midds (CSW), or corn-soybean meal-meat and bone meal (CSMB) based diets with or without 500 U of phytase/kg of diet. Each 2-wk period consisted of a 7-d adjustment, a 3-d total collection, a 12-h ileal digesta collection, a 3-d readjustment period, and a second 12-h ileal digesta collection. Pigs were individually housed in metabolic pens (1.2m x 1.2m). Upon analysis, diets formulated to contain 500 U of added phytase/kg of diet contained an average of only 319 U/kg of the diet. Wheat contributed an additional 250 U of endogenous phytase activity/kg of diet in the CSW based diets. The addition of microbial phytase to all diet types increased ADG ( $P < .05$ ) and tended to increase feed efficiency ( $P = .056$ ). Phytase addition also increased apparent total tract digestibility (ATTD) and apparent ileal digestibility (AID) of Ca ( $P < .001$ ) and P ( $P < .001$ ), but had no effect on amino acid AID. Pigs fed the CSMB based diet had higher ( $P < .05$ ) ATTD and AID of Ca and P compared to pigs fed the CS or CSW diets. Energy ATTD was higher ( $P < .05$ ) for pigs fed the CSMB based diet compared to pigs fed the CSW based diet. The AID of Asp, Thr, Ser, Glu, Gly, Ala, Met, Tyr, His, and Lys were affected ( $P < .01$ ) by diet type. However, no diet was consistently superior to any other diet with regards to amino acid AID. The results of this study demonstrate that phytase improves Ca and P digestibilities equally in CS, CSW, and CSMB based diets.

**Key Words:** pigs, phytase, amino acids

**725** Effects of Hemicell<sup>®</sup> addition to corn-soybean meal diets on energy and nitrogen balance in growing pigs. L. A. Pettey\*, S. D. Carter, and B. W. Senne, *Oklahoma State University, Stillwater.*

In previous studies, we have shown that the addition of Hemicell<sup>®</sup> ( $\beta$ -mannanase; ChemGen Corp., Gaithersburg, MD) to corn-SBM diets improved G:F in weanling and finishing pigs, and this response was similar to that observed when soybean oil was added to increase ME by 100 kcal/kg. Therefore, a 22-d experiment was conducted to determine the ME concentration and N digestibility of a diet with added Hemicell<sup>®</sup>. Five groups of 4 littermate barrows (31.3 kg BW) were allotted randomly by weight to four dietary treatments. Treatments were: 1) a corn-SBM based diet as a control (1.10% Lys), 2 and 3) as 1 with corn-starch (CS) added to the daily ration to increase ME by 100 and 200 kcal/kg, respectively, and 4) as 1 with Hemicell<sup>®</sup> (.05%). Calculated ME concentrations of Diets 1, 2, 3, and 4 were: 3.32, 3.42, 3.52, and 3.32 Mcal/kg, respectively. Pigs were housed individually in metabolic chambers and equally fed within litter. The total collection of feces and urine were conducted during two 5-d periods (d 3-7, d 18-22). GE of the diets were: 4.45, 4.55, 4.65, and 4.44 Mcal/kg DM. There were no period x treatment interactions; therefore, the data were pooled across periods.

ADFI and GE intake increased linearly ( $P < .01$ ) with increasing addition of CS, but there were no differences between pigs fed the control diet and the diet with Hemicell<sup>®</sup>. Total dry matter fecal excretion, fecal energy losses, total urine excretion, and urinary energy losses were similar for the four diets; however, DE concentrations increased linearly ( $P < .01$ ) with increasing CS addition. ME of the four diets, on a dry matter basis, were: 3.84, 3.98, 4.07, and 3.83 Mcal/kg. Addition of CS linearly increased ( $P < .01$ ) ME concentration, but the addition of Hemicell<sup>®</sup> had no effect. Also, N absorption and retention, as a percentage of intake, were similar ( $P > .10$ ) among the four treatments. Although Hemicell<sup>®</sup> has been shown to improve efficiency of feed utilization, the enzyme appears to have no effect on the ME concentration or N digestibility of a corn-SBM diet.

**Key Words:** Enzyme, Metabolizable energy, Pigs

**726** Effect of supplemental enzyme in barley with low, medium, and high DE content fed to grower pigs. R.T. Zijlstra\*<sup>1</sup>, B.K. Sloan<sup>2</sup>, and J.F. Patience<sup>1</sup>, <sup>1</sup>*Prairie Swine Centre Inc., Saskatoon, Canada,* <sup>2</sup>*Aventis Animal Nutrition, Atlanta, GA.*

A 20% range exists in DE content of barley, which is caused primarily by changes in concentrations of fibrous fractions. The project was designed to determine if responses in dietary energy (E) and AA digestibility in grower pigs to supplemental enzymes that degrade fibrous fractions depend on the specific barley sample. Samples of barley with a predicted range of DE content and hull-less barley were selected using chemical characteristics and a near infrared spectroscopy calibration. In two studies, barley samples were included at either 96% (Exp. 1) or 66% of the diet with 25% soybean meal and 5% canola meal (Exp. 2), with or without enzyme (Rovabio<sup>TM</sup> Excel; 500 U  $\beta$ -glucanase/kg diet). Grower pigs were cannulated at the distal ileum; feces and ileal digesta were collected in three periods ( $n = 6$ ). In Exp. 1, enzyme supplementation improved apparent fecal E-digestibility 7% for medium-DE ( $P < 0.01$ ) and 3% for high-DE barley ( $P < 0.05$ ), and apparent digesta E-digestibility 13% for medium-DE ( $P < 0.01$ ) and 8% for high-DE barley ( $P < 0.05$ ). Enzyme supplementation improved apparent digesta total-essential AA-digestibility 10% for medium-DE ( $P < 0.01$ ) and 8% for high-DE barley ( $P < 0.05$ ). In Exp. 2, enzyme supplementation improved apparent fecal E-digestibility 2% for barley 1 ( $P < 0.05$ ), 3% for barley 2 ( $P < 0.01$ ), and 2% for hull-less barley ( $P < 0.05$ ), but not for barley 3 ( $P > 0.10$ ). Enzyme supplementation improved apparent digesta E-digestibility 7% for barley 2 and 6% for hull-less barley ( $P < 0.01$ ) but not for barley 1 or 3 ( $P > 0.10$ ), and apparent digesta total-essential AA-digestibility 3% for barley 2 ( $P < 0.05$ ). Overall, hindgut fermentation diminished the increase in E-digestibility at the distal ileum. Enzyme supplementation improved digestibility of E and AA; however, responses depended on the specific barley sample. Thus, enzyme supplementation should be integrated with ingredient evaluation to maximize benefits of enzyme supplementation.

**Key Words:** Barley, Digestible Energy, Enzyme Supplementation

**727** Processing of barley and enzyme supplementation in diets for early-weaned piglets. P. Medel\*<sup>1</sup>, F. Baucells<sup>2</sup>, M.A. Latorre<sup>1</sup>, M.I. Gracia<sup>1</sup>, and G.G. Mateos<sup>1</sup>, <sup>1</sup>*Dpto. Producción Animal. Universidad Politécnica de Madrid*, <sup>2</sup>*Pinsos Bauccells. Barcelona.*

Two trials were carried out to study the influence of heat-processing (HP) of barley and enzyme supplementation (ES) of diets for early-weaned piglets. There were 6 diets arranged as a factorial 2x3 with two types of HP of barley (raw vs cooked and flaked) and 3 levels of ES (0, 600 and 1,200 ppm). The enzyme complex used contained 3,100 U/g  $\alpha$ -amylase (E.C. 3.2.1.1.), 275 U/g of  $\beta$ -glucanase (E.C. 3.2.1.6.) and 400 U/g of xylanases (E.C. 3.2.1.8.) and chromic oxide was used as undigestible marker to measure digestibility. A total of 120 male piglets weaned at 19 d were used in a 28-d Trial 1 (T1). In a second Trial (T2), four of the six diets of T1 (raw or HP barley at 0 or 600 ppm of ES) and 16 piglets were used to measure apparent ileal digestibility of starch, ileal viscosity of digesta, pH of stomach, cecum and colon, and cecum volatile fatty acids concentration (VFA). In T1 piglets fed HP barley grew faster and transformed feed into gain more efficiently than piglets fed raw barley (213 vs 184 g/d;  $P = 0.05$ , and 1.19 vs 1.08 g/g;  $P = 0.09$ , for growth and feed conversion, respectively) at 14 d after weaning, but the differences disappear thereafter. Productive performance was not affected by ES (391 vs 375 g/d and 1.24 vs 1.30 g/g for growth and

feed conversion with or without ES, respectively,  $P > 0.05$ ). Total tract digestibility of organic matter, energy, and protein were not affected by treatment. In T2, both HP of barley and ES improved ileal starch digestibility by 0.83 and 0.56%, respectively ( $P = 0.08$ ), but pH of stomach, cecum and colon, and ileal viscosity were not affected. Piglets fed HP barley had a higher acetic (1,217 vs 919  $\mu\text{g/g}$ ,  $P = 0.07$ ) and a lower butyric (299 vs 322  $\mu\text{g/g}$ ,  $P = 0.07$ ) concentration in the cecum than piglets fed raw barley. We conclude that HP of barley improved performance from 0 to 14 d after weaning, and modified the VFA production in the cecum at 14 d. Starch digestibility was improved by ES, but it had little effect on piglet performance traits.

**Key Words:** Barley Processing, Enzyme supplementation, Piglets

**728 Fermentability of pig feed treated with enzymes from stomach and pancreas, and of chyme.** E. Bauer<sup>\*1,2</sup>, B. Williams<sup>1</sup>, C. Voigt<sup>1,2</sup>, R. Mosenthin<sup>2</sup>, and M. Versteegen<sup>1</sup>, <sup>1</sup>Wageningen Agricultural University, The Netherlands, <sup>2</sup>Hohenheim University, Stuttgart, Germany.

Fermentation characteristics of enzyme-treated pig feed (EPF) was compared with chyme (CHY), to determine whether such treatment could lead to a material which might be representative of the digesta reaching the large intestine. The comparison was made between the fermentation kinetics of EPF, the untreated feed (PF) and CHY collected from pigs fed the same feed. The enzyme treatment of the pig feed was performed according to a modified Babinski method (1992), where the materials were incubated with a pepsin/HCl solution, followed by pancreatin, amylase, lipase and bile salts. CHY was collected daily over a period of four weeks from four ileally fistulated pigs which were fed the same standard PF rich in maize meal. Proximate and fibre analyses were determined for EPF, PF and CHY. Fermentation kinetics were analysed according to the cumulative gas production method (Theodorou et al., 1994). End-point products such as total gas,  $\text{NH}_3$  and VFA were also measured. The parameters were tested for significance by an analysis of variance using the Tukey multiple range test. A comparison between EPF and PF showed that the enzyme treatment only caused minor changes ( $P > .05$ ) in the final fermentability of the substrates. The DM loss during fermentation was lowest for the EPF ( $P < .0001$ ). A comparison between the fermentation characteristics of EPF and CHY showed very clear differences. CHY produced less gas ( $P < .0001$ ), and the time at which half of the gas had been produced, occurred later ( $P < .0001$ ). The maximum rate of fermentation was slower for CHY ( $P < .0001$ ). At the end of fermentation there tended to be more VFA and  $\text{NH}_3$  for CHY ( $P > .05$ ). These differences must be related to mechanisms which occur in the small intestine and which are probably not related to enzymatic digestion as such. In terms of fermentation characteristics, EPF is therefore not identical to CHY and cannot give a good approximation of the material reaching the large intestine.

**Key Words:** Pig feed, Enzyme-treatment, Fermentation kinetics

**729 The effect of dietary selenium source and level on broodmares and their foals.** K.M. Janicki\*, L.M. Lawrence, T. Barnes, and C.I. O'Connor, University of Kentucky, Lexington.

Fifteen pregnant mares were blocked by foaling date and randomly assigned to one of three selenium (Se) supplements: 1 mg Se/d (I1) or 3 mg Se/d (I3) as sodium selenite, or 3 mg Se/d (O3) as Se-enriched yeast (Alltech, Inc., Nicholasville, KY). Mares received their treatments daily for approximately 55 d pre-foaling and 56 d post-foaling. Blood samples were taken from each mare prior to supplementation and at 2 wk intervals throughout the study, including at time of foaling. A single colostrum sample was taken from each mare prior to the foal suckling. Blood samples were obtained from foals at 12 h, 2, 4, 6, and 8 wk post-foaling. Serum and colostrum samples were assayed for IgG concentration. Mares were weighed approximately 1 wk prior to foaling. Mares and foals were weighed 12 h PF, and at 2 wk intervals for 56 d. Se amount or form did not affect colostrum IgG concentration or foal serum IgG concentration at 12 h. To adjust for pre-treatment differences in IgG concentration among groups, mare IgG data were analyzed for treatment differences using the initial IgG concentration as a covariate. Mare IgG concentrations were not affected by treatment at 4 or 2 wk pre-foaling, or at foaling. Failure of passive transfer occurred in two foals in treatment I3, and a third foal in this group did not complete the study. Consequently, serum IgG data from the remaining foals in group I3 and all foals in group O3 were combined and compared to foals

in group I1. Foals from mares receiving 3 mg Se/d (either I3 or O3) had higher concentrations of IgG at 2 wk ( $P < .05$ ), and at 4 and 8 wk ( $P < .1$ ) compared to foals from mares receiving I1. Average daily gain of foals (1.5 kg/d for O3, 1.4 kg/d for I3, and 1.4 kg/d for I1) was not affected by treatment ( $P \geq .1$ ). Placental weight and time to placental expulsion were not affected by Se amount or form. Supplementing mares with 3 mg Se/d may be beneficial by increasing foal IgG concentrations during the first few months of life when foals are most vulnerable to disease.

**Key Words:** Selenium, Broodmare, Foal

**730 Effect of increasing available phosphorous levels on pig growth and carcass characteristics.** S.A. DeCamp<sup>\*1</sup>, D.C. Kendall<sup>1</sup>, C.T. Herr<sup>1</sup>, K.A. Bowers<sup>1</sup>, T.E. Weber<sup>1</sup>, M.L. Cobb<sup>1</sup>, C.J. Kendall<sup>1</sup>, B.T. Richert<sup>1</sup>, and A.L. Sutton<sup>1</sup>, <sup>1</sup>Purdue University, West Lafayette, IN.

One-hundred and thirteen grow-finish pigs (60 barrows (B) and 53 gilts (G); initial BW=25.9 kg) were blocked by sex and initial BW to examine the effects of dietary available phosphorous (AP) on growth and carcass characteristics. Pigs were fed one of four AP diet sequences ad libitum for 103 days. Diet sequences consisted of four BW phases (P1, 25-47; P2, 47-66; P3, 66-90; and P4, 90-110 kg, respectively). Diets were corn-soybean meal based with supplemental phytase (P1 & P2, 480 phytase units/kg and P3 & P4 300 phytase units/kg). Levels of AP increased by .075% increments between diets. Dietary phytase AP sequences were: diet 1) 2.5, 2.0, 1.5, 1.0; diet 2) 3.25, 2.75, 2.25, 1.4; diet 3) 4.0, 3.50, 3.0, 2.25; and diet 4) 4.75, 4.25, 3.75, 3.0 g/kg. Pigs were weighed at the end of each phase and total feed consumed was recorded to determine average daily gain (ADG), average daily feed intake (ADFI), and gain:feed (G:F). Carcass data and metacarpal bones were obtained at a commercial slaughter facility. There were no treatment effects on ADG (804, 838, 853, 840 g/d; respectively) during the grower period (P1 & P2). However, the grower period G:F tended to increase as AP increased (.409, .409, .423, .429, respectively; Lin.  $P < .1$ ). ADG increased during the finisher period (P3 & P4) as AP increased (759, 783, 793, 810 g/d, respectively; Lin  $P < .05$ ). Finisher G:F increased as AP increased (.284, .286, .289, .298, respectively; Lin.  $P < .05$ ). Overall (d0-103) ADG increased as AP increased (781, 810, 822, 824 g/d, respectively; Lin.  $P < .01$ ). Overall G:F also increased as AP increased (.332, .334, .340, .349, respectively; Lin.  $P < .05$ ). Last lumbar backfat decreased linearly with increasing AP (20.7, 20.8, 18.6, 17.4 mm, respectively;  $P < .05$ ). Percent lean tended to increase as dietary AP increased (53.6, 53.8, 54.1, 54.5%, respectively; Lin.  $P < .1$ ). B had greater overall ADG (836 vs. 782 g/d,  $P < .05$ ) and backfat thickness (24.1 vs. 20.5 mm,  $P < .01$ ) but reduced percent lean (53.3 vs. 54.8%,  $P < .01$ ). When corn-soy diets contain supplemental phytase, grower and finisher pig ADG and G:F were optimized with .425% and .30% phytase AP.

**Key Words:** pigs, phytase, phosphorous

**731 Dietary available phosphorus needs of high lean pigs fed from 9 to 119 kg BW.** T.S. Stahly, T.R. Lutz\*, and R.D. Clayton, Iowa State University, Ames.

Eighteen sets of six littermate barrows or gilts from a high lean strain were used to determine the dietary available phosphorus (AP) needs for high lean pigs fed from BW of 9 to 119 kg. Pigs were weaned via a SEW scheme, individually penned, and fed a diet containing .16% AP from weaning to 9 kg. Pigs were then self-fed one of six dietary AP concentrations during each of four stages of growth; S1, 9 to 37; S2, 37 to 65; S3, 65 to 92; S4, 92 to 119 kg BW. The basal diets in the four respective stages of growth contained .16, .128, .102, .082% AP which were supplemented with five incremental amounts of AP equivalent to S1, .08; S2, .064; S3, .051; S4, .041% AP. Dietary AP concentrations were achieved by the substitution of mono-dicalcium phosphate for starch while the calcium to AP ratio was maintained at 2.5:1, 2.25:1, 2:1, and 2:1 for the four stages of growth, respectively. As dietary AP concentration increased, ADG increased linearly in S1 (587, 659, 680, 693, 697, 692 g/d;  $P = .01$ ) and S4 (647, 869, 859, 827, 932, 930 g/d;  $P < .01$ ), and quadratically in S2 (828, 968, 964, 966, 983, 959 g/d;  $P < .01$ ) and S3 (810, 970, 967, 996, 1034, 974 g/d;  $P < .01$ ). As dietary AP concentration increased, gain:feed also was improved quadratically in S1 (.603, .630, .658, .643, .645, .635 g/g;  $P < .01$ ), S2 (.410, .449, .442, .434, .444, .420 g/g;  $P < .01$ ), S3 (.313, .337, .354, .348, .352, .338 g/g;  $P = .08$ ), and S4 (.235, .280, .289, .279, .299, .299 g/g;  $P = .03$ ). Based on these data,

it can be concluded that the dietary concentration of AP necessary to maximize the efficiency of feed utilization in high lean pigs (barrows and gilts) growing from 9 to 37, 37 to 65, 65 to 92, and 92 to 119 kg BW should be .32, .192, .205, and .164 to .245%, respectively.

**Key Words:** Pigs, Phosphorus, Growth

**732 Minimum biological capacity for phosphorus excretion in pigs.** B. R. Frederick\* and T. S. Stahly, *Iowa State University, Ames.*

Pigs (24 barrows) were allowed ad libitum access to semi-purified diets consisting of highly digestible sources of phosphorus (P, non-phytate) and nitrogen (N, ideal amino acid ratios relative to lysine). Dietary P and N were initially provided for 4 d at constant concentrations of .70% and 3.41%, respectively. Pigs were then fed control concentrations or lowered concentrations of P and/or N every 2 d for 8 d to achieve minimal excretion of digested P (<2% of dietary total P intake as inorganic P) and N (<10% of dietary N intake as urea) in the urine. Control P and N concentrations ranged from .70 to .85% and 3.41 to 3.74%, respectively. P and N concentrations were lowered in increments of approximately .03 and .40%, respectively, to achieve minimum dietary concentrations ranging from .61 to .65% and 2.12 to 2.54%, respectively. The process was then reversed and dietary P and N concentrations were raised every 2 d for 10 d to equal the control dietary N and P concentrations. Dietary P and N concentrations were achieved by altering the contribution of a calcium (Ca)-P (CaCO<sub>3</sub>, NaPO<sub>4</sub>) mix and protein mix (whey proteins, casein, amino acids) with an energy (cornstarch, corn oil, dextrin) and vitamin-mineral mix. All mixes contained a 2:1 total Ca to non-phytate P ratio. Based on two slope breakpoint analysis, the inflection point for body P retention per unit of digested P (dP) intake was achieved at an intake of .563±.020 g of dP/BW, kg<sup>.75</sup> (MBW)/d. Phosphorus excretion of pigs with intakes at or below the inflection point consisted of .037±.006 g of P/MBW/d of urinary P regardless of P intake and an average of .222 g of P/MBW/d of undigested fecal P, which was highly dependent on P intake (29.8±.9% of total dietary P). P excretion at intakes above the inflection point increased urinary P, representing 48.5±5.0% of dP intake. Dietary P intakes below the inflection point maximizes efficiency of dP for P retention while minimizing urinary P excretion.

**Key Words:** Pigs, Phosphorus, Excretion

**733 Boron affects growth performance and nutrient metabolism in growing barrows.** T.A. Armstrong\* and J.W. Spears, *North Carolina State University, Raleigh.*

An experiment was conducted to evaluate the effects of boron (B) on growth performance, bone mechanical properties, and the retention and excretion of nutrients. Thirty-six barrows were weaned at approximately 21 d of age and randomly assigned to receive one of three dietary treatments. Treatments consisted of: 1) low B basal diet (control), 2) control + 5 ppm B, and 3) control + 15 ppm B. Boron was supplemented as sodium borate. Barrows remained on their respective experimental diets throughout the nursery (35 d) and beginning of the grower (30 d) phases of production. Following the 30 d grower period, 8 barrows per treatment were transferred to stainless steel metabolism crates. Barrows had an adjustment period of 7 d, followed by a 7 d total collection of urine and feces. All barrows were fed at 90% of the ad libitum grower intake of the control animals during the adjustment and collection periods. Barrows were weighed and feed consumption was determined at the end of the nursery and grower periods. Blood samples were obtained from each barrow at the end of each phase. At the end of the collection period, barrows were sacrificed and femurs harvested for the assessment of bone mechanical properties. Boron increased (P < .05) ADG and ADFI during the nursery and grower phases; however, B did not affect feed efficiency during these production phases. The 5 ppm B treatment decreased (P < .06) the concentration of triiodothyronine in the serum during the grower phase. Boron did not affect the bone ash percentage, but the supplementation of 15 ppm B did increase (P < .10) bone stress or the intrinsic strength of the femur. The 5 ppm B treatment caused an increase (P < .08) in fecal N excretion, which resulted in a decrease (P < .08) in N retention. The 5 ppm B treatment resulted in a decrease (P < .09) in urinary Ca excretion, but had no effect upon Ca retention. These data indicate that B supplementation to pigs can stimulate growth, increase bone strength, and alter nutrient metabolism.

**Key Words:** Boron, Pigs

**734 Strategic application of Aureomycin chlortetracycline in lactation diets reduces sow mortality and improves reproductive performance.** J. Deen\*<sup>1</sup>, S. Keay<sup>2</sup>, R.D. Boyd<sup>2</sup>, D. Appleton<sup>2</sup>, P. Matzat<sup>3</sup>, and T. Wolff<sup>3</sup>, <sup>1</sup>*University of Minnesota, St. Paul*, <sup>2</sup>*PIC USA, Franklin, KY*, <sup>3</sup>*Roche Vitamins Inc., Parsippany, NJ.*

Sow mortality has significantly increased in the U.S. due to a number of risk factors that appear to be herd specific. The farrowing-lactation time frame is a period of high risk. This study examined strategic addition of chlortetracycline (CTC) to the lactation diet in a herd that experienced high (14%) annual mortality of varied etiologies. Treatments were imposed in alternate farrowing groups and involved feeding either no antibiotics (Control) or CTC in the lactation diet. The level of CTC was 0.734 g/kg diet (22 mg/kg BW). The medicated diet was fed on a 2-week on, 1-week off schedule. The data set involved 1944 Control and 1966 CTC sows (28 farrowing groups, average parity 3.05 and 2.99, respectively) for the current and subsequent reproductive cycle. The proportion of farrowed sows that subsequently died decreased by 2.75% (6.87 vs 4.12%), that were culled decreased by 2.9% (14.34 vs 11.47%) and that were re-bred and farrowed increased by 5.4% (62.21 vs 67.64%). During next farrow, stillbirths declined by 0.10 pigs/litter (P<.01) and liveborn increased by 0.23 pigs/litter (P<.06). Older sows died to a greater extent (Linear, P<.05). Approximately 52% of sow attrition occurred within 21 d of farrow. Strategic addition of CTC to lactation diets decreased the probability of sows dying by 41% (P<.001) and of being culled by 20% (P<.05). It increased the probability of farrowing by 8% (P<.02). The impact of CTC on increased sow retention (decreased maiden female entry rate) and subsequent reproduction was predicted to improve herd average pigs born alive/litter by: +.10 for lower stillbirth, +.17 for increased litter size, +.40 for decreased sow death and culling and +.10 for improved farrowing rate. This study illustrates that strategic CTC addition improves sow viability when significantly challenged. It confirms prior data that reproduction is improved with CTC use.

**Key Words:** Pigs, Sow viability, Antibiotics

**735 Effects of diet acidification on sow and litter performance.** C. W. Starkey\*<sup>1</sup>, J.D. Hancock<sup>1</sup>, J.S. Park<sup>1</sup>, C. Hankins<sup>2</sup>, K. Herkelman<sup>2</sup>, B. Moody<sup>2</sup>, and R. L. Odgaard<sup>3</sup>, <sup>1</sup>*Kansas State University, Manhattan*, <sup>2</sup>*Farmland Industries*, <sup>3</sup>*Kemin Industries, Des Moines, IA.*

A total of 314 sows (PIC line C22) were used in a 18d lactation experiment to determine the effects of diet acidification on sow and litter performance. The sows (parities 1 to 5) were fed three times/d to approximate ad-libitum consumption. Treatments were a corn-soybean meal-based control and the control with .5% of a cocktail of phosphoric, lactic, and citric acids (Kemgest™) and .5% of a cocktail of fumaric, lactic, citric, propionic, and formic acids (Acid Lac™). The diets were formulated to 1% lysine, 1% valine, .9% Ca, and .8% P and were introduced a minimum of 2 d prior to farrowing. Sows fed diets with Acid Lac lost less weight (P < .01) than sows fed Kemgest, however, no differences were observed in days to rebreeding or sow ADFI. Also no differences (P > .10) were observed for piglets born alive, stillbirths, mummies, piglet survivability, and litter weight gain among sows fed the various dietary treatments.

Item	Control	Kemgest	Acid Lac	SE
Sow ADFI, kg	6.0	6.0	6.1	.1
Sow weight loss, kg	36.8	37.7	32.3	1.4
Days to rebreeding	7.3	7.0	6.6	.6
Born alive	10.4	10.2	10.8	.3
Stillborn	1.0	1.0	1.2	.1
Mummies	.4	.4	.4	.1
No. pigs at 24h	11.0	10.9	10.9	.04
No. pigs at weaning	8.7	8.7	8.9	.1
Survivability, %	78.9	80.1	81.6	1.2
Litter weight gain, kg	29.2	29.9	30.0	.9

**Key Words:** Sows, Acidifiers, Lactation

**736 Limiting amino acids and ideal amino acid pattern for lactating sows.** S. W. Kim\*, D. H. Baker, and R. A. Easter, *University of Illinois, Urbana IL/USA.*

A simple approach was applied to determine limiting amino acids for lactating sows. Twenty-eight primiparous sows were fed 39.3 g/d lysine and 11.5 Mcal/d ME. Groups of four sows were allotted to litter-size treatments of 6, 7, 8, 9, 10, 11, or 12 by cross-fostering as needed within 48 h postpartum. Sows were killed on d 21 of lactation. Carcass, liver, gastrointestinal tract, reproductive tract, mammary gland, and other viscera were separated, weighed, ground, and analyzed for dry matter, crude protein, and amino acids. Simple linear equations were obtained for each amino acid within tissues as a function of litter size. Amino acids from carcass, liver, gastrointestinal tract, reproductive tract, and other viscera were mobilized as litter size increased (e.g., lysine mobilization was 31.2, .56, 1.12, .44, and .64 g per pig, respectively, for the 21-d lactation). Amino acids were accreted to mammary glands as litter size increased (e.g., 2.65 g lysine per pig for the 21-d lactation). Milk production needs were estimated (e.g., 49.9 g lysine per pig for the 21-d lactation). The quantity of each amino acid required additionally as litter size increased was obtained from the difference between amino acid needs for milk production and mammary gland growth and those provided from tissue mobilization. The relative ratio among amino acids that are required additionally was compared with the relative ratio of amino acid that can be provided from a common lactation diet. From the comparison, it was shown that lysine and threonine are the first-limiting amino acids, followed by valine, when sows are provided corn-soybean meal based diets during lactation. The calculations suggest that when threonine and lysine requirements are met, other essential amino acids should be sufficient for lactating sows that are fed corn-soybean meal based diets.

**Key Words:** Limiting Amino Acids, Lactating Sows, Ideal Amino Acid Pattern

**737 Response of gilts with naturally diverse body composition to low and high dietary lysine (protein) during lactation.** P.C. Penny\*<sup>1</sup> and H.M. Miller<sup>2</sup>, <sup>1</sup>*JSR Healthbred Ltd, Southburn, UK,* <sup>2</sup>*University of Leeds, School of Biology, Leeds.*

The objective of this study was to determine whether lean vs fat gilts, both derived from a high lean genotype (JSR Healthbred) were equally able to utilise lactation diets varying in total lysine content. Two hundred and thirty gilts were assigned to a 2 x 2 factorial arrangement of body type and dietary lysine. Gilts were weighed and P2 backfat thickness measured (65 mm from the midline over the last rib) at service and farrowing. Gilts with a P2  $\leq$  15 mm at service and P2  $\leq$  20 mm at farrowing were classed as lean (L), those with a P2 > 15 mm at service and P2 > 20 mm at farrowing were identified as fat (F). Within L and F body type, gilts were randomly assigned to one of two isoenergetic (3.4 Mcal/kg) diets with low lysine (LL) 0.7 % total lysine or high lysine (HL) 1.3 % total lysine. Gilts were fed twice daily to provide ad-libitum access to feed and number of piglets per gilt and litter weight were standardised on d1 postpartum. Of the 230 gilts, 174 remained within the same body composition classification and of these 19 did not complete a successful lactation. L gilts were lighter and leaner at farrowing (P < .001) compared to F (209.8 vs 226 kg and 17.7 vs 26.2 mm). P2 backfat loss during lactation was lower (P < .001) for L gilts (3.9 vs 6.1 mm) than F. There was also an interaction (P < .05) with L-HL and F-LL having lower backfat loss. Increasing dietary lysine had no effect on gilt BW loss between parturition and weaning for L vs F and LL vs HL. No differences were evident for litter start weight between LL and HL. Gilts on the LL diet produced a substantially lower total litter weight gain and individual piglet live weight at weaning (P < .01) compared to HL fed gilts (44.6 vs 49.3 kg and 7.1 vs 7.6 kg). ADFI was not different between either L and F body type or LL and HL (5.3 vs 5.4 kg and 5.3 vs 5.4 kg). These results demonstrate that gilts of both L and F body type are capable of utilising high lysine (protein) diets effectively during lactation.

**Key Words:** Gilts, Lysine, Lactation

**738 Skeletal muscle mobilization in lactating sows with divergent lactational protein loss.** E. J. Clowes\*, V. E. Baracos, and F. X. Aherne, *University of Alberta, Edmonton, Alberta, Canada.*

Skeletal muscle is mobilized during lactation in primiparous sows. To investigate possible mechanisms, an index of protein synthesis (RNA:DNA) and muscle free amino acid concentrations were studied in triceps of sows fed to lose divergent levels of body protein. Primiparous sows were randomly allocated to isocaloric diets (62  $\pm$  2.6 MJ DE/d) containing CP at 19.8% (n=8), 15.1% (n=7), or 11.9% (n=10). Litter weight, and sow live-weight and backfat were measured throughout lactation. Triceps muscle was biopsied 7 d prior to, and 12 and 23 d after parturition. A progressive body weight loss of 12.7, 17.0, and 28.2 kg (P = .002) was observed with decreasing level of dietary protein, but since all sows lost an equal amount of backfat, divergent levels of protein loss were achieved. Sows maintained similar litter growth rates in early lactation, but by the end of lactation litter growth rate declined and was 2.26, 2.44, and 2.73  $\pm$  .15 kg/d in sows fed 11.9%, 15.1%, and 19.8% CP, respectively (P = .03). Muscle RNA:DNA declined (P < .001) between 7 d prior to and 12 d after parturition in all sows, and declined (P = .03) thereafter to d 23 only in sows with the greatest protein loss. Concentrations of muscle total free amino acid, and most individual amino acids, increased between 7 d prior to and 12 d after parturition, but declined again by d 23. Levels of muscle free valine were inversely related (P = .001; R<sup>2</sup> = .31) to muscle protein loss at the end of lactation, and were lowest in animals showing the greatest protein loss. These results imply an imbalance between amino acid supply and demand in late lactation, which limits lactational performance and suggests that valine may be particularly limiting. By contrast, muscle free glutamine levels showed opposite changes to valine and other amino acids; muscle glutamine levels rose during lactation and were highest in animals showing the greatest body protein loss. This may reflect an imbalance between the proportions of valine and glutamine leaving muscle and the levels of those amino acids required for milk protein synthesis.

**Key Words:** Sow, Lactation, Muscle Loss

**739 Predictability of body weight changes in sows during gestation.** D.R. Cooper<sup>1,2</sup>, J.F. Patience\*<sup>1</sup>, R.T. Zijlstra<sup>1</sup>, and M. Rademacher<sup>3</sup>, <sup>1</sup>*Prairie Swine Centre Inc.,* <sup>2</sup>*University of Saskatchewan, Saskatoon, SK,* <sup>3</sup>*Degussa-Huels AG, Hanau, Germany.*

The pork industry's focus on economic efficiency and environmental sustainability underscores the need for greater precision in defining nutrient requirements. The objective of this study was to validate a factorial approach to defining daily DE requirements for gestating sows. Feed allowance in gestation was determined factorially for 419 multiparous sows based on estimated daily DE requirements for maintenance (110 kcal DE/kg BW<sup>.75</sup>), growth of conceptus and related tissue (411 kcal DE/d) and maternal BW gain (partitioned into protein and lipid deposition). Target net maternal BW gains were 35, 30, 20, 10 and 0 kg for parities 1, 2, 3, 4 and 5 or higher (5+), respectively. Total gain of the conceptus and reproductive tissues was assumed to be 20 kg for all sows. A barley-wheat-soybean meal gestation diet was provided once per day in quantities estimated to meet daily DE requirements. Sows gained an average of 10.6  $\pm$  1.3 (SEM) kg above the target total gestation BW gain. To further evaluate the factorial estimation of DE requirements, the daily DE intake for each sow was entered into the new NRC (1998) gestation model to compare actual vs. predicted changes in sow BW during gestation. The deviation between the predicted and actual gains (NRC prediction - actual BW gain) were -6.8  $\pm$  .8, -6.2  $\pm$  .8, -1.4  $\pm$  1.6, .1  $\pm$  1.4, 4.5  $\pm$  1.7, 1.1  $\pm$  2.0, 7.8  $\pm$  3.2 and 9.0  $\pm$  3.9 kg for parities 1 through 8, respectively. The coefficient of variation increased with increasing parity for both the predicted and actual BW gains in gestation. A positive correlation was found between actual BW gain in gestation and the number of piglets born (r = .37, .34, .50, .29 and .15 for parity 1, 2, 3, 4 and 5+, respectively; P < .05). A greater understanding of the relationship among BW changes, productivity and nutrient intake in gestation will improve the precision of gestation diet formation and hence, overall production efficiency and sustainability.

**Key Words:** Gestation, Sow, DE intake

**740 Impact of reduced dietary trace minerals on mineral and anti-oxidant status in swine.** G. M. Hill\*<sup>1</sup>, J. E. Link<sup>1</sup>, J. W. Spears<sup>2</sup>, and W. L. Flowers<sup>2</sup>, <sup>1</sup>Michigan State University, East Lansing, <sup>2</sup>North Carolina State University, Raleigh.

The presence of minerals in animal waste from dietary supplementation is often viewed as a threat to environmental sustainability. Therefore, the objective of this research was to determine if reducing dietary concentrations of zinc (Zn), copper (Cu), iron (Fe) and manganese (Mn) would alter mineral and antioxidant status of sows and their offspring through 3 parities. Crossbred gilts (n = 216) were weaned and assigned to diets meeting all known nutrient needs (NRC, 1988) with Zn, Cu, Fe, and Mn at (1) industry standard (minimum 15 ppm Cu, 100 ppm Zn and Fe, 40 ppm Mn) (IS), (2) reduced (5 ppm Cu, 25 ppm Zn and Fe, 10 ppm Mn) inorganic form (RI) or (3) reduced with 50% provided in the chelate form (RC). Pigs (n = 24, 1st parity; n = 18, 3rd parity) and sows after their 3rd parity (n = 18) were killed and tissues collected. Within age groups, tissue glutathione peroxidase and Mn superoxide dismutase (SOD) activity did not differ between treatments. However, Cu/Zn SOD activity was higher ( $P \leq .001$ ) in heart and kidney of RC 3rd parity offspring than IS or RI (18 vs 12, 12 and 24 vs 13, 15 U/mg protein, respectively). Sows fed RC had lower heart Cu/Zn SOD than those fed IS diets. Liver Zn was higher ( $P \leq .0003$ ) in 1st or 3rd parity pigs fed IS than those fed the reduced diets (60 vs 30, 30 ppm; 72 vs 52, 49 ppm). In sows, liver Zn was higher in those fed RC than IS ( $P \leq .003$ ; 83 vs 66 ppm). Renal Cu was higher in IS 3rd parity pigs and IS and RI sows than RC for their respective age group ( $P \leq .01$ ). Tissue Mn was not affected by dietary source or concentration. No measured parameter was outside the expected normal range. In conclusion, mineral source and concentration did not uniformly affect tissue concentration and antioxidant enzyme activity, and dietary Cu, Zn, Fe and Mn can be reduced in swine diets without affecting health.

**Key Words:** Swine, Antioxidant, Nutrient Management

**741 Glutamine stimulates the synthesis of immunoglobulin IgG in Infected Early Weaned Pigs.** J. Hernandez<sup>1</sup>, A. Borbolla\*<sup>1</sup>, R. Mendoza<sup>1</sup>, and G. García<sup>2</sup>, <sup>1</sup>Facultad de Medicina Veterinaria y Zootecnia UNAM, <sup>2</sup>Instituto de Biomédicas UNAM.

Glutamine has demonstrated its role as a fuel source for macrophages and other white cells; thus, improving the immune response mainly during stress and disease. The low activity of the immune system of the young pig prevents many producers from adopting early weaning strategies. Therefore, the objective of this study was to evaluate the role of glutamine on the production of IgG. Thirty-six pigs of  $14 \pm 2$  d were weaned on diets formulated with 0, 0.50, 0.77 or 1.50% of glutamine. One week after feeding the experimental diets, all pigs were inoculated abdominally with *E. coli* (Serotype 066,  $0.5 \times 10^{10}$  CFU/kg wt). Every three days after inoculation, two pigs per treatment were killed. Blood samples were taken and necropsy of each animal was performed to evaluate signs of infection with the bacteria. Samples of blood were subject to ELISA test to detect the presence of antibodies specific for the bacteria. Glutamine supplementation increased ( $P < .01$ ) serum IgG levels against *E. coli* antigens in a dose-response fashion (0.40, 0.99 y  $1.32 \mu\text{g}$  with 0.50, 0.77 y 1.50 % of glutamine, respectively). Infection signs in the abdominal cavity were lower ( $P < .05$ ) in the pigs that received 0.77 and 1.50% of glutamine, when compare with pigs in the control or 0.50 % groups. Glutamine supplementation in early-weaned pigs improves immune response against *E. coli* during the first two weeks after suffering the stress of weaning.

**Key Words:** Piglet, Early weaned pig, Glutamine

**742 Dietary fat supplementation effects on in vitro nutrient disappearance and in vivo nutrient intake and total tract digestibility by horses.** J.A. Bush\*, D.E. Freeman, K.H. Kline, N.R. Merchen, and G.C. Fahey, Jr., *University of Illinois, Urbana.*

Addition of fat to the diet of the equine is a popular method of increasing energy density of the diet while reducing feed intake. The effects of dietary fat on in vitro nutrient disappearance in the equine were studied in Exp. 1 using a split-plot design within a  $2 \times 2$  Latin Square. Two ponies were fed treatments consisting of alfalfa (ALF) alone (no fat-NF) or ALF plus 100 g/d corn oil (fat-F). Five substrates were used to determine IVDMD, IVOMD, in vitro NDF disappearance (IVNDFD), and

in vitro total dietary fiber (TDF) disappearance (IVTDFD). The substrates used included: ALF, tall fescue (TF), red clover (RC), soybean hulls (SBH), and rolled oats (RO). There were no significant effects on IVDMD, IVOMD, or IVTDFD due to fat supplementation. Addition of fat to the diet increased ( $P < .05$ ) the disappearance of NDF in RO. Among substrates, IVDMD and IVOMD were highest ( $P < .05$ ) for RO, followed by SBH, ALF, RC, and TF. In vitro NDF and TDF disappearance were highest ( $P < .05$ ) for SBH, followed by RO, ALF, RC, and TF. In Exp. 2, the effects of varying levels of fat on nutrient intake and total tract digestibility were examined using a  $4 \times 4$  Latin Square design. Four mature mares were fed a 60% forage-40% concentrate diet containing different concentrations of fat: control (C), 0% supplemental fat; 5% supplemental corn oil (5% CO); 10% supplemental corn oil (10% CO); and 15% supplemental corn oil (15% CO). Animals on the C treatment had the highest ( $P < .05$ ) intake of alfalfa cubes and of DM and OM followed by those on the 10, 5, and 15% CO treatments, respectively. Animals consuming the 15% CO diet had the highest ( $P < .05$ ) intake of fat, followed by those consuming the 10% CO, 5% CO, and C treatments, respectively. There were no effects ( $P > .05$ ) of treatment on digestibilities of DM, OM, CP, NDF, or gross energy. Animals consuming the 15% CO diet had the highest ( $P < .05$ ) fat digestibility, while those consuming the C treatment had the lowest fat digestibility, with the 10 and 5% CO treatments being intermediate. Fat in the form of CO had little effect on nutrient digestibility in the equine in vitro and in vivo.

**Key Words:** Equine, Fat, In Vitro Digestibility

**743 Vitamin B<sub>12</sub> requirements of early weaned pigs.** C.M.T. McDougall\* and J.D. House, *Department of Animal Science, University of Manitoba, Winnipeg.*

Two trials were conducted in early weaned pigs to: 1) determine their vitamin B<sub>12</sub> requirement and 2) examine the effect of dietary antibiotics on their vitamin B<sub>12</sub> status. In the first trial, sixty pigs, weaned at 17 $\bar{1}$  d, were *ad libitum* fed a pelleted corn-soyabean meal-lactose based diet (devoid of vitamin B<sub>12</sub>) supplemented with 0, 35, 70, 105 or 140 g vitamin B<sub>12</sub> kg<sup>-1</sup> diet, for 15-d. Average daily gain, average daily feed intake, feed efficiency ratio, and packed cell volume for the pigs were not influenced by the vitamin B<sub>12</sub> content of the diet (overall means  $\bar{n}$  SE = 0.200 $\bar{n}$ 0.043 kg, 0.212 $\bar{n}$ 0.036 kg, 0.939 $\bar{n}$ 0.093, and 33.1 $\bar{n}$ 3.1 %, respectively). However, plasma analysis revealed significantly lower vitamin B<sub>12</sub> (50 pg mL<sup>-1</sup> vs. 187, 168, 165, and 179 pg mL<sup>-1</sup> for the 35, 70, 105 or 140 g vitamin B<sub>12</sub> kg<sup>-1</sup> diet, respectively;  $P < 0.05$ ) and higher homocysteine (35 moles L<sup>-1</sup> vs. 23, 26, 25, and 23 moles L<sup>-1</sup> for the 35, 70, 105 or 140 g vitamin B<sub>12</sub> kg<sup>-1</sup> diet, respectively;  $P < 0.05$ ) concentrations in pigs given the vitamin B<sub>12</sub>-unsupplemented diet. In the second trial, forty-eight pigs, weaned at 17 $\bar{2}$  d, were *ad libitum* fed the vitamin B<sub>12</sub>-unsupplemented diet with or without 10 g of an antibiotic (ASP250) kg<sup>-1</sup> diet, for 15-d. Average daily gain, average daily feed intake, feed efficiency, packed cell volume, plasma vitamin B<sub>12</sub> and plasma homocysteine were similar for both the ASP250-unsupplemented and ASP250-supplemented pigs. These results indicate that the dietary vitamin B<sub>12</sub> requirement of the early weaned pig does not exceed 35 g vitamin B<sub>12</sub> kg<sup>-1</sup> diet and is not altered by the inclusion of an antibiotic. Future trials will further refine the early weaned pig's requirement for vitamin B<sub>12</sub>, and evaluate this estimated requirement under commercial production practices.

**Key Words:** Vitamin B12, Early weaned pigs, Homocysteine

**744 Effects of multiple stabilized enzymes on growth and performance of starter pigs.** A. Gueye\*<sup>1</sup>, C. R. Richardson<sup>1</sup>, and D. A. Haverkamp<sup>2</sup>, <sup>1</sup>Texas Tech University, Lubbock, <sup>2</sup>Natur's Way Inc, Horton, KS.

A series of five experiments were conducted using 21 d-old crossbred weanling pigs (9.48 $\pm$ .36 kg) to determine the effects of an enzymemicrobial product (Multiple Stabilized Enzymes MSE) on growth and performance of starter pigs. In each experiment, 96 pigs (4 pens of 6 pigs each) were randomly assigned to 4 dietary treatments: A) control, B) MSE, C) MSE + 1% fat, and D) MSE + 2% fat. Pigs were housed in environmentally controlled pens with plastic slotted floors, and equipped with a nipple waterer and a self-feeder. Pig weights and feed intake were recorded at the beginning of each experiment and at day 14 and 28. Pigs were allowed *ad libitum* access to feed and water. All five experiments were pooled and the data analyzed with pen as the

experimental unit for the periods 0-14 d, 15-28 d, and 0-28 d. ADG, ADFI, and feed conversion were analyzed as a completely randomized design using initial weight as a covariate. For d 0 to d 14, treatment had no effect on ADG, but ADFI decreased ( $P < .05$ ) for pigs fed MSE with increasing levels of fat as compared to the control group. Pigs fed MSE + 1% fat had an improved ( $P < .05$ ) feed conversion as compared to the control. For d 14 to d 28, treatment had no effect on ADG or feed conversion, but ADFI decreased ( $P < .05$ ) for pigs fed MSE + 1% fat. Overall (d 0 to d 28), treatment had no effect on ADG, but ADFI and feed conversion improved ( $P < .05$ ) for pigs fed MSE + 1% fat as compared to the pigs in the control group. In summary, addition of MSE in starter pig diets resulted in decreased average daily feed intake, improved feed conversion, but had no effect on average daily gain.

**Key Words:** Pigs, Enzyme-microbial, Performance

**745 Effect of dried porcine solubles on performance of lactating sows.** L. J. Johnston<sup>\*1</sup>, S. K. Baidoo<sup>1</sup>, G. C. Shurson<sup>1</sup>, G. Keller<sup>2</sup>, and R. D. Walker<sup>1</sup>, <sup>1</sup>University of Minnesota, Morris, <sup>2</sup>Nutra-Flo Protein Products, Sioux City, IA.

Mixed parity, maternal line sows ( $n=119$ ) were studied to determine the influence of dried porcine solubles (DPS) on performance of lactating sows and their litters. DPS is a co-product of heparin extraction from porcine small intestines dried on a soybean hull carrier. Sows at the West Central (WCRC;  $n=66$ ) and Southern (SRC;  $n=53$ ) Research Centers were used for this experiment. Corn-soybean meal based diets were formulated to contain .9% total lysine and 0, 1.5, or 3.0% DPS added at the expense of corn. Sows were assigned to dietary treatments within center, farrowing group, and parity at parturition. Pigs were crossfostered irrespective of treatments by d 3 to achieve a minimum of nine pigs per litter. Creep feed was not offered to litters. Lactation length was 23.3 and 18 d at WCRC and SRC, respectively. The statistical model for analysis of all data included effects of diet, center, farrowing group within center, and parity as a covariate. Lactation length was used as a covariate for postweaning interval to estrus. There were no significant interactions between treatments and center or treatments and farrowing group. A linear increase ( $P < .10$ ) in total feed consumed in the first 9 days of lactation (47.5, 52.0, 49.0 kg) and ADFI of sows over the entire lactation (6.07, 6.56, 6.32 kg) was observed for sows fed 0, 1.5 and 3.0% DPS. Litter size (9.33, 9.22, 9.08 pigs;  $P < .40$ ) and weight (53.6, 52.4, 51.9 kg;  $P < .75$ ) on d 18 of lactation were not affected by 0, 1.5 or 3.0% DPS, respectively. Days from weaning to estrus (4.67, 4.59, and 4.32;  $P < .40$ ) were not influenced by inclusion of 0, 1.5 or 3.0% DPS, respectively. Percentage of sows displaying estrus by d 15 after weaning was 94, 95, and 97% for sows fed 0, 1.5, and 3.0% DPS, respectively. Under the conditions of this experiment, inclusion of DPS at 1.5 or 3.0% tended to improve feed intake of lactating sows but had no significant influence on litter performance. Improvements in sow feed intake due to DPS additions to the lactation diet warrant further investigation.

**Key Words:** Sows, Lactation, Dried porcine solubles

**746 L-Carnitine increases muscle mass, bone mass and bone density in growing large breed puppies.** K.L. Gross\* and S.C. Zicker, Hill's Pet Nutrition, Inc. Topeka, KS.

Addition of L-carnitine to dog food (300 ppm DMB) during weight reduction in obese adult dogs has been shown to alter body composition, specifically increasing lean body mass. Dietary L-carnitine supplementation reduces daily fat accretion of growing pigs and accelerates growth rate, increases muscle and reduces fat in growing fish. We hypothesized that L-carnitine supplemented in the food of growing large breed dogs may reduce body fat mass and increase muscle mass. Forty six Labrador and Golden Retriever puppies from 6 different litters were fed either a L-carnitine-supplemented (300 ppm DMB) or unsupplemented growth food (Hill's Science Diet Large Breed Canine Growth) from weaning (8 wks of age) through 18 mo of age. Puppies were part of the Kansas Specialty Dog Service program (KSDS) and lived in homes with families. At 18 mo, the dogs returned to KSDS facilities to enter training programs to become assistance or guide dogs. Blood samples were collected at weaning, 6 mo, 1 yr and 18 mo of age for assay of carnitine. Body composition by DXA (Hologic QDR 2000) was determined at weaning and 18 mo. Plasma total carnitine concentration significantly increased from 23 nmol/ml at weaning to 47 nmol/ml at 18 mo in the L-carnitine supplemented pups ( $P=0.0001$ ) but remained unchanged in the unsupplemented group. At weaning, both groups of pups weighed 3.4 kg had

3044 g of lean mass, 288 g of fat mass and 59 g of bone mass. At 18 mo, the L-carnitine supplemented pups had significantly more bone mass (926 vs. 794 g,  $P=0.0004$ ), greater bone density (0.96 vs. 0.91 g/cm<sup>2</sup>,  $P=0.0019$ ), more lean body mass (23.9 vs 21.8 kg,  $P=0.0131$ ) and were heavier (30.6 vs 28.0 kg,  $P=0.0355$ ) than unsupplemented pups. Body fat mass (5.4 vs 5.1 kg) was unaffected by L-carnitine supplementation. L-carnitine supplementation to growing large breed dogs resulted in bigger dogs with more muscle, greater bone mass and stronger bones.

**Key Words:** Carnitine, Body composition, Dogs

**747 Substitution of DL-Methionine by Methionine Hydroxy Analogue (MHA-FA) in the diet of weaned pigs.** P.B. Lynch<sup>1</sup>, M. Rademacher<sup>\*2</sup>, and P.G. Lawlor<sup>1</sup>, <sup>1</sup>Teagasc, Moorepark Research Centre, Fermoy, Co. Cork, Ireland, <sup>2</sup>Degussa-Hüls AG, Feed Additives Division, 63457 Hanau-Wolfgang, Germany.

Methionine hydroxy analogue free acid (MHA-FA) differs from DL-methionine in that the molecule has a hydroxy group rather than an amino group. As a source of methionine for poultry MHA-FA has been shown to have 0.65 efficacy relative to DL-methionine. The objective of the present study was to determine if 65 parts of DL-methionine can be replaced by 100 parts of liquid MHA-FA in a methionine deficient diet for pigs after weaning. Ninety six pairs of crossbred pigs (one male, one female), were blocked on weight at weaning (age 27.7 s.e.=0.1 days; weight 8.2 s.e.=0.1kg) and assigned to treatment in a randomised block design for a 16-day experimental period, commencing 12 days after weaning when mean weight was 10.6kg s.e. 0.1. A commercial piglet starter feed was fed in the pre-experimental period. The treatments were: (a) control diet - deficient in methionine, (b) control diet with added 0.65g DL-methionine per kg, and (c) control diet with added 1.0g MHA-FA per kg. The composition of the control diet was (g/kg) barley 75, wheat 200, dried cheese whey 125, herring meal 25, heat treated soyabean 160, peas 240, soya oil 25, maize starch 120, lysine HCl 2.75, L-threonine 2.0, L-tryptophan 0.5, minerals and vitamins 24.75. The diet was pelleted after steam-heating to 50°C and fed ad libitum. Daily feed intakes on the three treatments were 688, 735, 714; s.e. 12g, NS, daily liveweight gains were 432, 501 and 488; s.e. 10g;  $P<0.01$  and feed:gain ratios were 1.61, 1.48, 1.48; s.e. 0.03;  $P<0.05$  for control, DL-methionine and MHA-FA diets respectively. It is concluded that 100 units MHA-FA can substitute for 65 units of DL-methionine in diets for weaned pigs.

**Key Words:** Methionine, Hydroxy analogue, MHA

**748 Effect of dietary supplementation with phyto-gen substances, carbadox, and colistin on performances and immune response in post-weaning pigs.** G. Savoini<sup>\*1</sup>, G. Mancin<sup>1</sup>, A. Agazzi<sup>1</sup>, F. Cheli<sup>1</sup>, A. Baldi<sup>1</sup>, E. Monfardini<sup>1</sup>, V. Sala<sup>1</sup>, and V. Dell'Orto<sup>1</sup>, <sup>1</sup>University of Milan, Italy.

Phytogen substances may be alternative to antimicrobials in weaned pig diets. We investigated the effects of supplementating postweaning piglets diet with phytogen substances (extract of Echinacea, genzian-root, essential oils of juniper and thyme, tannins and silicic acid) compared to carbadox and colistin on growth, blood parameters and immune response. Forty-eight Goland piglets, averaging 15 kg LW, were randomly allotted to three dietary treatments: carbadox (Cx) 50 mg/kg of feed as fed, colistin (Co) 120 mg/kg of feed as fed and phytogen substances (Ps) 300 mg/kg of feed as fed. Piglets weight was recorded at 0,10,20,30d. Feed intake of each dietary group was recorded daily. Blood samples were collected at 0,10,20,30d and analyzed for glucose, urea, total protein, leucocyte count, neutrophil chemotaxis and plasma concentration. Pooled faeces samples were taken from each group at 0, 10, 20, 30d to check the presence of enteropathogenic bacteria. Data were analyzed by ANOVA using the GLM procedure. Feed intake and incidence of diarrhea did not differ among treatments. Enteropathogenic and haemolytic *E. coli* were isolated from all groups, indicating a regular circulation of this opportunistic infection between the pigs. Average daily gain (Cx= 0.529 kg/d, Co= 0.526 kg/d, Ps= 0.521 kg/d) was not affected by the treatments. Plasma glucose, urea and total protein did not differ among the groups. Leucocyte count resulted higher in Ps treatment (18.55x10<sup>6</sup>/ml) than pigs of Cx and Co (Cx=14.61x10<sup>6</sup>/ml, Co=12.38x10<sup>6</sup>/ml). The leucocyte formula did not differ among the groups as neutrophil chemotaxis (Cx=2.01%, Co=2.19%, Ps=2.70%). The results indicate that the phytogen substances may be considered

a valid alternative to the use of carbadox and colistin for postweaning piglets.

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**Key Words:** Piglets, Weaning, Phytochemical substances

**749 Differing patterns of gestation and lactation feed intake on the reproductive performance of gilts and sows.** D. Embury<sup>1</sup>, S.K. Baidoo<sup>2</sup>, and R. Funk<sup>3</sup>, <sup>1</sup>University of Manitoba, Winnipeg, <sup>2</sup>University of Minnesota, Waseca, <sup>3</sup>Landmark Feeds, Landmark, MB.

A 2X2 factorial experiment in a randomized complete block design with 113 total females was conducted to determine the effect of feed intake pattern during gestation and lactation on the reproductive performance of gilts and sows. All diets were based on barley-wheat-soybean meal and exceeded NRC (1988) nutrient requirements for pregnant and lactating sows. The gestation control group (gilts, n=31; sows, n=26) was fed at 1.4 times maintenance requirement d-1 and the pattern fed group (gilts, n=29; sows, n=27) was fed in four stages, 1.1, 1.3, 1.5, and 1.7 times maintenance requirements d-1 on d 1-29, d 30-59, d 60-89, and d 90-until farrowing, respectively. Each gestation group was further divided into two treatments for the 17-d lactation. Control group was 'full-fed' and the pattern group was fed in three stages based on 1.9, 3.0 and 4.1 times maintenance requirements d-1 on d 1 to 6; 7 to 12 and 12 to 17 of lactation respectively. Total feed intake (286.4 vs. 283.5 kg), ultrasonic back fat depths (14.0 vs. 14.5 mm) and live body weight at farrowing, (179.8 vs. 177.9 kg) serum urea nitrogen (15.3 vs. 15.9 mg dl-1) and serum progesterone concentration (15.9 vs. 15.2 ng ml-1) did not differ (P>0.05) between control and pattern fed females during gestation. There was no (P>0.05) effect of gestation treatment on feed intake during subsequent lactation. During lactation, pattern fed females consumed more feed than the control group (4.92 vs. 4.57 kg d-1; P<0.05). Litter size born alive and at weaning were improved (P<0.01) for pattern fed gilts but did not differ (P>0.05) for first parity sows. Pattern fed gilts had a higher number of piglets born alive than control fed gilts (10.33 vs. 9.77 pigs; P<0.01). The results indicate that pattern of feed intake during gestation improved reproductive performance for gilts, but not for first parity sows.

**Key Words:** Sows, Gestation-lactation, Feedintake

**750 The use of Solanum glaucophyllum to improve phosphorus utilization in broilers.** Y.-H. Cheng<sup>\*1</sup>, J. P. Goff<sup>2</sup>, J. L. Sell<sup>3</sup>, S. Gill<sup>4</sup>, E. Pawlak<sup>4</sup>, M. Elena<sup>4</sup>, and R. L. Horst<sup>2</sup>, <sup>1</sup>Iowa State University/Biomedical Science, <sup>2</sup>National Animal Disease Center, <sup>3</sup>Iowa State University/Animal Science, <sup>4</sup>CAE, Buenos Aires, Argentina.

The availability of dietary phosphorus can be improved by adding 1,25-dihydroxyvitamin D3 to the diet of broilers. The following experiments were conducted to determine if Solanum glaucophyllum(Sg), a plant containing a glycoside of 1,25-dihydroxyvitamin D3, could be used as a substitute for 1,25-dihydroxyvitamin D3 in corn/soybean meal based diets to improve phosphorus utilization. The basal diet contained 0.6% calcium, 0.5% total phosphorus(0.2% available phosphorus) and adequate vitamin D3. Each treatment was fed to six replicate groups of eight chicks(total of 48 chicks/group) beginning at 8 days of age and continuing until 28 days of age. The treatment diets included the basal diet or basal diet supplemented with either 1,25-dihydroxyvitamin D3 (15ug/kg) or Sg(1, 2.5 or 5.0g/kg diet) and the normal diet (1% calcium and 0.7% total phosphorus). Compared to the basal diet response plasma phosphorus increased in a dose dependent manner with the addition of Sg. Weight gain and tibiae ash were significantly elevated in those animals fed the normal diet as well as those supplemented with 1,25-dihydroxyvitamin D3 and normal diet groups. The results indicated that Sg could be used as a source of 1,25-dihydroxyvitaminD3 for improving phosphorus utilization in chicks. Efforts are being made to identify the glycosides and to determine their relative biological activity in chicks and other species.

**Key Words:** Solanum glaucophyllum, phosphorus utilization, 1,25-dihydroxyvitamin D3

**751 Effect of selection for lean growth efficiency on growth performance, blood profile, and carcass and meat quality.** J. Fabian\*, L. I. Chiba, D. L. Kuhlers, L. T. Frobish, K. Nadarajah, W. H. McElhenney, J. Lin, and B. L. Anderson, Auburn University, Auburn, AL.

Eight select line (SL) and eight control line (CL) Duroc pigs were used to determine the effects of six generations of selection for lean growth efficiency on growth performance, serum profiles, and carcass and meat quality. At 20 kg BW, pigs were placed in pens individually. Three corn-soybean meal diets [grower (G), finisher 1 (F1), and finisher 2 (F2)] were formulated to meet the NRC nutrient requirements. Pigs were allowed ad libitum access to feed and water. Three blood samples were taken from each pig at 20, 50 and 105 kg BW for glucose, triglyceride (TG), and urea N (BUN) analyses. Pigs were subjected to ultrasound backfat (UBF) measurement at 50 kg BW and at 105 kg BW before slaughter. The SL pigs grew faster and more efficiently (P < 0.05) during the G [ADG: 812 vs 733 g/day; gain to feed ratio (G/F): 429 vs 402 g/kg] and F1 phases (ADG: 931 vs 804 g/day; G/F: 330 vs 296 g/kg), but there was no effect of line during the F2 phase and overall. The SL pigs had lower UBF (P < 0.05) at 50 (7.2 vs 9.0 mm) and 105 kg BW (17.6 vs 22.9 mm), and had higher initial serum TG (54.9 vs 32.3 mg/dL; P < 0.001) and lower initial BUN (9.5 vs 11.7 mg/dL; P < 0.05) than the CL pigs. The SL pigs had heavier heart (342 vs 298 g; P < 0.05), liver (1,459 vs 1,359 g; P = 0.08), and kidneys (298 vs 249 g; P < 0.01). Lower 10th rib backfat (21.7 vs 31.6 mm; P < 0.01) and larger longissimus muscle area (32.8 vs 30.0 cm<sup>2</sup>; P = 0.1) were reflected in higher estimated daily lean gain (279 vs 238 g/day; P < 0.01) in the SL pigs. The SL pigs had lower meat color (2.02 vs 2.29; P < 0.05), firmness (2.45 vs 3.23; P < 0.01), and marbling (2.82 vs 3.55; P < 0.1) scores. These results indicate that selection for lean growth efficiency has changed the growth rate and body composition of the SL pigs.

**Key Words:** Pigs, Selection, Lean Growth

**752 Bioavailability of phosphorus in high available phosphorus corn and normal corn for young pigs.** J. S. Sands\* and O. Adeola, Purdue University, West Lafayette, IN.

The bioavailability of phosphorus (P) in high available P (HAP) corn and normal (NORM) corn relative to monosodium phosphate (MSP) for young pigs (avg 9.75 kg) was assessed employing slope-ratio methodology. The experimental design employed was a restricted-randomized block, with 8 dietary treatments, 12 pigs per treatment (6 barrows and 6 gilts), fed for 28 days. A basal diet, composed mainly of cornstarch and soybean meal, containing a total of 2.25 g/kg of P served as the zero supplemental level for both the reference and test diets. The 2 reference and 4 test diets were formulated by adding P as MSP, HAP or NORM at 0.75 g/kg and 1.5 g/kg to the basal diet at the expense of cornstarch. A positive control diet with supplemental amino acids was added to test whether observed responses were due to higher amino acid levels in those diets in which cornstarch was completely replaced by corn. Body weights and feed consumption were recorded weekly and plasma samples taken at d 1 and d 28. Average daily gain and feed intake were greater (P<.05) for pigs consuming HAP corn at the highest supplemental P level. No differences (P>.10) in body weight gain or feed intake were observed between the basal and the positive control diets. Common-intercept, multiple linear regressions in a slope-ratio assay were performed using plasma inorganic P (mg/L) as a dependent variable and supplemental P level (g/kg) and supplemental P intake (g/d) as independent variables. Plasma inorganic P concentration responded linearly (P<.05) to supplemental P intake and supplemental P level. Estimates of P bioavailability from HAP corn and NORM corn based on supplemental P intake were 46 and 33 % respectively. Estimates of P bioavailability from HAP corn and NORM corn based on supplemental P level were 62 and 44 % respectively. The bioavailability of P in HAP corn as estimated by slope-ratio techniques is superior to that of NORM corn.

**Key Words:** Phosphorus, Bioavailability, High available phosphorus corn

**753 Efficacy of DL-methionine and liquid DL-methionine hydroxy analogue (MHA-FA) as methionine sources for pigs.** Birgit Schindler<sup>\*1</sup>, Rainer Mosenthin<sup>1</sup>, and Meike Rademacher<sup>2</sup>, <sup>1</sup>Hohenheim University, Stuttgart, <sup>2</sup>Degussa-Huels AG, Hanau, Germany.

The objective of the study was to determine the efficacy of liquid MHA-FA (88%) compared with DL-methionine (99%) using the N-balance technique in piglets (Piétrain x German Landrace barrows) with an average initial BW of 11.5 kg. A basal diet formulated based on wheat (28.0%), peas (19.0%), barley (15.0%) and tapioca (12.2%) was supplemented with three graded levels of DL-methionine (.025, .050 and .075%) or liquid MHA-FA (.0285, .0570 and .0855%) on an equimolar basis. The basal diet contained 18.3% CP, .22% Met and .51% Met+Cys, which is below the methionine requirement according to NRC (1998), but adequate in all other essential nutrients and energy. The trial consisted of two consecutive experiments with 21 piglets each. In total, 6 piglets were randomly allocated to each of seven dietary treatments. The animals were fed twice daily 225 g per meal and had free access to water. They were kept individually in metabolic crates and fitted with adhesive collection bags to the anus that allowed separate quantitative collection of feces and urine. After an adaptation period of 8 d, feces and urine were collected quantitatively over a period of 7 d. The efficacy of the two methionine sources was estimated from nitrogen retention data using an exponential model ( $Y = a + b[1 - e^{-(c_1x + c_2x^2)}]$ ). The efficacy of MHA-FA as compared to DL-methionine was calculated as the ratio of their *c*-values ( $c_2/c_1$ ). With increases in dietary methionine, nitrogen retention increased by 33%, which means that efficacy was tested in the sensitive range. Compared with DL-methionine on a weight for weight basis, efficacy of liquid MHA-FA was calculated to be 62%. The results of the present study show a biological effectiveness of liquid MHA-FA in pigs, which is lower than 88% and agrees well with the previous estimates in poultry.

**Key Words:** Pigs, Methionine sources, Efficacy

**754 The effect of enzyme treatment of soybean meal on oligosaccharide disappearance and chick growth performance.** K. K. Graham<sup>\*</sup>, J. M. Lynch, and M. S. Kerley, *University of Missouri, Columbia Missouri.*

The oligosaccharides raffinose and stachyose make up about 1.3% and 4.9% of soybean meal, respectively. These two sugars have been shown to be unavailable to many species, including the chick. Gut viscosity is increased in chicks fed soybean meal-based diets causing an increase in passage rate and therefore a decrease in nutrient absorption. Research was done to determine the effects of degrading raffinose and stachyose, using the alpha-galactosidase enzyme, on concentration of these oligosaccharides in feces of chicks fed the enzyme-treated soybean meal (ESBM). Alpha-galactosidase treatment was optimized for oligosaccharide degradation. Enzyme treatment degraded raffinose and stachyose in soybean meal by 84% and 93%, respectively, compared to untreated soybean meal. Diets containing treated soybean meal resulted in excreta raffinose and stachyose concentrations to be reduced to below measurable levels. Enzyme treatment increased ( $P < .05$ ) total metabolizable energy from 2974 to 3328 kcal/g. Two chick growth studies were conducted to determine the effect of feeding ESBM on growth performance. The first experiment showed an increase ( $P < .06$ ) in average daily gain by about 4% in the ESBM compared to the untreated soybean meal. A numerical increase in gain to feed of 1% was also seen in experiment one for the ESBM. The second experiment showed a numerical 3% increase in average daily gain, and an increased gain to feed ratio from .8 to .9. A third experiment was conducted to determine if drying the ESBM in a conventional oven increased monosaccharide concentration, increasing the potential for Maillard products to form. The ESBM showed a stoichiometric increasing of monosaccharides compared to extractable oligosaccharide disappearance. When the treated soybean meal with added lysine was fed to chicks, the average daily gains were the same as the chicks fed the control diet. These experiments demonstrated that feces can be made void of raffinose and stachyose. Soybean meal treated with the alpha galactosidase enzyme may have the potential to increase average daily gain and feed efficiency of chicks.

**Key Words:** Enzyme, Oligosaccharide, Chick

**755 Dietary zinc effects on performance and immune response of growing pigs infected with porcine reproductive and respiratory syndrome virus (PRRSv) and *Mycoplasma hyopneumoniae* (M. hyo).** E. Roberts<sup>\*1</sup>, E. van Heugten<sup>2</sup>, G. Almond<sup>1</sup>, and J. W. Spears<sup>2</sup>, <sup>1</sup>College of Veterinary Medicine,, <sup>2</sup>Department of Animal Science, North Carolina State University.

A 2 X 4 factorial arrangement of treatments was used in a randomized complete block design to determine the effects of dietary zinc (Zn) and PRRSv infection on performance, plasma Zn, alkaline phosphatase activity (ALP), and immune response of pigs exposed to M. hyo (n=72, initial mean BW=26 kg). Factors included 1) intranasal administration of 1 ml PRRSv ( $10^{3-4}$  TCID 50, isolate SD 23983), or sham inoculation with media and 2) supplemental Zn at 10, 50, 150 ppm, or added at 2000 ppm for two weeks in the nursery and then supplemented with 150 ppm zinc for the remainder of the trial. Diets were fed beginning in the nursery and continuing into the grower. The corn-soybean based basal diet contained 1% lysine and 34 ppm Zn. Pigs were inoculated with PRRSv on entry into the grower (d 0). Gain, feed intake and gain:feed decreased ( $P < .10$ ) from d 0 to d 31 for pigs infected with PRRSv. Percentage fat free lean was lower ( $P < .05$ ) for control gilts compared to PRRSv infected gilts on d 15. Plasma Zn and ALP increased linearly ( $P < .10$ ) with Zn. PRRSv infection decreased both plasma Zn and ALP ( $P < .10$ ) for d 7 and d 14. A febrile response occurred from d 3 to d 7 and d 26 to d 28 ( $P < .10$ ) for pigs infected with PRRSv. In vivo cellular immune response as measured on d 13 by skin thickness response to phytohemagglutinin was decreased ( $P < .10$ ) after 24 hr for 150 ppm Zn in non-infected pigs. PRRSv or Zn did not affect lymphocyte proliferation. Total antibody response (Ig) to sheep red blood cells was increased ( $P < .10$ ) on d 14 for 150 ppm Zn in control and PRRSv infected pigs. These data suggest that PRRSv and M. hyo act synergistically to produce observed performance deficits and that Zn supplementation in the face of disease is more complex than the conventional view that more is better.

**Key Words:** Pigs, Zinc, Immune response

**756 Biological availability of lysine in wheat for growing pigs.** M Cervantes<sup>\*1</sup>, N Torrentera<sup>1</sup>, S Espinoza<sup>1</sup>, and M Cuca<sup>2</sup>, <sup>1</sup>ICA, Universidad Autonoma de Baja California, Mexicali, <sup>2</sup>Colegio de Postgraduados, Montecillos, Edo, Mexico.

Although lysine is the first limiting amino acid in wheat, grain usually provides more than 50% of the lysine requirement for growing pigs. There is limited information on the bioavailability of soft winter wheat. An experiment was conducted with 35 crossbred (Yorkshire-Duroc-Landrace) growing pigs (27.8 avg wt) to determine the bioavailability of lysine in wheat for growing pigs. There were seven treatments with five replicates each. The dietary treatments were: 1) basal, 67% wheat, 30% corn starch; 2) + .05% lys; 3) + .10 lys; 4) + .15% lys; 5) 77% wheat, 20% corn starch; 6) 87% wheat, 10% starch; 7) 97% wheat. Two regression analysis were used to test for linearity; one included treatments 1 to 4, and the other one treatments, 1, 5, 6, and 7. The bioavailability of lysine was determined by single point regression (slope-ratio) techniques, using crystalline lysine (100% availability) as a reference. Daily gain and feed/gain ratio were the criteria upon which lysine availability was based. All diets were deficient in lysine to create a linear response, also all diets were added with .10% threonine. Daily gain and feed/gain were: 127, 254, 381, 556, 185, 382, 506 g/d; 5.23, 3.73, 3.42, 2.83, 5.20, 3.64, 2.88, respectively. There was a linear increase in both, ADG ( $r = .99$ ) and F/G ( $r = .96$ ), as the dietary lysine content was increased either as crystalline lysine or as intact protein. The relative bioavailability of lysine was 73, 79, 91; and 72, 94 and 98%, when ADG and F/G were used as criterion, respectively. The average availability was 81 and 89%, for ADG and F/G, respectively. The wide range of values for lysine availability suggests that threonine was not properly added to diets 4 and 7. These results indicate that lysine is highly available in soft winter wheat for growing pigs.

**Key Words:** Wheat, Lysine, Bioavailability

**757 Ileal amino acid digestibility in pigs fed a wheat based diet added with a fungal protease.** M. A. Morales<sup>1</sup>, M. Cervantes\*<sup>2</sup>, M. Cuca, and N. Torrentera, <sup>1</sup>*Colegio de Postgraduados, 2ICA, Universidad Autonoma de Baja California, Mexico.*

An experiment was conducted to evaluate the effect of adding a fungal protease to a wheat based diet on the apparent ileal amino acid digestibility in growing pigs. Six pigs fitted with a cannula in the terminal ileum (approximately 10 cm from ileo-caecal valve) were used in a two-period, crossover experimental design. A basal, wheat diet supplemented with .55% lysine, .10% threonine, vitamins and minerals was prepared. Treatments were 1) basal diet added without the enzyme, and 2) the basal plus .5% fungal protease. Both diets contained .2% chromic oxide as a digesta marker. The feed was mixed with water at a 1:1 ratio; the enzyme was added when the feed-water mixture was prepared. There were two 11-d experimental periods; each one consisting of 7 days of diet adaptation and 4 days of digesta collection. Ileal samples were continuously collected from 0700 to 1300 h on days 8 and 10, and from 1300 to 1900 h on days 9 and 11. Feed was provided twice daily in equal amounts at 0700 and 1900. The apparent ileal digestibilities (%) of essential amino acids in treatments 1 and 2 were: arginine, 78.7, 79.5; histidine, 78.2, 78.6; isoleucine, 52.2, 53.1; leucine, 66.1, 67.1; lysine, 76.6, 76.9; methionine, 67.1, 67.5; phenylalanine, 66.0, 67.5; threonine, 53.2, 54.0; tyrosine, 72.9, 73.5; valine, 50.4, 52.4, respectively. There was no difference in the apparent ileal digestibility of any amino acid ( $P > .10$ ) in pigs fed either the enzyme-free or the enzyme-added diet. Although the digestibility of two of the most limiting amino acids in wheat appears to be below average, the addition of the enzyme to the diet did not result in any improvement. Thus, from these results it is concluded that the addition of a single fungal protease to a wheat based diet for growing pigs, does not bring any benefit.

**Key Words:** Pigs, Amino acid digestibility, Fungal protease

**758 A comparison of soybean meal versus other protein sources on pork quality.** R. M. Storde\*<sup>1</sup>, M. D. Hemann<sup>1</sup>, G. L. Brashear<sup>1</sup>, F. K. McKeith<sup>1</sup>, M. Ellis<sup>1</sup>, J. L. Shelton<sup>2</sup>, L. L. Southern<sup>2</sup>, and T. D. Bidner<sup>2</sup>, <sup>1</sup>*University of Illinois, Urbana, IL,* <sup>2</sup>*Louisiana State University Agricultural Center, Baton Rouge, LA.*

Gilts (n=108) and barrows (n=108) from the Louisiana State University (LSU) and the University of Illinois (UI) were harvested to compare the effect of soybean meal in swine diets, relative to other protein sources, on pork quality. A total of 12 pigs/diet/location were selected from one of nine dietary treatments: SBM= corn soybean meal control, AA= crystalline amino acids, DESB= dry extruded soybean meal, CAN= canola meal, PNT= peanut meal, SFLR= sunflower meal, PEA= ground peas, MBM= meat and bone meal, and PLTY= poultry by-product meal. The diets were formulated to meet or exceed NRC(98) requirements and to have equal Lys:ME ratios. Pigs were killed at approximately 115 kg live weight and the following carcass measurements were taken: color, firmness, marbling, muscle score, L\*, a\*, b\*, 45-minute pH, and drip loss. Ultimate pH, sensory panels, shear force, and proximate analyses were also evaluated. Pigs fed the SBM diet had higher ( $P < .10$ ) subjective color scores than pigs fed other plant source protein diets (DESB, CAN, PNT, and SFLR). Ultimate pH of pigs fed the AA diet was higher ( $P < .10$ ) than pigs fed the SBM diet (5.52 vs 5.43). Pigs fed the SBM diet had more intense ( $P < .10$ ) pork flavor than pigs fed the DESB diet (6.28 vs 7.42, 0= very intense), whereas off-flavor intensity scores from pigs fed the SBM diet indicated less off-flavor ( $P < .10$ ) than pigs from the DESB diet (13.53 vs 11.79, 0=very intense). No differences in sensory tenderness or juiciness were observed between pigs fed the SBM diet and pigs fed the other diets. Pigs fed the SBM diet had less ( $P < .10$ ) intramuscular fat than pigs fed the AA diet or animal protein source (MBM and PLTY) diets. No differences ( $P > .10$ ) were observed between pigs fed the SBM diet and the other diets for L\*, a\*, b\*, drip loss, cook loss, or shear force. Results from this study suggest that dietary protein sources had few consistent effects on pork quality.

**Key Words:** Soybean Meal, Pork Quality, Protein Sources

**759 Ileum and whole-tract digestibility of carbohydrates contained in a corn- or a sorghum-acorn-based diet fed on finishing Landrace and Iberian pigs.** J. Morales, J.F. Perez\*, M.D. Baucells, and J. Gasa, *Universidad Autonoma de Barcelona, Spain.*

Twenty four finishing pigs (12 Landrace, L; 12 Iberian, I; wt 90.5 kg) were fed *ad libitum* 2 isoenergetic and isoproteic diets based on corn (Diet C; corn grain, 74.9%; soybean meal, 19.7%) or corn, sorghum and acorn (Diet S; corn, 37.2%; sorghum grain, 27.5%; decorticated acorn, 12.5%; soybean meal 19.5%), resulting 4 treatments (6 pigs/each treatment; LC, LS, IC, IS). Cr<sub>2</sub>O<sub>3</sub> (0.1%) was incorporated for digestibility measurements. Experimental period lasted approximately 28 days until animals reach an average final wt of 107 kg. At this weight, animals were slaughtered, and ileum and rectum digesta samples obtained and freeze dried. Glucose content in diets C and S were respectively, 62.6% and 57.9% (more than 90% in the starchy fraction). Voluntary intake were significantly higher ( $P < 0.01$ ) on Iberian (3.93 kg/d) than Landrace pigs (3.03 kg/d), not being observed significant differences between diets. Whole tract OM digestibilities (g/kg) determined from rectum digesta Cr contents were significantly different between breeds and diets ( $P < 0.01$ ; 866, LC; 808, LS; 836, IC; 762, IS). Whole-tract digestibility of glucose (g/kg) was also significantly affected by breed and diets, showing a significant interaction ( $P < 0.01$ ; 995, LC; 985, LS; 968, IC; and 937, IS). Differences on the whole-tract digestibility parameters were mainly associated to differences between diets on the ileum digestibility of glucose ( $P = 0.06$ ; 936 vs 843 on diet C and S, respectively) but not differences were observed between breeds ( $P = 0.71$ ; 899 vs 881). Present results suggest a lower hindgut glucose fermentability (g/kg glucose intake) in Iberian than Landrace pigs. Lower fermentability in Iberian pigs could reflect shorter retention times of digesta in the caecum-colon compartment, likely associated with their higher intake. In fact, these differences on fermentability were diet dependent, being Iberian restrictions significantly detected only with diet S.

**Key Words:** Carbohydrates, Digestibility, Swine

**760 Differential action of dietary conjugated linoleic acids (CLA) on lipogenic gene expression in adipose tissue of two porcine genotypes.** M.L. Heckart\*, J.M. Eggert, A.P. Schinckel, S.E. Mills, and S.S. Donkin, *Purdue University, West Lafayette, IN.*

Conjugated linoleic acids (CLA) when included in the diet for growing pigs decrease lipogenesis and carcass lipid content. A portion of the effect of CLA may involve changes in expression of genes such as Fatty Acid Synthase (FAS) to alter fatty acid synthesis and Stearoyl CoA Desaturase (SCD) to modify the profile of fatty acids in adipose tissue. Furthermore, the response to CLA may vary with genetic propensity for fat accretion. To test these possibilities, eighty pigs from each of two genetic populations characterized by high or average carcass lean (54 versus 52% fat-free lean) were fed a corn and soybean meal diet with the addition of 0 or 0.6% conjugated linoleic acids (CLA) in a 2 x 2 factorial arrangement of treatments. Pigs were serially slaughtered at 23, 46, 68, 91, 114 and 136 kg body weight to obtain subcutaneous adipose tissue for RNA analysis of FAS and SCD. The abundance of FAS mRNA, as determined by Northern blotting, was affected ( $P < .01$ ) by weight, genotype x diet, and genotype x diet x weight. The abundance of FAS mRNA when pigs were fed the control diet was 43% lower for high lean compared to average lean pigs. Feeding CLA decreased expression of FAS in the average lean line and increased ( $P < .05$ ) expression in the high lean pigs. No overall effects were demonstrated for genotype, diet, or diet x weight ( $P > .05$ ). The expression of SCD was responsive ( $P < .01$ ) to genotype, genotype x diet, weight, genotype x weight, diet x weight, and genotype x diet x weight interactions. In control-fed pigs, the abundance of SCD in adipose tissue was 38% lower ( $P < .05$ ) in high lean pigs than in average lean pigs. Feeding CLA decreased ( $P < .01$ ) SCD expression in average lean pigs and tended ( $P = .08$ ) to increase expression in the high lean group. These data suggest that CLA acts to modify expression of lipogenic genes in pigs that are not genetically predisposed to low adipose accretion.

**Key Words:** CLA, Gene expression, Genotype

**761 Potential for an extruded multiple protein complex (Profound™) as a replacement for fish meal in early weaned pig diets.** M. E. Davis\*<sup>1</sup>, D. C. Brown<sup>1</sup>, C. V. Maxwell<sup>1</sup>, Z. B. Johnson<sup>1</sup>, W. R. Walker<sup>2</sup>, and A.K.M.H. Haque<sup>3</sup>, <sup>1</sup>University of Arkansas, Fayetteville, <sup>2</sup>Land O'Lakes, Fort Dodge, IA, <sup>3</sup>American Dehydrated Foods, Inc., Springfield, MO.

A total of 216 weaning barrows (20 ± 2 d of age) were used to determine the potential for Profound™ produced using an extrusion process combining liquid egg protein with processed soy protein (Optipro) or soybean meal (SBM) as a replacement for fish meal (FM) in Phase 1 nursery diets. Pigs were transported to an off-site nursery and blocked by weight (6 pigs/pen). Six dietary treatments (6 pens/trt) were fed from d 0 to 10 postweaning and consisted of: 1) a negative control (NC) devoid of FM, 2) the positive control (PC) with 8% FM replacing SBM, 3) the PC with 50% or 4) 100% of FM replaced by Profound™ with Optipro, 5) the PC with 50% or 6) 100% of FM replaced by Profound™ with SBM. Substitutions were made on an equal Lys basis and diets contained 1.6% Lys and 14.7% lactose. A common diet was fed from d 10 to 24 (1.35% Lys) and d 24 to 38 (1.2% Lys) postweaning. From d 0 to 10, pigs fed the PC diet were more efficient ( $P \leq .03$ ) when compared to pigs receiving the NC diet. Average daily gain, ADFI, and gain:feed (G/F) from d 0 to 10, d 10 to 24, d 24 to 38, and d 0 to 38 were similar ( $P \geq .10$ ) among pigs fed the Profound™ diets formulated with either Optipro or SBM (TRT 3 and 4 vs. TRT 5 and 6). Pigs fed either the 50% or 100% replacement of FM with either Profound™ formulated with Optipro or Profound™ formulated with SBM had similar ( $P \geq .10$ ) performance (TRT 3 and 5 vs. TRT 4 and 6). From d 0 to 10, pigs fed the Profound™ diets had similar ( $P \geq .10$ ) ADG, ADFI, and G/F as pigs fed the PC diet (TRT 2 vs. TRT 3, 4, 5, and 6). Pigs previously fed the PC diet had lower ( $P \leq .02$ ) G/F during d 10 to 24 when compared to pigs previously fed the four Profound™ diets (TRT 2 vs. TRT 3, 4, 5, and 6). This study indicates that Profound™ may be effective in replacing 50% or 100% dietary FM in Phase 1 diets. Providing Profound™ in weaning pig diets from d 0 to 10 may improve efficiency from d 10 to 24 postweaning.

**Key Words:** Swine, Protein source, Egg protein

**762 Antioxidant status of puppies as affected by changes in vitamin C, E and iron/copper concentrations.** K. Wedekind<sup>1</sup>, S. Zicker<sup>1</sup>, and D. Jewell\*<sup>1</sup>, Hills Pet Nutrition, Inc., Topeka, KS.

Numerous studies have demonstrated the benefits of antioxidants in older animals, but few studies have evaluated the efficacy of antioxidants in young growing animals. Vitamin C is clearly an important antioxidant for humans (primates), but its importance in species not requiring vitamin C is not fully known. Commercial petfoods are inherently high in Fe and Cu because of its relatively high meat content, however, excessive iron and copper may negatively affect antioxidant status. Thus it was our objective to determine whether vitamin C and/or E addition was beneficial in puppies and determine if reductions in iron and copper concentrations would improve measures of antioxidant status. Thirty six beagle pups were assigned to a randomized complete block factorial design containing six treatments: 1) an AAFCO-tested Growth control formula, 2) Growth control + 400 IU/kg dl-alpha-tocopherol acetate (E), 3) Growth control + 100 mg/kg ascorbate (Stay-C; (C)), 4) Growth control + E + C, 5) Growth control w/o added Fe and Cu, and 6) Growth control + E + C w/o added Fe and Cu. All diets were fed for 8 wks. The response parameters measured included: serum alpha tocopherol (serum E), oxygen radical absorbing capacity (ORAC), serum chemistry, CBC, and measures of Fe and Cu status (ferritin, TIBC, sera Fe, zinc protoporphyrin, and ceruloplasmin). Significant main effects and interactions ( $P < .05$ ) were observed for both serum E and ORAC. Serum E was higher for pups fed E vs control ( $P < .05$ ), but puppies fed both E and C yielded higher serum E ( $P < .05$ ) than pups fed E only. ORAC was increased for pups fed C or E only relative to control ( $P < .05$ ), but E and C in combination was higher than E or C alone ( $P < .05$ ); reducing Fe and Cu increased ORAC relative to control ( $P < .05$ ), but not relative to pups fed E+C. No differences were observed for measures of iron or copper status. The combination of vitamins C + E was synergistic and improved antioxidant status in puppies relative to E or C alone, but was not further improved by dietary reductions of Fe and Cu.

**Key Words:** Antioxidants, Puppies, Vitamin E

**763 The rat as a model for the assessment of ileal amino acid digestibility of cottonseed meal for pigs.** L. Gutierrez\*, L. Garcia, F. Vazquez, D. Mendoza, R. Ramos, and B. Saavedra, Center of Research in Food and Development. Hermosillo, Sonora, Mexico..

The use of the laboratory rat as a model animal for the determination of apparent ileal amino acid (AA) digestibility in the growing pig, using the slaughter method, was evaluated. Twenty male Sprague-Dawley rats (190 g body weight) were allotted into two groups and housed individually in stainless steel wire-bottomed cages in a room maintained at 25°C with a 12 h light/dark cycle. Six male hybrid pigs (30 kg body weight) were also housed individually in open pens without bedding material at 25°C. Rats and pigs were fed diets containing cotton seed meal as the sole protein source. Chromic oxide was included in the diets as an indigestible marker. Ileal contents from the terminal 20 cm of ileum were collected after slaughter of the rats and pigs. Ileal and diets samples were analyzed for chromium by atomic absorption and for AA by liquid chromatography. Mean apparent ileal AA digestibility for rats and pigs were, respectively: LYS 45, 45; MET 57, 54; HIS 69, 69; PHE 74, 73; TYR 58, 56; THR 55, 48; LEU 64, 61; ISO 66, 67; ASP 50, 50; SER 59, 59; GLU 75, 72; GLY 48, 54; ALA 56, 57; ARG 85, 84; VAL 66, 67. The data were subjected to a one-way analysis of variance and differences between means were examined using a Tukey-Duncan test. There were no differences for all the AA tested, except for THR, showing that interspecies comparisons made under defined conditions indicated close agreement between rats and pigs for apparent ileal AA digestibility. It is concluded that the growing rat is a satisfactory model for determining ileal AA digestibility in cottonseed meal in the growing pig.

**Key Words:** Amino acid, Ileal digestibility, Pigs and rats

**764 Effects of dietary fat on pork loin quality in heavy pigs.** C. Corino<sup>1</sup>, V. Bontempo\*<sup>2</sup>, G. Pastorelli<sup>1</sup>, G. Salvatori<sup>2</sup>, and L. Pantaleo<sup>1</sup>, <sup>1</sup>University of Milan, Italy, <sup>2</sup>University of Molise, Campobasso, Italy.

A study was conducted to characterize the effect of long term feeding with different fat source on loin quality of heavy pigs. Fifty-four Large White barrows, starting weight 25 kg, were used in a completely randomized block design experiment. Pigs were assigned to three diets providing different supplemental fat: tallow (TA), corn oil (CO) and rapeseed oil (RO). Fats were added at 3% as fed from 25 to 110 kg LW, and 2.5% as fed from 110 kg LW to slaughtering. Diets were fed at 9% BW<sup>0.75</sup>. Ten pigs of each treatment were slaughtered at 160 kg LW. pH, muscle brightness, and color indexes a\* and b\* were evaluated at 45 minutes and 24 hrs postmortem on *Longissimus dorsi* muscle using a Chroma Meter CR-300 (Minolta Cameras, OSAKA, Japan). Dry matter content, crude protein, intramuscular fat and the oxidative stability, measured as induced TBA-values, on the same muscle were also evaluated. Data were analyzed by one-way Anova. Differences between treatment means were calculated using the t-Newman-Keuls multiple comparison test. No significant differences were found in growth performances. Dietary treatment did not affect pH, color, dry matter, crude protein and intramuscular fat. Inclusion of CO and RO in the diet reduced the oxidative stability of the pork chops only after 300 minutes of forced oxidation (12.20 vs 14.98 and 14.57 µg MDA/g tissue, SE=.75) ( $P < .01$ ). Fatty acid composition of pork loin was significantly affected only by RO treatment for the C18:3 content (1.05 vs .69 and .64 %, SEM= .07) ( $P < .01$ ). These data suggest that TA, CO, and RO supplement did not have adverse effect on loin quality of heavy pig. Dietary polyunsaturated fatty acids have a small effect on fatty acid content of *Longissimus dorsi* muscle in heavy pig.

**Key Words:** Heavy pig, Dietary fat, Loin quality

**765 Effect of dietary fat on fatty acid composition of backfat in heavy pigs.** V. Bontempo\*<sup>1</sup>, F. Cheli<sup>2</sup>, G. Pastorelli<sup>2</sup>, and C. Corino<sup>2</sup>, <sup>1</sup>University of Molise, Campobasso, Italy, <sup>2</sup>University of Milan, Italy.

The experiment evaluated changes in backfat fatty acid composition of pigs fed different fat sources. Fifty-four Large White barrows, averaging 25 kg wt, were allotted within weight to a randomized complete block design. Diets were calculated isoenergetic and with different fat sources: tallow (TA), corn oil (CO), and rapeseed oil (RO). Fats were included into the diet at 3 % as fed from 25 to 110 kg wt, and at 2.5 % from 110

kg to slaughtering. Average weight at slaughter was 160 kg LW. Immediately after slaughtering backfat samples were vacuum-packed, frozen, and stored at -20 C pending analysis for fatty acid content analysis. The pattern of dietary fatty acids was reflected in adipose tissue. Animals fed TA had the highest SFA contents. Animals fed CO had the highest PFA contents and lower MFA contents than TA and RO. Animals fed RO showed the highest C18:3 and C20:1 content. The inner layer of backfat was more saturated than the outer.

Fatty acid %	Dietary effect			Layer effect		SEM
	TA	CO	RO	Outer	Inner	
C14:0	1.44 <sup>a</sup>	1.30 <sup>b</sup>	1.31 <sup>b</sup>	1.36	1.35	.04
C16:0	20.94	20.41	19.68	19.74 <sup>a</sup>	20.95 <sup>b</sup>	.54
C16:1	2.09 <sup>a</sup>	1.69 <sup>b</sup>	1.74 <sup>b</sup>	1.88	1.81	.10
C18:0	13.46 <sup>a</sup>	12.16 <sup>b</sup>	11.68 <sup>b</sup>	11.59 <sup>A</sup>	13.33 <sup>B</sup>	.51
C18:1	44.77 <sup>A</sup>	39.30 <sup>B</sup>	44.29 <sup>A</sup>	43.15	42.78	.82
C18:2	12.17 <sup>A</sup>	19.33 <sup>B</sup>	14.01 <sup>C</sup>	15.52 <sup>a</sup>	14.36 <sup>b</sup>	.48
C18:3	.88 <sup>A</sup>	.85 <sup>A</sup>	1.58 <sup>B</sup>	.97 <sup>A</sup>	1.29 <sup>B</sup>	.12
C20:1	.72 <sup>A</sup>	.80 <sup>A</sup>	1.31 <sup>B</sup>	.98	.78	.08
SFA	35.84 <sup>A</sup>	33.87 <sup>B</sup>	32.67 <sup>B</sup>	32.70 <sup>A</sup>	35.63 <sup>B</sup>	.89
MFA	47.22 <sup>A</sup>	41.43 <sup>B</sup>	46.71 <sup>A</sup>	46.01 <sup>a</sup>	44.60 <sup>b</sup>	.91
PFA	13.05 <sup>A</sup>	20.10 <sup>B</sup>	15.54 <sup>C</sup>	16.49 <sup>a</sup>	15.55 <sup>b</sup>	.49

SFA: saturated fatty acids; MFA: monounsaturated fatty acids; PFA: polyunsaturated fatty acids. <sup>AB</sup>P<.01; <sup>ab</sup>P<.05

**Key Words:** Heavy pig, Dietary fat, Backfat

**766 Effect of dietary glucose phosphate yeast on some blood parameters of stressed gilts.** V. Bontempo<sup>\*1</sup>, A. Baldi<sup>2</sup>, L. Rossi<sup>2</sup>, E. Fusi<sup>2</sup>, V. Dell'Orto<sup>2</sup>, and G. Savoini<sup>2</sup>, <sup>1</sup>University of Molise, Campobasso, Italy, <sup>2</sup>University of Milan, Italy.

The experiment aimed at evaluating the impact of rapidly available energy sources on postprandial blood parameters in stressed gilts. Three gilts of averaging 30 kg LW, were used in a cross-over design. After an adaptation period of a week to a basal diet (calculated at 2.6 M, where M= 418 KJ ME/P<sup>0.75</sup>), animals were fasted for 24 h at the end of which they were injected i.m. ACTH solution (5 µg/kg LW). A hour later gilts were fed *ad libitum* one of the following diets: basal diet (C), basal diet plus 50 g of saccharose (S), basal diet plus 20 g of glucose phosphate yeast (GP-Y). Glucose phosphate content in yeast was 30 % on dry matter basis. Blood samples were taken through the jugular vein directly before and subsequently at 0.15, 1.15, 3.15, 5.15, and 7.15 hours after feeding, and analyzed for plasma glucose, NEFA, cholesterol, tryglicerides, protein, urea, GOT concentration. Dietary treatment had no effect on investigated blood parameters. Plasma glucose concentration was significantly influenced by sampling time: gilts supplemented with S and GP-Y showed a lower plasma glucose concentration at 0.15 h than C (9.03 and 9.08 vs 10.85 mM/L, SE= 0.84) (P<0.05). Plasma glucose concentration was greater over the following 7 hours in gilts fed GP-Y than C and S groups, although no significant difference was found. Thus, results suggest that the supply of carbohydrates as sucrose or glucose phosphate may enhance a more rapid utilization of glucose by peripheral tissues in energy deficit and stress conditions. Research supported by CNR UCR SISPROAN n.9802840.CT06 and MURST 60 %

**Key Words:** Gilts, Glucose phosphate, Blood parameters

**767 Efficacy of partially hydrolyzed corn syrup solids as a replacement for lactose in manufactured liquid diets for neonatal pigs.** W.T. Oliver<sup>\*</sup>, S.A. Mathews, O. Phillips, E.E. Jones, J. Odle, and R.J. Harrell, North Carolina State University, Raleigh.

Feeding manufactured liquid diets to early-weaned pigs improves growth performance and reduces days to market weight. Few alternative dietary ingredients are utilized other than by-products of the dairy industry, especially for sources of carbohydrates. This experiment was designed to evaluate the efficacy of starch from partially hydrolyzed corn syrup solids (CSS) as a replacement for lactose in manufactured liquid diets. Forty-eight pigs were removed from the sow at one day of age and trained to a liquid feeding system. Pigs were randomly assigned to one of three treatments: 1) control with lactose as the carbohydrate source, 2) lactose replaced with CSS dextrose equivalent (DE) 20, and 3) lactose

replaced with DE-42. Twenty-four pigs were removed from the study on d 10 of treatment and the remaining 24 pigs were removed on d 20 of treatment. Mucosa and intestinal segments were collected from the jejunum and ileum for enzyme analysis and morphological measurements, respectively. Pigs averaged 9.8±2 kg at d 20 of treatment regardless of dietary treatment (P > .20). No differences in ADG, ADFI, or feed efficiency were detected between treatment groups from d 0 to 10 or 0 to 20 (P > .19). Replacement of lactose with CSS did not affect intestinal villi height, width, or crypt depth (P > .10). Pigs fed lactose tended to have greater lactase activity on d 10 than pigs fed CSS (P < .07). Also, pigs fed lactose tended to have lower oligosaccharidase activity than pigs fed the DE-20 diet on d 20 (P < .07). No other differences in lactase, maltase, or oligosaccharidase specific activity on d 10 or 20 of treatment were detected (P > .10). Whole body water, protein, lipid, or ash accretion rates were unaffected by dietary treatment from d 0 to 10 or 0 to 20 (P > .20). These results suggest that partially hydrolyzed CSS can be used as a replacement for lactose in manufactured liquid diets for neonatal pigs.

**Key Words:** Swine, Neonatal, Carbohydrate

**768 The effect of spray-dried animal plasma addition to nursery diets varying in soybean meal concentration.** J. Hartke<sup>\*1</sup> and G. Apgar<sup>1</sup>, <sup>1</sup>Southern Illinois University, Carbondale.

A total of 180 crossbred pigs (avg 14 +/- 3 d, 4.6 +/- 0.4 kg) were used in two trials to determine if feeding spray dried animal plasma (SDAP) in phase 1 nursery diets with differing soybean meal (SBM) levels can influence performance. Pigs were blocked by initial weight, sex and litter and randomly assigned to one of three treatment diets. All diets were formulated to be equal in lysine concentration and contained 10% dried whey (DW), 10% rolled oats, select menhaden fishmeal, ground corn, and mineral and vitamin supplementation. The dietary treatments were as follows: 1) 10% SBM and 7.5% SDAP, 2) 20% SBM and 7.5% SDAP, and 3) 20% SBM without SDAP. The dietary treatments were fed from d 0-14 post-weaning. A common corn-SBM diet containing 10% DW was fed to all pigs d 14-35 post-weaning. Data from the two trials were analyzed using the GLM procedure of SAS. Contrast statements were used to test differences between treatment means. The testing alpha was adjusted using a Bonferroni procedure in order to maintain a family-wise error rate of .05 (resulting alpha = .017). In trial one, pigs fed either treatment 1 or 2 performed similarly. There were no significant differences in ADG, ADFI, or gain to feed ratios (G:F) days 0-35. Pigs receiving treatment 1 had higher ADG (d 0-21), ADFI (d 0-28), and G:F (d 0-7) than pigs fed treatment 3 (P<.017). Pigs fed treatment 2 had better ADG (d 0-7), ADFI (d 0-21), and G:F (d 0-7) when compared to pigs fed treatment 3 (P<.017). These data suggest that SDAP addition to phase 1 nursery diets greatly improves the pig's ability to utilize SBM. In trial 2, no differences were noted among treatment groups when evaluating ADG or G:F. Pigs fed treatment 1 or 2, however, consumed more feed d 7-14 than pigs fed treatment 3 (P<.017). Because the second trial did not appear to adequately replicate the findings of trial one, a third trial is planned.

**Key Words:** Nursery pig, Spray-dried Plasma, Soybean Meal

**769 Feeding spray-dried plasma decreases the activation of the hypothalamic-pituitary-adrenal axis.** K.J. Touchette<sup>\*1</sup>, G.L. Allee<sup>1</sup>, R.L. Matteri<sup>2</sup>, C.J. Dyer<sup>2</sup>, and J.A. Carroll<sup>2</sup>, <sup>1</sup>University of Missouri-Columbia, <sup>2</sup>Animal Physiology Research Unit, Agricultural Research Service, USDA, Columbia, MO 65211.

Previously we reported that pigs fed spray-dried plasma (SDP) have greater hypothalamic-pituitary-adrenal (HPA) axis (i.e., higher serum ACTH and cortisol) and immune (higher serum tumor necrosis factor-α and interferon-γ) responses following a lipopolysaccharide (LPS) challenge than pigs fed a diet with no SDP. The objective of this study was to evaluate mRNA expression of hormones in tissues associated with the HPA axis. Twenty pigs (14 d, 5 kg) were weaned to an isolated environment and allotted to one of four treatments in a 2x2 factorial arrangement, with two levels of SDP (0 vs 7%) and two i.p. injections (LPS vs saline). Both diets were formulated to contain equal ME and digestible essential amino acids and fed for 7 d postweaning. On d 7, i.p. injections of either LPS (150 µg/kg BW) or saline were given. After 3 hr, pigs were sacrificed and tissue was collected for mRNA analysis. Tissue mRNA levels measured were not affected by LPS treatment. Pigs

fed the diet with SDP had a lower level of hypothalamic CRH mRNA compared to pigs fed the diet without SDP ( $P < .05$ ). Pigs fed the diet with SDP also had a lower level of CRH receptor mRNA in the pituitary compared to pigs fed the diet without SDP ( $P = .12$ ). Dietary treatment did not affect POMC mRNA in the pituitary. Pigs fed the diet with SDP had a lower level of adrenal ACTH receptor mRNA compared to pigs fed the diet without SDP ( $P < .05$ ). These results suggest that the HPA axis of pigs fed SDP after weaning may be less activated than that of pigs fed a diet without SDP. Considering the well-known effect of pathogen exposure as a stimulator of the HPA axis, our observation of a lower level of HPA activation may reflect a decreased immune activation as previously reported. Thus, feeding SDP may provide immunological protection for weaned pigs under typical production conditions, and reduce basal activation of the HPA axis.

**Key Words:** Plasma Protein, Pigs, Stress Response

#### 770 Evaluation of PROTIMAX during various phases of rearing on piglet performance. J.A. Godfredson-Kisic\* and T. Shipp, *DuCoa, Highland, IL.*

The effects of PROTIMAX<sup>®</sup>, hyperimmunized egg protein, on piglets were evaluated for 5 wk, during various phases of rearing. Crossbred pigs ( $n=339$ ) averaging 6.0 kg were weaned at 28 days and kept in weaner units until 56 days of age. Pigs were randomly assigned to one of 8 treatment diets consisting of 0.1% PROTIMAX<sup>®</sup> (P), or a control (C) diet without P. Treatments were; (1) P, or (2) C diets before weaning 22-28 days of age, (3)P, or (4) C before and after weaning 22-42 days of age, (5) P, or (6) C 22-56 days of age, and (7) P, or (8) C after weaning 29-56 days of age. Diets were equivalent in protein, lysine and macronutrients. Pigs had ad libitum access to feed and water during the trial. Weight and intake were measured weekly, health status was monitored daily. Growth rate of pigs fed P vs. C diets was improved across all treatments, most notably occurring between treatments 3&4 during wk 2 (122.8 g, 110.0 g,  $P < .05$ ), and wk 5 between treatments 5&6 (200.0 g, 172.8 g,  $P < .05$ ). Overall, ADG was greater for piglets fed P than C diets (323.2 g and 311.1 g,  $P < 0.01$ ). Feed conversion was also improved, overall conversion was 1.49 and 1.54 ( $P < 0.05$ ) for P and C. The most dramatic affects of P were on mortality and morbidity. Total mortality for pigs on C diets ranged from 4.6 - 9.8%. Mortality of pigs fed P regardless of phase ranged from 2.3-2.5%. Control group mortality due to diarrhea was 50-74%, which occurred exclusively during 22-35 days of age. There was no mortality due to diarrhea in P fed pigs. Total episode of diarrhea in C pigs was 10.7-15% vs. 1.8-7.1% for P pigs, regardless of phase of supplementation. Duration of diarrhea for P pigs averaged 0.9 days vs. 2.1 days for C. Gain and feed conversion were improved for pigs receiving P, yet dramatic effects were witnessed on overall mortality, mortality due to diarrhea and extent of diarrhea. Profitability can be improved by including hyperimmunized egg protein in the diet during all stages of the rearing period.

**Key Words:** PROTIMAX, Egg Yolk Antibodies, Piglets

#### 771 Evaluation of ProtiOne<sup>TM</sup> versus plasma protein for two-week-old weanling pigs. T.E. Shipp\* and J.A. Godfredson-Kisic, *DuCoa, Highland, IL.*

The objective of this study was to compare a new proprietary hyperimmunized protein product (ProtiOne<sup>TM</sup>) with spray dried porcine plasma for early-weaned pigs. ProtiOne<sup>TM</sup> consists primarily of porcine globulin and hyperimmunized egg proteins. Two hundred crossbred barrows were utilized in a randomized complete block design and assigned to the following treatments: 1) 6% spray dried porcine plasma (C); 2) 4% ProtiOne<sup>TM</sup> (4PO); 3) 2% ProtiOne<sup>TM</sup> (2PO); and 4) 2% spray dried porcine plasma (NC). The barrows were blocked according to body-weight and randomly assigned their respective dietary treatments. Diets were equivalent in nutrients and offered *ad libitum* during the trial. Data were recorded for ADG, average daily feed intake (ADFI) and gain to feed (GF) for weeks 1, 2, and overall. During the first week, pigs fed C or 4PO were equal with respect to ADG (0.19 and 0.18 kg/d, respectively) and both C and 4PO grew faster ( $P < .05$ ) than those fed 2PO or NC (0.14 and 0.14 kg/d, respectively). No differences were found for GF during the first week. During the second week, ADG and GF for C, 4PO or 2PO were equal and improved ( $P < .05$ ) over NC fed pigs. Overall, pigs fed C or 4PO were equal with respect to ADG (0.3 and 0.28 kg/d, respectively) and both 4PO and C fed pigs grew faster ( $P < .05$ ) than NC (0.24 kg/d). Overall improvements ( $P < .05$ ) in GF were found

for C and 4PO over pigs fed 2PO or NC (0.7, 0.69, 0.64, and 0.62, respectively). No differences were found for ADFI regardless of period. This study shows that supplementation with 4% ProtiOne<sup>TM</sup> can offer performance as well as those fed diets supplemented with 6% porcine plasma. Additionally, the lowest inclusion level of porcine plasma does not offer the performance found in higher plasma inclusion rates with two-week-old pigs.

**Key Words:** pigs, plasma, protein

#### 772 Nitrogen balance of nursery pigs fed different soybean fractions. B.W. Senne\*, S.D. Carter, L.A. Pettey, and J.A. Shriver, *Oklahoma State University, Stillwater.*

Eight sets of three littermate barrows weaned at  $21 \pm 2$  d were used to determine N balance of nursery pigs fed different soybean components. Treatments were typical starter diets with either SBM, soy protein concentrate (SPC), or soy protein isolate (SPI) added on an equivalent dig Lys basis. Phase 1 (P1) diets were fed from d 1 to 7 and were formulated to contain 1.26% dig Lys and 3.3 Mcal/kg ME. Phase 2 (P2) diets were fed from d 8 to 21 and were formulated to contain 1.11% dig Lys and 3.3 Mcal/kg ME. Soybean meal, SPC, and SPI, accounted for 22, 21, and 17% of the total P1 diet, and 25, 21, and 18% of the total diet in P2, respectively. Dextrose was used to replace the difference in both phases. Crystalline AA were added as needed to provide an ideal ratio to lysine in all diets. Pigs were housed individually in metabolic chambers to allow for total collection of urine and feces. Rate and efficiency of gain were not affected by treatment. Dry matter excretion as % of intake was similar for all pigs in P1; however, DM digestibility was greater ( $P < .07$ ) for pigs fed SPI compared with pigs fed SBM or SPC in P2. Nitrogen intakes for P1 were 8.7, 8.4, and 10.3 g/d for pigs fed SBM, SPC, and SPI, respectively. Fecal N, urinary N, and total N excretion for the three diets were 1.27, 1.06, and 1.03 g/d; .68, .64, and .88 g/d; and 1.93, 1.69, and 1.92 g/d. Absorption of N as % of intake was lower ( $P < .08$ ) for pigs fed SBM compared with SPI. No differences were detected in retention of N as % of intake. Phase 2 N intakes were 15.1, 15.6, and 16.0 g/d for pigs fed SBM, SPC, and SPI, respectively. Fecal N, urinary N, and total N excretion for the three diets were 1.90, 1.78, and 1.32 g/d; .96, .78, and 1.16 g/d; and 2.86, 2.55, and 2.47 g/d. Pigs fed SPI absorbed more ( $P < .05$ ) N as % of intake compared with pigs fed SBM or SPC. Retention of N as % of intake was similar for pigs fed either SPC or SPI; however, pigs fed SPI retained more ( $P < .08$ ) N compared with pigs fed SBM. These results with nursery pigs suggest that N digestibility improves as refinement of the soybean increases.

**Key Words:** Pigs, Soybeans, Nitrogen

#### 773 The effect of arginine and glutamine on post-weaning performance and intestinal morphology of pigs. K. J. Touchette\*<sup>1</sup>, G.L. Allee<sup>1</sup>, K. Watanabe<sup>2</sup>, Y. Toride<sup>2</sup>, I. Shinzato<sup>2</sup>, and J.L. Usry<sup>3</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>Ajinomoto Co. Inc., <sup>3</sup>Heartland Lysine, Inc.

A total of 125 pigs were weaned at 17 d (5.09 kg) to determine the effect of arginine (Arg) and Glutamine (Gln) on nursery performance and intestinal morphology. Pigs were assigned to 1 of 4 treatments with 6 replicates. The positive control contained 7% spray-dried plasma (SDP) with a negative control with no SDP (NP). The other diets contained .6% Arg or 1.2% Gln replacing starch in the NP diet. Diets were fed from d 0 to 14 postweaning. Pigs and feed were weighed on d 0, 7, 14, and 28. Five pigs at weaning (d 0), and one pig from each pen were killed on d 7 and 14 for small intestinal measurements. Villous height (VH), crypt depth (CD), and VH to CD ratio (VCR) were measured. In the 1st wk postweaning, pigs fed Arg had a lower ADG ( $P \leq .05$ ) than pigs fed SDP or Gln, while pigs fed NP had an intermediate ADG. In the 2nd wk postweaning, pigs fed SDP had a higher ( $P \leq .05$ ) ADFI than all other treatments and a higher ( $P \leq .05$ ) ADG than pigs fed Arg, while pigs fed Gln or NP had an intermediate ADG. From d 14 to 28, when pigs were fed a common diet, pigs initially fed Gln had a higher ( $P \leq .05$ ) ADG than pigs fed Arg or SDP, while pigs initially fed NP had an intermediate ADG. Pigs initially fed either SDP or Gln were heavier ( $P \leq .10$ ) than pigs fed Arg on d 28 postweaning, while pigs initially fed NP had an intermediate weight. Pigs at weaning had greater VH, lesser CD, and a higher VCR compared to all pigs on both d 7 and 14 postweaning. Pigs fed SDP had a deeper ( $P \leq .05$ ) CD than all other pigs. Pigs fed SDP had a higher ( $P \leq .05$ ) VCR than pigs fed Arg, while pigs fed Gln or NP had an intermediate VCR. On d 14, pigs fed Gln had a deeper

( $P \leq .05$ ) CD than pigs fed either NP or Arg, while pigs fed SDP had an intermediate CD; VH and VCR were not affected by treatment. These results suggest that .6% Arg is detrimental to nursery pig performance, while 1.2% Gln had positive effects on both performance and intestinal morphology.

**Key Words:** Glutamine, Intestinal morphology, Piglet

**774 Supplemental alpha-lipoic acid and neonatal health and performance in weaned pigs.** K.R. Maddock\*<sup>1</sup>, E.P. Berg<sup>1</sup>, M.E. Zannelli<sup>2</sup>, L.A. Beausang<sup>2</sup>, C.A. Stahl<sup>1</sup>, M.L. Linville<sup>1</sup>, and J.A. Carroll<sup>3</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>Endogen, Inc., Woburn, MA, <sup>3</sup>Animal Physiology Research Unit, Agricultural Research Service, USDA, Columbia, MO.

The objective of this study was to determine if supplementation of  $\alpha$ -lipoic acid (LA) to neonatal pigs has benefits to immune function, feed conversion, and gain. Fourteen weaned gilts (d 21, 7.06 kg) were randomly allotted to two treatments, no LA (CON; n=7) and 56 mg (LA; n=7) of LA/pig/day. The pigs were individually penned and treatments were administered orally for eleven days. Feed intake and body weights were recorded. On d 11, the pigs were nonsurgically fitted with jugular cannulae. On d 12, the pigs received a dose of 150  $\mu$ g/kg of lipopolysaccharide (LPS). Blood samples were collected at 15 minute intervals for 30 minutes prior to the LPS challenge and for three hours after to monitor serum concentrations of cortisol, glucose, tumor necrosis factor-alpha (TNF- $\alpha$ ), interferon gamma (IFN- $\gamma$ ), % Neutrophils (N), and % Lymphocytes (L). Serum cortisol concentrations showed a time by treatment interaction ( $P=0.08$ ), such that, while serum cortisol increased in both groups between 15 and 135 minutes post LPS, LA pigs showed a less dramatic increase. Serum glucose concentrations showed an overall treatment effect ( $P=0.007$ ) where serum glucose was higher in LA pigs at basal concentrations and throughout the LPS challenge. In both groups, serum glucose concentrations increased between 0 and 90 minutes post LPS, and then decreased for both groups. Percentages of N and L showed a time by treatment effect ( $P=0.04$  and  $P=0.02$ , respectively). Basal %N was 40.9 and decreased in CON post LPS to 14% and increased in LA pigs to 43.25%. Basal %L was 51.9 and increased in CON post LPS to 81% and decreased in LA pigs to 49.25%. LA was shown to help maintain neutrophil and lymphocyte populations following an acute LPS challenge. The present study suggests that LA may be beneficial as a feed supplement to enhance neonatal health.

**Key Words:** Neonatal Pigs, Alpha-Lipoic Acid, Immune Function

**775 Effect of various combinations of copper citrate and copper sulfate on the growth performance of weanling pigs.** C. R. Dove\* and T. C. Schell, University of Georgia, Tifton.

Two hundred and seventy crossbred pigs (3 trials of 90 pigs, 25+/- 2 days of age, average initial weight 7.64 kg) were used to determine the effects of various combinations of copper citrate and copper sulfate on the growth performance of weanling swine. Pigs were allotted to experimental treatment by weight, sex and ancestry. Pigs were housed in an environmentally controlled nursery (5 pigs/pen) and the number of females and castrated males were consistent within all pens in a replication. Pigs had ad libitum access to feed and water for the 28-day study. Dietary treatments were 1) a negative control, containing 15 ppm of Cu from Cu sulfate; 2) a positive control, containing 250 ppm Cu from Cu sulfate; 3) a diet containing 15 ppm Cu from Cu citrate and 50 ppm Cu from Cu sulfate; 4) a diet containing 15 ppm Cu from Cu citrate and 100 ppm Cu from Cu sulfate; 5) a diet containing 30 ppm Cu from Cu citrate and 50 ppm Cu from Cu sulfate; and 6) a diet containing 30 ppm Cu from Cu citrate and 100 ppm Cu from Cu sulfate. Pigs fed the diets containing all combinations of Cu citrate and Cu sulfate had increased ADG ( $P < .05$ ) compared to the negative control pigs and ADG similar to the positive control pigs. Average daily gains over the 28-day study were 350, 401, 397, 400, 421, 392 g/d for diets 1 through 6 respectively. Over the 28-day study ADFI was increased in pigs receiving diets 3, 4, and 5 compared to pigs receiving both the positive and negative controls ( $P < .05$ ). Gain:feed ratios were improved ( $P < .05$ ) over the 28-day study in pigs fed the positive control diet compared to pigs fed the negative control diet. All other diets had gain:feed ratios similar to the negative controls. These data indicate that combinations of Cu compounds are as effective at stimulating the growth of young pigs as the individual Cu compounds and combinations of Cu compounds can be used at much lower total concentrations of Cu to achieve this growth

response. However, higher concentrations of Cu appear to be needed to improve feed efficiency.

**Key Words:** Swine, Copper, Nursery

**776 Effect of pharmacological ZnO levels in starter pig diets on fecal excretion of Zn.** T. A. Meyer\*, M. D. Lindemann, and G. L. Cromwell, University of Kentucky, Lexington.

Eighteen weanling crossbred barrows (7.3 kg and 22 d of age) were used in a randomized complete block design to evaluate three levels of supplemental Zn (0, 2000, and 3000 ppm) from ZnO on fecal Zn excretion. All diets contained 150 ppm Zn from the trace mineral mix. Two pigs (balanced for ancestry, weight and age across treatments) were assigned per pen (experimental unit). Pens were modified stainless steel metabolism crates (49 x 37 cm) with a plastic adjustable feeder and a stainless steel nipple waterer. Pigs were fed a complex phase I diet (1.50% lysine) for 1 wk, then a complex phase II diet (1.28% lysine) for 2 wk. Dietary Ca, P and premix concentrations were held constant across treatments and phases. Pigs had ad libitum access to water and feed. Feed wastage was collected daily, and feed intake and growth rate were determined weekly. A total fecal collection was performed with indigo blue marking the beginning and end of each weekly period. Feces were pooled weekly for each pen. Treatment means for ADG, ADFI and F/G (.42 kg, .51 kg, and 1.21, respectively) did not differ ( $P > .05$ ) among treatments. Dietary Zn affected ( $P < .01$ ) the amounts of Zn consumed, apparently absorbed and excreted in the feces. Overall, pigs fed the 2000 and 3000 ppm Zn diets absorbed greater absolute amounts of Zn, and they excreted 14.1 and 21.5 times as much fecal Zn, respectively, as pigs fed the control diet. The following table presents daily Zn intake, excretion and apparent absorption in grams per pig.

Item	Zinc, ppm			SEM	P <
	0	2000	3000		
1 to 7 d					
Zn intake	.043	.474	.613	.035	L .01
Excreted	.028	.362	.468	.033	L .01
Absorbed	.015	.112	.145	.015	L .01
8 to 21 d					
Zn intake	.114	1.531	2.080	.082	L .01
Excreted	.076	1.088	1.704	.056	L .01
Absorbed	.038	.443	.376	.058	L .01; Q .07
1 to 21 d					
Zn intake	.091	1.179	1.592	.063	L .01
Excreted	.060	.846	1.292	.037	L .01
Absorbed	.031	.333	.300	.039	L .01; Q .07

L=linear effect; Q=quadratic effect

**Key Words:** Feces, Zinc, Pigs

**777 Evaluation of conjugated linoleic acid (CLA) and dietary antibiotics as growth promotants in weanling pigs.** T. E. Weber\*, S. A. DeCamp, K. A. Bowers, C. T. Herr, S. L. Knoll, B. T. Richert, and A. P. Schinckel, Purdue University, West Lafayette, IN.

Weanling pigs (n=192; 28.5 d of age) were randomly assigned to a 2 x 2 factorial arrangement consisting of added dietary fat (1 % of a CLA oil containing 60 % CLA isomers (CLA) or 1 % soybean oil (SBO)) and dietary antibiotic treatment (antibiotics (M) or no antibiotics (NM)). Diets were fed ad libitum for 9 wk in four phases (I, 1; II, 2-3; III, 4-6; IV, 7-9 wk) after which all pigs were fed identical medicated diets for the duration of the finishing stage. M diets contained: phases I and II, 55 mg/kg carbadox; phase III, 299 mg/kg tilmosin; and phase IV, 110 mg tylosin and 110 mg sulfamethazine. Pigs and feeders were weighed at the completion of each dietary phase and prior to moving from the nursery to the grow-finish stage to determine average daily gain (ADG), average daily feed intake (ADFI), and gain:feed (G:F). M pigs had higher overall ADG than NM pigs for wk 0-9 (.566 vs. .524  $\bar{n}$  .01 kg/d,  $P=.03$ ). G:F was greater for M pigs than NM pigs during phase I (.356 vs. .277  $\bar{n}$  .02,  $P=.03$ ) and the duration of the nursery stage of the trial (.582 vs. .546  $\bar{n}$  .01,  $P=.02$ ). There were no significant effects of CLA on ADG, ADFI, or G:F. BW were collected at wk 17 post-weaning to determine any residual effects of dietary treatments on finisher ADG (FADG). No significant effects of dietary fat or antibiotic treatments were realized for FADG. Serum samples were harvested from a subset of pigs (n=72)

at the completion of phases II, III, and IV to determine concentrations of IGF-I. There were no significant effects of dietary fat type ( $P=.22$ ) or antibiotics ( $P=.27$ ) on overall serum IGF-I concentrations. However, there was a tendency for M pigs to have greater IGF-I than NM pigs at the completion of phase IV (151 vs. 130  $\bar{n}$  7.9 ng/mL,  $P=.06$ ). These results demonstrate that .6% added dietary CLA is not effective in enhancing growth performance in weanling swine and that the use of dietary antibiotics can increase production efficiency in nursery pigs.

**Key Words:** CLA, Antibiotics, Growth

**778 Lactitol and tributyrin synergistically prevent the post-weaning syndrome in swine.** A. Piva<sup>\*1</sup>, A. Prandini<sup>2</sup>, L. Fiorentini<sup>2</sup>, M. Morlacchini<sup>3</sup>, F. Galvano<sup>4</sup>, and J. B. Luchansky<sup>5</sup>, <sup>1</sup>Università di Bologna, Italy, <sup>2</sup>Università Cattolica del S. Cuore, Piacenza, Italy, <sup>3</sup>CERZOO, Italy, <sup>4</sup>Università di Reggio Calabria, Italy, <sup>5</sup>USDA, Agricultural Research Service, NAA, ERRC.

The effect of diet on the performance of 64 weaned piglets was monitored for 42 days. At 21 days after birth, the piglets were moved from the piggery to the production barn and fed a medicated diet. At 28 days, the piglets were allotted into the following 4 groups and fed a pelleted feed: 1) control diet (CTR); 2) control diet with tributyrin (TRB; 10 g/kg diet); 3) control diet with lactitol (LCT; 3 g/kg); 4) control diet with a patent-pending nutraceutical containing tributyrin (10 g/kg diet) and lactitol (3 g/kg diet) (TRB+LCT). On days 0, 14, and 42 the animals were weighed, and animal health, feed intake, and FCR were determined. On day 42, the heaviest 2 castrated males and 2 females from each treatment were sacrificed to measure the empty and full weights of the stomach, cecum, and colon, as well as the weights of the liver and kidneys. Additionally the lumen content from the jejunum and cecum were sampled for lactic acid, SCFA, and mono-, di-, and polyamines. Mortality after 42 days ranged from 19% for CTR, to 6% for TRB or LCT, to 0% for TRB+LCT. After 14 days, the ADG was greater (127%;  $P<0.05$ ) in animals fed TRB+LCT compared to CTR or TRB. After 42 days, animals fed TRB+LCT were heavier than animals fed the other diets. At slaughter, no differences in organ weights were observed. With the exception of animals fed LCT wherein cecal lactic acid levels increased 3-fold ( $P<0.01$ ), the concentrations of the organic acids tested were not different among treatments. Moreover, among the various amines analyzed, the only appreciable response ( $P<0.05$ ) was a 66% and 49% decrease in histamine levels in the jejunum and cecum, respectively, in animals fed TRB+LCT. In conclusion, feeding TRB+LCT to stressed piglets was more beneficial than either TRB or LCT alone or the CTR diet for reducing mortality and weight loss and for improving weight gain and health status.

**Key Words:** additive, histamine, pigs

**779 Enteroguard as an alternative feed additive to antibiotics in weanling pig diets.** C.M.C. v.d. Peet-Schwering and J.W.G.M. Swinkels, *Research Institute for Pig Husbandry, Rosmalen, The Netherlands.*

In a 39-d 2X2 factorial study, 660 crossbred weaned piglets (BW 8.3 $\pm$ .01 kg; age 26.8 $\pm$ .16 day) were used to examine whether Enteroguard (a combination of freeze-dried garlic and cinnamon oil) is an alternative feed additive to growth promoting antibiotics. The four treatment groups were: (1) no added growth promoting antibiotic and no added Enteroguard, (2) no added growth promoting antibiotic but added Enteroguard (1 kg/tonne), (3) added growth promoting antibiotic (40 mg/kg avilamycin) but no added Enteroguard, (4) added growth promoting antibiotic (40 mg/kg avilamycin) and added Enteroguard (1 kg/ton). All piglets were given free access to feed and water. Piglets were housed in compartments that contained 10 pens (9 or 10 piglets per pen). From d 1 to 15, ADG and G/F were numerically improved with 6.5% and 4.2%, respectively, when Enteroguard was added to the negative control. From d 1 to 39, the addition of Enteroguard to the negative control did not improve the performance of the piglets. Enteroguard does not have an extra benefit in performance when there is already a growth promoting antibiotic in the diet. The addition of avilamycin to the diet improved overall ADG and G/F from d 1 to 39 by 6.1% and .7% with the greatest response occurring during day 1 to 15 (17.9% and 10.8%, respectively). The addition of Enteroguard to the diet reduced the mortality of piglets caused by intestinal disorders from 3.9% to 1.2% ( $P<.05$ ). The number of piglets that received a veterinary treatment was not reduced. The addition of avilamycin to the diet

reduced the number of piglets that required a veterinary treatment for intestinal disorders with 30% ( $P<.001$ ), but it did not reduce mortality. In conclusion, the addition of Enteroguard to weanling pig diets reduces piglet mortality and increases initial performance, although not to the extent of a growth promoting antibiotic.

Group	1	2	3	4	SEM
D 1 to 15					
ADG, g	168	179	198	199	7.7
ADFI, kg	.23	.24	.25	.25	.007
G/F	.69	.72	.77	.77	.017
D 1 to 39					
ADG, g	378	380	401	402	7.7
ADFI, kg	.55	.56	.58	.58	.011
G/F	.69	.68	.69	.70	.009

**Key Words:** piglets, antibiotics, performance

**780 Influence of heat-processing of cereals on performance of piglets.** G.G. Mateos<sup>\*1</sup>, E. Gómez<sup>2</sup>, R. Lázaro<sup>1</sup>, and P. Medel<sup>1</sup>, <sup>1</sup>Dpto Producción Animal, Universidad Politécnica de Madrid, <sup>2</sup>Centro de Pruebas de Porcino, Junta de Castilla y León.

A trial was conducted to study the influence of heat-processing (HP) of cereals on productive performance of piglets. There were 8 treatments arranged factorially with 4 cereals (corn, barley, oats and decorticated oats) and two HP (raw vs cooked and flaked). Each treatment was replicated 4 times (12 piglets per replicate). The piglets received their respective experimental diet from 28 to 50 d of age, and then, all of them received a common starter diet until 67 d. From 28 to 50 d, HP improved growth and feed efficiency by 10.6 and 7.8%, respectively ( $P<0.01$ ), and the differences were maintained at 67 d. Piglets fed oats diets grew better and more efficiently than piglets fed corn or barley diets ( $P<0.05$ ). From 50 to 67 d piglets fed corn during the prestarter period grew faster than piglets fed barley ( $P<0.05$ ) but no other differences were found in this period. For the global period (28 to 67 d) HP improved feed intake, growth, and feed conversion by 6.4, 3.6, and 2.7%, respectively ( $P<0.05$ ). Also piglets fed corn grew faster (415 vs 384 g/d) and more efficiently than piglets fed barley (1.43 vs 1.54 g/g;  $P<0.01$ ). There were some interactions between HP and type of cereal for the prestarter and global period; HP improved more piglet performance when fed decorticated oats or barley than when fed corn or whole oats. It is concluded that HP improved performance of piglets from 28 to 50 d of life and that the beneficial effects remained at least up to 67 d of age. Also, HP was more efficient for barley than for corn. The use of oats and HP of cereals for piglets is recommended.

**Key Words:** Heat processing, Piglets, Cereals

**781 Effects of expanding and pelleting diets for finishing pigs fed from wet/dry feeders.** N. Amornthawaphat\*, J. D. Hancock, K. C. Behnke, R. H. Hine, L. J. McKinney, C. W. Starkey, D. W. Dean, and D. J. Lee, *Kansas State University, Manhattan.*

A total of 208 finishing pigs (average initial BW of 60 kg) were used to determine the effects of expanding and pelleting diets on growth performance, nutrient digestibility, carcass characteristics, and water usage. There were 13 pigs per pen and four pens per treatment. Treatments were: 1) meal; 2) conventional pellets; 3) expanded pellets; and 4) expandate (expanded but unpelleted meal) offered through a single-hole, wet-dry feeder (Crystal Spring<sup>®</sup>). The diets were formulated to .95% and .80% lysine for 60 to 88 and 88 to 113 kg BW, respectively. Pigs fed thermally processed diets (pelleted, expanded-pelleted, and expandate) had 4.4% greater ( $P < .04$ ) ADG, 7.9% greater ( $P < .001$ ) gain/feed, and 3.7 and 4.6% greater digestibilities of DM and N ( $P < .001$ ) compared to pigs fed the meal control. Pigs fed expanded diets (expanded-pelleted and expandate) had 4% greater ( $P < .01$ ) gain/feed than those fed the conventional pellets. Finally, gain/feed in pigs fed expandate was 4.5% greater ( $P < .02$ ) than in pigs fed the expanded-pelleted diet. There were no differences in water usage ( $P > .85$ ) or last rib backfat thickness ( $P > .45$ ) among pigs fed the various dietary treatments. Thermally processed diets (pelleted and expanded) improved growth performance and digestibility of nutrients in finishing pigs fed from wet/dry feeders and, of the thermal treatments, expandate supported the best gain/feed.

	Meal	Standard pellet	Expanded pellet	Expandate	SE
ADG, g	915	960	951	955	15
ADFI, g	2,750	2,745	2,671	2,570	51
G/F, g/kg	333	350	356	372	4
DM dig, %	87.5	91.7	90.6	89.9	.4
N dig, %	84.6	89.2	88.8	87.6	.6
Backfat, mm	23.1	23.7	23.5	25.6	1

**Key Words:** Wet/dry feeder, Expanding, Pig

**782 Effects of soybean genotype and extrusion on digestibility of nutrients and intestinal morphology in nursery pigs.** H. Cao\*, J. D. Hancock, J. M. DeRouchey, D. J. Lee, N. Amornthwaphat, J. S. Park, R. H. Hines, and W. T. Schapaugh, *Kansas State University, Manhattan.*

A total of 40 weanling pigs (average initial BW of 4.8 kg) were used in a 7-d metabolism experiment to determine the effects of soybean genotype and extrusion on nutrient utilization. All pigs were fed dried skimmed-milk for 2 d post-weaning (to establish feed consumption) and then switched to soy-based experimental diets. A diet was formulated with mill-run, dry-extruded soybeans (DEWS, Insta-Pro 2000, 150°C). The soybeans were the only source of protein and energy in the diet which had 1.05% lysine, .9% Ca, and .8% P and vitamin and mineral supplements to meet NRC recommendations. Genetically modified DEWS replaced mill run DEWS on a wt:wt basis. Treatments were: 1) the mill-run control; 2) low trypsin inhibitor; 3) high protein; 4) low oligosaccharide; and 5) high oleic acid soybeans. The high protein genotype had 39% CP (vs 35% in mill run sorghums). Trypsin inhibitor activity of the low trypsin inhibitor genotype was 19 mg/g fat-free DM (vs 34 mg/g in mill run soybeans) and the low oligosaccharide soybeans had 11.3% sucrose with undetectable amounts (< .01%) of stachyose and raffinose (vs 5% sucrose, 4% stachyose and .7% raffinose in mill run soybeans). Finally, the high oleic acid soybean genotype had 83% oleic acid (vs 36% in mill run soybeans). The processed DEWS had urease activities ranging from .02 to .16 ΔpH, trypsin inhibitor ranging from 3.6 to 5.9 mg/g of fat-free DM, and protein dispersibility index ranging from 8.6 to 13.9% when fed to pigs, there were no differences among the DEWS diets for ME, apparent digestibilities of C16:0 and C18:1 (P > .13). The pigs fed mill run soybeans had longer villi (P < .09) but similar villi height: crypt depth ratios and serum HDL:LDL compared to modified soybeans (P > .13). Pigs fed low oligosaccharide and high oleic acid soybeans had greater (P < .08) pancreatic chymotrypsin activity than those fed low trypsin inhibitor and high protein soybeans but lower mucosal amylase activity (P < .07). Our data indicated that different soybean genotypes did affect enzyme secretion and intestinal morphology, but had little effect on digestibility of nutrients.

**Key Words:** Nursery pigs, soybean genotype, extrusion

**783 Effects of feed- and food-quality sorghums on milling characteristics and growth performance in nursery pigs.** C. L. Jones\*, J. D. Hancock, C. M. Sowder, L. J. McKinney, D. W. Dean, D. J. Lee, J. S. Park, and N. Amornthwaphat, *Kansas State University, Manhattan.*

A total of 192 weanling pigs (average initial BW of 6.8 kg) were used to determine the effects of identity-preserved sorghums on milling characteristics and growth performance. Treatments were mill-run corn and sorghum and identity preserved bronze seed/purple glume (feed quality, Asgrow A570) and white seed/tan glume (food quality, Asgrow 6126) sorghums. The corn was ground through a hammermill (1.6 mm screen openings) and used in diets formulated to 1.7, 1.55, and 1.4% lysine for d 0 to 7, 7 to 21, and 21 to 35, respectively. The sorghums were ground through the same hammermill screen and substituted for corn on a wt/wt basis. No differences in net grinding energy or production rate were observed among corn and the sorghums (P > .50). However, true grinding efficiency (surface area generated per Wh of energy input) was greater for the sorghums than corn (P < .01) mill-run sorghum required less energy to grind than the identity preserved sorghums (P < .003). Finally, the bronze sorghum tended to grind easier (P < .06) and with greater production rates (P < .03), and resulted in diets having greater pellet durability index (P < .03), than the white sorghum. In the pig feeding experiment, there were no differences in ADG or gain/feed among pigs fed corn- vs sorghum-based diets (P > .13). Also, there were

no differences in growth performance of pigs fed mill-run vs identity-preserved sorghums (P > .26) or the bronze vs white sorghum (P > .33). In conclusion, mill-run sorghum ground easier than the identity-preserved sorghums but there were no differences in growth performance among pigs fed the various cereal grains.

Item	Mill-run		Bronze seed/ purple glume	White seed/ tan glume	SE
	Corn	sorghum			
Production rate, t/h	2.52	2.39	2.83	2.26	.04
Net energy, kWh/t	7.9	6.8	8.1	8.8	.2
True efficiency, m <sup>2</sup> /Wh	1.4	2.2	1.3	1.3	.1
Pellet durability, %	83.5	84.1	84.0	82.1	.5
ADG, g	486	503	508	501	10
ADFI, g	599	626	627	604	16
Gain/feed, g/kg	812	804	815	832	14

**Key Words:** Sorghum, Food-quality, Pig

**784 Comparative DE values of wheat, corn, soybean and their by-products in growing pigs and adult sows.** J. Noblet\* and G. Le Goff, *INRA, Saint Gilles, France.*

The DE values of wheat and wheat by-products (W; n=9), corn and corn by-products (C; n = 9) and soybean products (SB; n = 7) were measured in 65-kg growing pigs (G) and adult non-pregnant, non-lactating sows (S). Three, one and four ingredients were wheat, corn and soybean meal (SBM) in the W, C and SB groups, respectively. The other SB ingredients were soybean hulls (SBH; n = 1) and combinations of SBM and SBH. The W and C by-products originated from milling or starch extraction industries. Relative to DM, W and C ingredients differed in starch (70 to 19% and 74 to 23%, respectively) and NDF (12 to 50% and 12 to 58%, respectively) contents; average starch contents of wheat and corn were 70 and 74%, respectively. The SB ingredients varied in CP (11% to 54%; 51% on average for SBM) and NDF (62% to 9%; 13% on average for SBM) contents. The ingredients were fed as a single ingredient or combined with a basal diet at about 2.0 and 2.4 kg/d for G and S, respectively. Each feed was given to at least four animals of each physiological stage. Excreta were collected for 10-d. The DE values (MJ/kg DM) of all ingredients were higher in S than in G and averaged 14.1 and 14.8 for W ingredients (16.2 and 16.4 for wheat), 13.0 and 15.1 for C ingredients (16.7 and 17.4 for corn) and 15.0 and 16.6 for SB ingredients (17.0 and 17.8 for SBM) in G and S, respectively. The DE value decreased as the dietary fiber (DF) content increased (minus 15.0, 14.9 and 16.9 kJ/g additional NDF in G and minus 12.9, 7.3 and 10.1 kJ/g NDF in S for W, C and SB ingredients, respectively). Consequently, the difference in DE value between S and G was linearly related to the DF level of the feed and varied by 2.5, 5.7 and 6.5 kJ for each additional g of NDF in W, C and SB groups, respectively. The results demonstrate that different DE values should be used for G and S; the difference between values depends on the amount of DF and its botanical origin (i.e., the chemical characteristics of DF). Further information is required to take into account changes in gas and heat losses associated with the higher rate of fermentation of DF in adult pigs.

**Key Words:** Energy Value, Growing Pig, Adult Sow

**785 Apparent ileal amino acid digestibilities of corn distiller's dried grains with solubles produced from new ethanol plants in Minnesota and South Dakota.** M. H. Whitney<sup>1</sup>, M. J. Spiels<sup>\*1</sup>, G. C. Shurson<sup>1</sup>, and S. K. Baidoo<sup>2</sup>, <sup>1</sup>University of Minnesota, St. Paul, <sup>2</sup>University of Minnesota, Waseca.

Two studies were conducted to determine the apparent ileal amino acid (AA) digestibilities of corn distiller's dried grains with solubles (DDGS) produced from newer (< 5 yrs old) ethanol plants in Minnesota and South Dakota (MNSD), and compare these to values for DDGS originating from an older Midwestern plant (OMP). In experiment 1, eight crossbred pigs averaging 38.8 kg initial body wt were surgically fitted with a simple T-cannula, inserted at the ileal-cecal junction. After a 14 d recovery period, pigs were allotted to experimental diets in a latin square

design. Pigs were limit fed (approximately 75% ad lib) each of four experimental diets: control containing 90% corn-soybean meal (CSBM), 30% MNSD-60%CSBM, 60% MNSD-30%CSBM, and 90% MNSD. The remaining 10% of each diet contained supplemental vitamins and minerals to meet or exceed NRC (1998) requirements. Pigs were allowed a 9-d adjustment period, followed by a 2-d digesta collection period (12 hr/d) in each of four consecutive 11-d feeding periods. Samples were immediately frozen for subsequent AA analysis. Apparent ileal Lys, Met, Thr, and Trp digestibility coefficients of MNSD were 53.6, 58.5, 55.2, and 63.6%, resulting in apparent digestible AA levels of .44, .32, .62, and .15%, respectively. Immediately following experiment 1, pigs were allotted to one of two dietary DDGS treatments (90% MNSD or 90% OMP) for two collection periods. Pigs fed the MNSD DDGS diet had greater ileal Lys (47.4 vs 3.8%,  $P < .01$ ), Met (65.8 vs 48.5%,  $P < .02$ ), and Thr (59.9 vs 36.5%,  $P < .01$ ) digestibility coefficients compared to OMP DDGS, but there were no differences between sources for Trp digestibility (67.4 vs 68.3%,  $P > .10$ ). Results from these studies suggest that apparent ileal AA digestibility of MNSD DDGS is superior to OMP DDGS, and higher than published NRC (1998) values. Knowledge of apparent AA digestibilities will allow more effective use of MNSD DDGS in swine diets.

**Key Words:** Pigs, Distiller's dried grains with solubles, Apparent amino acid digestibility

### 786 Determination of the metabolizable energy concentration of three corn hybrids fed to growing pigs. R.W. Fent\*, S.D. Carter, B.W. Senne, and M.J. Rincker, *Oklahoma State University, Stillwater.*

Eight sets of three littermate barrows (initial wt = 25.6 kg) were utilized to determine the ME concentration of three commercially available corn hybrids. The hybrids (A, B, and C) were grown in the same location during the same year, and they were ground to a common particle size prior to mixing the experimental diets. The experimental diets (A, B, and C; 1.0% Lys) consisted of each corn hybrid (90.48%) supplemented with casein (5.04%), crystalline AA, and mineral and vitamin sources. Pigs were housed individually in metabolism chambers and equally fed within replicate. Pigs were allowed a 7-d adjustment period to the diets followed by a 5-d collection of feces and urine. All data are reported on a DM basis unless otherwise noted. The GE concentrations (kcal/kg) of Hybrids A and B were similar (4,349 and 4,323), but was greater for Hybrid C (4,467). The GE of the experimental diets were 4,306, 4,317, and 4,337 kcal/kg, respectively. Fecal GE excretion tended to be greater ( $P < .11$ ) for Diet C vs Diets A and B. Digestible energy for Diets A, B, and C were 3,884, 3,909, and 3,836 kcal/kg, which resulted in DE:GE of .902, .906, and .885, respectively. Urinary energy excretion was similar among treatments. The ME concentrations of the 3 diets were 3,811, 3,838, and 3,773 kcal/kg and ME:GE was .885, .889, and .870. The ME concentrations of the three diets were similar, but ME:GE tended to be lower ( $P < .14$ ) for Diet C as compared with Diets A and B. To approximate the ME concentration of each corn hybrid, the ME provided by casein was subtracted from the ME of each experimental diet. As a result, GE and ME, on an as-fed basis, were, 3,858 and 3,523; 3,846 and 3,560; and 3,971 and 3,493 kcal/kg for Hybrids A, B, and C, respectively. Thus, ME:GE was .913, .926, and .879. These results suggest only minor differences in ME content of three corn hybrids grown in one location during the same year. However, based on these data, GE of corn is not indicative of the ME concentration as the ME:GE ratios varied with corn hybrid.

**Key Words:** Corn, Metabolizable energy, Pigs

### 787 A biochemical model of nutrient utilization in growing pigs. J. van Milgen\* and J. Noblet, *INRA, Saint-Gilles, France.*

A mathematical model was developed that allows calculation of the biochemical efficiency of nutrient utilization in growing pigs. The model is based on a number of intermediates and cofactors that are involved in the metabolism of amino acids and carbon chains. These intermediates include glucose, pyruvate, acetylCoA,  $\alpha$ -ketoglutarate, oxaloacetate and serine. Degradation of dietary amino acids and synthesis of non-essential amino acids can be expressed as a function of these intermediates and cofactors. Excess intermediates (both from protein and starch) yield acetylCoA, which can be used for ATP or lipid synthesis. The calculated efficiency of glucose for lipid synthesis was 83%. Based

on the body amino acid composition and assuming that 5 ATP are used per peptide bond, the calculated energetic efficiency of protein synthesis is 86%. This value is much higher than experimental values (approximately 0.60). However, the former calculation assumes that amino acids are directly used for protein synthesis (i.e., protein turnover is not considered). Using three protein turnover cycles (i.e., four times formation and three times hydrolysis of the peptide bond), the efficiency reduces to 61%. Amino acids differ largely in the efficiency with which they can be used for ATP (or lipid) synthesis. The ME/DE ratio ranges from 0.66 (arginine) to 0.93 (tyrosine and phenylalanine). The NE/ME ratio ranges from 0.62 (cysteine) to 0.96 (glutamate). If dietary amino acids are incorporated into protein before being catabolized (e.g., through stimulation of endogenous secretions or protein turnover), the NE/ME ratio drops rapidly ranging from 0.23 (glycine) to 0.83 (isoleucine). Viscera catabolize large quantities of dietary glutamate and glutamine, and synthesis of these amino acids (e.g., from glucose) is required for protein deposition. The efficiency of this scenario is relatively high (95% for glutamate and 92% for glutamine) and is similar to the temporary storage of glucose as glycogen (95-97%). Energy losses that occur in the transformation of nutrients for ATP synthesis and lipid deposition seem to be mainly of biochemical origin. Other processes (e.g., turnover or biophysics) may play a major role in the energetic efficiency of protein deposition.

**Key Words:** Mathematical Model, Energy Metabolism, Protein Metabolism

### 788 Utilization of low heat increment diets at high ambient temperatures in growing pigs. L. Le Bellego<sup>1</sup>, J. Van Milgen<sup>1</sup>, M. Rademacher<sup>2</sup>, S. Van Cauwenberghes<sup>3</sup>, and J. Noblet\*<sup>1</sup>, <sup>1</sup>INRA, Saint Gilles, France, <sup>2</sup>Degussa-Hls, Hanau, Germany, <sup>3</sup>Eurolysine, Paris, France.

Sixty-four barrows were used to study the effect of using diets with a low heat increment (HI) at thermoneutral (22 C) and high (29 C) ambient temperatures on growth performance. For each dietary treatment, two diets providing 0.85 and 0.70 g of digestible lysine per MJ NE were prepared for the growing (30 to 65 kg) and finishing periods (65 to 100 kg), respectively. A reduction in HI was achieved by partial replacement of soybean meal in a wheat - corn - soybean diet (NP diet) by wheat and corn (LP diet), or by wheat, corn and 4% fat (LPF diet). The CP levels were 19.7, 15.3, 16.4% for the growing period and 17.5, 12.5, 13.3% for the finishing period for the NP, LP and LPF diets, respectively. Industrial amino acids were used to maintain an optimal and balanced amino acids supply. Pigs were penned individually with ad libitum access to feed and were slaughtered at 100 kg. Increase of ambient temperature from 22 to 29 C resulted in marked reductions of ADFI (15%), ADG (13%) and body fatness (22.8 vs 24.8% fat tissues in carcass). At 22 C, ADFI (g/d) was higher for the NP (2752) than for the LP (2575) and LPF (2544) diets but NE intakes were similar (27.8 MJ/d), as were ADG (1080 g/d) and carcass composition (24.8% fat). At 29C, ADFI values were not different (2265, 2243 and 2202 g/d for NP, LP, and LPF diets, respectively) and NE intake (MJ/d) was higher for LPF (24.5) than for the NP (23.2); it was intermediate for LP diet (23.6). Despite differences in NE intakes at 29 C, ADG were similar (934 g/d) and pigs tended to be fatter with the LP and LPF diets (23.1 and 23.3% fat) than for the NP diet (22.0%). The feed to gain ratio was not affected by temperature or dietary treatment (25.7 MJ NE/kg on average). These results confirm that at optimal amino acid supplies, CP can be reduced without negative effect on performance of growing-finishing pigs. The additional NE intake of the low HI diets at high ambient temperature results mainly in fat tissue gain.

**Key Words:** Growing Pig, Heat Increment, High Temperature

### 789 Effects of the addition of *Yucca schidigera* extract and an acidified diet on reducing ammonia emission in nursery pig facilities. J. J. Colina\*, A. J. Lewis, P. S. Miller, and R. L. Fischer, *University of Nebraska, Lincoln.*

Three trials were conducted to determine the effects of the addition of *Yucca schidigera* extract or calcium chloride to the diet on ammonia emission and growth performance in nursery pigs weaned between 11 and 15 d of age (initial body weight of 3 to 5 kg). In Trial 1, 90 cross-bred barrows were allotted by weight to three identical, environmentally controlled rooms (6 pigs per pen, 30 pigs per room). In each room, relative humidity, temperature, and ventilation were maintained constant.

In Trials 2 and 3, 150 crossbred pigs were used (10 pigs per pen, 50 pigs per room). Pigs were fed one of three diets: 1) Control, containing 23% CP; 2) Control diet plus 125 ppm of *Yucca schidigera* extract (30%); and 3) Control diet plus 1.95% calcium chloride. Each trial consisted of a 1-wk adaptation period (during which a common diet was fed) and a 3-wk experimental period (during which the experimental diets were fed). Average daily gain, ADFI, and ADG/ADFI were recorded weekly. Aerial ammonia was measured daily using detector tubes. Manure samples from the pit in each room were taken on d 4, 7, 11, 14, 18, and 21. Ammonia concentration in manure samples was measured using an ammonia-gas detecting electrode. An electronic pH meter was used to measure manure pH. Data were analyzed using a linear model with trial as a block and week as a repeated measurement. There were no differences in ADG, ADFI, or ADG/ADFI ( $P > .5$ ) between pigs fed the control diet and pigs fed the *Yucca schidigera* diet. Pigs fed the calcium chloride diet had lower ADG, ADFI, and ADG/ADFI than pigs fed the other two diets ( $P < .001$ ). Aerial ammonia concentrations were greater ( $P < .001$ ) in rooms in which pigs were fed the control diet than in rooms in which the other two diets were fed. Manure ammonia and pH did not differ among diets. Although ammonia concentrations were relatively low in these trials, both the addition of *Yucca schidigera* extract and calcium chloride to diets of nursery pigs seemed to reduce ammonia emission.

**Key Words:** Pigs, Ammonia, Growth

**790 Diet modification to reduce odorous compounds in pig manure.** S. Hankins<sup>\*1</sup>, A. Sutton<sup>1</sup>, J. Patterson<sup>1</sup>, O. Adeola<sup>1</sup>, B. Richert<sup>1</sup>, A. Heber<sup>1</sup>, D. Kelly<sup>1</sup>, and K. Kephart<sup>2</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>Pennsylvania State University, University Park.

Three replicate 4 X 4 Latin square trials were conducted with cecal cannulated grow-finish crossbred gilts to determine the effects of amino acid supplementation, fiber and anthraquinone (Anth) additions to the diet on production of odorous compounds from cecal contents, fresh manure and stored manure. Corn-soy diets fed were Diet I; a 13% crude protein (CP) corn-soy diet with total Lys, 0.61%; total Met+ Cys, 0.47%; total Trp, 0.12%; total Thr, 0.39%; Diet II; a 10% CP corn-soy diet with crystalline amino acids, 0.36% Lys (0.6% total Lys), 0.0% Met (0.40% total Met+Cys), 0.02% Trp (0.10% total Trp) and 0.1 % Thr (0.40% total Thr); Diet III; Diet II with 5% cellulose and, Diet IV; Diet I with 0.1% Anth. Pigs were ad libitum fed. Reducing the CP from 13% to 10% and adding cellulose reduced pH in stored manure by .6 and .8 units ( $P < .05$ ), respectively. Total nitrogen content in fresh manure was reduced 33% by reduced CP and 48% with reduced CP and added cellulose ( $P < .05$ ). The lower stored manure pH and total N was partially due to a .8 - .9 unit ( $P < .05$ ) decrease in urine pH and a 21 - 22% ( $P < .05$ ) decrease in total urinary N content. Ammonium and total N were reduced 75% and 60% ( $P < .05$ ), respectively, in stored manure when the reduced CP diet also contained cellulose, compared to the 13% CP diet. Total VFA in stored manure were reduced 41% ( $P < .05$ ) with the reduced protein diets and 83% ( $P < .05$ ) with added cellulose compared to the 13% CP diet. Lower CP diets that were supplemented with synthetic amino acids and cellulose showed a numerical decrease in sulfide and phenolic compounds in fresh and stored manure compared to the 13% CP diet. Addition of Anth to the standard diet numerically decreased carbon disulfide, hexane, and 2-butanone in stored manure and phenolic compounds in freshly excreted manure compared to manure from pigs fed the control diet. However, numerically higher levels of volatile sulfide compounds were noted in stored manure from pigs fed Anth. Although there is evidence that Anth might reduce certain volatile organic compounds, Anth's effectiveness in controlling sulfur containing odors needs further experimentation. Reducing dietary amino acid excesses significantly reduced odorous compounds and this reduction was further enhanced by the addition of 5% cellulose to the reduced CP diet.

**Key Words:** Pigs, Manure, Odors

**791 Effects of dietary supplementation of exogenous fibers on ammonia and hydrogen sulfide emission from growing-finishing pigs fed corn and soybean meal-based diets.** Y. Gao<sup>\*1</sup>, T. Rideout<sup>1</sup>, D. Lackeyram<sup>1</sup>, T. Archbold<sup>1</sup>, M. Z. Fan<sup>1</sup>, E. J. Squires<sup>1</sup>, C. F. M. de Lange<sup>1</sup>, T. K. Smith<sup>1</sup>, and G. Duns<sup>1</sup>, <sup>1</sup>University of Guelph, Ontario, Canada.

A trial was conducted to examine the effects of dietary supplementation of exogenous fibers on ammonia and hydrogen sulfide emission from swine slurry. Five Yorkshire barrows, initial weight of 25 kg, were fed five diets according to a 5 x 5 Latin square design with five experimental periods. The diets were corn and soybean meal-based, contained the same amount of protein and amino acids and differed in the source and levels of fibers. Diet 1 had no extra fiber and served as the control; diets 2 and 3 were with 4.5 and 9.0% of apple pectin; diets 4 and 5 were with 4.5 and 9.0% of cellulose, respectively. Each period lasted for 14 days with 10-d adaptation followed by 4-d collection of feces and urine. For each period, fresh manure slurry was made by mixing the collected fresh feces with urine at a ratio of 1: 2.5 (wt/wt). Accumulative ammonia and hydrogen sulfide emission from the slurry of different dietary treatment conditions was measured with our recently established trapping system at different time points (0, 24, 30, 54, 78 and 102 h, respectively) at the room temperature. Inclusion of apple pectin at the level of 4.5% decreased the 102-h accumulative NH<sub>3</sub> emission by 35.7% (9.9 vs. 15.4 g NH<sub>3</sub>/kg DM slurry) in comparison with the control diet. Furthermore, adding apple pectin at the levels of 4.5 and 9.0% also decreased the 102-h accumulative H<sub>2</sub>S emission by 12.9 and 56.7%, respectively (2.6 and 1.3 vs. 3.0 g H<sub>2</sub>S/kg DM slurry) in comparison with the control diet. However, cellulose tended to have less effects on both NH<sub>3</sub> and H<sub>2</sub>S emission. In conclusion, dietary supplementation of exogenous water-soluble fiber such as pectin is effective to reduce ammonia and hydrogen sulfide emission related pollution to the environment.

**Key Words:** Fiber, Ammonia and hydrogen sulfide emission, Pigs

**792 Lipogenic enzyme activities in adipose and muscular tissues of Landrace and Iberian pigs fed on different sources of carbohydrates.** J. Morales<sup>1</sup>, J.F. Perez<sup>\*1</sup>, J. Mourot<sup>2</sup>, M.D. Baucells<sup>1</sup>, and J. Gasa<sup>1</sup>, <sup>1</sup>Universidad Autonoma de Barcelona, Spain, <sup>2</sup>INRA, St-Gilles, France.

Iberian is swine breed from Southwest Iberian Peninsula traditionally fattened in an extensive production system. Iberian meat and meat products have attained a high acceptability, generally attributed to a higher marbling. The present study explores the lipogenic enzyme activities of Landrace and Iberian finishing pigs with different depositions. Twelve Landrace and 12 Iberian pigs were grown on two diets based on corn (diet C) or sorghum and acorns (diet S). No differences were observed in the average daily gain (767 g/day). At 107 kg wt animals were slaughtered and samples obtained from backfat (SC), intermuscular fat (IM) and glutens medium (GM), immediately frozen in liquid N<sub>2</sub> and stored at -80C until analyses of lipogenic enzyme activities (acetyl-CoA-carboxylase, ACX; malic enzyme, ME; and glucose-6-phosphate-dehydrogenase, G6PDH; nM/g x min). The activities of all enzymes were lower in GM than SC and IM fat, especially of G6PDH. No significant differences were observed between breeds or diets on the ACX activities in the SC (1.53) and GM (0.51), but were lower ( $P < 0.01$ ) in the IM fat of Iberian pigs (0.61) vs Landrace (1.45). Malic enzyme and G6PDH activity was significantly higher in Iberian than Landrace pigs in SC fat (34.3 vs 21.5, ME; 14.8 vs 10.6, G6PDH) and GM muscle (5.35 vs 2.93, ME; 0.52 vs 0.38, G6PDH). Experimental diets (diet C and S) did not promoted significant differences on the ME and G6PDH activity of different tissues, except on Iberian pigs which showed higher activities with diet C than S, in SC ( $P = 0.21$ ) and IM fat (22.5 vs 10.5, ME; 10.5 vs 5.6, G6PDH;  $P < 0.05$ ). Significant differences between breeds were modulated by dietary characteristics, encouraging further studies on the metabolic effects of nutrients absorbed.

**Key Words:** Lipogenesis, Breed, Swine

**793 Soybean meal versus other protein sources on growth and carcass traits of swine.** J. L. Shelton<sup>\*1</sup>, R. M. Strode<sup>2</sup>, M. D. Hemann<sup>2</sup>, G. L. Brashear<sup>2</sup>, F. K. McKeith<sup>2</sup>, M. Ellis<sup>2</sup>, L. L. Southern<sup>1</sup>, and T. D. Bidner<sup>1</sup>, <sup>1</sup>Louisiana State University Agricultural Center, <sup>2</sup>University of Illinois, Urbana.

Gilts (n=200) and barrows (n=200) from the Louisiana State University (LSU) Agricultural Center and the University of Illinois (UI) were used to compare the effect of soybean meal in swine diets, relative to other protein sources, on growth performance and carcass traits of growing-finishing pigs. A total of 20 pigs/diet/location were allotted to nine dietary treatments: SBM= corn soybean meal control, AA= crystalline amino acids, DESB= dry extruded soybean meal, CAN= canola meal, PNT= peanut meal, SFLR= sunflower meal, PEA= ground peas, MBM= meat and bone meal, and PLTY= poultry by-product meal. The diets were formulated to meet or exceed NRC (98) requirements and to have equal Lys:ME according to dietary phase and sex. Pigs (12/pigs/diet/location) were killed at a BW of 115 kg in the LSU and UI Meat Science Laboratories. Pigs fed SBM had an increased (P < 0.04) ADG relative to pigs fed the AA, plant sources (DESB, CAN, PNT, and SFLR), or animal sources (MBM and PLTY) of protein and an increased (P < 0.02) ADFI relative to pigs fed the AA, DESB, or the animal sources. Feed efficiency was decreased (P < 0.05) in pigs fed AA but increased (P < 0.05) in pigs fed DESB compared with SBM. Loin muscle area was increased (P < 0.01) in pigs fed SBM compared with pigs fed the AA diet. Tenth rib backfat thickness was decreased (P < 0.09) in pigs fed SBM relative to those fed AA, peas, or animal sources of protein. Percentage muscling was decreased (P < 0.09) in pigs fed AA, peas, or the animal sources of protein, and kilograms of lean was decreased (P < 0.05) in pigs fed AA or peas relative to SBM. Visual muscle scores were increased (P < 0.09) in pigs fed diets with SBM relative to pigs fed any other protein source. Results from this experiment suggest that pigs fed SBM have equal or better growth performance and carcass traits than pigs fed other protein sources.

**Key Words:** Soybean Meal, Carcass Traits, Protein Sources

**794 The use of near infrared spectroscopy and in vitro methods to predict the digestibility of compounded pig diets.** J.V. O' Doherty<sup>\*</sup>, M.G. Dore, and F.P. O' Mara, *University College Dublin, Ireland.*

In vivo digestibility trials with 82 concentrates containing widely diversified feed ingredients were carried out in grower-finisher pigs to calibrate and evaluate near infrared spectroscopy (NIRS) and invitro digestibility techniques for the prediction of nutrient digestibility and digestible energy (DE) content of pig feedstuffs. The feed samples were initially analysed for dry matter (DM), gross energy (GE), crude protein (CP), crude fibre (CF), ether extract (EE), ash and neutral detergent fibre (NDF). The predicted DE content of the diets was estimated using the in vitro (EFOS) technique. Two different subsamples of each sample were scanned over the near infrared spectrum, 1100 to 2500 nm at 2 nm intervals. Equations to predict DE and the digestibility of the organic matter (OM), energy and nitrogen (N) were calibrated and validated using 3 mathematical regression models; Principal Component Regression (PCR), Partial Least Squares (PLS) and Modified Partial Least Squares (MPLS). The relationship between in vivo DE and in vitro DE resulted in the prediction equation:  $DE = 5.22 + 0.638 \times EFOS$  (RSD = 0.416;  $R^2 = 0.85$ ; mean DE = 13.85 MJ/kg). The prediction equation of DE from the invitro DE and the chemical composition gave  $DE = -4.45 + 0.229 \times EFOS - 0.023 \times CP - 0.088 \times Ash - 0.138 \times EE - 0.045 \times NDF - 0.007 \times CF + 1.05 \times GE$  (RSD = 0.326;  $R^2 = 0.91$ ). Chemical composition alone gave the following equation:  $DE = -2.68 - 0.021 \times CP - 0.10 \times Ash - 0.044 \times EE - 0.067 \times NDF - 0.023 \times CF + 1.14 \times GE$  (RSD of 0.341;  $R^2 = 0.89$ ). With NIRS the most accurate statistical technique for predicting DE (MJ/kg) was MPLS which resulted in a standard error of calibration = 0.27 ( $R^2 = 0.924$ ); standard error of cross validation = 0.408 (1-VR = 0.828) using the second derivative with scatter correction and 9 terms included. MPLS also gave the most accurate calibration and validation for digestibility of OM ( $R^2 = 0.827$ ), energy ( $R^2 = 0.772$ ) and N ( $R^2 = 0.691$ ). In conclusion, NIRS and EFOS produced predictions of DE which were of similar accuracy.

**Key Words:** Pig, NIRS, Calibration

**795 Evaluation of a diet formulation method that assigns nutrient values to microbial phytase in swine diets.** J.S. Radcliffe<sup>\*</sup>, A.F. Harper, and E.T. Kornegay, *Virginia Polytechnic Institute and State University, Blacksburg.*

One hundred eighty crossbred grow-finish pigs with an average initial weight of 22.3kg were fed corn-soybean meal based diets. Dietary treatments were: 1) Positive control (100% NRC, 1998), 2) 90% NRC Lys, 100% Ca, P and other nutrients, 3) Formulated to be equivalent to diet 2 based on the inclusion of 500 U/kg of Natuphos600 phytase (BASF, Mount Olive, NJ) with assigned nutrient values 4) Formulated to the same ingredient levels as diet 3, but with no added phytase, and 5) Diet 4 with added Ca and P to meet NRC requirements. Dietary treatments were kept constant, but ingredient levels were altered based on NRC (1998) requirements for pigs during the grower (20-50kg), finisher I (50-80kg), and finisher II (80-110kg) phases. Pig BW and pen feed consumption were recorded biweekly. Fecal grab samples were collected from each pen during the last week of the finisher I phase. At the end of the experiment, all barrows were slaughtered for collection of third metacarpals. Feeding pigs at 90% of the NRC Lys requirement (diet 2) had no effect (P > .05) on ADG, ADFI, or gain:feed, compared to pigs fed diet 1. Pigs fed diet 3 had lower ADG (P < .05) than pigs fed diet 1, and ADG was further depressed in pigs fed diet 4 (P < .05). However, when Ca and P were added back to diet 4 (diet 5), ADG returned to a level similar to that of pigs fed diet 1 as a result of an increased (P < .05) feed efficiency. Pigs fed the 90% NRC Lys diet had a higher (P < .05) Ca digestibility compared to pigs fed the 100% NRC diet. Calcium digestibility was further improved by the addition of microbial phytase (P < .05). The digestibility of P, Ca, and DM were similar for pigs fed diets 1 and 2. The inclusion of phytase in diet 3 resulted in an increase (P < .05) in P digestibility relative to pigs fed diet 1, and an increase (P < .05) in DM and energy digestibility relative to pigs fed diets 1 or 2. Based on the results of this study, the formulation matrix designed for Natuphos appears to overestimate the P and Ca equivalency values of phytase.

**Key Words:** pigs, phytase, minerals

**796 Dietary conjugated linoleic acid alters fatty acid composition of pig skeletal muscle and fat.** T.G. Ramsay<sup>\*1</sup>, C.M. Evock-Clover<sup>1</sup>, N.C. Steele<sup>1</sup>, and M.J. Azain<sup>2</sup>, <sup>1</sup>USDA-ARS, Beltsville, MD, <sup>2</sup>University of Georgia, Athens.

This study examined the fatty acid profile of adipose tissue and skeletal muscle in pigs treated with dietary conjugated linoleic acid (CLA) and/or porcine somatotropin (pST). CLA was fed at doses of 0%, .25%, .5%, 1.0% or 2.0% to gilts and barrows from 20 to 55 kg BW. One additional group was treated with 50 mM bicarbonate buffer and 0% CLA, while two additional groups of animals were treated with pST (100 µg/kg BW) and either .5% CLA or 2.0% CLA. Animals were fed a diet containing 18% CP, 1.2% lysine, and 3.5 Mcal of DE/kg at 110% of ad libitum intake until slaughter at 55 kg BW. A half-carcass was ground in entirety and samples frozen for carcass analysis. The fatty acid profile in dorsal subcutaneous adipose tissue (SQ) and latissimus dorsi (LD) samples was determined by gas chromatography. CLA supplementation did not affect ADG, feed intake, feed efficiency or carcass composition. Dietary CLA produced significant changes in skeletal muscle and adipose tissue fatty acid composition. Dietary CLA at 1 or 2% produced an increase in the percentage of total fatty acids as stearic acid while the percentages as oleic and linolenic acids were reduced in LD. Linolenic acid appears to be the most sensitive to dietary CLA as a response in LD was observed with as little as .25% CLA. Treatment with CLA + pST increased the percentages of linoleic and arachidonic acids in LD fatty acids while reducing the percentages of palmitate and oleic acids. CLA increased the percentages of palmitic and stearic acids in SQ while reducing the percentages of oleic, linoleic, linolenic and arachidonic acids at dietary CLA concentrations as low as .25%. The percentage of total fatty acid as palmitic acid was reduced in SQ while linoleic acid was increased with CLA + pST administration. Thus, pST functions to enhance the percentage of polyunsaturated fatty acids while reducing the percentages of saturated fatty acids in skeletal muscle and adipose tissue of swine fed CLA.

**Key Words:** conjugated linoleic acid, fatty acids, carcass composition

**797 Amino-Lac as a substitute for spray-dried animal plasma in starter diets for weanling pigs.** G.L. Cromwell, M.D Lindemann, and H.J. Monegue\*, *University of Kentucky, Lexington.*

Amino-Lac, a product consisting of concentrated whey, meat, and yeast proteins (International Ingredient Corp., St. Louis, MO), contains approximately 50% CP, 3.4% lysine, 3.0% fat, 35% lactose, .36% Ca, .52% P, and .57% Na. A 28-d experiment was conducted to assess Amino-Lac compared with spray-dried animal plasma (AP-920, American Protein Corp., Ames, IA) in Phase I starter diets for pigs. Crossbred pigs (n = 318) initially averaging 21.7 d of age and 6.5 kg BW were allotted to six treatments with ten pen-replicates of five or six pigs/pen. Phase I diets (1.4% lysine, 16% lactose) were fed for 14 d followed by Phase II diets (1.2% lysine, 10% lactose) for 14 d. Diets consisted of the basal (mainly corn, dehulled soybean meal, and lactose) and the basal with 2.5% plasma, 5% plasma, 5% Amino-Lac, 10% Amino-Lac, or a combination of 2.5% plasma and 5% Amino-Lac. During Phase II, pigs that previously received the Phase I basal diet were continued on the Phase II basal diet, whereas all other pigs received the Phase II basal diet with 2% spray-dried blood cells (AP-301G, American Protein Corp.). The Amino-Lac, plasma, and cells were substituted for corn and soybean meal on an equal lysine basis. All diets were fortified with vitamins, minerals, and an antimicrobial agent (carbadox, 55 mg/kg). Zn oxide (3,000 ppm Zn) and Cu sulfate (250 ppm Cu) were included in the Phase I and II diets, respectively. Diets were fed in meal form. During Phase I, gain and feed/gain were improved ( $P < .05$ ) when plasma or Amino-Lac was included in the diet (307, 338, 344, 323, 341, 354 g/d; 1.34, 1.25, 1.18, 1.21, 1.15, 1.16, respectively) but feed intake was not affected (406, 421, 404, 380, 387, 405 g/d). Similar improvements ( $P < .05$ ) in gain and feed/gain occurred over the entire 28-d test period (458, 486, 488, 476, 489, 492 g/d; 1.53, 1.46, 1.42, 1.47, 1.46, 1.45), but feed intake was unaffected (698, 713, 694, 698, 716, 711 g/d). The results indicate that Amino-Lac is comparable to spray-dried animal plasma on a lysine basis in starter diets for early-weaned pigs.

**Key Words:** Pigs, Plasma, Lactose

**798 Use of animal protein sources in combination with different types of milk protein in diets for early-weaned piglets.** P. Medel<sup>1</sup>, F. Baucells<sup>2</sup>, M.J. Aranibar<sup>1</sup>, and G. G. Mateos<sup>1</sup>, <sup>1</sup>Dpto. Producción Animal, Universidad Politécnica de Madrid, <sup>2</sup>Pinosos Baucells, Barcelona, Spain.

A trial was conducted to evaluate the influence of milk and two animal protein sources in diets for piglets. There were four diets (2,500 kcal NE/kg and 1.35% digestible lysine) arranged as a factorial 2x2 with two types of milk protein: casein and whey protein, and two high quality animal proteins: fish meal LT and poultry meat meal. Lactose permeate was added to the casein based diets to maintain constant the lactose content of the diets. Each treatment was replicated 6 times (5 male piglets caged together). The four experimental diets were fed from weaning at 21 d until 41 d of age. Then, all the animals received a common starter diet (2,435 kcal NE/kg and 1.07% digestible lysine) until 51 d of age. No differences were detected among milk or animal protein sources for growth or feed intake from 0 to 20 d. However, a significant interaction was observed for feed conversion at this period: it was improved in poultry meat meal diets that included whey (1.16 vs 1.06 g/g), but was impaired in the diets that included casein (1.07 vs 1.12 g/g). Piglets fed fish meal LT from 21 to 41 d of age grew faster from 41 to 51 d than animals fed poultry meat meal LT although in this period the animals received a common diet (543 vs 472 g/d,  $P=0.05$ ). No differences in any productive performance traits among treatments were observed at the end of the trial. It is concluded that milk protein source did not influence piglet performance at 51 d, and that high quality poultry meat meal allowed similar performance of piglets than fish meal LT.

**Key Words:** Milk proteins, Fish meal, Poultry meat meal

**799 Efficacy and pH dependence of phytate-phosphorus hydrolysis by four different phytases are modulated by buffer and substrate specificities.** T. Xiang\*, E. Rodriguez, J.R. Thornton, and X.G. Lei, *Cornell University, Ithaca, NY.*

We have expressed *Escherichia coli*, *Aspergillus flavus*, and *A. fumigatus* phytase genes in yeast and obtained partially-purified enzymes.

This study was to determine effects of buffer, pH, and substrate on the efficacy of phytate-P hydrolysis by these three phytases, in comparison with those of Natuphos. In Exp. 1, hydrolyses of sodium phytate by these four enzymes were compared at pH 2.5 to 5.5 in eight different combinations of 0.2 M citrate, acetate, and glycine-HCl as the reaction and/or the substrate buffers. There was a strong interaction ( $P < 0.01$ ) between the buffer system and pH on the efficacy of all four enzymes. Although the highest efficacy of the three *Aspergillus* phytases occurred at pH 5.5 within a given buffer system, the previously-reported pH 2.5 optimum for Natuphos was not seen in several buffers. The best buffer combination for the catalysis of these fungal enzymes was acetate and citrate as the reaction and substrate buffer, respectively. The *E.coli* phytase exhibited its pH optimum at 3.5 and had greater ( $P < 0.01$ ) P release in the acetate reaction buffer than in others. In Exp. 2, these four phytases (0.6 units) were incubated for 1 h with 2 g soybean meal (SBM) suspended in 0.2 M citrate or acetate buffer, pH 3.5 or 5.5. While the citrate buffer allowed the three fungal phytases to release more P from SBM than the acetate buffer at pH 5.5 ( $P < 0.05$ ), these two buffers were not different for the hydrolysis of this intrinsic phytate by the *E.coli* phytase at pH 3.5 or 5.5. In Exp. 3, hydrolyses of sodium phytate and calcium phytate by the *E.coli* phytase were compared in 0.2 M acetate and citrate, pH 3.5. There was a difference ( $P < 0.05$ ) in P released from only sodium phytate, but not calcium phytate between these two buffers. In conclusion, efficacy of phytases on phytate-P hydrolysis is highly affected by the nature of buffer and substrate, and their pH optima are not inherent.

**Key Words:** Phytase, Phytate, Buffer

**800 Effects of betaine levels in reduced energy diets for finishing pigs.** G.L. Cromwell\*, M.D Lindemann, J.R. Randolph, K.M. Laurent, G.R. Parker, and R.D. Coffey, *University of Kentucky, Lexington.*

Previous research at our station suggested that betaine was more effective in low energy diets than in typical corn-soy diets. Two experiments were conducted to assess dietary levels of betaine as a carcass modifier in reduced energy diets. Two dietary energy levels (3,325 vs 3,175 kcal ME/kg) were achieved with a fortified corn-soybean meal diet (Diet 1) or a similar diet with 20% wheat middlings (Diets 2-5). Middlings were substituted for corn and soybean meal on a lysine basis. Betaine was included in Diets 2-5 at 0, .68, 1.14, and 1.82 g/kg of diet by adding 0, .075, .125, or .200% Betafin (Finnfeeds, Fenton, MO). Crossbred pigs (8 reps of 4-5 pigs/pen, n = 165) were fed the 5 diets from 56 to 111 kg BW. Dietary lysine was reduced from .85 to .70% at 84 kg BW. All pigs were scanned by real-time ultrasound at 106 kg BW for backfat (BF) and longissimus depth (LD), and carcass lean was estimated from these measurements. Carcass BF, longissimus area (LEA), and estimated lean were determined on all barrows at termination. Means for the 5 treatments were, respectively: gain (ADG), 934, 901, 913, 895, 905 g/d; feed/gain (F/G), 3.41, 3.69, 3.59, 3.61, 3.75; scanned BF, 19.3, 18.9, 17.9, 18.5, 19.2 mm; scanned LD, 5.46, 5.29, 5.31, 5.48, 5.37 cm; estimated lean, 53.3, 53.3, 54.0, 53.8, 53.3%; and lean gain, 375, 361, 377, 367, 363 g/d. Carcass 10th rib BF, LEA, and estimated lean of barrows were, respectively: 26.4, 26.0, 22.5, 23.3, 26.0 mm; 35.3, 35.3, 36.5, 36.8, 34.9 cm<sup>2</sup>; 48.6, 48.9, 50.8, 50.6, 48.9%. ADG was reduced ( $P < .10$ ) and F/G was increased ( $P < .01$ ) in pigs fed the low energy diets. Betaine level did not influence ADG, but affected F/G quadratically ( $P < .03$ ). Feeding the low energy diets tended to reduce scanned and carcass BF, but not significantly ( $P = .30$ ). Barrow carcass responses to betaine tended to be quadratic ( $P < .07$  for BF and estimated lean). The .68 and 1.14 g/kg levels of betaine seemed to be effective in reducing backfat and increasing lean percentage and lean gain; whereas the 1.82 g/kg level was ineffective.

**Key Words:** Pigs, Betaine, Energy

**801 Effects of nursery diet and supplementation with a combination of dietary acidifiers, enzymes and flavor on pig performance.** B. F. Wolter<sup>1</sup>, M. Ellis<sup>1</sup>, A. V. Frampton<sup>1</sup>, R. A. Easter<sup>1</sup>, E. Roura<sup>2</sup>, J. Brenes<sup>2</sup>, and J. Sola<sup>2</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>Lucta SA, Barcelona, Spain.

This study tested the effects of three dietary supplements (added at .5%) (control [1, sodium bentonite] and two commercial supplements [2, 3, (Luctaplus<sup>®</sup>, Lucta SA)] containing a combination of inorganic and organic acids, a blend of enzymes, and a flavor) in two diet formulations

(A and B) on pig performance for 2 wk post-weaning. Crossbred pigs (n=288; 5.2±.66 kg BW; 18±2 d of age) were allotted (12 reps) to six treatments; 1) 1A; 2) 2A; 3) 3A; 4) 1B; 5) 2B; 6) 3B. Groups of 4 pigs were given ad lib access to a two-phase regimen (Table) with each phase fed for 1 wk. Diets differed in soy- and animal-based protein content, but had an equal lysine to energy ratio within each phase. The control treatment with lower SBM content (1A), compared to the control with higher SBM content (1B), resulted in heavier pig weights (5 and 9%, P<.06), greater ADG (43 and 20%, P<.08), greater G/F (31 and 8%, P<.10), but similar ADFI (P>.10) in wk 1 and 2, respectively. The supplements had no effect (P>.10) on the performance of pigs consuming the low SBM diet (A) during either phase (e.g. ADG 138 vs 142 vs 153, and 346 vs 322 vs 336 g/d for A1, A2 and A3 and for phase 1 and 2, respectively). In the high SBM diet (B), the supplements (2B and 3B) produced similar (P>.10) ADG (129 and 127 vs 138, SE=16.1 g/d, and 323 and 331 vs 346, SE=16.7 g/d for phase 1 and 2, respectively) ADFI (144 and 138 vs 147, SE=13.6 g/d and 389 and 397 vs 419, SE=18.4 g/d for phase 1 and 2, respectively) and G/F (.90 and .91 vs .93, SE=.062 and .83 and .84 vs .83, SE=.024 for phase 1 and 2, respectively) compared to the control, low SBM diet (1A). These results suggest that using the particular combinations of acid blend, enzyme blend, and flavor used in this study prevents a reduction in pig performance when replacing more digestible animal-protein feedstuffs with SBM in a nursery diet.

Phase/ Diet	Corn	Whey	SBM	Plas- ma	R oat	Fish M	Oil	AA's	Vit/ Min	Lys	ME
1/A	31.3	23.0	8.0	6.5	13.5	12.5	2.5	.1	2.1	1.65	3356
1/B	32.7	23.0	20.0	2.4	6.5	7.2	4.1	.5	3.1	1.65	3356
2/A	46.4	18.0	18.0	3.0	-	8.5	2.7	.1	2.8	1.44	3344
2/B	44.0	18.0	25.0	1.0	-	3.0	4.1	.5	3.9	1.44	3344

**Key Words:** Pigs, Diet Complexity, Dietary Supplement

**802 Phytase in low phosphorus corn-soybean meal diets for finishing swine: Calcium and phosphorus absorption and excretion.** T. L. Veum\*<sup>1</sup>, D.W. Bollinger<sup>1</sup>, and D.R. Ledoux<sup>1</sup>, <sup>1</sup>University of Missouri, Columbia.

This experiment was conducted to evaluate lower, more cost effective phytase concentrations on P absorption and excretion by finishing pigs (n = 120, 51.5 kg initial and 123 kg final BW) fed a low-P corn-soybean meal diet. Growth performance and bone breaking strength have been reported (J. Anim. Sci. 75, Suppl. 1:68). The basal low-P diet with no added inorganic P contained .32% total (t)P, .05% available (a)P and .38% Ca. The basal low-P diet was supplemented with 0, 150, 300 or 450 phytase units (PU)/kg (Natuphos 5,000, BASF, Inc.). The positive control (PC) diet contained .41% tP, .15% aP, and .50% Ca. The Ca:tP ratio as kept at 1.2:1 in all diets by reducing Ca below the NRC requirement in the low-P diets. All diets contained 13% CP, .66% lysine and 3.45 Mcal of ME/kg. Chromium oxide was added to the diets at .05% for a two week period midway through the experiment as a nondigestible indicator. Fecal samples were collected from each pen (experimental unit) daily for four consecutive days. There were linear increases (P<.01) in Ca and P absorption and linear decreases (P<.01) in fecal P excretion with increasing concentration of phytase. Absorption of P (g/d) was similar (P≥.2) for the PC and the 450 PU/kg treatments. Fecal P excretion (g/d) was reduced (P<.01) 37 and 38% by the 300 and 450 PU/kg treatments, respectively, compared to the PC. In conclusion, phytase was effective in increasing P absorption and reducing P excretion in low-P corn-soybean meal finishing diets.

**Key Words:** Swine, Finishing, Phytase

**803 Soybean protein products affect nutrient digestibilities and fecal characteristics of dogs.** G. M. Clapper\*<sup>1</sup>, C. M. Grieshop<sup>1</sup>, N. R. Merchen<sup>1</sup>, J. C. Russett<sup>2</sup>, and G. C. Fahey, Jr.<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>Central Soya Company, Inc., Fort Wayne, IN.

Plant-based protein sources are generally less variable in chemical composition as compared to animal-based protein sources. However, relatively little data are available on the nutrient digestibility of plant-based protein sources by companion animals. The effects of including selected soybean products in dog diets on nutrient digestion at the ileum and in the total tract, as well as fecal characteristics, were evaluated. Six protein sources were utilized: soybean meal (SBM), Soyafluff 200W (soy

flour), Profine F [traditional aqueous-alcohol extracted soy protein concentrate (SPC)], Profine E (extruded SPC), Soyarich I (modified molecular weight SPC), and poultry meal (PM). Diets were extruded and kibbled. Protein sources varied widely in crude protein (CP) and fat content; however diets were isonitrogenous and isocaloric. Nutrient intakes were similar, except for total dietary fiber (TDF), which was lower for dogs fed the PM diet. No differences (P>.05) were observed in dry matter (DM) intake. Ileal digestibilities of DM, organic matter (OM), fat, and TDF were not different (P>.05); however, CP digestibility at the terminal ileum tended (P<.06) to be higher for diets containing plant-based protein sources compared to the PM diet. Total tract CP digestibility was greater (P<.02) when feeding plant-based proteins vs. PM diets. Dry matter, OM, fat, and TDF total tract digestibilities were not different (P>.05) among treatments. As-is fecal weight was highest (P<.05) for dogs consuming the soy flour diet; however excretion of feces by dogs consuming the SPC diets was not different from that of dogs consuming the PM diet. Fecal weight on a DM basis was higher (P<.05) for the soy flour treatment as compared to all other treatments, and the SPC treatments were not different (P<.05) from the PM treatment. Soy protein concentrates offer a viable alternative to PM as a protein source in premium canine diets.

**Key Words:** Dog, Soy, Nutrient digestibility

**804 Effect of liquid whey and L-glutamine supplementation on the productive parameters and intestinal integrity of the piglet and early-weaned pig.** B. Sanchez<sup>1</sup>, A. De la Cruz<sup>1</sup>, G. Villar<sup>1</sup>, R. Mendoza<sup>1</sup>, G. Mariscal<sup>2</sup>, and G. Borbolla\*<sup>1</sup>, <sup>1</sup>Facultad de Medicina Veterinaria y Zootecnia U.N.A.M., <sup>2</sup>Centro Nacional de Investigación Disciplinaria.

The effect of L-glutamine on the small intestinal mucosa (SIM) of the piglet and early-weaned pig and its performance were evaluated in this study. One hundred and one lactating pigs (7d of age) were randomly distributed into three treatment groups. In the first group (C), besides the milk provided by the sow, the piglets had unrestricted access to a drinker containing tap water. Pigs in the second group received fresh cow liquid whey (LW), while animals in the third group (LWG) had unlimited access to liquid whey and 1% L-glutamine (glutamine). All the solutions were changed in a daily basis and drinkers replenished as needed. At weaning (d 21), eight pigs per treatment were killed and samples of the SIM were taken for histological evaluation. The remaining pigs were transferred to another facility and fed a corn-soybean base diet (1.2% lys, and 3240 ME Mcal/kg). For seven days more, the pigs received the same solution as during the lactation period. Animal exposed to liquid whey with or without glutamine had a superior (P<.01) daily liquid consumption when compared to pigs with access to tap water (1486, 1201 and 625 ml, respectively), The same trend (P<.01) was observed with feed consumption (117, 106 and 65 g/day, respectively). For ADG, diarrhea and mortality, there were not differences (P>.05), among treatment groups. However the ADG was numerically superior in the treatments LW and LWG when compared with the C (157, 137 and 119 g/day, respectively). The inclusion of glutamine improved (P<.06) the jejunum villus height when compared to the LW and C groups (356.3, 332.2 and 272.3 μm, respectively). The use of L- Glutamine and liquid whey in the piglet and early weaned pigs can decrease the damage to the small intestine mucosa observed at weaning, and improved feed consumption.

**Key Words:** Piglet, Early Weaning, Glutamine

**805 Order of limiting amino acids in a practical corn-soy diet for growing pigs.** M.E. Johnston\*<sup>1</sup>, R.D. Boyd<sup>1</sup>, C.E. Fralick<sup>2</sup>, and J.L. Usry<sup>3</sup>, <sup>1</sup>PIC USA Inc., Franklin, KY, <sup>2</sup>Swine-Tek Research and Consulting, Van Wert, OH, <sup>3</sup>Heartland Lysine Inc., Chicago, IL.

The objective was to determine if threonine or tryptophan is more limiting for grower pigs (37.3 to 62.7 kg BW) fed corn-soy diets. PIC337 x C22 castrates and gilts (48 pens, 10 pigs/pen) were sorted by weight and randomly allotted to one of eight diets (37.3±0.6 kg, 60 pigs/treatment). The control diet (1) contained corn and soy as the only amino acid sources (0.88% true ileal digestible lysine (TIDLys)). A negative control diet (2) limiting in TIDLys (0.80%) was also formulated using corn and soy as the only amino acid source. In diets 3, 4, and 5 L-lysine was added at 0.15, 0.225, and 0.30%, respectively, to maintain a 0.80% TIDLys level. Diet 6 contained 0.30% L-lysine and 0.10% L-threonine

(TIDThr:Lys ratio=65%). Diet 7 was the same as diet 6 plus 0.05% DL-methionine (TIDM+C:Lys ratio=62%). Diet 8 was formulated as diet 7 with the addition of 0.03% L-tryptophan (TIDTrp:Lys ratio=19%). Feed intake was unaffected ( $P > .35$ ) by dietary treatment. There was a numerical increase in feed conversion (GF) when pigs were fed diet 2 vs 1 suggesting that TIDLys was limiting in diet 2. Pigs fed diets 4 and 5 had decreased ( $P < .01$ ) ADG compared to pigs fed diet 2 (0.88 and 0.87 vs 0.92 kg/d). The addition of threonine to diet 6 resulted in a numerical improvement in ADG (0.90 kg/d) compared to pigs fed diets 4 and 5 and GF (0.44) equal to diet 2. With the addition of DL-methionine and tryptophan to diet 8, pigs had ADG (0.94 kg/d) comparable to pigs fed the control diet (0.93 kg/d) even though the TIDLys level was lower. The data indicate that threonine is second limiting in practical corn-soy diets and that the addition of 0.10% L-threonine will give comparable results as a corn-soy diet with no added synthetic amino acids but formulated to the same TIDLys level. Addition of threonine, methionine, and tryptophan to a diet containing 0.30% L-lysine tended to improve ADG and GF so that no difference existed between the control and amino acid supplemented diets.

**Key Words:** Pigs, Lysine, Threonine

**806 Pork quality characteristics of pigs fed different types of fat and high levels of vitamin E.** E. van Heugten\* and M. T. See, *North Carolina State University, Raleigh.*

An experiment was conducted to evaluate the effects of short term vitamin E supplementation on pork quality of pigs ( $n=300$ , 88.5 kg initial BW) fed saturated or unsaturated types of fat. Pigs were allotted to 60 pens based on body weight, sex, and litter of origin and received one of 10 dietary treatments during the final 6 wk of the finisher period. Treatments were arranged in a  $2 \times 5$  factorial randomized complete block design. Factors included: 1) fat type (choice white grease or soybean oil) and 2) supplemental vitamin E level (0, 100, 200, 400, or 800 mg/kg). The basal corn soybean meal diet contained 5% fat, 15 mg/kg vitamin E and 0.75% lysine. Pigs were slaughtered at a commercial plant and loin samples obtained 24 h post-mortem. Performance and carcass characteristics were not affected ( $P > .27$ ) by fat type or vitamin E. Muscle vitamin E concentration increased linearly ( $P < 0.01$ ) from 3.22 mg/kg to 6.65 mg/kg for pigs fed 0 to 800 mg/kg of vitamin E in diets containing soybean oil. In pigs fed choice white grease, muscle vitamin E concentration increased quadratically ( $P < 0.06$ ) and reached a maximum (5.92 mg/kg) at 400 mg/kg of vitamin E. Minolta L\* and b\* values were lower (less pale and yellow, respectively) for loin chops from pigs fed either 0 or 400 mg/kg of vitamin E compared with pigs fed 200 mg/kg of vitamin E ( $P < 0.05$ ). Pork redness (a\* value) and drip loss were not affected by treatments ( $P > 0.16$ ). Oxidative stability (TBARS) of cooked loin samples was decreased in pigs fed soybean oil ( $P < 0.02$ ) compared to pigs fed choice white grease. Oxidative stability (measured only for diets containing 0, 400, or 800 mg/kg of vitamin E) was improved by 400 mg/kg of vitamin E, but no further improvement was observed with 800 mg/kg ( $P < 0.10$ ). These results suggest that the extent of vitamin E accumulation in loin muscle depends on dietary fat type. Furthermore, vitamin E supplementation and fat type had minimal effects on fresh pork quality, but have the potential of improving oxidative stability of cooked product.

**Key Words:** Vitamin E, Fat, Pork Quality

**807 Effect of iron supplementation of piglets on bioavailability of iron in ferrous sulfate.** B. K. Anderson\*, N. R. Augspurger, and M. Ellis, *University of Illinois, Urbana.*

This study tested the effect of iron supplementation of piglets on bioavailability of iron (Fe) in ferrous sulfate using hemoglobin (Hb) depletion/repletion. A slope-ratio design used sixty pigs ( $4.69 \pm .34$  kg BW, and  $18.44 \pm .34$  d of age) from six litters of a commercial genotype (PIC L-337 x PIC C-22) were utilized in a  $2 \times 5$  factorial arrangement of treatments in which two levels of iron supplementation (0 or 30 mg) were given via IM injection at birth, and five dietary levels of iron (27, 52, 77, 102, or 127 ppm) were fed during a 21-d study period. Post-weaning, pigs were moved to plastic nursery pens and randomly assigned to dietary treatment from outcome groups formed on the basis of supplementation level, litter and weight. A basal diet based on dried skim milk and corn contained 27 ppm Fe. Experimental diets were formulated from aliquots of the basal diet to have incremental additions of 25, 50, 75, and 100 ppm Fe via substitution of corn starch

with ferrous sulfate. Pigs were given ad libitum access to assigned diets for 3 wk and feed disappearance and weight gain were recorded for the period. Initial and final blood samples were obtained by jugular puncture and Hb concentrations were measured colorimetrically. Initial Hb concentration was different ( $P < .008$ ) between supplementation levels; however, no difference between dietary levels was detected. Supplementation level exhibited no effect on ADG and ADFI, but both parameters increased significantly ( $P < .001$  and  $P < .03$ , respectively) in response to increasing dietary iron concentration. Final plasma Hb concentration was affected significantly ( $P < .02$  and  $P < .001$ ) by increasing both supplementation level and dietary iron concentration. The regression of final hemoglobin and average daily iron intake was determined to be linear (0 mg:  $Y=3.933948$  (SE .68012390) + .069948 (SE.01376826) \* Iron intake;  $R^2=.5398$ ;  $P < .001$ . 30 mg:  $Y=5.998730$  (SE .41543038) + .050084 (SE .00818588) \* Iron intake;  $R^2=.5901$ ;  $P < .001$ ). This study suggests iron supplementation at birth does affect the estimate of iron bioavailability in ferrous sulfate.

**Key Words:** Pigs, Iron, Bioavailability

**808 Growth rate, carcass composition and onset of estrus in developing gilts fed cottonseed meal.** T.C. Schell\*<sup>1</sup>, C.R. Dove<sup>1</sup>, and D.K. Bishop<sup>2</sup>, <sup>1</sup>University of Georgia, <sup>2</sup>Brown's of Carolina.

Ninety-three crossbred gilts (ave initial wt, 54.7 kg) were used to evaluate the effects of feeding one of three levels of cottonseed meal (0, 7.5, or 15%) to developing gilts. At the initiation of the trial, the diets were formulated to contain 16.5% CP, 0.85% lysine, and 1550 kcal ME. When the gilts reached an average body weight of 91 kg the diets were formulated to contain 15.5% CP, 0.75% lysine and 1550 kcal ME. The control diet was a corn-soybean meal based diet. For the treatment diets, cottonseed meal (CSM) replaced soybean meal. Fat and synthetic lysine were used as necessary to balance for energy and lysine. The CSM contained 1.2% total gossypol and 0.09% free gossypol. Gilts were penned four to a pen and when the average body weight of a pen reached 91 kg, the pen was given fence exposure to boars for at least 15 min twice a day. After the average body weight of a pen reached 109 kg, gilts were individually heat checked twice a day using a boar. After reaching a standing estrus, gilts were removed from the pen and trial. Age, weight, 10th rib backfat depth, loin eye area, ADG, and feed intake were compared when the gilts reached their first estrus. Feeding CSM reduced the days to first estrus linearly ( $P < .05$ ). Gilts fed the 0, 7.5 and 15% CSM reached first estrus at 186 d, 181 d and 177 d respectively. Feed intake increased as the level of CSM in the diet increased (3.3, 3.1 and 3.5 kg/d, linear effect,  $P < .01$ ). Feeding CSM meal also tended ( $P < .08$ ) to increase ADG to first estrus (1.92, 1.92 and 2.02 kg/d respectively). However, the gilts fed the 7% CSM had the best ( $P < .05$ ) feed efficiency (G/F: 0.29) compared with the gilts fed other two diets (0.27). There were no differences in body weights (125 kg), 10th rib backfat depth (29 mm) or loin eye area at estrus. In summary, feeding up to 15% CSM to developing gilts can reduce the number of days to first estrus, increase ADFI and ADG to first estrus and produce carcass characteristics similar to those of gilts fed soybean meal.

**Key Words:** Swine, Cottonseed meal, Puberty

**809 Iron bioavailability in Methiron 65 measured by hemoglobin regeneration in anemic rats.** I. Mejia-Haro\*<sup>1</sup> and H.-Y. Chen<sup>2</sup>, <sup>1</sup>CIGA ITA de Ags., Mexico, UNL, <sup>2</sup>University of Nebraska, Lincoln.

The objective of this study was to determine the bioavailability of iron (Fe) in Metiron 65. Thirty male weaned rats were fed individually an iron deficient diet (7 ppm) for 1 wk (depletion period). Twelve rats were completely randomized and assigned to one of three treatments (a purified diet with different levels of supplemented Fe); T1, 8 mg/kg; T2, 16 mg/kg; and T3, 24 mg/kg for a 3-wk period. The control group (CG) consisted of 18 rats fed the purified diet with no Fe supplement. Ferrous sulfate heptahydrated was used as a standard to which data were compared. Rats were weighed at the beginning of the depletion period and every week. Another group of 10 rats was sacrificed prior to the depletion period to know the degree of Fe depletion. At the end of the experiment, blood samples were taken and hemoglobin concentration (HbC) was determined. Data of average daily gain (ADG), daily feed intake (DFI), HbC, Hb repletion (HbR), HbFe retention and HbFe efficiency were calculated. Values of HbR, HbC and efficiency of HbFe

were compared with the standard source by slope ratios. Data were analyzed by ANOVA and slope ratio methods. The lowest HbC ( $P < .01$ ) was found in rats of CG, followed by rats of T1 and T2 and the highest value in rats of T3. The value of DFI was lower ( $P < .01$ ) in CG than in T2 and T3 and higher in T2 than T1 and T3. ADG in CG was lower ( $P < .05$ ) than the rest of the treatments; T2 was higher ( $P < .01$ ) than T1 and T3. Rats in T2 had the greatest ADG and compared to the standard source, Methiron presented a relative efficiency of 123%. HbR was lower ( $P < .01$ ) in CG and higher in T2 and T3; HbFe efficiency was only different between CG and T1, ( $P < .01$ ) and ranged from 57 to 69%. HbR was higher ( $P < .01$ ) in T2 and T3 than in T1 and CG. Comparing these data with those of the standard, an efficiency of 67% was calculated for Methiron 65. Values of HbC and HbR were inversely related to ADG and the relative availability of Fe in Methiron 65 was lower than that of the standard when the response was HbC and HbR and higher for ADG. Response to dietary Fe intake is different in ADG and Hb regeneration.

**Key Words:** Iron, Bioavailability, Rats

**810 Effects of vitamins and minerals on growth performance and pork quality in finishing pigs.** J. S. Park\*, J. D. Hancock, D. H. Kropf, R. H. Hines, C. L. Jones, D. J. Lee, D. W. Dean, and N. Amornthawaphat, *Kansas State University, Manhattan.*

A total of 80 crossbred pigs (average initial BW of 84 kg) were used to determine the effects of manipulating vitamin and mineral concentrations in late finishing on growth performance and pork quality. There were two pigs per pen and 10 pens per treatment. The basal diet was corn-soybean meal-based with treatments arranged in a split-plot design. Whole plot treatments (phase 1) were: 1) no vitamin/trace mineral premixes; and 2) standard additions of vitamin and mineral premixes from 84 kg to 102 kg BW. For 102 kg to slaughter at 120 kg (phase 2), subplot treatments (no change in vitamin/trace mineral supplementation vs addition of a special premix with 500 mg/kg of vitamin E, 500 mg/kg of vitamin C, 200 mg/kg of Mg from magnesium proteinate, and 150 mg/kg of Fe from iron proteinate) were imposed within the whole-plot treatments. For 84 kg to 102 kg, removing vitamin and trace mineral premixes did not affect ADG ( $P > .15$ ), ADFI ( $P > .80$ ), or gain/feed ( $P > .28$ ). For 102 kg to slaughter, growth performance also was not different ( $P > .11$ ) among pigs fed diets without or with vitamin/trace mineral premixes. Furthermore, measurements of meat quality (pH, color, marbling, firmness, drip loss, thawing loss, cooking loss, shear force, and hunter  $L^*a^*b^*$ ) were not affected ( $P > .15$ ) by removing vitamin/trace mineral premixes or addition of the special premix. In conclusion, removing vitamin/trace mineral premixes and/or supplementation with extra vitamin E, vitamin C, Mg, and Fe did not affect growth performance or meat quality in finishing pigs.

**Key Words:** Vitamin, Mineral, Finishing pig

**811 Separation and detection of essential amino acids using High Performance Liquid Chromatography (HPLC).** J. Aranda-Ruiz\*, R. González-González, E. Gutiérrez-Ornelas, H. Bernal-Barragán, and E. Olivares-Sáenz, *Universidad Autónoma de Nuevo León, México.*

The objective of this study was to develop a technique for analysis of amino acids using high performance liquid chromatography (HPLC) in feed ingredients. A solution (30  $\mu$ l of 100 mM) of each one of the 10 essential amino acids, as well as mixtures of the 10 amino acids (30  $\mu$ l of each one) were placed in Eppendorf tubes. Dilutions of the amino acids standard (1.25, 2.5, 5, 7.5, 15 and 30  $\eta$ M) were made in order to carry out a calibration curve. All these solutions were subjected to derivatization using 200  $\mu$ l of methanol, 50  $\mu$ l of triethylamine and 30  $\mu$ l of phenylisothiocyanate. The derivatized amino acids were lyophilized and resuspended in 2 ml of methanol. The chromatography was carried out injecting 10  $\mu$ l of the sample in the HPLC equipment. It was used a column of reverse phase ODS (C18 of 244 mm, 4mm of internal diameter with a size of particle of 4 microns). It was used a UV-V detector with a wavelength of 254 nm. The attenuation was of 100 millivolts. The elution was in a gradient, using sodium acetate 0.03 M pH 6.4 as a buffer (Solution A) and a mixture of acetonitrile and water 60:40 (Solution B). Linearity, repeatability, reproducibility and limit of detection were evaluated. The coefficient of variation (CV) of the repeatability of the analysis was less than 1% for most of the amino acids. The CV for reproducibility was less than 7% for most of the amino acids. The

regression coefficient for linearity was 0.98. The limit of detection was as low as 0.125 nM.

**Key Words:** Amino acid analysis, HPLC, Feed analysis

**812 Methodology of measuring phosphorous digestibility in feedstuffs for pigs.** M. Z. Fan\*<sup>1</sup>, T. Archbold<sup>1</sup>, D. Lackeyram<sup>1</sup>, T. Rideout<sup>1</sup>, Y. Gao<sup>1</sup>, R. R. Hacker<sup>1</sup>, C. F. M. de Lange<sup>1</sup>, W. C. Sauer<sup>2</sup>, and E. J. Squires<sup>1</sup>, <sup>1</sup>*University of Guelph*, <sup>2</sup>*University of Alberta, Canada.*

The objective of this study was to develop a valid method for measuring phosphorous digestibility in feedstuffs for pigs. Soybean meal was used as a "model feedstuff". Four Yorkshire barrows, with an average initial weight of 10 kg, were fitted with a simple T-cannula at the distal ileum and fed four diets according to a 4 x 4 Latin square design with four experimental periods. The diets were cornstarch-based containing four levels of phosphorous from soybean meal (.09, .18, .27 and .35, respectively, on as-fed basis). Chromic oxide (.4%) was included as a digestibility marker. Each experimental period consisted of 8 d with 4-d adaptation and 4-d collection of representative ileal digesta and fecal samples. Apparent ileal and fecal phosphorous digestibility values in soybean meal were determined by the marker technique, whereas true ileal and fecal phosphorous digestibility values were determined by the regression analysis technique. The apparent ileal and fecal phosphorous digestibility values were affected ( $P < .05$ ) by phosphorous levels in the assay diets. Apparent ileal and fecal phosphorous digestibility in soybean meal increased from -24.8 to 37.1% and from 18.8 to 45.2%, respectively as dietary phosphorous content was increased from .09 to .35%. There was no difference ( $P > .05$ ) between the true ileal ( $50.7 \pm 7.1$ ) and the true fecal ( $48.5 \pm 5.4$ ) phosphorous digestibility (%) in soybean meal, indicating that the large intestine does not contribute to phosphorous absorption. Our results suggest that differences in phosphorous content between assay diets are primarily responsible for the reported large variability in apparent phosphorous digestibility values within the same feedstuff. True rather than apparent phosphorous digestibility should be determined in feedstuffs and used in diet formulation for swine.

**Key Words:** Phosphorous, Digestibility in Pigs, Soybean meal

**813 A dynamic model to estimate nutrient requirements in pregnant and lactating sows.** J. G. Kim\*, Y. W. Shin, and K. Y. Whang, *Korea University, Seoul, Korea.*

A dynamic computer model was developed to estimate the energy and protein requirements in pregnant and lactating sows and propose the customized feeding program based on body weight (BW) and body condition. Input variables were BW and P2 backfat depth (P2) at breeding, expected fetus number and litter size. The BW and P2 were used to determine the body components. During gestation, sow growth was divided into two segments, maternal and conceptus growth. The potential maternal BW gain during gestation was derived from the BW at breeding. Body weight changes of pregnant sows calculated from published data were used to determine the maternal growth pattern, and equations were adapted to estimate the energy and protein requirements for conceptus growth. The P2 at farrowing was calculated according to potential BW gain and ideal maternal body condition. The energy and protein requirements of conceptus were determined by fetus number. Fetus number in pregnancy and litter size in lactation were not necessarily the same, and the litter size was a factor that influenced on the energy requirement of lactating sows. The energy requirement for milk production was decided by the expected milk consumption by piglets or milk production capacity of sows, whichever was smaller. Regression equations of the estimated energy (E, KJ/d) and protein requirements (P, g/d), employing BW and day (D) as factors, are as follows: during gestation,  $E_G = 188500 \cdot \exp(-0.5 \cdot ((BW-214)/161.9)^2 + ((D-1210)/638.4)^2)$  ( $r^2 = 0.94$ ) and  $P_G = 1710 \cdot \exp(-0.5 \cdot ((BW-159)/94.7)^2 + ((D-1120)/539)^2)$  ( $r^2 = 0.84$ ), and during lactation,  $E_L = 118403 \cdot \exp(-0.5 \cdot ((BW-693.1)/689.5)^2 + ((D-16.7)/14.8)^2)$  ( $r^2 = 0.99$ ) and  $P_L = 1074.2 \cdot \exp(-0.5 \cdot ((BW-989.1)/1901.1)^2 + ((D-17.4)/14.3)^2)$  ( $r^2 = 0.99$ ). Estimated values by the model indicate that the energy and protein requirements vary markedly with potential body growth and the litter size. In late gestation, the rates of increase in energy and protein requirements of heavier sows are relatively higher than those of lighter sows. These results also suggest that NRC sow model (1998) generally overestimated the protein requirement

but underestimated the energy requirement during both gestation and lactation periods.

**Key Words:** Sows, Dynamic Model, Nutrient Requirements

**814 Effects of dietary supplementation of diatomaceous earth and zeolite on ammonia and hydrogen sulfide emission from growing-finishing pigs fed corn and soybean meal-based diets.** Y. Gao<sup>\*1</sup>, T. Rideout<sup>1</sup>, D. Lackeyram<sup>1</sup>, T. Archbold<sup>1</sup>, M. Z. Fan<sup>1</sup>, E. J. Squires<sup>1</sup>, C. F. M. de Lange<sup>1</sup>, T. K. Smith<sup>1</sup>, and G. Duns<sup>1</sup>, <sup>1</sup>*University of Guelph*.

A trial was conducted to examine the effects of dietary supplementation of two natural binding compounds, i.e., diatomaceous earth and zeolite, on ammonia and hydrogen sulfide emission from swine slurry. Six Yorkshire barrows, initial wt of 25 kg, were fed six diets according to a 6 x 6 Latin square design with six experimental periods. The diets were corn and soybean meal-based, contained the same amount of protein and amino acids and differed in the source and level of binding compounds. Diet 1 had no binding compounds and served as the control; diets 2, 3 and 4 were with 1.2, 2.4 and 3.6% of diatomaceous earth, respectively; diets 5 and 6 were with 0.6 and 1.2% of zeolite, respectively. Each period lasted for 14 d with 10-d adaptation followed by 4-d collection of feces and urine. For each period, fresh manure slurry was made by mixing the collected fresh feces with urine at a ratio of 1:2.5 (wt/wt). Accumulative ammonia and hydrogen sulfide emission from the slurry of different dietary treatment conditions was measured with our recently established trapping system at different time points (0, 24, 30, 54, 78 and 102 h, respectively) at the room temperature. Supplementing diatomaceous earth in the diets 2, 3 and 4 respectively decreased the 102-h accumulative NH<sub>3</sub> emission by 27.4, 41.5 and 43.9% (11.9, 9.6 and 9.2 vs. 16.4 g NH<sub>3</sub>/kg DM slurry) in comparison with the control diet. Furthermore, adding zeolite at the level of 0.6 but not at the level of 1.2% also decreased the 102-h accumulative NH<sub>3</sub> emission by 29.3% (11.6 vs. 16.4 g NH<sub>3</sub>/kg DM slurry) in comparison with the control diet. However, adding both diatomaceous earth and zeolite appeared to have no effects (P>.50) on H<sub>2</sub>S emission from the slurry. In conclusion, adding diatomaceous earth in swine diets can effectively decrease ammonia emission from swine manure slurry.

**Key Words:** Diatomaceous earth and zeolite, Ammonia and hydrogen sulfide emission, Pigs

**815 Effects of early-weaning versus suckling on the gastrointestinal tract and whole body growth in neonatal pigs.** D. Lackeyram<sup>\*1</sup>, M. Z. Fan<sup>1</sup>, T. Archbold<sup>1</sup>, T. Rideout<sup>1</sup>, Y. Gao<sup>1</sup>, M. Borysenko<sup>1</sup>, A. M. Gibbins<sup>1</sup>, E. J. Squires<sup>1</sup>, and D. G. Burrin<sup>1</sup>, <sup>1</sup>*University of Guelph, Ontario, Canada*, <sup>2</sup>*Baylor College of Medicine*.

This experiment is to compare effects of weaning piglets at early age with low-quality corn and soybean meal-based starter diet versus suckling on the gastrointestinal tract and whole body growth. A group of six Yorkshire piglets were weaned with a Phase II starter diet containing corn and soybean meal to meet NRC requirements for CP (26% CP) and amino acids for 10 d from the age of 10 to 22 d. The suckling group of piglets were suckling with access to a creep diet for the same period of time. As expected, the weaning group only had about 28% (48.8±10.2 vs. 177.8±13.4 g/day, n = 6) of body weight gain of the suckling piglet group. The weaning group piglets had much longer small intestine than the suckling group piglets (188.0±4.8 vs. 163.0±7.7 cm/kg BW), suggesting weaning stimulates the elongation of the small intestine in neonatal pigs. There were no differences (P>.05) in the absolute fresh weights of the small intestine (189.9±10.7 vs. 189.4±18.4 g/pig, n=6) between the two groups of piglets. Relative fresh weights of the small intestine were much smaller in suckling (38.2±1.4 g/kg BW) than in the weaning (46.1±3.0 g/kg BW) piglets, indicating that the gut is less efficient in handling nutrient digestion and absorption in support of whole body growth in the weaning piglets than the suckling.

**Key Words:** Early-weaning and suckling, Growth, Neonatal pigs

**816 Effects of early-weaning versus suckling on the gastrointestinal tract and whole body growth in neonatal pigs.** D. Lackeyram<sup>\*1</sup>, M. Z. Fan<sup>1</sup>, T. Archbold<sup>1</sup>, T. Rideout<sup>1</sup>, Y. Gao<sup>1</sup>, M. Borysenko<sup>1</sup>, A. M. Gibbins<sup>1</sup>, E. J. Squires<sup>1</sup>, and D. G. Burrin<sup>1</sup>, <sup>1</sup>*University of Guelph*, <sup>2</sup>*Baylor College of Medicine*.

This experiment is to compare effects of weaning piglets at early age versus suckling on the gastrointestinal tract and whole body growth. A group of six Yorkshire piglets were weaned on Phase II starter diet for 10 d from the age of 10 to 22 d. The diets contained corn and soybean meal to meet NRC requirements for crude protein (26% CP) and amino acids. Another group of piglets were suckling from sows and had access to a creep diet for the same period of time. As expected, the weaning group only had about 28% (48.8±10.2 vs. 177.8±13.4 g/day, n=6) of body weight gain of the suckling piglet group. The weaning group piglets had much longer small intestine than the suckling group piglets (188.0±4.8 vs. 163.0±7.7 cm/kg BW), suggesting weaning stimulates the elongation of the small intestine in neonatal pigs. There are no differences (P > .05) in the absolute fresh weights of the small intestine (189.9±10.7 vs. 189.4±18.4 g/pig, n=6) between the two groups of piglets. Relative fresh weights of the small intestine is much smaller (P<.05) in suckling (38.2±1.4 g/kg BW) than in the weaning (46.1±3.0 g/kg BW) piglets. These results suggest that the gut is less efficient in handling nutrient digestion and absorption to support whole body growth in the weaning than in the suckling piglets.

**Key Words:** Early-weaning and suckling, Growth, Neonatal pigs

**817 Postprandial kinetics of supplemental K-difformate in duodenal digesta of weaned piglets.** Z. Mroz<sup>\*1</sup>, A.W. Jongbloed<sup>1</sup>, and M. Overland<sup>2</sup>, <sup>1</sup>*Institute for Animal Science and Health, Lelystad, Holland*, <sup>2</sup>*Norsk Hydro ASA (Hydro Nutrition), Oslo, Norway*.

An experiment was conducted to measure the postprandial kinetics of supplemental K-difformate (an alternative to in-feed antibiotics) in the small intestine of weaned piglets. Six crossbred sib gilts initially 10 kg BW and 34 d of age were fitted with T-duodenal cannula, and fed a cereal-soybean meal based diet with graded doses of K-difformate (.0, .9, and 1.8%) according to a double 3 x 3 Latin square design. Feeding level was 2.5 MJ ME/kg metabolic BW. Daily rations were given in two meals (water:feed ratio of 3:1). Duodenal digesta were sampled at 0, 30, 60, 90, 120, 180 and 240 min. after feeding. The piglets had no clinically manifested health problems related to the duodenal T-cannulation and/or doses of K-difformate. The contents of formate in the duodenal digesta were linearly increasing (P<.001) with increasing doses of K-difformate, irrespective of the sampling time. Luminal amounts of formate varied from 79 to 93% of the consumed formate from K-difformate. Due to the greater concentrations of formate in digesta, also the luminal pH has been decreasing by .3 to .5 units (P<.05), particularly up to 65 min after feeding. Concentrations of K in the duodenal digesta were positively correlated with increased K intake from K-difformate. The postprandial amount of luminal K gradually increased up to 3 times of its dietary intake, presumably due to a meaningful contribution of endogenous K from the outflow of pancreatic juice into the duodenum. Postprandial flow patterns of Co (a marker for liquid phase in digesta) were found similar among the treatments, what implies that K-difformate did not affect the gastric emptying patterns. Trypsin activity in the duodenal digesta was similar among the treatments. In conclusion, we found that K-difformate did not affect gastric emptying patterns, and its composite formate entered into the small intestine. Thereby, colonisation of epithelial cells by enterotoxigenic bacteria could be inhibited.

**Key Words:** Piglet, K-difformate, Kinetics

**818 Evaluating variable feed energy levels for grow-finish pigs.** C.T. Herr<sup>\*</sup>, D.C. Kendall, K.A. Bowers, and B.T. Richert, *Purdue University, West Lafayette, IN*.

One-hundred fifty-nine pigs, 84 barrows (B) and 75 gilts (G), with an initial weight of 29.0 kg were allotted by sex and weight to evaluate the effects of dietary metabolizable energy (ME) concentrations on growth performance and carcass traits. Pigs were fed one of four dietary treatment sequences ad libitum for 97 days. Diet sequences consisted of four phases (29-54, 54-74, 74-98, 98-115 kg, respectively) with lysine levels consistent through all four dietary energy treatments (total lysine

1.1, .9, .75, and .6%, phase 1-4, respectively) and varying energy levels; diet sequence 1 (Corn-soy + fiber) containing 3.20, 3.20, 3.22, 3.12 Mcal/kg, diet 2 (corn-soy) 3.31, 3.32, 3.33, 3.23 Mcal/kg, diet 3 (corn-soy + 3.5% fat) 3.47, 3.49, 3.50, 3.34 Mcal/kg, and diet 4 (corn-soy + 7% fat) 3.63, 3.65, 3.66, 3.51 Mcal/kg of feed. Pigs were weighed at the end of each phase and total feed consumed was recorded to determine average daily gain (ADG), average daily feed intake (ADFI), and gain:feed (G:F). Carcass data were obtained at a commercial slaughter facility. Increased levels of ME increased in overall (0-97 d) ADG (846, 872, 897, 917 g/d respectively; linear,  $P < .001$ ) and G:F (.32, .34, .36, .39 respectively; linear,  $P < .001$ ). Overall ADFI decreased as ME levels increased in the diet (2.60, 2.57, 2.49, 2.35 kg/d respectively; linear,  $P < .001$ ). Final BW increased with increasing ME (111, 114, 116, 118 kg, respectively; linear,  $P < .001$ ). Overall, ADG and ADFI were higher in B than G (921 vs. 845 g/day; 2.62 vs. 2.4 kg/day, respectively,  $P < .001$ ). As ME was increased in the diet, backfat depth increased (18.9, 18.7, 20.9, 22.4 mm respectively; linear,  $P < .001$ ). B had greater backfat thickness than G (21.84 vs. 18.57 mm;  $P < .001$ ). Percent lean decreased as ME increased (54.6, 54.6, 54.1, 53.5%; linear,  $P < .02$ ) and G had a higher percent lean than B (54.8 vs. 53.6%;  $P < .001$ ). During phase 1, all pigs had similar ADFI ( $P > .75$ ), consequently, ADG increased linearly with increasing ME/kg ( $P < .001$ ). However, during phases 2, 3, and 4, pigs adjusted ADFI relative to dietary energy concentration to achieve similar ME intakes ( $P > .46$ ). Based on growth rate, optimal dietary lysine:energy ratios for phase 1, 2, 3, and 4 were 3.00, 2.50, 2.25, and 1.80 g Lysine/Mcal ME, respectively.

**Key Words:** Pigs, Grow-finish, Dietary energy

**819 Evaluating inclusion levels of soybean hulls in finishing pig diets.** K. A. Bowers\*, C. T. Herr, T. E. Weber, D. Smith, and B. T. Richert, *Purdue University, West Lafayette, IN.*

One hundred sixty-five pigs (85 barrows (B) and 80 gilts (G); initial BW=70.8 kg) were used to evaluate feeding varying levels of soybean hulls (SH) added to corn/soybean meal diets for finishing pigs. Pigs were blocked by weight (6 to 7 pigs/pen) and phase fed one of five dietary treatments for eight weeks: 1) 0% SH; 2) 3% SH; 3) 6% SH; 4) 9% SH; and 5) 9% SH with added fat to make near-isocaloric to diet 1. Diets were formulated for the first 4 wk (P1), at .56% App. Dig. Lys and Kcal ME/kg as follows: diet 1) 3380; 2) 3334; 3) 3288; 4) 3244; 5) 3385, and the second 4 wk (P2), at .48% App. Dig. Lys and Kcal ME/kg; 1) 3394; 2) 3349; 3) 3303; 4) 3257; 5) 3398. Diets 1 through 4 were compared for linear, quadratic, and cubic effects of SH concentrations and diet 5 was contrasted with diet 1 for effects of SH in a similar energy density diet. Average daily gain (ADG), average daily feed intake (ADFI), and gain to feed ratio (G:F) were determined at 14-day intervals. In P1, ADG and ADFI increased with diet 2 and then decreased with increasing concentrations of SH (ADG; 930, 993, 839, 871, and 971 g/d, respectively; lin.,  $P < .04$ ; cubic,  $P < .01$ ; ADFI; 2.98, 3.07, 2.72, 2.88, and 2.92 kg/d, respectively; cubic,  $P < .04$ ). During P1, pigs fed diet 5 had greater G:F than pigs fed diet 1 (.337 vs. .310;  $P < .005$ ), however, no differences were observed in ADG in P1, P2, or overall between pigs fed diets 1 and 5. Pigs fed increasing levels of SH had decreasing G:F (.279, .274, .271, .252, and .275, respectively; linear,  $P < .03$ ) in P2. Over the entire 8 wk, increasing levels of SH decreased ADG (921, 943, 857, 866, and 930 g/d, respectively; lin.,  $P < .01$ ; cubic,  $P < .03$ ), G:F (.294, .298, .288, .276, and .302, respectively; lin.,  $P < .02$ ) and final BW (122.5, 123.8, 118.3, 119.3, and 122.9 kg, respectively; lin.,  $P < .01$ ; cubic,  $P < .03$ ). There were no dietary effects on backfat thickness, however, loin depth increased in pigs fed diet 2 and then decreased with increasing levels of SH (quad.  $P < .009$ ). B had greater fat depth ( $P < .001$ ), lower loin depth ( $P < .0001$ ) and % lean ( $P < .001$ ) than G. These results indicate that adding 3% SH may improve growth performance of late finishing pigs. However, inclusion rates greater than 3% SH without increasing ME/kg results in significant reductions in ADG and G:F.

**Key Words:** Soybean hulls, Pigs, Growth

**820 Digestibility of nutrients in diverse soybean genotypes when fed to growing pigs.** D. J. Lee\*<sup>1</sup>, J. D. Hancock, R. H. Hines, J. M. DeRouchey, C. A. Maloney, D. W. Dean, H. Cao, and J. S. Park, <sup>1</sup>*Kansas State University, Manhattan.*

Four crossbred barrows (60 kg average BW) were fitted with T-cannulas at the distal ileum and used in a 4 x 4 Latin square to determine the digestibility of nutrients in various extruded soybean preparations.

Cornstarch-based diets were formulated to 19% CP with: 1) soybean meal (46.5% CP); 2) low trypsin inhibitor soybeans; 3) low oligosaccharide soybeans; and 4) high oleic acid soybeans. Urease activities of the extruded soybeans ranged from .02 to .03 DpH indicating that proper heat processing was accomplished. Apparent digestibilities for DM, N, and lys were not different ( $P > .70$ ) among the soybean meal and dry-extruded whole soybean (DEWS) preparations. Digestibility of fatty acids was greater for the DEWS preparations than for the soybean meal ( $P < .001$ ), but no differences were detected among the various DEWS treatments ( $P > .35$ ). Our data indicate that digestibility of nutrients was similar among soybean meal and DEWS made from low trypsin inhibitor, low oligosaccharide, and high oleic acid soybean genotypes.

Item	Soy bean meal	Low trypsin inhibitor	Low oligo-saccharide	High oleic acid	SE
DM dig, %	78.6	78.4	79.2	77.4	1.0
N dig, %	82.0	80.9	82.1	82.5	1.1
Lys dig, %	85.8	86.2	86.0	86.8	1.0
True lys dig, %	88.8	89.2	89.1	89.9	1.0
Fatty acid dig, %	76.4	90.2	91.2	89.0	1.5

**Key Words:** Pig, Soybeans, Digestibility

**821 Digestibility of nutrients in food-grade sorghum for finishing pigs.** D. W. Dean\*, J. D. Hancock, R. H. Hines, and D. J. Lee, *Kansas State University, Manhattan.*

Six crossbred barrows (average initial BW of 73 kg) were used in a 6 x 6 latin square to determine digestibility of nutrients in food grade sorghum. Treatments were: 1) corn; 2) bronze-pericarp sorghum (Pioneer 8500); 3) heterowaxy food-grade (white pericarp/tan plant) sorghum (NC+ 7W97); and 4 and 5) two food-grade sorghums with normal starch type (Cargill 888Y and Jowar 1). The cereals were hammermilled through a 3.2-mm screen and fed as 95.5% of a diet with vitamins, minerals, and synthetic amino acids added to meet or exceed NRC (1998) recommendations. Apparent digestibilities of DM ( $P < .01$ ), N ( $P < .001$ ), and GE ( $P < .01$ ), and percentage N retention ( $P < .01$ ) and ME ( $P < .01$ ) were greater for pigs fed corn compared to those fed sorghum. The heterowaxy sorghum had greater digestibility of DM ( $P < .01$ ) and ME ( $P < .01$ ) than the food-grade genotypes with normal starch type but these effects were caused primarily by the low digestibilities of DM and energy for Cargill 888Y (Jowar 1 vs 888Y,  $P < .001$ ). However, none of the food-grade sorghums were superior to the bronze pericarp sorghum for utilization of energy or N ( $P > .2$ ). Thus, our results suggest that sorghums are lower in digestibility of energy and N compared to corn and that nutrient digestibilities among the bronze and white pericarp sorghums were similar.

Item	Pioneer		Cargill		SE	
	Corn	8500	NC+ 7W97	888Y Jowar 1		
DM digestibility, %	87.8	87.1	87.2	84.3	87.0	.4
DE, %	87.6	86.3	86.3	83.5	86.8	.5
ME, %	86.2	85.0	85.2	82.1	85.8	.5
ME, Mcal/kg	3.28	3.18	3.21	2.97	3.20	.02
N digestibility, %	83.9	75.2	76.6	73.9	76.1	1.0
Biological value, %	77.6	73.7	73.2	75.7	70.9	2.4
N retention, %	65.1	55.5	56.0	56.0	53.9	2.2

**Key Words:** Sorghum, Food-grade, Pig

**822 Effect of high oil corn and method of substitution on grow-finish pig performance and dust production.** R.C. Thaler\* and S.H. Pohl, *South Dakota State University, Brookings.*

Effect of high oil corn and method of substitution on grow-finish pig performance and dust production.

Two trials involving a total of 200 gilts averaging 22.7 kg were conducted to determine the effect of high oil corn (HOC) on performance and dust production. Pigs were housed in mirror-image rooms with separate mechanical ventilation systems with dust levels measured every 2 weeks. A 3-phase feeding program was used in both trials with meal diet switches made at pig weights of 41 and 77.3 kg. Lysine levels by phase in the corn diets were 1.00, .85, and .75%, respectively. At a final weight of 109 kg, all pigs were ultrasonically scanned for 10th rib BF and LMA. In trial 1, the treatments were either normal corn (C) or HOC (LB)

replacing normal corn on a lb-for-lb basis. In the grower phase, pigs fed HOC tended to gain faster ( $P < .07$ ) and were more efficient ( $P < .04$ ) than pigs fed the C diet. There were no differences in performance in the finisher 1, finisher 2, or overall periods, nor were there differences in BF. However, there was a tendency ( $P < .075$ ) for pigs fed HOC diets to have smaller LMA. The mean dust concentrations in the HOC room was 40% less than the levels in the C room. In trial 2, the treatments were the same as in trial 1 plus a third treatment in which HOC replaced corn on a constant lysine:calorie ratio (L:C). The ratios for the 3 phases were 3.05, 2.60, and 2.27 g lysine/mcal ME, respectively. In the grower phase, L:C pigs gained faster ( $P < .05$ ) than pigs consuming LB diets, and were more efficient ( $P < .01$ ) than pigs fed the other 2 diets. No differences were observed in the finisher 1 or 2 phases. In the overall period, pigs fed L:C ate less feed ( $P < .08$ ) than C pigs, and pigs fed wither of the HOC diets were more efficient ( $P < .05$ ) than pigs were C diets. No differences were observed in BF, but feeding L:C diets tended to result in larger LMA when compared to LB diets ( $P < .16$ ). Mean dust levels were reduced 37% in the HOC room. Thus, HOC results in a 40% reduction in dust levels, and needs to be incorporated into diets on a constant lysine:calorie basis.

**Key Words:** Pigs, High Oil Corn, Dust

### 823 Nutrient digestibilities of intact and insect damaged high oil corn and commercial corn fed to growing pigs. R. F. Gilliam\*, C. S. Darroch, and K. R. Robbins, *University of Tennessee, Knoxville*.

The objective of the trial was to determine the nutritive values of damaged high oil corn (DHOC), undamaged high oil corn (UHO) and commercial corn (NC). Two groups of 12 crossbred barrows, average BW of 32.1 kg, were placed in metabolism crates in a RCBD to determine energy and protein digestibilities. In each 10-d feeding period (5 d adaptation, 5 d total collection), pigs were fed the test grain as the only source of protein and energy in the diet. Vitamins and minerals were supplied to meet NRC (1998) requirements. Insect damaged HOC had lower ( $P < .0001$ ) 1000 kernel weights, 238.1 g ( $\pm 3.32$ ;  $n=5$ ) when compared to UHO (355.4 g) and NC (272.0 g). Compared to UHO, insect damaged HOC had fewer intact kernels (50.8% vs 77.0%,  $P < .0001$ ), more insect damaged whole kernels (15.9% vs 5.0%,  $P < .0001$ ), more fragmented kernels (32.3% vs 17.6%,  $P < .0001$ ) and more chaff (0.9% vs 0.4%,  $P = .0028$ ). NC had the greatest percentage of intact kernels (87.9%), and the lowest percentages of damaged whole kernels (1.5%) and fragmented kernels (10.2%). Despite differences in quality, UHO and DHOC had higher GE values (3866 kcal/kg and 4081 kcal/kg, respectively) than NC which averaged 3562 kcal/kg. UHO had the highest level of crude protein (9.1%), DHOC was intermediate (8.9%) and NC had the lowest crude protein level (7.6%). Final pig live BW, adjusted for initial BW were not different among treatments ( $P = .8692$ ) but pigs in the second replication were heavier ( $P = .0168$ ) than those in the first replication. The coefficient for apparent fecal protein digestibility was highest (85.2%) for UHO. DHOC had a lower ( $P = .0464$ ) coefficient for protein digestibility (81.3%,  $\pm 1.10$ ). The apparent fecal protein digestibility of NC was intermediate to those of UHO and DHOC. Digestible energy differed among treatments ( $P = .0001$ ) and averaged 3658.42 kcal DE/kg, 3788.72 kcal DE/kg and 3314.21 kcal DE/kg for UHO, DHOC and NC respectively. The results of this experiment suggest that insect damage to HOC lowers protein quality and availability, but has little impact on digestible energy levels. HOC even when damaged may be used as a replacement for commercial corn in diets for growing pigs.

**Key Words:** High oil corn, Nutrient digestibility, Growing pigs

### 824 Effect of creatine monohydrate on finishing pig growth performance, carcass characteristics, and meat quality. B. W. James\*, R. D. Goodband, J. A. Unruh, M. D. Tokach, J. L. Nelssen, P. R. O'Quinn, and B. S. Andrews, *Kansas State University, Manhattan*.

Growth performance, carcass characteristics, and meat quality were evaluated from 320 pigs (PIC C22  $\times$  L326) fed either a control diet (.75% lysine) or diets containing added creatine monohydrate (CMH). Pigs (initially 53.5 kg) were sorted by weight, gender, and ancestry in a randomized complete block design and allotted to one of four dietary treatments with eight replicates. Pigs were fed a sorghum-soybean meal

diet until 30-d preharvest (87.2 kg) when dietary treatments were initiated. Experimental treatments consisted of: 1) a control diet; 2) control diet with 3 g CMH/pig/d for 30-d (maintenance); 3) 25 g CMH/pig/d for 5-d followed by 3 g CMH/pig/d for the next 25-d (early load); 4) or 25 g CMH/pig/d 5-d before slaughter (late load). Average market weight was 112.4 kg. Feeding CMH did not affect ( $P > .10$ ) ADG, ADFI, or gain:feed ratio (G:F) during the 30-d supplementation period. Average back fat, tenth rib fat depth, longissimus muscle area, and percentage lean were not affected ( $P > .25$ ) by feeding CMH. Visual color and marbling scores were not affected ( $P > .20$ ) at 24-h or 14-d postmortem; however, the mean firmness score of all pigs fed CMH was greater ( $P < .05$ ) at 24-h and 14-d postmortem than pigs fed the control diet. Longissimus muscle percentage moisture, protein, and lipid and 14-d postmortem loin purge loss and Warner-Bratzler shear force values were not affected ( $P > .21$ ) by treatment. Longissimus muscle drip loss percentage at 24-h postmortem was less ( $P < .05$ ) for pigs fed maintenance and late load CMH compared to pigs fed early load CMH (4.06, 4.15, vs 5.76%). Maintenance CMH pigs also tended to have less ( $P < .09$ ) drip loss than control pigs (4.06 vs 5.31%). At 14-d postmortem, the mean of pigs fed CMH had less ( $P < .06$ ) drip loss compared to control pigs. These results suggest that added CMH does not affect finishing pig growth performance but may increase longissimus muscle firmness and decrease drip loss at 14-d postmortem.

**Key Words:** Pigs, Creatine, Meat Quality

### 825 Effects of feeding supra-nutritional levels of vitamin E on pork quality in two different genotypes. J. L. Hasty\*, E. van Heugten, and M. T. See, *North Carolina State University, Raleigh*.

The objective of this study was to examine the effects of feeding supra-nutritional levels of vitamin E on pork quality of different genotypes. Pigs ( $n=240$ ) with an average initial BW of 87 kg, were blocked by weight and randomly assigned to one of ten treatments (8 pens/trt, 3 pigs per pen) in a 2  $\times$  5 factorial arrangement. Factors included: 1) genotype, (Berkshire  $\times$  PIC as superior meat quality breed and Hampshire  $\times$  PIC as poor meat quality breed) and 2) supplemental levels of vitamin E (0, 75, 150, 300 and 600 mg/kg). Animals were fed standard corn and SBM based diets containing 2.5% fat, 0.83% lysine and 15 mg/kg vitamin E for 6 weeks. Biopsies of the longissimus dorsi (LD) were obtained at the initiation of the experiment, d 21, and d 42 of supplementation. Fluid loss and pH of the fluid from biopsy samples were used as indicators of pork quality and were not affected by vitamin E supplementation ( $P > .10$ ). However, fluid loss was greater ( $P < .07$ ) in Hampshire pigs (51.9 vs. 47.7%) and pH of the fluid was greater ( $P < .10$ ) in these pigs compared to Berkshire pigs (6.40 vs. 6.35). Pigs were slaughtered at a commercial facility after the 6 week experimental period and loin samples were obtained 24 hr post-mortem. Drip loss was greater ( $P < .001$ ) in Hampshire pigs compared to Berkshire pigs (92.9 vs. 66.3 mg fluid accumulated on filter paper). Muscle vitamin E concentration increased linearly ( $P < .001$ ) from 2.02 to 5.92 mg/kg for pigs fed 0 to 600 mg/kg of vitamin E. Concentration of vitamin E in muscle was greater in Berkshire pigs compared to Hampshire pigs when 75 mg/kg of vitamin E was fed (4.72 vs. 3.76 mg/kg). In summary, pre-slaughter muscle biopsy fluid loss appeared to be an accurate indicator of post-slaughter drip loss. Results of the study further demonstrate that differences in fresh pork quality exist between genotypes (as measured by drip loss), but did not appear to be improved by vitamin E supplementation.

**Key Words:** Vitamin E, Genotype, Pork Quality

### 826 Effects of increasing L-lysine HCl on growth performance and carcass characteristics of gilts from 27 to 120 kg. M. De La Lata\*, S.S. Dritz, M.D. Tokach, R.D. Goodband, and J.L. Nelssen, *Kansas State University, Manhattan*.

A total of 1,200 gilts (PIC C22  $\times$  337) with an initial weight of 29 kg were used in a 116-d growth trial to determine the effect of increasing L-lysine HCl in corn-soybean meal based diets on growth performance and carcass characteristics. Pigs were housed in a fully slatted commercial research facility and allotted to one of 8 dietary treatments in a randomized complete block design with 25 pigs/pen and 6 pens/treatment. The dietary treatments were fed in four phases and consisted of a positive control diet with no added L-lysine HCl and 6 increasing levels of L-lysine HCl (.05, .10, .15, .20, .25, and .30%) replacing the lysine

provided by soybean meal. A negative control treatment with no added L-lysine HCl was formulated to contain .10% less total lysine than the other treatments to ensure dietary lysine was not above required levels. For the overall experiment, ADG and G/F decreased in a quadratic fashion ( $P < .05$ ) by increasing L-lysine HCl in the diet. Treatment did not influence ( $P > .70$ ) ADFI. The response was similar for every phase. Fat depth increased (linear  $P < .01$ ) and loin depth, percent lean, and fat free lean index (FFLI) decreased by increasing L-lysine HCl in the diet. The results of this experiment indicate that no more than .15% L-lysine HCl should replace lysine from soybean meal in a corn-soybean meal based diet to avoid deficiencies of other amino acids.

Item	Neg.	L-Lys HCl, %							P <	CV
		0	.05	.10	.15	.20	.25	.30		
ADG, g	717	798	807	794	798	744	717	708	.01 <sup>a</sup>	3.2
G/F	.353	.387	.390	.388	.391	.361	.356	.356	.01 <sup>a</sup>	2.6
BF, mm	17.8	16.8	16.9	17.2	17.1	17.6	18.2	17.8	.01 <sup>b</sup>	4.7
Lean, %	54.8	55.8	55.6	55.3	55.5	55.3	54.7	54.8	.01 <sup>b</sup>	1.0
FFLI	50.1	50.5	50.5	50.3	50.4	50.1	49.8	50.1	.01 <sup>b</sup>	.78

<sup>a</sup>Quadratic effect.

<sup>b</sup>Linear effect.

**Key Words:** Lysine, Corn, Finishing Pigs

**827 Growth performance of gilts fed low-crude protein diets supplemented with crystalline amino acids including valine, isoleucine, and histidine.** J. L. Figueroa\*, A. J. Lewis, P. S. Miller, and R. L. Fischer, *University of Nebraska, Lincoln.*

Two experiments were conducted to determine the fifth-limiting amino acid in a low-crude protein, corn-soybean meal diet. In each experiment, thirty-six gilts (initial weight 19.5 and 21.9 kg, respectively) were individually penned and fed one of six diets in a randomized block design for 35 d. Diets containing 16% CP (positive control), 12% CP (neutral control), and 11% CP (negative control) were used in each experiment. In Exp. 1, the 11% CP diet was supplemented with isoleucine (Ile), valine (Val), or Ile + Val to concentrations equal to those in the 16% CP diet. In Exp. 2, the 11% CP diet was supplemented with histidine (His), His + Val, or His + Val + Ile. All low-CP diets were supplemented with lysine, tryptophan, threonine, and methionine to provide the same concentrations, on a total basis, as those in the 16% CP diet. Gilts were allowed ad libitum access to feed and water. In Exp. 1, Ile supplementation of the 11% CP diet decreased growth performance and backfat thickness ( $P < .05$ ). Valine supplementation did not affect growth performance ( $P > .05$ ). However, the addition of Ile + Val resulted in ADG, ADFI, and longissimus muscle areas that were similar to the 12% CP and 16% CP diets ( $P > .05$ ). Plasma urea nitrogen (PUN) concentrations were reduced as CP concentration was reduced ( $P < .01$ ), but there was no further effect with addition of Ile and/or Val ( $P > .05$ ). In Exp. 2, supplementation of the 11% CP diet with His decreased ADG by 7% and ADG/ADFI by 3%, but the decreases were not significant ( $P > .30$ ). Supplementation of His + Val increased ADG ( $P < .05$ ) and tended to increase ( $P < .10$ ) ADFI and ADG/ADFI. Reduction in CP concentration reduced PUN concentration ( $P < .01$ ). There were no differences among all low-CP diets in PUN concentration ( $P > .05$ ). These data indicate that supplementation of Val in combination with Ile or His improved growth rate of pigs fed an 11% CP corn-soybean meal diet. Neither Ile, Val, nor His alone resulted in beneficial effects.

**Key Words:** Pigs, Amino Acids, Crude Protein

**828 Influence of energy and lysine concentration on performance and carcass yield of heavy weight pigs.**

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A total of 192 Pietrain\*Large White x Large White\*Landrace pigs were used to study the influence of dietary energy and lysine concentration on performance of heavy weight pigs. They were fed a common diet (2,300 kcal NE/kg and 0.97% lysine) from 20 to 80 kg and then their respective experimental diets to 120 kg of live weight. There were six diets arranged as a factorial 2x3 with two levels of dietary net energy (2,300 vs 2,415 kcal/kg) and three levels of total lysine (0.65, 0.70 and 0.75%). Each treatment was replicated 8 times (2 females and 2 castrated males caged together). Pigs fed high energy diets grew faster and transformed feed into gain more efficiently than pigs fed low energy diets (977 vs 927 g/d and 3.26 vs 3.45 g/g; respectively,  $P < 0.05$ ). Feed intake was not affected by the energy concentration of the diet. Increasing the level of lysine up to 0.65% improved growth and feed conversion (979 vs 897 g/d and 3.25 vs 3.55 g/g, respectively;  $P < 0.01$ ) but no additional improvement was detected between 0.70 and 0.75%. Castrated males grew faster (989 vs 928 g/d;  $P < 0.01$ ). Neither energy concentration nor lysine content of the diet influence carcass yield ( $P > 0.05$ ). At 120 kg body weight castrated males and females had similar killing out percentage (76.3 vs 75.9%;  $P > 0.05$ ). It is concluded that growth and feed conversion of pigs of 120 kg were improved when the energy concentration of the diet was increased from 2,300 to 2,415 kcal NE/kg and that 0.70% of lysine was sufficient to optimize performance traits at this weight. Killing out percentage was not modified by any of the treatments studied.

**Key Words:** Heavy weight pigs, Lysine, Net energy

**829 Modeling of dietary lysine requirements for pigs fed Ractopamine.**

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Ractopamine (RAC) has been approved to be fed to market pigs at levels (RL) from 5 to 20 ppm. RAC increases empty body protein accretion (PA, 24%), fat-free lean growth rate (34%) and reduces feed intake (FI 5.3%) when fed at 20 ppm for the last 40.8 kg live weight gain. The response to RAC is greatest the first 21 d or 20 kg live weight gain on RAC, after which time, the RAC response decreases. The relative RAC response was modeled as  $RR = 1.408 \exp [0.050224 w - (1.09164/w) - (.002607w^2)]$  where w is live weight gain (kg) on RAC. This RR function is based on data in which barrows (N=142) and gilts (N=143) were individually scale fed two levels of RAC (0 vs. 44.7 mg/d; Williams et al. 1994). The RAC response is affected by RL. The increase in PA (g/d), due to RAC, was modeled as  $.24 (RL/20)^{.50}$  times the control PA at each live weight. The reduction in FI (kg/d) was modeled as  $.053 (RL/20)^{.66}$  times the control FI at each live weight. The lysine content of empty body protein for pigs fed RAC was modeled as  $.068 + (.002 RR \times [RL/20]^{.50})$ . Predicted daily lysine requirements increased rapidly as RR increased. Maximum RR was achieved at 11.1 kg weight gain on RAC. After 22 d on test, RR decreased, and control PA decreased, resulting in decreased daily lysine requirements. The predicted percent lysine required (PLY) for the first 21 d or 20 kg live weight gain on RAC are 41.7% greater than required by pigs not fed RAC. The PLY after 21 d or 20 kg live weight gain on RAC is 21.5% greater than that required by pigs not fed RAC. The predicted percent increases in PLY for pigs fed 10 ppm RAC are 28.1 and 14.4% for the two feeding periods. The predicted percent increase in PLY is 19.3 and 9.7% for pigs fed RAC at the 5 ppm level. The results indicate a two-phase feeding strategy: feed higher percent lysine diets for the first 21 d or 20 kg live weight gain on RAC and reduced lysine levels after 21 d or 20 kg of RAC feeding.

**Key Words:** Ractopamine, Pigs, Lysine