121 Effect of conjugated linoleic acid on DNA fragmentation of preadipocytes in culture. K.M. Hargrave* and J.L. Miner, *University of Nebraska*.

Conjugated linoleic acid (CLA) reduces body fat and increases DNA fragmentation in fat pads of mice. CLA also reduces proliferating 3T3-L1 preadipocyte cell number and differentiating 3T3-L1 cell size and triglyceride content. The hypotheses were: (1) that CLA, and (2) that serum from mice fed CLA, can increase DNA fragmentation and reduce triglyceride content of 3T3-L1 cells. 3T3-L1 preadipocytes were plated in 12-well plates with DMEM and 10% calf serum plus 0, 50, 100, or 200 μM linoleic acid (LA) or CLA complexed to albumin (6.6:1), or 50 nM Staurosporine (4 wells per treatment). Media were changed every 2 d. Detached and attached cell number was determined during proliferation (2 d of treatment), confluence (4 d of treatment), and at three stages of differentiation (8, 10, and 12 d of treatment). Additional cells were supplied with DMEM containing 10% mouse serum from mice fed for 1 wk either a control (7% soy oil) or CLA (6% soy oil + 1% CLA) diet and cells were harvested at 2 d (proliferating) and 4 d (confluence). DNA fragmentation is expressed as the percent of fragmented to total DNA. Intracellular triglyceride content was determined enzymatically. Cell number was reduced ($P < 0.001$) in proliferating and confluent wells treated with 50 or 200 μM of either LA or CLA compared to the control. The 200 μM dose of each fatty acid also reduced ($P < 0.001$) cell number in the first stage of differentiation. The effect of CLA on cell number did not differ from the effect of LA at any stage. However, CLA caused an increase in DNA fragmentation compared to LA in proliferating ($P < 0.001$) and confluent ($P < 0.01$) cells (10.03 vs 1.72 and 3.61 vs 0.67% respectively), but not in differentiating cells. Triglyceride content was increased ($P < 0.01$) by both LA and CLA at the first stage of differentiation. CLA and LA caused a reduction in cell number, but only CLA caused an increase in DNA fragmentation. Interestingly, this increase was present only in preadipocytes, not in cells undergoing differentiation.

Key Words: Conjugated Linoleic Acid, DNA Fragmentation, 3T3-L1 Preadipocytes

122 Fibroblast growth factor receptor 1 mediates disuse atrophy in gastrocnemius and soleus muscles of mice. J.K. Eash*, A. Olsen, A.L. Grant, D.E. Gerrard, and K.M. Hannon, *Purdue University, West Lafayette, IN*.

Skeletal muscles exhibit atrophy following periods of reduced weight bearing. During this atrophy, there is an increased expression of fibroblast growth factor (FGF) in those fibers resistant to atrophy. Members of the FGF family are involved in muscle hypertrophy, however, their effects on muscle atrophy are not known. Therefore, the objective of this study was to determine if changes in FGF signaling alters muscle atrophy. The gastrocnemius and soleus muscles of the left limb of six mice were injected with plasmid DNA containing a cytoplasmic β-galactosidase (β-gal) reporter gene construct with a constitutively active (CMV) promoter (15 μg/limb). Contralateral limb muscles received the same reporter gene construct and 30 μg of plasmid DNA encoding fibroblast growth factor receptor 1 (FGFR-1). Limbs were then subjected to 16 pulses of 150 V of electricity using a pulse stimulator to facilitate plasmid uptake. Mice were randomly assigned to hindlimb suspension (HS) for 7 or 14 d. Another group was suspended for 7 d, then allowed to recover for 7 d. Muscle samples were collected, sectioned, and stained for β-gal. The cross sectional area (CSA) of β-gal positive fibers was determined using light microscopy and image processing software. After 7 d of suspension, β-gal fibers were 20.8 % larger ($P < 0.05$) in FGFR-1 injected muscles than contralateral controls. Similarly, β-gal positive fibers in FGFR-1 treated muscles of animals suspended 14 d were 17.9 % larger ($P < 0.01$) than contralateral muscles. In animals allowed to recover, fibers remained 13.9 % larger ($P < 0.01$) in FGFR-1 injected muscles than controls. These data suggest that fibers expressing FGFR-1 experienced less atrophy and exhibited improved muscle recovery, suggesting that elements of FGF signaling may mediate changes in protein metabolism during disuse atrophy.

Key Words: Muscle Atrophy, Fibroblast Growth Factor, Hindlimb Suspension

123 Regulation of Ankyrin Repeat and SOCS Box Protein (ASB) 15 mRNA Expression in Models of Skeletal Muscle Development. T.G. McDaneld*[1] and D.E. Moody[1], [1]*Purdue University,* [1]*Purdue University*.

Ankyrin repeat and SOCS box protein (ASB) 15 belongs to a family of genes characterized by the presence of both an ankyrin repeat and SOCS (suppressor of cytokine signaling) box motifs. Bovine ASB-15 mRNA was previously shown to be down-regulated in skeletal muscle in response to an anabolic compound. The objectives of this research were to further evaluate ASB-15 mRNA expression in additional models of muscle accretion and cell culture. Regulation of ASB-15 mRNA expression in response to various anabolic compounds was determined in rats. Thirteen 7-wk-old female rats were randomly assigned to each of four treatment groups: control, clenbuterol, trenbolone acetate (TBA), and growth hormone (GH). Changes in blood urea nitrogen (BUN) and ASB-15 mRNA expression were measured at 30 min, 12 h, and 24 h following intraperitoneal injections of each compound (50g/kg). Rats were humanly killed by CO2 asphyxiation prior to collection of blood and tissue samples. Clenbuterol treatment decreased ASB-15 mRNA expression in skeletal muscle at 12 and 24 h ($P<0.01$) and also decreased mRNA expression in lung at 12 h ($P<0.05$). BUN levels were also decreased for clenbuterol treated rats at 12 and 24 h ($P<0.05$) indicating an anabolic response corresponding to the decrease in ASB-15 mRNA expression. TBA treatment decreased BUN levels at 12 h ($P<0.05$), yet ASB-15 mRNA expression was not changed in any of the tissues evaluated ($P>0.10$). GH treatment had no effect on BUN or ASB-15 mRNA expression ($P>0.10$). Expression of ASB-15 mRNA was also measured in C2C12 myoblasts (day 0) and 1, 3, 5, and 7 days after induction of differentiation. ASB-15 mRNA expression increased with differentiation of myoblast to myotubes when compared to day 0 myoblasts ($P<0.01$). We conclude that ASB-15 mRNA is regulated by the anabolic compound clenbuterol and also differentiation of myoblasts. Our data, combined with previous reports of other ASB genes involved in progression of cellular growth, suggest that ASB-15 has a potential role in signaling pathways that regulate skeletal muscle development.

Key Words: Ankyrin, SOCS Box, Muscle Accretion

Nonruminant Nutrition

124 Effects of a growth-altering pre-pubertal feeding regimen on gilt growth and reproductive longevity. P. A. Lyvers-Peffer, J. J. Peng*, J. A. Snedegar, and D. W. Rozeboom, *Michigan State University, East Lansing*.

Two hundred fifty-four crossbred gilts were allotted to one of two rearing nutrition regimens (Moderate or Control) from 9 to 25 wk of age to determine the effects of a high-fiber diet fed intermittently on gilt growth and reproductive longevity. The Moderate regimen used dietary fiber to achieve alternating phases of moderate and maximum growth during four distinct pre-pubertal periods. High-fiber diets, containing 35% ground sunflower hulls, were fed during periods 1 and 3 (3 and 5 wk, respectively) to slow growth. During periods 2 and 4, low-fiber corn-soybean meal (CSBM)-based diets were fed for 3 and 5 wk, respectively, to maximize growth. Control gilts were fed CSBM-based diets in all periods to maximize growth. Ad-libitum access to feed was allowed at all times with both regimens. After 25 wk of age, both treatment groups were managed similarly. Average daily gain was lower ($P < 0.01$) for the Moderate gilts during periods 1 and 3, and greater ($P = 0.03$) for the Moderate gilts during period 4. Moderate gilts consumed more feed during period 4 ($P < 0.01$). During periods 1 and 3, feed efficiency was lower for Moderate gilts ($P < 0.01$). Plasma concentrations of IGF-1 were decreased for Moderate gilts during period 1 and the first wk of period 3 ($P < 0.01$ and $P = 0.03$, respectively). However, there were no differences in plasma IGF-1 concentrations during the last wk of period 3. At puberty, Moderate gilts weighed less than Control gilts ($P = 0.001$; 136.5 ± 1.56 versus 144.1 ± 1.74 kg), but age was similar. All subsequent measures of weight, backfat depth, and loin-eye area were similar. More ($P < 0.05$) Control gilts were culled during rearing and pre-breeding than Moderate gilts, with locomotive failure being the most prevalent reason. Of sows successfully completing parity one, 17% fewer ($P < 0.05$) Control females went on to complete three parities. Altering pre-pubertal growth of developing gilts by intermittent inclu-

sion of dietary fiber may be beneficial in improving their reproductive longevity.

Key Words: Gilts, Fiber, Longevity

125 Efficacy of restricted/ad libitum feeding strategy for group-fed gilts during development. J. Klindt*, J. T. Yen, and R. K. Christenson, *USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

Our previous studies, with gilts individually penned and feed-restricted during a 12-wk growth period prior to entering a breeding facility with *ad libitum* access to feed, showed that d to first estrus were least in gilts subjected to the most severe restriction during the development period. Herein, 180 gilts, 122 d of age and 75.6 kg BW, were assigned to 18 pens with 10 gilts/pen. Gilts were pen-fed to achieve 50%, 68%, and 88% of calculated *ad libitum* intake (treatment, trt). Diets were formulated to restrict only energy. At 221 d of age, gilts were moved to the breeding barn, repenned within trt, given ad libitum access to a common diet, and checked for estrus daily using mature boars. From 245 to 266 d of age, gilts were inseminated (AI) on 1st and 2nd d of estrus. During development period, 122 to 221 d of age, feed consumption was 1512, 2006, and 2647 kg/pen in the 50%, 68%, and 88% groups ($P < 0.01$), respectively. Trts influenced ($P < 0.01$) ADG and BW at 221 d of age; 0.330, 106.4; 0.506, 126.5; and 0.657 kg/d, 138.8 kg for 50%, 68%, and 88% trts, respectively. Within pen, SDs for ADG were not influenced by trt ($P > 0.15$). During breeding period, prior energy restriction induced compensatory feed consumption ($P < 0.09$): 1489, 1348, and 1198 kg/pen for 50%, 68%, and 88% trts, respectively. Total feed fed from 121 to 266 d of age was 3001, 3354, and 3854 kg/pen for 50%, 68%, and 88% trts ($P < 0.01$), respectively. Trts affected ($P < 0.01$) BW after AI or at 266 d of age; 134.6, 151.0, and 157.9 kg for 50%, 68%, and 88% trts, respectively. Treatments did not affect ($P > 0.38$) percentages acyclic, cyclic, and pregnant at 46 d after breeding: 10.0, 88.3, 76.7; 15.0, 80.0, 71.7; and 18.3, 78.3, 70.0; for 50%, 68%, and 88% trts, respectively. Subjecting gilts to dietary energy restriction from 122 d of age until three wk before the start of mating, followed by *ad libitum* feed during breeding period, reduced total feed consumed and had no measurable impact on reproductive performance through 46 d after end of breeding.

Key Words: Gilts, Growth, Reproductive Performance

126 Effects of intrauterine location on fetal growth and development in the pig: nutritional implications. R. L. McPherson*[1], F. Ji[1], G. Wu[2], and S. W. Kim[1], [1]*Texas Tech University,* [2]*Texas A&M University.*

Three hundred and four fetuses from 25 primiparous sows were used in this study to determine fetal growth as related to fetal location within the uterine horn during gestation. All the sows were fed the same gestation diet at equal amounts (2.0 kg/d) and housed in crates during the trial. Sows were randomly assigned to slaughter groups representing days of gestation: 45 (6-sows), 60 (4- sows), 75 (3-sows), 90 (3-sows), 100 (5-sows), and 110 (4-sows). After slaughter, the reproductive tracts were obtained from all the sows and dissected to obtain the fetuses and the placentas. Before the dissection, the location of each fetus was recorded with the cranial extremity of each horn being location number one. The fetuses were further dissected to obtain individual organs: heart, liver, lung, gastrointestinal tract (GIT), spleen (75+ days), and kidneys. Overall, no relationship ($P > 0.05$) was found between fetal location and fetus weight on d 45, 75, 90 or 110 of gestation. However, there was a linear relationship between fetal location and fetus weight on d 60 and d 100 of gestation ($P < 0.01$), showing that the fetuses at the cranial extremities were proportionally larger than those at the caudal extremities of the uterine horn. When gestation day was not considered in analyzing the data, the weights of the fetus, fetal carcass, gastrointestinal tract (GIT), liver and kidney decreased linearly ($P < 0.01$), but the weights of the placenta, heart, lung and spleen decreased linearly ($P < 0.05$), as the location within the uterine horn proceeded cranial to caudal. These data suggest that the fetus at the cranial extremities of the uterine horn may receive more nutrient supplies than the fetus at the caudal extremities. In addition, the results suggest the availability of nutrients in sows on d 60 and d 100 of gestation may have a greater impact on fetal growth than at other gestational ages.

Key Words: Pigs, Intrauterine Location, Fetus

127 Changes of maternal tissues during gestation in primiparous sows: nutritional implications. F Ji*[1], Y. G. Kim[1], G. Wu[2], and S. W. Kim[1], [1]*Texas Tech University, Lubbock,* [2]*Texas A&M University, College Station.*

Thirty-five gilts (128.44±7.45 kg SE) were used to determine the weight changes of various body tissues of sows during gestation. Gilts were housed in individual gestation crates and were divided into two groups (heavy and light) based on BW. Three sows from each group were randomly selected and slaughtered to provide baseline information as day 0 of gestation. The remaining sows were bred and, within a group, randomly assigned to one of six slaughter groups: day 45 (6 sows), day 60 (4 sows), day 75 (5 sows), day 90 (4 sows), day 102 (5 sows) and day 112 (5 sows). All sows were fed 2 kg diet/d (3.115 Mcal ME/kg and 0.56% Lys) until the assigned slaughter d. Body weights of any remaining sows were measured on day 10, 25, 45, 60, 75, 90, 102, and 112 of gestation. The carcass, liver, stomach, small intestine, large intestine, spleen, pancreas, kidney, lung, heart, liver, uterus, mammary gland, and other remaining viscera were obtained, weighed, and ground for further analysis. The body weights and the weights of hot carcass, soft tissue (carcass without bone), bone, and the remaining viscera were increased linearly ($P < 0.05$) as gestation progressed. The proportion of hot carcass, soft tissue, bone, kidney, lung, and liver relative to the body weight was decreased linearly ($P < 0.0001$) as gestation progressed. The weights of stomach, small intestine, large intestine and pancreas, as well as the proportion of these organs relative to body weight were decreased linearly ($P < 0.001$) which might be due to restricted feeding during the gestation period. The weights of the reproductive tract (including fetuses) and average mammary glands were increased with gestation (quadratic, $P < 0.01$). Uterus weight and the proportion of the reproductive tract (including fetuses), fetus and uterus relative to body weight were increased linearly ($P < 0.01$). These data show that growth rates of maternal tissues in restrictedly fed sows vary greatly during gestation. Our findings may have important implications for establishing a feeding strategy for gestating sows to improve reproductive performance.

Key Words: Sows, Gestation, Tissue Growth

128 Apparent digestibility of soluble and insoluble fiber in diets for gestating sows. J. A. Renteria*[1], L. J. Johnston[2], D. D. Gallaher[1], and G. C. Shurson[1], [1]*University of Minnesota, St. Paul,* [2]*University of Minnesota, Morris.*

Twenty-four gestating sows (12 nulliparous, NULL; 12 multiparous, MULT) were fed four experimental diets to assess the apparent digestibility of soluble fiber (S) and insoluble fiber (IS). Experimental diets included corn-soybean meal control (C; 1.59% S, 7.67% IS), corn-soybean meal-34% oat bran high in S (HS; 3.19% S, 8.95% IS); corn-soybean meal-12% wheat straw high in IS (HIS; 1.46% S, 15.36% IS); and corn-soybean meal-16% sugar beet pulp (HS+HIS; 3.20% S, 15.31% IS). Sows were assigned randomly to diets within parity group, and individually fed to meet their energy requirements according to the NRC (1998) assuming 10 pigs per litter and 40-kg gestation gain. Total collections of feces and urine were conducted in 5-d periods at Wk 5, 10, and 14 of gestation. There were no parity group by diet interactions for any response criteria. Apparent digestibility of dietary S (83.8 vs 82.8%; $P > 0.20$) was similar between MULT and NULL sows, while IS digestibility was greater for MULT vs NULL sows (54.5 vs 51.6%; $P < 0.06$). Apparent S fiber digestibility was different among experimental diets (HS, 89.5%; C, 85.8%; HS+HIS, 80.3%; HIS, 77.7%; $P < 0.01$; SE= .84). Apparent IS digestibility was similar between HS+HIS and HS (61.9 and 58.4%), but greater than C (53.5%), while IS digestibility of HIS (38.3%) was lowest ($P < 0.01$; SE = 1.47). There was a time by treatment interaction ($P < 0.01$) for IS digestibility. Generally, digestibility of S improved ($P < 0.01$) as gestation progressed for sows fed C (82.6, 86.7, and 88.2%), HS (89.6, 89.9, and 89.1%), HS+HIS (74.8, 83.5, and 82.5%), and HIS (73.7, 76.9, and 82.5%). Digestibility of IS decreased as gestation progressed for sows fed C (57.6, 52.7, and 50.1%) and HS (67.5, 51.7, and 56.1%), but increased for sows fed HS+HIS (58.3, 64.3, and 63.0%), with no linear trend for sows fed HIS (40.5, 32.9, and 41.6%). In conclusion MULT had greater ability to digest IS than NULL. As gestation progressed, S digestibility improved. Digestibility of IS appeared to improve in the presence of S.

Key Words: Sows, Fiber, Digestibility

129 Comparison of three methods of feeding sows in gestation. M. G. Young*[1], M. D. Tokach[1], F. X. Aherne[2], R. G. Main[1], S. S. Dritz[1], R. D. Goodband[1], and J. L. Nelssen[1], [1]*Kansas State University, Manhattan,* [2]*Alberta Pig Company, Canada*.

A total of 689 sows were used to compare 3 methods of feeding during gestation. Control gilts and sows were fed according to body condition, based on a scale of 1 to 5 (1 = thin, 5 = fat). Feed allowance was arbitrarily set by the farm manager to achieve a body condition score of 3 at farrowing. For method 2, feeding level was based on backfat and weight (at weaning for sows or service for gilts). Feed allowance was modeled from calculations of weight and backfat gain to achieve a target backfat of 19 mm at farrowing with a constant feed allowance from d 0 to 101. Method 3 was similar to method 2, except feeding pattern was altered for thin sows and gilts (< 15 mm backfat at service) in an attempt to reach 19.0 mm backfat by d 36 of gestation. Sows were weighed at weaning (gilts at service) and at entry to the farrowing house (d 112 to 114 of gestation). Backfat was measured between d 0 to 5 and d 108 to 113 of gestation. Sows fed by methods 2 and 3 had achieved backfat of 19.0 and 19.1 mm at farrowing, respectively, while control fed sows numerically tended to have greater ($P < 0.11$) backfat at farrowing (19.9 mm). Control sows had greater backfat gain in gestation (3.6 mm, $P < 0.05$), than those fed using method 2 (2.6 mm), while sows fed with method 3 had intermediate backfat gain (3.0 mm). Control sows had greater weight gain in gestation (49.6 kg, $P < 0.05$) than sows fed with method 2 and 3 (42.3 kg). Sows targeted to gain 6 and 9 mm of backfat in gestation failed to achieve target gains regardless of feeding method. Feeding sows in gestation based on backfat resulted in a higher proportion of sows in the target backfat range (17 to 21 mm) at farrowing and a lower percentage of fat sows (> 21 mm backfat), but no difference in the percentage of thin sows (< 16 mm backfat) compared to the standard method of feeding based on body condition. The higher proportion of sows in the optimum backfat category demonstrates that feeding based on backfat and body weight has the potential for facilitating more precise gestation feeding.

Key Words: Sows, Feed Intake, Backfat

130 Effect of gestation feeding method on sow performance in lactation. M. G. Young*[1], M. D. Tokach[1], F. X. Aherne[2], R. G. Main[1], S. S. Dritz[1], R. D. Goodband[1], and J. L. Nelssen[1], [1]*Kansas State University, Manhattan,* [2]*Alberta Pig Company, Canada*.

A total of 562 sows were used to examine the effect of 3 gestating feeding methods on lactation performance. Control gilts and sows were fed according to a standard 5-point visual body condition score (1 = thin, 5 = fat). Feed allowance was arbitrarily set by the farm manager to achieve a body condition score of 3 at farrowing. For method 2, feeding level was based on backfat and weight (at weaning for sows or service for gilts). Feed allowance was modeled from calculations of weight and backfat gain to achieve 19.0 mm backfat at farrowing with a constant feed allowance from d 0 to 101. Method 3 was similar to method 2, except feeding was altered for thin sows and gilts (< 15 mm backfat at service) in an attempt to reach a target of 19.0 mm backfat by d 36 of gestation. Sow weight and backfat was recorded at entry into the farrowing house (d 108 to 113 of gestation) and at weaning. Lactation feed intake, total number of pigs born, born alive, born dead, mummified, fostered, and weaned were recorded. Dates of weaning and estrus were recorded to calculate wean-to-estrus interval. Performance in lactation and wean-to-estrus interval were not affected ($P > 0.10$) by gestation feeding method. Sow weight at farrowing, weaning, and lactation weight loss were not different ($P > 0.20$) among the three feeding methods. Lactation ADFI was not affected by gestation feeding method. The relationship between weight gain in gestation and lactation feed intake was highly variable with weight gain only explaining 9% of the differences in lactation feed intake. However, when comparing lactation ADFI for the high backfat sows (> 23 mm) to the rest of the population ($\leq$ 23 mm), a tendency ($P < 0.06$) was observed for high backfat sows to have lower ADFI in lactation (5.6 vs 5.9 kg). Total number of pigs born, born alive, born dead, mummified, and fostered pigs were not affected by gestation feeding method. The results indicate that the gestation feeding methods used in this trial had no effect on performance in lactation.

Key Words: Sows, Feeding Method, Lactation

131 Effect of dietary levels of soluble and insoluble fiber on litter size and sow performance. J. A. Renteria*[1], L. J. Johnston[1], S. K. Webel[2], and R. L. Moser[2], [1]*University of Minnesota, St, Paul.,* [2]*United Feeds, Sheridan, IN*.

Three concurrent experiments involving 716 sows were conducted to evaluate the effects of soluble (S) and insoluble (IS) dietary fiber during gestation on litter size and sow performance. Sows were assigned randomly to a common control diet or a high fiber diet within each experiment. In Exp. 1, diets included a corn-soybean meal control (C; 1.54% S, 7.97% IS; n = 122) or corn-soybean meal-30% oat bran high in S fiber (HS; 3.18% S, 8.03% IS; n = 124). In Exp. 2, diets included C (n = 97) or corn-soybean meal-13% wheat straw high in IS fiber (HIS; 1.41% S, 15.63% IS; n = 119), and in Exp. 3, sows received C (n = 123) or corn-soybean meal-21% soy hulls (HS+HIS; 2.99% S, 20.80% IS; n = 131). Experimental diets were offered to sows to supply similar daily amounts of ME (6172 kcal), protein (250 g), and lysine (12 g) beginning two d post-mating. All sows, regardless of treatment, had ad libitum access to a standard lactation diet. The HS diet compared with C supported more sow wt gain during gestation (26.7 vs 16.1 kg; $P < 0.01$), but had no effect ($P > 0.30$) on total litter size born (11.15 vs 11.37 pigs), litter weaning wt (48.39 vs 49.09 kg), or ADFI of lactating sows (5.26 vs 5.45 kg). The HIS diet compared with C had no effect ($P > 0.20$) on sow wt gain during gestation (16.9 vs 13.4 kg), total litter size born (11.44 vs 11.32 pigs), litter weaning wt (54.8 vs 55.2 kg), or ADFI of lactating sows (6.01 vs 6.02 kg). The HS+HIS diet compared with C supported less sow wt gain during gestation (18.5 vs 28.6 kg, $P < 0.01$), and greater ADFI of lactating sows (6.20 vs 5.66 kg, $P < 0.01$), but had no effect ($P > 0.30$) on total litter size born (11.94 vs 12.27 pigs) or litter weaning wt (51.8 vs 53.2 kg). Post-weaning interval to estrus averaged 6.4 d and was not affected ($P > 0.15$) by dietary treatments. In conclusion, gestation diets high in soluble and(or) insoluble fiber can be fed at recommended energy and nutrient intakes without compromising sow or litter performance.

Key Words: Sows, Fiber, Litter Size

132 Full-Fat canola seed as an energy substitute for vegetable oil in late gestation and lactation diets. B. S. Zimprich*[1], R. L. Harrold[1], T. E. Socha[1], and D. Landblom[2], [1]*North Dakota State University, Fargo,* [2]*Dickinson State University, Dickinson, ND*.

A total of 143 litters from 94 mixed parity sows were used to evaluate litter performance, sow body condition change, days to estrus, milk composition, and litter weights, when sunflower oil (SA) or full-fat canola seed (CA) were added to the control (C) diet of corn-soybean meal. Sows were randomly assigned to diets at day 100 of gestation. Sows were weighed and measured for body condition change using realtime ultrasound on day 100 of gestation, farrowing, day 7 and weaning. Milk samples were taken from three randomly selected sows per treatment per farrowing. Milk samples were analyzed for solids, protein, and fat at d 0 and 14. Litter weights were taken on d 0, 1, 7, and at weaning. SA sows returned to estrus earlier than C sows (4.60 vs. 5.25; $P < 0.07$). Sows on SA and CA diets weaned heavier litters than C sows (55.14, 53.37 vs. 49.44 kg; $P < 0.02$). The C and SA sows consumed more feed from d 100 to 0 than CA sows (39.25, 39.94 vs. 37.33 kg; $P < 0.03$). From d 0 to 7 SA sows ate more than sows on C and CA treatments (36.65 vs. 33.46, 32.78 kg; $P < 0.05$). Sows on SA and CA diets consumed more feed than sows on diet C between d 7 and weaning (58.12, 59.51 vs. 51.77 kg; $P < 0.02$). Overall feed intake showed SA sows consumed more feed than C sows (135.3 vs. 124.5 kg; $P < 0.03$). Milk collections taken on d 0 showed no differences between treatments, however, sows on SA diet had a higher butterfat content than sows on diets C and CA at d 14 (9.06 vs. 7.55, 7.86; $P < 0.03$). Sows on the SA diet also had a higher milk solids content on d 14 than sows on diets C and CA (19.61 vs. 18.24, 18.56; $P < 0.02$). Differences in survival rateof nursing piglets among treatments were not observed (88.96, 92.55, and 90.14%). There are benefits of increasing the fat content of late gestation and lactation diets for increased litter performance, and a quicker return to estrus. However, the cost of fat sources must be considered in determining the potential for these inclusions.

Key Words: Full-Fat Canola, Sow Performance, Milk Composition

133 Threonine is more limiting than valine in diets of lactating sows with high body protein loss. K. T. Soltwedel, R. A. Easter, and J. E. Pettigrew, *University of Illinois, Urbana*.

The objective of this study was to determine whether threonine or valine is more limiting in corn-soybean meal diets fed to lactating sows mobilizing a high amount of body protein, using plasma urea nitrogen concentration (PUN) as an indicator of amino acid limitation. The study was conducted as a replicated 4 X 4 Latin Square with three squares. Initial sow BW averaged 241 kg and initial litter size averaged 9 pigs. A diet containing corn and soybean meal as the only protein sources formulated to 0.90% lysine was diluted with starch, sucrose and soybean oil to lower the protein concentration and induce a high rate of body protein loss. L-lysine·HCl and D,L-methionine were added at 0.112 and 0.016% of the diet, respectively, to ensure that lysine and methionine were not limiting. From this basal diet, each of the following dietary treatments was formulated: 1) the negative control (NC) basal diet, 2) the NC diet supplemented with 0.139% L-threonine (NC+T), 3) the NC diet supplemented with 0.174% L-valine (NC+V), 4) the NC diet supplemented with 0.139% L-threonine and 0.174% L-valine (NC+T+V). Dietary treatments were made isonitrogenous by glycine supplementation. The study was initiated on either d 3, 4, or 5 of lactation for each sow. Feed intake was standardized to 4.8 kg/d, an amount of feed that did not exceed sow appetite, yet provided sufficient energy intake (18 Mcal ME/d). Each diet was fed to each sow for a period of four days. At the end of each period, blood samples were collected 5 to 6 h postprandial for analysis of PUN. The PUN was lower ($P < 0.01$) for the threonine-supplemented treatments, and was not affected ($P < 0.10$) by supplemental valine intake (see Table). Total sow BW loss and litter gain averaged 19.58 and 35.05 kg, respectively, for the entire 16-d study. This study demonstrates that threonine is more limiting than valine in corn-soybean meal diets fed to lactating sows with a high rate of body protein loss in lactation, when PUN is used as an indicator.

Diet	NC	NC+T	NC+V	NC+T+V	SEM
PUN, mg/dl	6.43	5.18	6.62	5.33	0.40

Key Words: Sows, Lactation, Limiting Amino Acids

134 Sow and litter responses to dietary organic or inorganic selenium over four parities. D. C. Mahan* and J. C. Peters, *The Ohio State University, Columbus*.

Ninety crossbred (L × Y) gilts evaluated the effects of Se source and levels on sow reproductive performance, and the Se status of the sow and litter. Experimental diets contained inorganic or organic Se (0.15 or 0.30 ppm Se) in a 2 × 2 factorial. A fifth group was fed an equal combination of the Se sources to 0.30 ppm Se. In addition, a basal non-Se fortified diet (0.06 ppm Se) served as a negative control. Diets were C-SBM based and met 1998 NRC nutrient requirements, except for Se. Six treatments were fed to each of three groups over a four parity period. Sows were bled at 70, 110 d postcoitum and at weaning with serum Se and glutathione peroxidase (GSH-Px) determined. Milk was collected at farrowing and weaning from all sows. Blood Se and serum GSH-Px activity were determined from three weanling pigs/litter. Data were analyzed as a repeated measures design. Sow and litter served as the experimental unit. Total and live pigs born were lower ($P < 0.07$) when the basal was fed. There was no increase in litter size beyond 0.15 ppm Se. Organic and inorganic Se resulted in similar sow and litter performances, except that fewer sows fed the 0.30 ppm Se diets completed the study. There was a trend ($P < 0.07$) for sows fed 0.30 inorganic Se to have more spraddle-legged pigs. Sows fed 0.30 ppm Se had higher serum Se ($P < 0.01$) but similar serum GSH-Px levels as 0.15 ppm Se; both being higher than the basal. Sows fed the combination of Se sources had serum Se and GSH-Px values similar to sows fed other 0.30 ppm Se diets. Colostrum and milk Se concentrations were higher ($P < 0.01$) when organic Se was fed, while feeding the combination of Se sources had colostrum and milk Se concentrations similar to the 0.15 ppm organic Se. Weaning pig serum Se increased as the sow Se level increased but GSH-Px activity values were similar when sows were fed 0.15 or 0.30 ppm Se. These results indicate that reproductive performance of sows can be attained with 0.15 ppm Se from either Se source, but the Se status of the sow and weaned pig was higher with 0.30 ppm Se from organic Se.

Key Words: Selenium, Reproduction, Sows

135 Available phosphorus requirements for finishing pigs reared in a commercial facility. C. Hastad*, S. Dritz, J. Nelssen, M. Tokach, R. Goodband, and J. DeRouchey, *Kansas State University, Manhattan*.

We conducted an experiment in a commercial research barn to determine the appropriate dietary P level for pigs from 88 to 109 kg BW. We utilized 1,260 gilts allotted by weight to one of five dietary treatments. There were 28 pigs/pen and 9 pens/treatment. The corn-soybean meal-based diets contained 6% added fat and were formulated to 0.80% total lysine. Available P levels were 0.05, 0.10, 0.14, 0.19, or 0.23% which correspond to 0.152, 0.277, 0.402, 0.527, or 0.652 g aP/Mcal ME. A constant Ca:P ratio (1.1:1) was maintained in all diets. At the conclusion of the experiment, two pigs from each pen where randomly selected, tattooed, and slaughtered to obtain third and fourth metacarpals (MC3 & MC4) which were used to determine bone properties. From d 0 to 14, ADG increased linearly ($P < 0.01$; 621, 683, 691, 734, and 707 g/d) and gain/feed increased (linear $P < 0.02$; 0.325, 0.342, 0.344, 0.361, 0.361) with increasing aP. For d 14 to 26 or overall, there were no differences in growth performance between treatments ($P > 0.17$). For bone properties, MC3 bending moment increased (linear, $P < 0.01$; 100.2, 110.3, 118.4, 112.9, and 120.0 kg-cm) with increasing aP; however, bending moment was not different for MC4 ($P > 0.59$). The percentage ash increased, (linear, $P < 0.01$) for both MC3 (50.1, 50.7, 51.9 52.0, and 52.1%) and MC4 (51.2, 51.6, 51.8, 52.7 and 53.3.%) with increasing aP. Using the repeated measures analysis of SAS for combined MC3 and MC4; bending moment and percentage ash increased (linear, $P < 0.04$ and $P < 0.01$, respectively). Results from this study demonstrate the need for supplemental P in the final finishing diets of pigs raised in a commercial facilities. Using the result from this experiment and data presented last year [JAS 80(Suppl 2): Abstr.# 177] , a regression equation ($0.0000316*(\text{wt, kg})^2$ - $0.00745*(\text{wt, kg})$ + 0.95) was developed to estimate the aP:Mcal ME ratio for pigs reared in commercial facilities.

Key Words: Pigs, Phosphorus, Commercial Facilities

136 Available phosphorus requirement to maximize growth and bone mineralization in 9 to 22-kg pigs. R. W. Fent*[1], G. L. Allee[1], D. M. Webel[2], J. D. Spencer[2], A.M. Gaines[1], D. C. Kendall[1], and J. W. Frank[1], [1]*University of Missouri, Columbia,* [2]*United Feeds Inc., Sheridan, IN*.

A total of 128 barrows (9.5 kg BW) were used in a 21-d feeding experiment to determine the available phosphorus (aP) requirement that maximizes growth performance and bone mineralization. Pigs were allotted by weight to one of eight dietary treatments in a completely randomized design with two pigs/pen and eight replications/treatment. Dietary treatments were formulated to contain varying levels of aP through the addition of monosodium phosphate (MSP). Concentrations of aP ranged from 0.08% to 0.64% at 0.08% increments. All diets were corn-soybean meal-based and formulated to contain 1.25% true digestible lysine and a fixed 1.2:1 Ca:total P ratio. The basal diet contained no added MSP. Breaking load and ash content of the left fibula were determined on all pigs at the end of the 21-d test period. Pen served as the experimental unit. Average daily gain, ADFI, and gain:feed increased quadratically ($P < 0.01$) as aP concentration increased in the diet. Two-slope regression analysis indicated that the breakpoint for ADG (0.55 kg/d) and gain:feed (0.74) occurred at 0.22% and 0.29% dietary aP, respectively. Bone breaking load, grams of fibula ash, and percentage of fibula ash also increased quadratically ($P < 0.01$) as dietary aP concentration increased. Fibula ash, as a percentage of dried fat-free bone weight, was maximized in pigs fed the 0.56% aP diet. However, breakpoint analysis determined the point of inflection to be 0.36% dietary aP. Break-point analysis was not appropriate for evaluation of bone breaking load or grams of fibula ash content. Therefore, 90% of quadratic maximum response of these criteria was utilized to estimate the requirement. Both bone breaking load and grams of fibula ash were maximized at 0.56% aP, but 90% of quadratic maximum occurred at 0.41% and 0.39% dietary aP, respectively. These results indicate a differential aP requirement (growth performance, 0.29%; bone mineralization, 0.41%) for the 9 to 22-kg pig depending upon the evaluation criteria measured.

Key Words: Phosphorus, Pigs, Bone

137 Phosphorus balance in growing pigs fed semi-purified diets adequate or low in dietary phosphorus. L. A. Pettey*, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky, Lexington.*

An experiment was conducted to measure P balance of growing pigs fed semi-purified diets at or below the dietary requirement for P and to estimate the portion of excreted P attributable to endogenous origin. Twelve pigs (59.4 kg) were penned individually in metabolism crates and randomly assigned to three dietary treatments. Diets were: (1) a semi-purified sucrose-dextrose-cornstarch-casein diet (0.82% lysine, 0.08% P) with no added P; (2) as 1 with 0.07% added P from monosodium phosphate (MSP); and (3) as 1 with 0.14% added P from MSP. Calcium was added as Ca carbonate to each diet so that total Ca and P in Diets 1, 2, and 3 were 0.21 and 0.08; 0.39 and 0.15; and 0.57 and 0.22%, respectively. Cellulose (4%) and sand (1%) also were added to the diet. Pigs were fed twice daily equal amounts of feed per replicate to maintain incremental P intake. Pigs were adjusted to treatments for 7 d, followed by a 6-d marker-to-marker collection period. ADG was similar ($P > 0.10$) for each dietary treatment. DM and P intakes for Diet 1, 2, and 3 were 2220, 2237, and 2243 g/d; and 2.18, 3.69, and 5.32 g/d, respectively. Phosphorus excretion in the feces increased linearly ($P < 0.01$) with increasing P intake. Urinary P excretion was low for Diets 1 and 2 (0.018 and 0.102 g/d; $P > 0.10$) but increased ($P < 0.01$) for Diet 3 (0.901 g/d). Absorption and retention of P as a percentage of intake for Diets 1, 2, and 3 were 86.5, 89.8, and 91.1%, and 85.7, 87.1, and 73.9%, respectively. When P absorption (g/d) was regressed on P intake, the relationship was linear ($R^2 = 0.99$) with y = 0.945x - 0.1556. Similarly, as P intake increased, fecal P excretion (g/d) also increased linearly ($R^2 = 0.68$) with y = 0.0608x + 0.1556. From the two intercepts, excretion of endogenous P in the feces was estimated to be 156 mg/d. Based on this experiment, we estimate the daily endogenous contribution of fecal P loss to be approximately 2.6 mg/kg BW in 60-kg growing pigs fed semi-purified diets at or below the dietary requirement for P.

Key Words: Endogenous Loss, Phosphorus Balance, Pigs

138 Whole body composition and phosphorus accretion in growing pigs. L. A. Pettey*, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky, Lexington.*

An experiment was conducted to determine whole body accretion of P in growing pigs. Five sets of five littermate barrows (18 kg) were allotted randomly to five slaughter groups (18, 27, 36, 45, and 54 kg BW). Average initial BW was equalized among slaughter groups. Pigs were fed fortified corn-SBM diets that met or exceeded requirements for all nutrients in two dietary phases (Phase 1, 18-36 kg, 1.10% lysine; Phase 2, 36-54 kg, 0.91% lysine). At assigned BW, pigs were killed and body components were separated into hair, toenails, blood, head, empty viscera, and carcass. Carcasses were split along the dorsal midline with the left side ground for analysis and the right side dissected into lean tissue, fat tissue, skin, and bone. The empty viscera and head components also were ground for analysis. Mass and accretion rates of DM, N, lipid, ash, and P were determined for each body component and dissected tissue. Whole body composition of pigs in each group were: empty body weight (EBW): 16.4, 26.1, 34.1, 43.1, 51.6 kg; N: 397, 650, 888, 1090, 1314 g; ash: 408, 642, 844, 1037, 1268 g; P: 71, 111, 146, 191, 236 g. Accretion rates from 18 kg to final BW for each group were: EBW: 583, 669, 716, 787 g/d; N: 15.0, 18.4, 18.4, 20.5 g/d; ash: 13.9, 16.4, 16.7, 19.2 g/d; P: 2.6, 3.0, 3.3, 3.8 g/d. As EBW increased, the mass (g) of N, ash, and P increased linearly ($R^2 = 0.98$). N:P did not change with increasing EBW ($R^2 = 0.01$) and averaged 5.8 across all weight groups. P accretion rate was linearly ($P < 0.10$) related to N accretion rate ($R^2 = 0.82$) and ash accretion rate ($R^2 = 0.68$). Expressed as a percentage of EBW, whole body composition of pigs in each group were: N: 2.41, 2.49, 2.61, 2.53, 2.55%; ash: 2.46, 2.46, 2.47, 2.41, 2.46%; P: 0.43, 0.42, 0.43, 0.44, 0.46%. Dissected muscle, fat, bone, and skin tissues were: 62.9, 14.9, 15.9, and 6.3% of the carcass for 18 kg pigs, compared with 64.2, 19.0, 12.2, and 4.6% for 54 kg pigs. Based on this study, P retention appears to increase linearly with EBW and is positively related to the accretion of N and ash in 18 to 54 kg growing pigs.

Key Words: Body Composition, Phosphorus, Pigs

139 Effects of an experimental phytase product on phosphorus utilization in pigs. A. M. Gaines*[1], D. C. Kendall[1], J. W. Frank[1], G. F. Yi[1], R. W. Fent[1], G. L. Allee[1], J. D. Spencer[2], and D. M. Webel[2], [1]*University of Missouri, Columbia,* [2]*United Feeds, Inc., Sheridan, IN.*

A 28 d trial was conducted to evaluate the efficacy of an E-coli phytase product (EcoPhos™; Phytex; Portland, ME) on improving the utilization of phytate-bound P in growing pigs. At an initial weight of approximately 8.3 kg, a total of 108 nursery pigs (TR-4 × PIC C22) were allotted to one of nine dietary treatments in a randomized complete block design with six replicate pens per treatment (Trt). The basal diet (Trt 1) was a corn-soybean meal-based diet formulated to contain 0.08% available P, 0.80% Ca, and 1.30% total lysine. Trts 2-4 consisted of the basal diet with three levels of added P (0.05, 0.10, and 0.15%) from monosodium phosphate (MSP) to generate a standard curve for calculation of phytase induced P release. Trts 5-8 consisted of the basal diet supplemented with four levels of EcoPhos™ that supplied 250, 500, 1000, and 2000 phytase units (FTU/kg) of complete feed, respectively. Trt 9 consisted of the basal diet supplemented with Natuphos® phytase that supplied 500 FTU/kg of complete feed. Feed intake, weight gain, and feed efficiency were calculated at the end of the 28 d period, at which time fibulae were removed for ash determination. Both ADG and G:F responded linearly ($P \leq 0.001$) to graded increments of P from MSP (Trts 1-4). Similarly, there was a linear improvement ($P \leq 0.001$) in ADG, G:F and ADFI with the addition of graded levels of supplemental phytase from EcoPhos™. No differences ($P \geq 0.76$) were observed between EcoPhos™ and Natuphos® when supplemented at 500 FTU/kg of complete feed for any of the growth parameters measured. Based on the linear regression of fibula ash on supplemental P intake ($r^2 = 0.75$) the addition of supplemental phytase from EcoPhos™ resulted in a linear improvement in bioavailable P release ($P \leq 0.001$). There were no observed differences ($P \geq 0.67$) in bioavailable P release between EcoPhos™ and Natuphos® (0.08 vs. 0.07%, respectively). These results indicate that supplemental phytase from EcoPhos™ linearly improves utilization of phytate P in corn-soybean meal-based diets fed to young pigs.

Key Words: Phytase, Pigs

140 Effects of a solid-state fermented phytase on growth performance and phosphorus excretion of growing pigs fed corn-soybean meal diets. J. S. Park*, S. D. Carter, J. D. Schneider, and T. B. Morillo, *Oklahoma State University, Stillwater.*

Forty-two barrows (avg BW = 19.9 kg) were used in a 33-d study to determine the effects of the addition of a solid-state fermented phytase complex (Allzyme SSF; Alltech, Inc) to low P, corn-soybean meal diets on growth performance and P excretion. Pigs were blocked by weight and ancestry, and randomly allotted to one of seven dietary treatments (6 pigs/trt). A basal diet consisted of corn and soybean meal and was adequate in all nutrients, except Ca and P. This diet contained 0.34% total P (0.07% available P), all of which was provided by corn and soybean. Treatments were the basal, the basal plus monosodium phosphate (MSP) to provide 0.05, 0.10, and 0.15% added available P, and the basal plus enzyme to provide 250, 500, and 1,000 PU/kg. All diets were formulated to 0.95% total lysine and a Ca:total P ratio of 1.2:1. Pigs were housed individually in metabolic chambers with ad libitum access to feed and water. There were two 5-d total collection periods (d 10-15 and d 25-30) during the 33-d study. Overall, ADG and G:F were, respectively: 0.63, 0.67, 0.74, 0.72, 0.69, 0.74, 0.74 kg/d and 0.45, 0.47, 0.48, 0.49, 0.47, 0.48, 0.49 kg/kg. ADG and G:F increased (linear, $P < 0.03$) with addition of MSP or SSF. However, ADFI was not affected by either addition of MSP or SSF. The addition of 500 or 1,000 PU/kg to the low P, corn-soybean meal diet increased ADG and G:F similar to that for the highest level of MSP. Dry matter, N, and energy digestibility were not different ($P > 0.10$) among treatments, but digestibility of P (44.1, 49.7, 55.8, 60.7, 54.8, 59.5, and 70.5%, respectively) increased (linear, $P < 0.01$) with addition of MSP or SSF. Compared to the basal diet, additions of SSF decreased P excretion (3.06 vs 2.99, 2.35, 1.67 g/d) by 19.3, 23.3, and 45.4%, respectively. These data indicate that the addition of a solid-state fermented phytase improves growth performance and P utilization, and markedly reduces P excretion of pigs fed low-P, corn-soybean meal diets.

Key Words: Pigs, Phytase, Excretion

141 Effects of a solid-state fermented phytase on bone traits and tissue accretion rates of growing pigs fed corn-soybean meal diets. J. S. Park*, S. D. Carter, J. D. Schneider, and T. B. Morillo, *Oklahoma State University, Stillwater*.

A 33-d experiment using 42 barrows (avg BW = 19.9 kg) was conducted to determine the effects of solid-state fermented phytase complex (Allzyme SSF; Alltech, Inc) addition to low P, corn-soybean meal diets on bone traits and tissue accretion rates. Pigs were blocked by weight and ancestry, and randomly allotted to one of seven dietary treatments (6 pigs/trt). A basal diet consisted of corn and soybean meal and was adequate in all nutrients, except Ca and P. This diet contained 0.34% total P (0.07% available P), all of which was provided by corn and soybean meal. Treatments were the basal, the basal plus monosodium phosphate (MSP) to provide 0.05, 0.10, and 0.15% added available P, and the basal plus enzyme to provide 250, 500, and 1,000 PU/kg. All diets were formulated to 0.95% total lysine and a Ca:total P ratio of 1.2:1. Pigs were individually housed in metabolic chambers and allowed ad libitum access to feed and water. At the end of the 33-d study, all pigs were killed, the femurs were excised, and the feet removed to collect the 3rd/4th metacarpals and metatarsals (MM). The remainder of the carcass was ground for ash and P analysis. Bone breaking strength (BS) of MM and femurs and ash (%) increased (linear, $P < 0.01$) with increasing MSP or SSF (35.5, 46.2, 55.2, 69.7, 48.5, 59.3, 65.5 kg; 113, 141, 197, 236, 164, 213, 220 kg; and 47.4, 48.9, 50.3, 52.5, 49.6, 51.5, 52.2%, respectively). Based on average BS and ash, addition of 250, 500, or 1,000 PU/kg was equivalent to 0.066, 0.120, and 0.140% available P, respectively. For the carcass, the contents (%) and accretion rates of water, protein, and fat were not affected ($P > 0.10$) by either MSP or SSF. The content (%) and accretion of P and ash increased (linear, $P < 0.01$) with addition of MSP and SSF. The increase in bone strength and carcass P associated with increasing SSF was similar to that for MSP addition. These data indicate a solid-state fermented phytase improves P utilization in growing pigs fed low P, corn soybean meal diets.

Key Words: Pigs, Phytase, Bone Strength

142 Efficacy of an *E. coli* phytase for growing-finishing pigs and laying hens. N. R. Augspurger*[1], D. M. Webel[2], and D. H. Baker[1], [1]*University of Illinois, Urbana,* [2]*United Feeds, Inc., Sheridan, IN*.

Two trials were conducted to determine the efficacy and safety of an *E. coli* phytase expressed in yeast (ECP; EcoPhos^{TM}, Phytex, Portland, ME) when added to P-deficient corn-soybean meal diets fed to growing-finishing (GF) pigs and second-cycle laying hens. Sixty GF pigs (49 kg BW) were randomly allotted to either the P-deficient diet, or the P-deficient diet supplemented with either 0.10% inorganic P (iP) from KH_2PO_4 or 250, 500, 1,000, or 10,000 FTU/kg of ECP. Pigs were individually fed and allowed ad libitum access to the experimental diets until individual blocks of pigs reached 120 ± 4 kg BW, at which time pigs were euthanized and the left fibula and 4^{th} metatarsal were harvested for determination of bone ash. Pigs were fed a two-phase dietary program for early- and late-finishing pigs; available P in the basal diets was set 0.10% below the requirement. The sexes responded differently (sex × iP vs phytase, $P < 0.05$) in weight gain to addition of ECP, wherein ECP additions were superior to iP additions in gilts but equal to iP additions in barrows. Fibula ash was highest ($P < 0.01$) for pigs fed diets containing 10,000 FTU/kg of ECP. Supplementation of 0.10% iP resulted in bone ash responses that were equal to those resulting from 500 FTU/kg of ECP. Laying hens (n = 240) were allotted to a P-deficient diet, or the P-deficient diet supplemented with either 0.10% iP (from KH_2PO_4) or 150, 300, or 10,000 FTU/kg of ECP for a 12-wk assay. The basal diet was a corn-soybean meal diet with no added iP (17% CP, 3.8% Ca, 0.07% estimated available P). Hens on the P-deficient diet were removed from the study after 4 wk due to poor egg production. Supplementation of iP and ECP resulted in superior ($P < 0.01$) feed intake, egg weight, and egg production during the first 4 wk. There were no differences ($P > 0.05$) among the iP- and ECP-supplemented groups in body weight, feed intake, egg weight, or egg production at the end of the 12-wk trial. These studies revealed that ECP was as efficacious as 0.10% supplemental iP, and that supplementation of a 10 to 20-fold higher dose of ECP was safe in both GF pigs and laying hens.

Key Words: Phytase, Pigs, Hens

143 Phytase from transgenic alfalfa leaf meal improves phosphorus bioavailability in growing pigs. K. L. Saddoris*, D. K. Schneider, and T. D. Crenshaw, *University of Wisconsin, Madison*.

Twenty crossbred barrows (∼9 kg BW) were randomly assigned to dietary treatments to evaluate growth, apparent digestibility of P and Ca, and bone mineral content (BMC) gain responses to phytase supplementation in corn-SBM diets. Phytase was provided by leaf meal from alfalfa plants genetically modified to express phytase protein (t-alfalfa). Dietary treatments consisted of corn-SBM diets with 0.45, 0.50, or 0.55% total phosphorus (tP) without phytase plus diets (0.45% tP) with either 200 or 400 FTU/kg obtained by t-alfalfa additions at 1.33 or 2.66 g/kg diet, respectively. Pigs (10/trial) were individually penned for 16 d (trial 1) and 13 d (trial 2) for diet adaptation, then placed in crates for a 4 d total collection of urine and feces. Initially, pigs were scanned with dual-energy x-ray absorptiometry to determine BMC and re-scanned on d 1 and d 4 of collection. Over the trial, supplemental P tended to increase ADG (quadratic, $P < 0.1$), fecal P excretion (quadratic, $P < 0.1$), and BMC gain (linear, $P < 0.05$). Increasing tP levels increased Ca retention (quadratic, $P < 0.01$) and BMC gain (linear, $P < 0.05$). ADFI, feed:gain, P and Ca apparent digestibility did not differ ($P > 0.1$) among tP treatments. Compared to the 0.45% tP group, pigs fed diets with 200 FTU/kg increased ($P < 0.05$) P retention (2.48 to 3.65 g/d) and increased ($P < 0.05$) Ca retention (3.48 to 5.39 g/d). However, increasing from 200 to 400 FTU/kg decreased ($P < 0.05$) P retention (3.65 to 2.61 g/d) and Ca ($P < 0.01$) retention (5.39 to 4.01 g/d). During the collection period phytase supplementation increased ($P < 0.01$) BMC gain (10.34 and 9.37 g/d for 200 and 400 FTU/kg groups, respectively) compared with pigs fed 0.45, 0.50, and 0.55% tP (3.56, 7.12, and 7.50 g/d). ADG, ADFI, feed:gain, fecal P excretion, apparent digestibility of P and Ca, and BMC gain did not differ ($P > 0.1$) between the 200 and 400 FTU/kg treatments. In conclusion, t-alfalfa phytase improves P bioavailability from corn-SBM diets as indicated by a 65% increase in BMC gain over the collection period compared to pigs fed diets with 0.45% tP. Supplementing t-alfalfa at a level greater than 200 FTU/kg offered no advantage, indicating a greater bioavailability of t-alfalfa phytase than predicted by phytase activity assays.

Key Words: Pigs, Phytase, Phosphorus

144 Effect of phytase on growth performance, plasma metabolites, carcass traits, and pork quality in growing-finishing pigs. J. L. Shelton*, L. L. Southern, and T. D. Bidner, *Louisiana State University Agricultural Center, Baton Rouge*.

An experiment was conducted to determine the effect of phytase (Natuphos®) on growth performance, plasma metabolites, carcass traits, and pork quality in growing-finishing pigs. Pigs (initial and final BW of 22 and 108 kg) were allotted to three treatments with six replications (three barrow and three gilt) of four pigs each in a randomized complete block design. The three dietary treatments were: 1) corn-soybean meal (C-SBM) control, 2) C-SBM with Ca and aP reduced by 0.10%, 3) as Diet 2 + 500 FTU phytase/kg. Blood was collected from pigs on d-29 and at slaughter. Three pigs per replicate were randomly selected for slaughter. Pigs fed the reduced Ca and aP diet had a decreased ($P < 0.05$) ADG relative to those fed the control diet or diet with phytase. Daily feed intake was decreased ($P < 0.10$) in pigs fed the reduced Ca and aP diet relative to pigs fed the control diet. Gain:feed, plasma NEFA, and fasting plasma glucose were not affected ($P > 0.10$) by diet. Pigs fed the reduced Ca and aP diet had increased ($P < 0.05$) liver and kidney weights and decreased ($P < 0.05$) dressing percentage, hematocrit, and bone ash percentage relative to pigs fed the control diet or the diet with phytase. Tenth-rib backfat thickness was increased ($P < 0.10$) in pigs fed the reduced Ca and aP diet relative to pigs fed the diet with phytase. Kilograms of lean were decreased ($P < 0.10$) in pigs fed the reduced Ca and aP diet relative to pigs fed the control diet. The CIE L* value was decreased ($P < 0.10$) in pigs fed the diet with phytase compared to pigs fed the control or reduced Ca and aP diets. These data indicate that reducing the Ca and aP in diets for growing-finishing pigs results in decreased growth performance and inferior carcass traits, all of which were returned to normal by dietary phytase. Furthermore, phytase supplementation to reduced Ca and aP diets had no negative effects on growth, carcass traits, or pork quality in growing-finishing pigs.

Key Words: Phytase, Pigs, Pork Quality

145 Evaluation of phytase source and level in diets for pigs 12 to 86 kg body weight. B. V. Lawrence[1], J. D. Hahn[1], J. Boychuk*[2], S. Hansen[1], J. Hedges[1], E. Hansen[1], R. Musser[1], and G. Dial[3], [1]*Hubbard Feeds Inc., Mankato, MN*, [2]*Feed-Rite, Winnipeg, MB Canada*, [3]*New Fashion Pork, Jackson, MN*.

Two experiments were conducted to evaluate phytase source (Natuphos® vs. Ronozyme® P) in corn-soy bean meal diets. In Exp. 1, 985 pigs (C22 X TR4) weighing 12.2 ± 0.75 kg were allotted to 6 treatments (n = 6). Treatments included Negative (Neg) Control (0.50% P), Positive (Pos) Control (0.70% P), or Neg with 300 or 500 FTU/kg of phytase from Natuphos or Ronozyme P. Pigs were housed in a conventional nursery at 27 or 28 pigs/pen. During the 21-d trial, pigs fed either source of phytase and the Pos diet had gains greater than (561 vs. 528 g/d) the Neg group ($P < 0.05$) Gains for the Phytase and Pos groups were similar ($P > 0.10$). Gain was similar across levels of phytase ($P > 0.10$). Intake was greater ($P < 0.05$) for pig fed phytase (881 vs. 837 g/d) compared with the Neg and Pos fed pigs. No phytase source or level differences were detected ($P > 0.10$). Gain/feed was greater ($P < 0.001$) for the Pos pigs than for other treatments (0.68 vs. 0.63). Gain/feed for the phytase pigs was similar ($P > 0.10$) to the Neg pigs regardless of source or level. Experiment 2 evaluated the interaction of Natuphos and Ronozyme P. A total of 1,004 Compart Boar Store terminal Duroc pigs (L442 X D100) weighing 14.7 ± 0.81 kg were allotted to 4 dietary treatments (n = 12). All diets were formulated to 500 FTU/kg phytase from Natuphos and/or Ronozyme P in ratios of 500/0, 375/125, 250/250, 125/375 FTU/kg. Diets were formulated to contain 0.60, 0.55, 0.50, and 0.45% total P during four 21-d growth periods ending at 29.7, 47.5, 68.1, and 86.2 kg, respectively. Pigs were housed in a curtain-sided, pit-ventillated finishing facility at 20 or 21 pigs per pen. No treatment differences were detected ($P > 0.10$). Cumulative gain, intake, and gain/feed were 831 ± 41.8 g/d, 1.74 ± 0.08 kg/d, and 0.48 ± 0.02 respectively. These results suggest both sources of phytase are equally effective phosphorus deficient swine diets. Additionally, there do not appear to be any synergies between the two sources of phytase in phosphorus adequate diets.

Key Words: Phytase, Phosphorus, Pigs

146 Efficacy of phytase in diets containing high- and low-phytate corn and high- and low-phytate soybean meal. E. G. Xavier*, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky, Lexington*.

An experiment was conducted to assess the efficacy of phytase additions on the bioavailability of P in diets containing combination of normal corn (N-corn) and normal soybean meal (N-SBM), and low-phytate corn (LP-corn) and low-phytate soybean meal (LP-SBM) for growing pigs. Diet 1, a low P (0.11%), phytate-free basal diet (1.2% lysine, 0.8% Ca), consisted of casein, dextrose-sucrose (1:1), cellulose, supplemental AA, minerals (except P), and vitamins. In Diet 2, monosodium phosphate (MSP) provided 0.20% added P. Diet 3 was a 3:1 blend of N-corn and N-SBM substituted for the sugars to provide 0.26% added P. Diet 4 was as Diet 3 with phytase (Natuphos, 750 units/kg). Diet 5 was a 3:1 blend of LP-corn and LP-SBM providing 0.26% added P. Diet 6 was as Diet 5 with the addition of phytase. Non-phytate P levels of Diets 1 to 6 were: 0.11, 0.31, 0.17, 0.24, 0.29, and 0.32%, respectively. Each diet was fed to six individually penned pigs for 28 d, from 11.0 to 29.0 kg. Gain, feed intake, feed:gain, femur strength, metacarpal and metatarsal (MM) strength, and MM ash of pigs fed Diets 1-6 were: 426, 644, 602, 656, 699, 740 g/d; 947, 1186, 979, 999, 1049, 1094 g/d; 2.22, 1.84, 1.63, 1.53, 1.50, 1.48; 45, 184, 90, 136, 168, 193 kg; 16.2, 38.3, 25.9, 32.8, 37.7, 40.3 kg; and 2.20, 4.12, 3.04, 3.71, 3.89, 4.23 g ($P < 0.01$), respectively. Breaking strength of femurs and MM, and MM ash were regressed on added P intake and single-point, slope-ratio procedures were used to assess P bioavailability in the corn-SBM mixes, assuming MSP = 100. Bioavailability of P increased from 35% in the N-corn, N-SBM diet to 64% when phytase was added and from 79% in the LP-corn, LP-SBM diet to 90% when phytase was added. Apparent digestibility of P and P excretion of pigs fed Diets 1-6 were: 82, 86, 44, 58, 65, 79%; 0.28, 0.51, 2.03, 1.55, 1.37, 0.87 g/d ($P < 0.01$). The results indicate that phytase is efficacious when added to diets containing either high- or low-phytate corn and SBM, but its efficacy is greater in high-phytate diets than in low-phytate diets.

Key Words: Pigs, Phosphorus, Phytate

147 Effects of low phytic acid corn, low phytic acid soybean meal, and phytase on nutrient digestibility and excretion in growing pigs. B. E. Hill*, S. L. Hankins, S. A. Trapp, A. L. Sutton, and B. T. Richert, *Purdue University, West Lafayette, IN*.

Forty-eight grower pigs were used to evaluate the effects of feeding low phytic acid (LPA) corn, LPA soybean meal, normal (NRM) corn, NRM soybean meal, and the phytase enzyme on P digestibility and excretion. Pigs (initial BW = 45.3 kg) were blocked by BW and ancestry and randomly assigned to one of eight dietary treatments in a 2×2×2 factorial arrangement (6 pigs/trt). Pigs were fed twice daily (0700 and 1700 hr) at three times maintenance requirement for energy (NRC, 1998). Phytase was added to the diet at 510 PU/kg of feed, at the expense of cornstarch, and all diets were formulated to provide 0.38% total P, 0.50% Ca, and 1.0% Lys with no supplemental P. Pigs were adapted to metabolism crates and dietary treatments for 7 d followed by a 3-d total collection of urine and feces. Total fecal DM excreted, %DM of feces, and %DM digested was not different ($P > 0.53$) among treatments. Fecal phosphorus excretion was reduced 11% for pigs fed LPA corn vs NRM corn, 2.87 vs 3.22 g/d ($P < 0.05$), 17% for pigs fed LPA soybean meal vs NRM soybean meal, 2.74 vs 3.34 g/d ($P < 0.001$), 18% for pigs fed phytase vs non-phytase diets, 2.74 vs 3.35 g/d ($P < 0.02$) and 43% for pigs fed LPA corn, LPA soybean meal, and phytase vs NRM corn, NRM soybean meal without phytase, 2.13 vs 3.76 g/d ($P < 0.0001$). Phosphorus digestibility was increased 21% for pigs fed diets containing LPA corn vs NRM corn, 48.3 vs 39.9% ($P < 0.10$), 16% for pigs fed LPA soybean meal vs NRM soybean meal, 47.3 vs 40.9% ($P < 0.05$), and 22% for pigs fed phytase vs non-phytase diets, 48.5 vs 39.7% ($P < 0.008$) respectively. Corn type and soybean meal type had no significant effect on water-soluble phosphorus (WSP) excretion. However, pigs fed diets containing phytase had significantly less total WSP excreted than those without phytase inclusion, 1.96 vs 2.29 g/d ($P < 0.024$). This study demonstrates that the feeding of any combination of LPA corn, soybean meal, and phytase can significantly improve P digestibility while dramatically decreasing P excretion.

Key Words: Phosphorus Digestibility, Pigs, Low Phytic Acid Grain

148 L-lysine disposal over 24 h exceeds the rate limiting step for piglet L-lysine catabolism. N. J. Benevenga*, L. G. Haas, and T. D. Crenshaw, *University of Wisconsin, Madison*.

The first enzyme for saccharopine dependent catabolism of L-lysine (lysine α-ketoglutarate reductase, LKR), is exclusively housed in the matrix of liver mitochondria of piglets [J. Anim. Sci. 80(Suppl. 1): 30], thus mitochondrial uptake could be a rate limiting step. To identify dietary factors altering the capacity to degrade L-lysine, piglets were fed liquid diets containing 10, 50 or 75% protein for up to 12 d. When compared to 10% protein, 50 or 75% protein causes a 5-fold increase in piglet lysine oxidation (LOX) , a measure of mitochondrial lysine uptake, and a 10-fold increase in LKR (moles/(h·kg pig). To test the effect of lysine, piglets were fed liquid diets with 2, 4 or 6% of L-lysine added to a 10% protein diet. No decrease in piglet weight gain over 12 d and no increase in piglet LOX or LKR (mmoles/(d·pig) was observed. Comparison of the amount of L-lysine consumed over 24 h with the potential capacity of liver for L-lysine oxidation over 24 h revealed that less than 2% of the lysine consumed could be oxidized. Excess lysine must be degraded when 2, 4, or 6% is added to a 10% protein diet as amino acids can not be stored as such. In a preliminary study to determine the fate of lysine added to the low protein diet, two pairs of pigs were fed intragastrically (20 mL/h) via a Foley catheter, over 24 h, a diet containing 10% protein or 10% protein + 4% of L-lysine. Blood and urine samples were obtained at 6 h intervals. Piglets were killed, frozen and later homogenized. Free lysine was determined in the piglet homogenate. Lysine was analyzed by HPLC. Comparison of blood lysine over 24 h revealed a plateau in lysine concentration after 12 h in the piglets infused with the diet containing 4% free L-lysine. Comparison of the lysine recovered after subtracting the lysine recovered in the two piglets given the 10% protein from the two given the 10% protein diet + 4% free L-lysine revealed less than 1/3 of the increment of lysine infused could be recovered. The accepted pathway for lysine catabolism cannot account for the disappearance of lysine.

Key Words: Pigs, Lysine, Liver Mitochondria

149 Effects of dietary glutamine on growth performance and small intestine characteristics of weanling pigs before and after an immune challenge. S. J. Kitt*, P. S. Miller, and R. L. Fischer, *University of Nebraska, Lincoln*.

A total of 36, 20-d-old pigs with an initial BW of 6.52 kg (± 0.38) were individually housed and used in a 14-d growth study. Pigs were blocked by location (n = 6) and randomly assigned to one of three dietary treatments during d 0 to 7 and one of six treatments during d 7 to 14. Treatments during d 0 to 7 were: a purified control diet (Lysine = 1.55%; ME = 2,800 kcal/kg) (CON), CON + 5 % glutamine (GLN), and CON + mixture of nonessential amino acids (NAA). Treatments during d 7 to 14 were CON, GLN, and NAA diets and an injection of saline (SAL) or 200 mg kg BW^{-1} lipopolysaccharide (LPS) from E. coli. Average daily gain and ADFI were measured on d 7 and 14. Pigs were euthanized on d 14 and small intestine length and wet weight were measured. Diet did not affect ADG ($P \geq 0.21$), ADFI ($P \geq 0.79$), or ADG/ADFI ($P \geq 0.26$) during d 0 to 7. During d 7 to 14, LPS reduced ADG (109 vs 209 g; $P \leq 0.001$) and ADG/ADFI (0.74 vs 0.50 g/g; $P \leq 0.001$) by 48% and 32%, respectively. Pigs fed GLN and injected with LPS had a smaller reduction in ADG and ADG/ADFI than other dietary treatments, which resulted in a diet × injection interaction ($P \leq 0.02$; $P \leq 0.05$, respectively). Feed intake was reduced ($P \leq 0.005$) by 25% in pigs injected with LPS. Pigs fed GLN and injected with LPS had similar ADFI compared to pigs fed GLN and injected with SAL (diet × injection interaction, $P \leq 0.06$). From d 0 to 14, diet did not affect ($P \geq 0.22$) ADG, ADFI, or ADG/ADFI. Injection of LPS reduced ADG ($P \leq 0.05$) and there was diet × injection interaction ($P \leq 0.05$) for ADFI. Small intestine length and empty weight were reduced (10.49 vs 9.19 m, $P \leq 0.001$; 305 vs 259 g, $P \leq 0.001$, respectively) for pigs injected with LPS. Pigs fed GLN and injected with LPS tended to have similar empty small intestine weight compared to pigs fed GLN and injected with SAL (diet × injection, $P \leq 0.07$). These data suggest that dietary glutamine improves growth performance and small intestine characteristics in weanling pigs after an immune challenge.

Key Words: Glutamine, Pigs, Immune Challenge

150 Impact of glutamine and spray-dried plasma on growth performance, small intestinal morphology, and immune responses in *Escherichia coli* K88$^+$ challenged weaned pigs. G. F. Yi*[1], J. A. Carroll[2], G. L. Allee[1], A. M. Gaines[1], D. C. Kendall[1], Y. Toride[3], and I. Izuru[3], [1]*University of Missouri, Columbia,* [2]*ARS-USDA, Columbia, MO,* [3]*Ajinomoto Co. Inc., Japan*.

A total of 40 barrows (5.32 ± 0.3 kg) were used to investigate the effects of feeding glutamine (GLN) and spray-dried plasma (SDP) diets on *E. coli* K88$^+$ LT/STb$^+$ challenged pigs. Pigs were allotted in a RCBD to four dietary treatments which included: positive control (POS), negative control (NEG), SDP and GLN treatments. The POS and NEG were fed the same corn-soy-whey diet, whereas the SDP and GLN were fed 7% SDP and 2% GLN supplemented diets, respectively. On d 11 postweaning, all pigs were fitted with indwelling jugular catheters. On d 12 postweaning, pigs on the NEG, SDP and GLN were orally challenged with 5.5 X 10^8 CFU *E. coli* K88$^+$, whereas pigs on the POS were treated with skim milk. Rectal temperature and fecal diarrheic scores were recorded and blood samples collected, at 0, 6, 12, 24, 36, and 48 h postweaning for serum hormone and cytokine measurements. At 48 h post-challenge, all pigs were sacrificed for small intestinal morphology evaluation. At 48 h post-challenge, compared to the non-challenged POS, pigs on the NEG had decreased ADG and G: F ($P \leq 0.08$). However, feeding both SDP and GLN alleviated growth depression and feed efficiency reduction associated with *E. coli* challenge. At 12 h post-challenge, pigs on the NEG had the highest incidence of diarrhea among treatments ($P \leq 0.09$). There were no treatment X time interactions for rectal temperature ($P \geq 0.81$), ACTH ($P \geq 0.74$), cortisol ($P \geq 0.43$), or IL-6 ($P \geq 0.10$) during the *E. coli* challenge period. In proximal, mid-jejunum and ileum, compared with the POS, pigs on the NEG had greater villous atrophy and intestinal morphology disruption ($P \leq 0.08$), whereas feeding both SDP and GLN mitigated or prevented villous atrophy and intestinal morphology impairment after *E. coli* challenge. At 6 h post-challenge, compared to baseline measurement, all pigs had increased GH ($P \leq 0.001$) and decreased IGF-1 ($P \leq 0.001$). At 12 h post-challenge, pigs on the POS had higher IGF-1 compared to the *E. coli* challenged pigs ($P \leq 0.08$). These results indicate that feeding SDP and GLN have beneficial effects in alleviating growth depression of *E. coli* K88$^+$ challenged pigs mainly via maintaining intestinal morphology and function, and possibly via modulating the somatotrophic axis.

Key Words: Pigs, Glutamine, Spray-dried Plasma

151 Effect of a β-glucan product on performance and immune function of weanling pigs. S. Singh[1], J. D. Arthington[2], D. C. Brown[1], M. E. Davis*[1], Z. B. Johnson[1], P. A. Willis[3], and C. V. Maxwell[1], [1]*Univeristy of Arkansas, Fayetteville,* [2]*University of Florida, Gainesville,* [3]*Cypress Systems, Inc., Fresno, CA*.

An experiment using 120 pigs was conducted to monitor the impact of feeding different levels of a β-glucan product, BetaPrecise 929 (Cypress Systems, Inc. Fresno, CA), on performance and inflammation of weaned pigs. Pigs (19 ± 3 d of age) were sorted into eight weight blocks and allotted into six equal subgroups (2-3 pigs/pen) with stratification based on sex and litter. Treatments were randomly assigned to pens within each block (16 pens/treatment). Pigs were fed one of three dietary treatments from d 0 to 10 after weaning: 1) Control diet (1.6% Lys), 2) Control diet supplemented with 0.05% BetaPrecise 929, 3) Control diet supplemented with 0.10% BetaPrecise 929. Treatments were fed throughout phase 2 (1.40% Lys, d 10 to 20) and phase 3 (1.23% Lys, d 20 to 31). Serum from three pigs per treatment per block was collected on d 0, 3, 7, 14, and 28 to measure acute phase protein (ceruloplasmin and haptoglobin) levels. During the overall study, ADG was higher ($P \leq 0.10$) for pigs fed BetaPrecise 929 compared to pigs fed the control diet (0.37 ± 0.01 and 0.34 ± 0.01 kg). During the combined phase 1 and 2 periods, pigs fed BetaPrecise 929 had higher ($P \leq 0.05$) G:F (0.76 ± 0.02 and 0.78 ± 0.02 for 0.05% and 0.10% supplementation, respectively) compared to pigs fed the control diet (0.72 ± 0.02). At the termination of the study, pigs fed 0.05% and 0.10% BetaPrecise 929 supplemented diets were, respectively, 0.98 and 0.99 kg heavier ($P \leq 0.14$) than pigs fed the control diet. On d 14 after weaning, pigs fed the control diet had higher ($P \leq 0.01$) levels of ceruloplasmin when compared to pigs fed BetaPrecise 929 supplemented diets. On d 28 after weaning, pigs fed the control diet had lower ($P \leq 0.04$) haptoglobin levels as compared to pigs fed BetaPrecise 929 supplemented diets. The study indicates that β-glucan can be fed to nursery pigs to improve weight gain and impact the acute phase response.

Key Words: Beta-glucan, Acute Phase Proteins, Nursery Pigs

152 Effect of dose of sodium chlorate on growth performance of nursery pigs. T. E. Burkey*, S. S. Dritz, and J. E. Minton, *Kansas State University, Manhattan*.

A feed additive that shows promise for pigs as an alternative to commonly fed antimicrobials is sodium chlorate (CHLOR). Pigs orally gavaged with CHLOR had decreased bacterial numbers following infection with *Salmonella typhimurium* (ST). However, the effect of chronic feeding of CHLOR to pigs on growth performance has not been thoroughly evaluated. Feeding 800 mg/kg CHLOR to weaned pigs challenged orally with ST appeared to decrease feed intake and growth. Thus, our objective was to determine if lower rates of dietary CHLOR inclusion would affect nursery pig growth performance. A total of 84 nursery pigs (13.1 ± .9 kg) were blocked by weight and assigned randomly within blocks to four dietary treatments. Experimental diets were fed in meal form for a total of 14 d. Dietary energy, mineral and vitamin levels were held constant across all treatments. The dietary treatments included a control (0 mg CHLOR/kg) and three levels of CHLOR (200, 400, and 800 mg/kg). Each pen contained 3 pigs, with 7 replicates (pens) per treatment. Pigs were weighed and feed disappearance was measured on d 0, 7, and 14 to determine ADG, ADFI and F/G. Overall (d 0 to 14), pigs fed diets containing 200 mg CHLOR/kg had greater ($P < 0.01$) ADG and ADFI than pigs fed diets containing 800 mg CHLOR/kg. Although, ADG from d 0 to 14 did not differ significantly for pigs fed the control diet and pigs fed 200 mg CHLOR/kg. Generally, ADG, ADFI, and F/G improved linearly as dietary CHLOR decreased from 800 to 200 mg/kg ($P < 0.01$, $P < 0.02$, and $P < 0.08$, respectively). At d 14, pigs fed 200 mg CHLOR/kg had increased ($P < 0.01$) body weight compared to pigs fed the diet containing 800 mg CHLOR/kg. Also, there was a strong linear trend for d 14 average weights to be increased as CHLOR content decreased from 800 to 200 mg/kg ($P < 0.01$). The addition of CHLOR at levels less than 800 mg/kg may be beneficial in improving ADG, ADFI, and F/G in nursery pigs. Further work is warranted to determine if

levels of CHLOR less than 800 mg/kg are, in fact, antimicrobial when added to diets for nursery pigs.

Key Words: Sodium Chlorate, Antimicrobials, Nursery Pigs

153 Effect of dietary mannanoligosaccharide and sodium chlorate on bacterial shedding in weaned pigs challenged with *Salmonella enterica* serotype Typhimurium (ST). T. E. Burkey*, S. S. Dritz, J. C. Nietfeld, B. J. Johnson, and J. E. Minton, *Kansas State University, Manhattan*.

There continues to be a high level of interest in potential alternatives to dietary antibiotics for swine. The current study was conducted to evaluate the effect of two potential feed additives on bacterial shedding in weaned pigs undergoing enteric disease challenge. One substance of interest, mannanoligosaccharide (MOS), may alter health status of pigs. The second product, sodium chlorate (CHLOR), is effective in reducing bacterial numbers in pigs infected with ST. But, the effect of chronic dietary inclusion of these products on fecal shedding of bacteria following ST challenge has not been reported. Ninety six weaned pigs (6.3 $\pm$ 1.3 kg) were blocked by weight and assigned randomly within blocks to four dietary treatments. The negative control diet contained no added antimicrobial (CON), whereas the positive control contained Carbadox (CARB; 55 ppm). Test diets contained MOS (1.5 g/kg) or CHLOR (800 mg/kg). There were 12 pens per treatment with 2 pigs/pen. Pigs were fed treatment diets for 2 wk. Then, all pigs were given ST orally, and the study continued for an additional 2 wk. Fecal samples were obtained after 7 and 14 d post-challenge, and evaluated for the presence of Salmonella organisms using a semi-quantitative approach. Samples were scored on a 0 to 3 scale (0 = no culturable Salmonella; 3 = abundant culturable Salmonella). At 7 d, shedding scores were lower ($P < 0.05$) for pigs fed CHLOR (1.2 $\pm$ 0.2) than CON (2.1 $\pm$ 0.2), CARB (2.1 $\pm$ 0.2), and MOS (2.2 $\pm$ 0.2) treatments. At d 14, pigs fed CON, CARB, and MOS had similar shedding scores, although pigs fed CARB had lower scores than pigs fed CHLOR ($P < 0.05$). Thus, in this model of enteric disease challenge in weaned pigs, the presence of dietary CHLOR altered the pattern of fecal shedding of Salmonella.

Key Words: Mannanoligosaccharide, Sodium Chlorate, Bacterial Shedding

154 Effects of Ractopamine HCl (Paylean) on Finishing Pig Growth and Variation. M. R. Barker*, S. S. Dritz, R. D. Goodband, M. D. Tokach, C. N. Groesbeck, S. M. Hanni, C. W. Hastad, T. P. Keegan, K. R. Lawrence, and M. G. Young, *Kansas State University, Manhattan*.

A total of 336 pigs were used in a 21-d study to determine the effect of Ractopamine HCl (Paylean, 10 mg/kg) on finishing pig growth and variation. Pigs (168 barrows and 168 gilts) were weighed and allotted to treatments in a completely random design so that within sex, each pen had the same mean BW and degree of BW variation among pigs in each pen. Fourteen pens (7 of barrows, 7 of gilts) were assigned to each treatment. Diets were a sorghum-soybean meal-based and formulated to contain 1.00% total Lys with or without 10 mg Paylean/kg. Pigs were weighed and feed intake was determined every 7 d during the 21 d experiment. Average daily gain, ADFI, feed efficiency (G/F), and pen CV were determined. Pigs fed Paylean had greater ADG and improved feed conversion compared to control pigs ($P < 0.05$; 0.939 kg/d and 0.327 vs 0.798 kg/d and 0.276, respectively). Feed intake was not affected ($P > 0.90$) by dietary treatment (2.76 vs 2.77 kg/d, respectively). Pigs fed Paylean were heavier ($P < 0.05$) at the end of the 21 d trial (120 vs 116 kg), due to higher ADG than the pigs fed the control diet. Initial pen CV was 9.2% and 8.7% for the pigs on control and Paylean diets, respectively. At the end of the 21 d study, no differences were observed in pen BW variation among dietary treatments ($P > 0.70$). Control pigs averaged a pen CV of 7.71% with 68% of the pigs between 107.4 and 125.3 kg, or a range of 8.97 kg. Pigs fed Paylean had a CV of 8.15% with 68% of the pigs between 110.1 and 129.6 kg, or a range of 9.75 kg. These findings suggest that Paylean (Ractopamine HCl) improves growth performance and feed efficiency of finishing pigs, but does not impact variation of growth.

Key Words: Ractopamine, Pigs, Variation

155 Growth performance and carcass characteristics of pigs fed diets containing a corn germ-corn bran product compared to diets composed of corn, soybean meal, and tallow. S. J. Kitt*, P. S. Miller, R. L. Fischer, and D. E. Reese, *University of Nebraska, Lincoln*.

A total of 240 mixed-sex, growing-finishing pigs were used to evaluate the feeding value of a corn germ-corn bran by-product. Pigs were blocked by weight (initial BW = 32.2 kg) and randomly assigned to one of four dietary treatments and allotted to pen (n = 24). Pigs and feeders were weighed biweekly to determine ADG, ADFI, and ADG/ADFI. Treatments were diets containing corn-soybean meal (CON), corn-soybean meal-4% tallow (TAL), corn-soybean meal-8% corn germ-corn bran (8% GERM), and corn-soybean meal-16% corn germ-corn bran (16% GERM). All diets met or exceeded the 1998 NRC requirements. During the 102-d trial, there were no differences among treatments for ADG ($P \geq 0.10$). Pigs fed TAL had a 5.3% decrease in ADFI ($P \leq 0.007$) and 8.7% improvement in feed efficiency (ADG/ADFI; $P \leq 0.005$) compared to all other treatments. Ultrasound scans revealed no differences ($P \geq 0.10$) in longissimus muscle area among treatments and an increased (2.57 vs 2.31 cm; $P \leq 0.02$) backfat depth for pigs fed TAL compared to other treatments. Calculated (NPPC, 1991) carcass lean percentage of pigs fed TAL was less (48.09 vs 49.02; $P \leq 0.06$) than the other treatments. Dressing percentage was greater ($P \leq 0.05$) for pigs fed diets containing TAL compared to pigs fed 8% GERM or 16% GERM. Pigs fed CON had greater ($P \leq 0.02$) subjective marbling score than pigs fed TAL and 16% GERM. Longissimus muscle pH of pigs fed CON tended to be greater (5.67 vs 5.60 vs 5.61, respectively; $P \leq 0.08$) than pigs fed TAL or 8% GERM. Subjective muscle firmness tended to be greater ($P \leq 0.09$) for pigs fed CON compared to all other treatments. Pigs fed TAL had greater ($P \leq 0.01$) longissimus muscle Minolta a* color score than other treatments. These data suggest that the feeding value of of corn germ-corn bran is lower than that predicted from its chemical composition.

Key Words: Pigs, Corn Germ, Corn Bran

156 The effect of body composition on dietary protein selection in finishing gilts. S. A. Meers*, R. Jones, T. D. Pringle, and M. J. Azain, *University of Georgia, Athens*.

The objective of this study was to determine if pigs of similar BW, but differing in tenth rib fat thickness, differ in their selection for dietary protein. The study was designed in a 2 $\times$ 2 factorial arrangement with main effects of body fat (Lean vs Fat) and diet (single vs choice). Crossbred gilts (n = 32) with an initial BW of 80 kg were sorted into high and low backfat groups based on real-time ultrasound scans at the 10th rib. Gilts in the low (Lean) and high fat (Fat) groups had 1.5 and 2.2 cm of 10th rib fat ($P < 0.001$) and 27.7 and 30.9 cm^2 loin area ($P < 0.05$), respectively, at the start of the study. Diets were: 1) a low-protein, corn-based diet that was supplemented with essential amino acids (EAA) such that all EAA were at, or above, the level suggested for an ideal pattern (8.5% CP, 0.58% Lys) and 2) a high protein, corn-soybean meal-based diet that was supplemented with Lys and Met such that it also had all EAA at or above an ideal pattern (22.7% CP, 1.275% Lys). During the first week, all pigs were fed a 50/50 mix of diets 1 and 2 (15.3% CP, 0.93% Lys). From d 7 to 28, one-half of the pigs in the Lean and Fat groups were given a choice of diets 1 and 2 in separate feeders. The position of the diets was rotated daily. The other pigs continued to be fed a 50/50 blend (single diet). Average daily gain (1.06 kg/d) and total intake (2.64 kg/d) were not different between treatment groups. However, the pattern of selection was different in the choice groups. Lean pigs consumed more (64.4%) of the high protein diet than did Fat pigs (35.6%, $P < 0.002$), resulting in a difference in the percent protein consumed. Lean pigs selected a 16.7% CP diet while Fat pigs selected a 12.6% CP ($P < 0.01$) diet. Thus, body composition influences diet selection. While allowing pigs to self select did not alter performance parameters, the results suggest that allowing individual animals to self-select may decrease the nitrogen intake and thus, cost of production. The implication of this work is that diet selection can be used to allow pigs to more closely meet their individual nutrient requirements.

Key Words: Diet Selection, Body Composition, Protein Intake

157 Effect of soy isoflavones on growth, carcass composition, pork quality, and plasma metabolites of growing-finishing barrows. R. L. Payne*, T. D. Bidner, and L. L. Southern, *Louisiana State University Agricultural Center, Baton Rouge*.

An experiment was conducted with 80 barrows to evaluate the effects of soy isoflavones (ISF) on growth, carcass composition, pork quality, and plasma metabolites. Average initial and final BW were 32.3 and 111.7 kg, respectively. The four diets were: 1) corn-soybean meal diet (C-SBM); 2) C-SBM + two times ISF content of C-SBM (2x ISF); 3) corn-soy protein concentrate diet (C-SPC, void of ISF); 4) C-SPC + ISF equal to ISF level in C-SBM (C-SPC+ISF). Each treatment was replicated five times with four barrows each in a randomized complete block design. Growth performance, carcass composition, and plasma metabolites were not affected (P > 0.10) in pigs fed 2x ISF diet compared with those fed C-SBM. However, b* color score was increased (P < 0.10) in pigs fed 2x ISF compared with those fed C-SBM. Overall ADG was decreased (P < 0.10) in pigs fed C-SPC diet compared to pigs fed C-SBM or 2x ISF, but the addition of ISF to the C-SPC returned ADG to a level similar to pigs fed C-SBM. Otherwise, growth of pigs fed C-SPC or C-SPC+ISF was not affected (P > 0.10) by diet. Average backfat was decreased (P < 0.10) in pigs fed C-SPC compared to those fed C-SBM. Pigs fed C-SPC+ISF had increased (P < 0.10) ultrasound and carcass measurements of 10th rib backfat thickness, average backfat, leaf fat, total fat, percentage fat, lean:fat, total ham fat, percentage ham fat, and butt fat thickness compared to those fed C-SPC. Percentage carcass lean and percentage ham lean were decreased (P < 0.10) in pigs fed C-SPC+ISF compared to pigs fed C-SPC. Pigs fed C-SPC+ISF had a higher (P < 0.10) 45-min pH compared to those fed C-SPC. Drip loss was decreased (P < 0.10) in pigs fed C-SPC+ISF compared to those fed C-SPC. Pigs fed C-SPC or C-SPC+ISF diets had a decreased (P < 0.10) insulin:glucose ratio compared to those fed C-SBM. The effects of isoflavones were variable, but they had little effect on growth, carcass composition, pork quality, or plasma metabolites of growing-finishing pigs.

Key Words: Soy Isoflavone, Pigs, Pork Quality

158 The effects of fructooligosaccharide on fecal pH and microbial activity in the yearling horse. E. L. Berg*, C. J. Fu, and M. S. Kerley, *University of Missouri, Columbia*.

The objective of the present study was to compare the effects of two different doses of dietary fructooligosaccharide (FOS) on colonic health in the horse, using fecal pH and fecal bacteria population as indicators. Nine yearling Quarter Horses were used in a 3 x 3 Latin square design and fed according to the 1989 NRC requirements. The diets were supplemented with no FOS (CON), 8 g FOS/d (LOW), or 24 g FOS/d (HIGH) over three 10-d feeding periods. Feces were collected the last three d of each 10-d period. Fecal pH was determined immediately following collection by submerging the pH probe in a mixture of equal amounts of feces and double distilled water. For later analysis of *E. coli* and *Lactobacilli* populations, feces were mixed with a glycerol salts solution (1:2), placed on ice, and then frozen at 80°C. Fecal color was recorded and fecal consistency scored (1 to 5 with 1 = extremely dry, 3 = normal, and 5 = diarrhea) with no differences (P > 0.05) found between treatments. Fecal pH was lower (P < 0.05) for the HIGH compared to the CON. Fecal *E. coli* population was lower (P < 0.05) for the LOW compared to both the HIGH and CON. No difference (P > 0.05) was found in fecal *Lactobacilli* population between treatments. Fructooligosaccharide supplementation at the level of 8 g/day decreased fecal *E. coli* population and pH without negatively affecting fecal consistency or color. These findings indicate a positive effect of FOS supplementation on gut health in the yearling horse.

Key Words: Fructooligosaccharide, Horses, Gastrointestinal Health

159 Effects of an intraperitoneal bolus injection of L-phenylalanine on physiological parameters in weanling pigs. K. Bregendahl*[1], L. Liu[1], M. Z. Fan[1], H. S. Bayley[1], J. P. Cant[1], B. W. McBride[1], L. P. Milligan[1], and J. T. Yen[2], [1]*University of Guelph, Guelph, ON,* [2]*U.S. Meat Animal Research Center, Clay Center, NE*.

Effects of an i.p. injection of Phe on concentrations of free AA, glucose, and insulin in plasma, and contents of free amino acids (AA) in tissue homogenates were assessed in pigs. Five blocks of five littermate gilts were weaned at 16 d of age and fed a pelleted starter diet (3340 kcal ME/kg, 1.2% true ileal digestible Lys). On d 8 post-weaning, L-Phe (1.5 mmol/kg BW) in saline (154 mM) was injected i.p. according to a randomized complete block design with euthanasia and tissue collection at 15, 30, 45, 60, or 75 min post-injection. Blood samples were collected immediately before Phe injection and euthanasia. Collected tissues were rinsed with ice-cold saline and frozen in liquid nitrogen. Free AA in plasma and tissue homogenates were measured with L-norleucine as an internal standard by gas chromatography-mass spectrometry after derivatization with hepta-fluorobutyrate. Plasma Phe increased logarithmically ($P < 0.05$) from 85 to 711 μM (836%) and reached 95% of the maximum concentration 48 min post-injection. Plasma Glu+Gln, Leu, and Lys concentrations decreased quadratically over time ($P < 0.05$), yet by no more than 28%. No other plasma AA changed over time ($P > 0.05$). Plasma glucose increased from 4.8 mM pre-injection to 5.8 mM 15 min post-injection and returned to pre-injection levels thereafter (cubic effect, $P < 0.05$). The plasma insulin concentration did not change over time ($P > 0.05$). Free Phe contents in cecum, colon, longissimus dorsi, distal small intestine, and stomach increased quadratically over time ($P \leq 0.05$), but did not change in heart, kidneys, liver, lungs, pancreas, proximal small intestine, and spleen. No changes in tissue free AA other than Phe were observed ($P > 0.05$). In conclusion, Phe injected i.p. quickly distributes into plasma and tissues with no or little effect on plasma glucose, AA, and insulin concentrations or on tissue free AA contents.

Key Words: Intraperitoneal Injection, Plasma Free Amino Acids, Tissue Free Amino Acids

160 Effects of dietary energy and lysine on growth performance and hormone profiles in finishing pigs. S. B. Cho*[1], J. S. Lim[2], I. B. Chung[1], S. H. Cho[1], Y. Y. Kim[2], and I. K. Han[2], [1]*National Livestock Research Institute, RDA, Korea,* [2]*Seoul National University, Korea*.

A total of 96 crossbred barrows (initial BW = 58.3 kg) were used to investigate the effect of various dietary energy and lysine levels on productivity and hormone profiles in finishing pigs. The experiment was conducted in a 2 x 4 factorial arrangement as a randomized complete block (RCB) design. Two energy levels (3,350 and 3,600 kcal DE) and four lysine levels (1.5, 1.8, 2.1 and 2.4 g/Mcal DE) were used in this experiment. Average daily feed intake of pigs was not influenced by the energy level, while dietary lysine level significantly influenced on ADFI (P < 0.05). Average daily gain was improved in the high energy treatments (P < 0.05) and was higher when pigs were fed high levels of lysine (P < 0.05). Feed efficiency (G:F) was higher (P < 0.05) when pigs were fed high dietary lysine or high energy throughout the whole experimental period. The concentration of IGF-1 was decreased in the low energy group and was lower when low lysine diets were provided, resulting in an interaction (P < 0.01). Leptin concentration tended to increase as dietary lysine level increased (P < 0.05), however, it was not affected by dietary energy. Carcass grade was not affected by dietary energy (P = 0.12) but was better as dietary lysine level increased (P < 0.05) resulting in an interaction(P < 0.05). Water holding capacity (WHC) tended to increase as dietary lysine level increased (P > 0.15). The CIE values (L^*, a^* and b^*) were not affected by dietary energy or lysine level. The results indicated that feed efficiency could be improved by dietary energy and lysine level but carcass characteristics were not influenced by dietary treatments.

Key Words: Barrows, Energy, Lysine

161 Oat-based diets for market pigs in deep-bedded hoop barns. Z. M. Sullivan* and M. S. Honeyman, *Iowa State University, Ames*.

The objective was to determine the effects of the addition of dietary oats on performance and carcass traits of market pigs in deep-bedded hoop barns. A total of 36 pens of ten barrows each (3 diets × 2 pens/diet × 2 seasons × 3 replications) were fed. Summer season was May through September. Winter season was November through March. Barrows were started at 73 kg BW and fed until 123 kg BW. Pigs were weighed at 14-d intervals. Average daily gain, ADFI, and gain:feed ratio (G:F) were calculated. Backfat (BF) and loin eye area (LEA) were taken from the slaughter sheets. Three dietary treatments were fed ad libitum: 1) 20% oat diet, 2) 40% oat diet, and 3) control (corn and soybean meal).

The oats were heavy test weight oats (minimum test weight of 16.4 kg/bushel). The diets were isolysinic (calculated basis). Prior to random allotment, pigs were fed together in a separate deep-bedded hoop barn. Oats fed to finishing pigs in hoop barns did not affect ADFI, ADG, or G:F. For winter, ADFI was 4.11, 4.15, and 4.04 kg/d (P = 0.87); ADG was 0.98, 1.03, and 1.00 kg/d (P = 0.81); G:F was 238, 247, and 249 g/kg (P = 0.39), for pigs fed the 20% oat diet, 40% oat diet, and control diet, respectively. For summer, ADFI was 3.54, 3.60, and 3.36 kg/d (P = 0.87); ADG was 0.96, 0.95, and 0.94 kg/d (P = 0.81); G:F was 271, 261, and 278 g/kg (P = 0.39), for pigs fed the 20% oat diet, 40% oat diet, and control diet, respectively. Feeding oats to finishing pigs in hoop barns did not affect carcass traits. For winter, BF was 22.0, 21.3, and 21.9 mm (P = 0.98); LEA was 43.2, 43.6, and 42.8 cm^2 (P = 0.68), for pigs fed the 20% oat diet, 40% oat diet, and control diet, respectively. For summer, BF was 23.4, 22.7, and 23.6 mm (P = 0.98); LEA was 42.5, 42.5, and 42.6 cm^2 (P = 0.68), for pigs fed the 20% oat diet, 40% oat diet, and control diet, respectively. Oats may be a suitable feedstuff for pigs in deep-bedded hoop barns.

Key Words: Pigs, Oats, Hoop barn

162 The effects of dietary calcium level and citric acid supplementation on growth performance and gastrointestinal pH in chicks.

L. Peddireddi* and J. S. Radcliffe, *Purdue University, West Lafayette, IN.*

A total of 192 male broiler chicks were used in a 2 × 2 factorial design to study the effects of Ca level (0.6% or 1%) and citric acid addition (0 or 3 %) on growth performance and gastrointestinal pH. Birds were obtained on the day of hatch and randomly assigned to pens (6 birds/pen; 8 reps/diet). After a 1-wk adjustment period, dietary treatments were provided ad libitum for 2-wk. Pen BW and feed consumption were recorded weekly. On d13, excreta was collected for 24h. At the end of the 2-wk experimental period, all birds were fasted for two hours, refed for four hours, and killed by asphyxiation with CO_2. The contents of the proventriculus, gizzard, duodenum, jejunum, and ileum were removed for pH determination. The pH of excreta and intestinal samples was determined on a subsample of each mixed with deionized water, in a 1:10 ratio (wt:v). Diet titration values, calculated as: mEq of NaOH/kg to pH 8 and mEq of HCl/kg to pH 4,were increased (P < 0.05) by increasing the level of dietary Ca, or by adding 3% citric acid to the diet. Body weight gain was unaffected (P > 0.10) by dietary Ca level, but adding 3% citric acid to the diet decreased growth rate (P < 0.02). There was a trend for decreased feed intake with higher dietary Ca levels (P < 0.10), but feed efficiency was not affected. Adding 3% citric acid to the diet decreased feed intake (P < 0.05) but did not affect feed efficiency (P > 0.10). Birds fed diets with higher Ca levels had an increased pH (P < 0.05) in the proventriculus, gizzard, duodenum, jejunum, and ileum. Adding 3% citric acid to diet had no effect (P > 0.10) on pH in the proventriculus, gizzard and ileum but decreased the pH (P < 0.05) in duodenum and jejunum. Excreta pH was higher (P < 0.05) in birds fed adequate levels of dietary Ca than in birds fed low levels of dietary Ca. The addition of 3% citric acid to the diet had no effect on excreta pH (P > 0.10). No interactions between dietary Ca level and citric acid addition to the diet were observed. Based on the results of this study, the level of Ca carbonate in the diet clearly affects physiological conditions within the gastrointestinal tract.

Key Words: Citric Acid, Calcium, Gastrointestinal pH

163 Effect of stage of lactation on colostrum and milk composition in multiparous sows.

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An experiment for measuring total milk solids (TMS) and CP of colostrum and milk from sows at different stages of lactation was conducted. Crude protein as a percentage of total milk solids at different stages of lactation was calculated as well. Thirteen sows (parity 6) originating from a triple cross mating of Yorkshire x Duroc x Landrace were used in this experiment. Litter size was standardized to 11 piglets per litter. Sows were fed a 14% CP corn-soybean meal based diet in gestation. In lactation, sows were fed an 18% CP corn-soybean meal based diet. During the initial 3 d of lactation, feed intake was restricted, but after that sows were allowed to consume their diets on an ad libitum basis. Both diets were formulated to meet or exceed the NRC requirements for all nutrients. The experimental period lasted 28 d, with milk being collected on d 0 (within 12 h of farrowing), 3, 7, 14, 21, and 28. One ml of oxytocin was administered intravenously (via the ear vein) to facilitate milk letdown. All functional teats on both sides of the sow mammary gland were hand stripped in succession and a total of 50 ml of mammary secretions were collected per collection date. Milk samples were analyzed for TMS and CP, and CP as a percentage of TMS was calculated. Sow performance data were also summarized and compared. Total milk solids decreased ($P < 0.002$) from 26.7% on d 0 to 23.1% on d 3. It further decreased ($P < 0.001$) to 19.3% on d 7, but after that, it remained constant ($P > 0.05$) at 18.2, 18.8, and 19.2% on d 14, 21, and 28, respectively. Milk CP decreased ($P < 0.001$) from 16.8% on d 0 to 7.7% on d 3. It further decreased ($P < 0.01$) to 6.2% on d 7, but after that, no changes ($P > 0.05$) were observed (5.5, 5.7, and 6.3% on d 14, 21, and 28, respectively). Throughout lactation, milk CP was positively correlated to TMS ($P < 0.05$). Changes in sow BW during lactation were correlated to ADFI ($P < 0.001$). The results of this study suggest that the TMS and CP concentrations of sow mammary secretions change during the first week of lactation, but after that it is constant. A positive correlation between TMS and CP exists. During lactating, ADFI is correlated to changes in sow BW.

Key Words: Sows, Lactation, Milk Composition

164 Effect of chromium source on tissue retention of chromium in pigs.

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The relative bioavailability of Cr from tripicolinate (CT), propionate (CP), methionine (CM) and yeast (CY) was evaluated by tissue Cr deposition in 40 crossbred finishing pigs (48 kg and 87 d of age). Pigs were blocked by gender and BW and randomly assigned to pens (gilts: 1/pen; barrows: 2/pen). The control corn-SBM diet (CONT) had no added Cr and met all NRC (1998) requirement estimates. Treatments used were CONT and CONT plus 5,000 ppb Cr from either CT, CP, CM or CY. Feed and water were supplied ad libitum during the study. Pigs were killed, carcasses processed, and tissue samples collected at a mean BW of 115 kg. Loin samples were taken after chilling the carcasses for 24h. Serum clinical chemistry evaluations at study termination were normal for all Cr forms. ADG for pigs fed CONT, CT, CP, CM and CY (0.864^a, 0.914^{ab}, 0.914^{ab}, 0.864^a, 0.936^b kg, respectively, P < 0.05) was relatively uniform as were ADF (2.48^a, 2.60^{ab}, 2.55^{ab}, 2.55^{ab}, 2.67^b kg, respectively, P < 0.10) and F/G (2.88, 2.86, 2.81, 2.95, 2.86 kg, respectively) for pigs fed the five diets. Tissue Cr (ng/g) results are provided below. Retention was highest in every tissue for CT, except for loin where there were no differences (P > 0.10). The largest increase in tissue concentration occurred in the ovary with CT (12-fold increase). In summary, the most consistent response in, and largest magnitude of, tissue deposition was with CT, indicating greater relative bioavailability of Cr in Cr tripicolinate.

	Diet					
Tissue	CONT	CT	CP	CM	CY	SEM
Bone	27^a	95^c	45^a	81^c	59^b	10.2
Kidney	42^a	185^c	61^{ab}	106^b	77^{ab}	16.2
Liver	12^a	91^b	21^a	41^a	14^a	14.4
Loin	96	151	219	82	205	84.8
Ovary	4^a	51^c	4^a	24^b	12^{ab}	5.0

$^{a,\ b,\ c}$ Means on each row without a common superscript differ, P < 0.05

Key Words: Pigs , Chromium, Mineral Nutrition

165 Effect of adding a bacillus-based direct fed microbial on performance of nursery pigs fed diets with or without antibiotics.

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The objective of this study was to evaluate the effect of a bacillus-based direct fed microbial (DFM) on performance of nursery pigs fed diets with or without antibiotics (AB). A total of 96 weanling pigs (4.3 kg BW) were blocked by initial weight and randomly assigned to one of four dietary treatments (trt), with six pens/trt and four pigs/pen. The trts were a 2 × 2 factorial arrangement, with two levels of DFM (0 vs

1.1 million spores per g of feed derived from BioPlus 2B) and two levels of AB (0 vs 35 g/ton of tiamulin and 400 g/ton of chlortetracycline). ADG, ADFI and G/F were measured throughout 5 phases ending at d 7, 14, 28, 42 and 56. Pigs were fed experimental diets through d 42 and then a common diet (containing no AB or DFM) through d 56. Feeds were pelleted through d 14 and meal thereafter. No interactions (Int) were observed between DFM and AB, indicating that this bacillus-based DFM and AB could have an additive effect. AB improved ADG ($P < 0.01$), ADFI ($P < 0.01$; data not shown) and G/F ($P < 0.07$) from d 0 to 56. Although DFM did not have a significant effect on performance from d 0 to 42, DFM increased ADG and G/F from d 0 to 56. This suggests that DFM could have a positive carryover effect on performance after its withdrawal. In summary, AB improved performance, and the addition of DFM tended to improve ADG and G/F for pigs fed diets with or without AB.

DFM	-	+	-	+			P values	
AB	-	-	+	+	SE	AB	DFM	Int
End weight, kg	29.7	32.1	33.4	34.4	0.70	0.001	0.03	0.32
ADG, g (d 0 - 14)	168	191	227	250	12.7	0.001	0.11	0.96
ADG, g (d 0 - 42)	390	409	468	486	12.2	0.001	0.22	0.98
ADG, g (d 0 - 56)	454	490	522	540	13.4	0.001	0.07	0.53
G/F (d 0 - 14)	0.85	0.89	0.95	1.02	0.03	0.001	0.07	0.90
G/F (d 0 - 42)	0.69	0.71	0.72	0.75	0.02	0.012	0.12	0.77
G/F (d 0 - 56)	0.60	0.62	0.63	0.64	0.01	0.066	0.08	0.63

Key Words: Pigs, Antibiotics, Direct Fed Microbial

166 Effect of dietary levels of soluble and insoluble fiber on embryo survival in gilts. J. A. Renteria*[1], L. J. Johnston[2], and G. C. Shurson[1], [1]*University of Minnesota, St. Paul,* [2]*University of Minnesota, Morris.*

Forty-three gilts were assigned randomly to one of four experimental diets to determine the effects of soluble (S) and insoluble (IS) dietary fiber on ovulation rate and embryo survival. Diets included corn-soybean meal control (C; 1.54% S, 7.97% IS), corn-soybean meal-30% oat bran high in S fiber (HS; 3.18% S, 8.03% IS); corn-soybean meal-13% wheat straw high in IS fiber (HIS; 1.41% S, 15.63% IS); and corn-soybean meal-21% soybean hulls HS+HIS fiber (2.99% S, 20.80% IS). Gilts were housed in group pens (6 gilts/pen) by dietary treatment to facilitate twice daily estrus detection by a mature boar. On the first day of the second detected estrus, gilts were fitted with an auricular venous catheter to draw blood samples from estrus until 14 d after mating. At estrus, gilts were moved to individual crates and artificially inseminated three times using pooled semen. Daily feed was offered to gilts based on their initial body weight to meet their daily nutrient requirements (NRC, 1998) for ME (avg. = 5910 kcal), protein (avg. = 255 g), and lysine (avg. = 12.5 g). Reproductive tracts of gilts were harvested 32 d post-mating (range = 28 to 35 d). Statistical analysis of data included effects of diet and day of gestation as a covariate. Pregnancy rates were not affected ($P > 0.20$) by diet (9/12 C; 9/10 HS; 10/10, HIS; 9/11 HS+HIS). Number of corpora lutea was not affected by diet (avg. = 14.1; $P > 0.50$). Fertilization rate for gilts fed HS+HIS was lower than for gilts fed C, HS, and HIS (65.1 vs 84.3, 80.3, 76.4%; $P < 0.05$). Number of live embryos was lower for HIS and HS+HIS gilts compared to C and HS gilts (9.9 and 9.1 vs 11.9 and 10.6; $P < 0.05$). Survival rate of embryos was not influenced by dietary treatments (avg. = 97.3%; $P > 0.50$). High levels of dietary S combined with high levels of dietary IS fiber may decrease fertilization rate. However, under the conditions of this experiment, elevated dietary levels of S and(or) IS fiber did not affect ovulation rate or embryo survival rate.

Key Words: Gilts, Embryo Survival, Fiber

167 The optimal true ileal digestible threonine requirement for nursery pigs between 11 to 22 kg body weight. B. W. James*[1], M. D. Tokach[1], R. D. Goodband[1], S. S. Dritz[1], J. L. Nelssen[1], and J. L. Usry[2], [1]*Kansas State University, Manhattan,* [2]*Ajinomoto-Heartland Lysine, Chicago, IL.*

The objective of this 22-d growth assay was to determine the optimal true ileal digestible Thr:Lys ratio in nursery pig diets to maximize growth performance. A total of 380 pigs were randomly allotted to pens (5 pigs/pen and 7 pens/treatment) within blocks based on initial BW (approximately 11 kg). In a previous experiment, the true ileal digestible Lys requirement for these pigs was determined to be 1.2% and 1.3% for ADG and gain/feed (G:F), respectively. In this experiment, diets were formulated at and below the Lys requirement. The ten dietary treatments consisted of two basal diets (1.1 and 1.2% true ileal digestible Lys; 16.1 and 17.4% CP) with increasing levels of Thr (50, 55, 60, 65, and 70% of Lys). Pigs fed 1.2% true ileal digestible Lys had increased ($P < 0.01$) ADG and G:F compared to pigs fed 1.1% Lys, suggesting that the Lys requirement was greater than 1.1%. Increasing Thr had no effect ($P > 0.07$) on ADG. A Thr × Lys interaction ($P < 0.04$) was observed for G:F as pigs fed 1.1% Lys had a greater response to increasing Thr than pigs fed 1.2% Lys. Feed efficiency improved (quadratic, $P < 0.01$) for pigs fed increasing true ileal digestible Thr with the greatest improvement observed as the ratio increased to 60 and 65% of Lys for pigs fed 1.1 and 1.2% true ileal digestible Lys, respectively. These results suggest that the optimal true ileal digestible threonine requirement for 11 to 22 kg pigs is 60 to 65% of lysine.

	Threonine: Lysine, %				
Item	50	55	60	65	70
1.1% Lysine					
ADG, g	490	540	494	481	503
G:F	.55	.61	.64	.63	.65
1.2% Lysine					
ADG, g	540	553	540	531	544
G:F	.63	.65	.66	.68	.68

Key Words: Threonine, Lysine, Weanling Pigs

168 The use of soldier fly prepupae as a replacement for blood plasma in phase 1 and 2 nursery diets. C. R. Dove*, G. L Newton, and D. C. Sheppard, *University of Georgia, Tifton.*

Two studies were conducted to determine if dried soldier fly prepupae (SF) could be used to replace blood plasma (BP) in nursery diets. In study 1, 84 pigs, weaned at 21 d of age, were randomly allotted to dietary treatment. Pigs were housed in an environmentally controlled nursery with ad libitum access to feed and water over the 35 d study. Experimental treatments were: 1) 5% BP during phase 1, 2.5% BP during phase 2 (PLA); 2) 2.5% BP, 2.5% SF during phase 1, 1.25% BP, 1.25% SF during phase 2 (COMBO); 3) 5% SF during phase 1, 2.5% SFL during phase 2 (SFP). All pigs were fed a common phase 3 diet with no BP or SF. The SF were produced on swine and poultry manure, resulting in over a 50% reduction of manure DM. In study 2, 105 pigs were weaned, housed and managed as in study 1. Dietary treatments were the same, except that dietary Lys, Thr, Trp and Met concentrations were equalized across diets. In both studies, data was analyzed using SAS Mixed Models procedures, with the pen as the experimental unit. In study 1, pigs fed SFP tended to have decreased ADG during phase 1 and had decreased ($P < 0.05$) ADG during phase 2. During phases 1 and 2 of study 1, pigs fed SFP had decreased ($P < 0.05$) ADFI. Pigs fed COMBO had ADG and ADFI similar ($P > 0.1$) to pigs fed PLA during phases 1 and 2. Over the 35 d study, ADG was decreased ($P < 0.05$) in pigs fed SFP compared to those fed PLA, with the COMBO diet being intermediate. ADG for the 35 d study 1 was 383, 369, and 331 g/d for the PLA, COMBO and SFP diets, respectively. Feed efficiency was not affected ($P > 0.1$) by the COMBO or SFP treatments compared to pigs fed PLA in study 1. In study 2, pigs fed SFL had decreased ($P < 0.05$) ADG compared to the PLA or COMBO fed pigs during phase 1. During phase 2 and 3 of study 2, both the SFP and COMBO fed pigs had decreased ($P < 0.05$) ADG compared to the PLA fed pigs. Daily feed intake was decreased ($P < 0.05$) in pigs fed SFP during phases 1 and 2 in study 2 compared to the PLA or COMBO fed pigs. Gain:feed ratio was decreased ($P < 0.01$) in pigs fed the COMBO diet during phase 3 and over the entire 35 d study. The data from these studies indicate that SFP can be used to replace 50% of the BP in phase 1 nursery diets and that supplementation of SF diets with amino acids did not improve pig performance.

Key Words: Pigs, Soldier Fly Prepupae, Growth

169 Efficacy of mannan oligosaccharide supplementation through late gestation and lactation on sow and litter performance. C. V. Maxwell*[1], K. Ferrell[2], R. A. Dvorak[3], Z. B. Johnson[1], and M. E. Davis[1], [1]*University of Arkansas, Fayetteville,* [2]*MFA, Inc., Columbia, MO,* [3]*Alltech, Nicholasville, KY.*

A previous experiment evaluating mannan oligosaccharide (MOS) supplementation to sows in a commercial facility reported improvements in milk immunoglobulin (Ig) levels, d to estrus, birth weight, and weaning weight. This study was conducted to confirm the efficacy of MOS supplemented in a commercial facility during late gestation and throughout lactation on sow and litter performance. The experiment was conducted on a 600-sow farrow-to-wean commercial facility. A total of 318 sows were administered treatments during the last 21 d of gestation and through lactation. Treatments included control sows and MOS-supplemented (5 g of MOS/d) sows. Sows were fed standard diets and treatments were top-dressed by providing a placebo or treatment bolus immediately at feeding. On d 10 after farrowing, litters were scored for scours using a 1 to 5 scale, such that 1 = watery stool and 5 = firm stool. Additionally, a 5-mL milk sample was obtained from 15 sows/treatment prior to the time that pigs nursed and was analyzed for IgA, IgG, and IgM. Sow records from 3 wk after the study was completed were used to determine d to estrus. There was no difference ($P \geq 0.10$) in number of pigs born alive, birth weight, Ig levels, or number of pigs weaned between sows supplemented with MOS and control sows. The percentage of litters with a scour score of 5 was similar between treatments. However, of the litters with scour scores of 1, 2, 3, or 4, 38.7% of these were in the MOS-supplemented group compared to 61.3% in the control group (Chi-square, $P = 0.10$) Although not statistically significant ($P \geq 0.10$), litter weaning weight (55.6 vs 57.5 kg), and d to estrus (6.4 vs 5.9) were improved when sows were supplemented with MOS compared to control sows. Results of this study suggest that MOS supplemented to sows during gestation and lactation may benefit sow and litter performance and warrants further investigation.

Key Words: Pigs, Sows, Mannan Oligosaccharides

170 Effect of increasing corn oil on apparent amino acid digestibility of soybean meal. J. W. Frank* and G. L. Allee, *University of Missouri , Columbia.*

A study was conducted to evaluate the effect of corn oil on apparent digestibility (AD) of amino acids in soybean meal (SBM). This experiment was designed as two - 6 × 6 Latin Squares using ileal-cannulated pigs (average BW = 74.2 kg). The first diet contained 34.1% SBM (48% CP) with 2% corn oil. Three additional diets with the same level of SBM included increasing levels of corn oil resulting in total corn oil contents of 5, 8, and 11%. The corn oil replaced cornstarch, while all other ingredients remained the same as the first diet. An additional diet contained soy protein concentrate (SPC), which replaced SBM on an isolysine basis. The final diet contained casein as the protein source. The SPC and casein diets included 2% corn oil. Apparent amino acid digestibility was calculated using chromic oxide in the diet as an indigestible marker. The diet containing SBM had consistently greater AD of essential amino acids than SPC ($P < 0.05$). These amino acids included isoleucine (83.2 vs 80.6%), leucine (83.0 vs 79.5%), methionine (85.4 vs 81.6%), and threonine (76.4 vs 69.4%). In addition, the AD of amino acids in SBM was greater than casein for arginine, isoleucine, tryptophan, and threonine ($P < 0.05$). No differences in the AD of lysine were observed among the three protein sources (84.8, 82.5, and 84.9% for SBM, SPC, and casein, respectively). The AD of amino acids of the SBM used in this trial agree with the values reported in the NRC; however, the AD values for SPC and casein were lower than reported in the NRC. No improvement in AD in SBM was observed with increasing dietary corn oil from 2% to 11% for any of the amino acids measured. These results demonstrate further processing of soybean meal to soy protein concentrate does not improve apparent amino acid digestibility and increasing the level of corn oil in the diet does not significantly increase apparent amino acid digestibility of soybean meal.

Key Words: Pigs, Digestibility, Amino Acids

171 Growth performance, carcass characteristics, and pork color in finishing pigs fed two sources of supplemental iron. K. L. Saddoris*[1], T. D. Crenshaw[1], J. R. Claus[1], and T. M. Fakler[2], [1]*University of Wisconsin, Madison,* [2]*Zinpro Corporation, Eden Prairie, MN.*

The potential for two iron sources to induce a pork color change was evaluated in pigs. 72 pigs (D×LR×LW) ∼70 kg were randomly assigned to dietary treatments. Treatments consisted of a corn-soybean meal Control diet (50 ppm Fe added from iron sulfate), Control + 90 ppm Fe from iron sulfate, and Control diet + 90 ppm Fe from Availa-Fe 60. Three trials were conducted, each with 2 pens/treatment and 4 pigs/pen, and pen was used as the experimental unit. Pigs were fed their diets for 47 d and then slaughtered. Carcass traits were assessed at 24 h postmortem. Loin color and purge loss was assessed during a 7 d storage (2-3°C), and Minolta and reflectance spectrophotometry measurements were made on d 1, 3, 5, 7. Differences among dietary treatments were not detected ($P > 0.10$) in ADG, ADFI, or gain:feed ratio. Backfat, LEA, loin pH, and 24 h L∗ and b∗, and subjective color, marbling, and firmness scores did not differ ($P > 0.10$) among treatment groups. The 24 h a∗ value was lower ($P < 0.05$) for pigs fed the iron sulfate diet compared to the control. During storage, L∗, b∗, and estimated deoxymyoglobin, metmyoglobin, and oxymyoglobin did not differ ($P > 0.10$) among treatment groups. Availa-Fe 60 increased ($P < 0.05$) a∗ values on d 1, 3, 5, 7 compared with the iron sulfate fed groups, and increased ($P < 0.05$) a∗ values on d 3, 5, 7 compared with the control fed groups. Iron sulfate decreased ($P < 0.05$) a∗ value on d 1 of storage compared to pigs fed the control and Availa-Fe 60 diets. Purge loss was decreased ($P < 0.05$) by pigs fed iron sulfate (4.82%) and Availa-Fe 60 (4.64%) compared to the control (5.40%). In conclusion, 90 ppm of both iron sulfate and Availa-Fe 60 had no beneficial effects on growth, carcass composition, or 24 h pork color. On d 7 of storage, Availa-Fe 60 increased redness 5.3% compared to pigs fed the control diet (a∗ 7.86 control vs 8.28 Availa-Fe). Iron supplementation of 90 ppm from iron sulfate or Availa-Fe 60 resulted in a 10-15% reduction in purge loss over the 7 d storage.

Key Words: Pigs, Color, Iron

172 The effect of a calcified seaweed product on growth performance, carcass traits, and meat quality in swine. D. W. Dean*, L. L. Southern, and T. D. Bidner, *Louisiana State University Agricultural Center, Baton Rouge.*

Two experiments were conducted to determine the effects of a calcified seaweed product (CSP) in diets for pigs. The CSP (Marigro) contained 30% Ca (100% bioavailable as previously determined) and was added at the expense of limestone in both experiments. In Exp. 1, 64 crossbred barrows and gilts (76.9 kg average initial BW and 110.6 kg average final BW) were blocked by weight and allotted to pens based on sex and ancestry. There were four replications of barrows and four replications of gilts with four pigs/replicate. The pigs were fed diets containing 0 or 0.50% CSP in a 57-d growth assay. Growth performance and carcass traits were not affected by CSP ($P > 0.10$). Minolta L* and b* values were increased by CSP ($P < 0.05$). However, there were no effects on initial and final pH, drip loss, or subjective color and marbling scores of the longissimus muscle ($P > 0.10$). In Exp. 2, 150 weanling barrows and gilts (5.7 kg average initial BW) were allotted to three treatments and used in a 178-d growth assay. Each treatment was replicated 10 times (five replications/sex) with five pigs/replicate for the nursery phase (d 0 to 33). After the nursery, the five replications of gilts were continued on their dietary treatments until slaughter (117.3 kg average final BW). Pigs were fed 0, 0.25, or 0.50% CSP. Overall rate and efficiency of gain in the nursery period were linearly decreased ($P < 0.08$) by CSP; however CSP did not affect ($P > 0.10$) growth performance in the growing and finishing periods. Carcass lean and fat measurements as well as pork quality measurements were not affected ($P > 0.10$) by CSP. These results suggest that CSP may be substituted for limestone through the growing and finishing phases with no adverse effect on growth or carcass traits.

Key Words: Pork Quality, Carcass, Seaweed

173 Influence of dietary energy on growth performance of the late nursery pig. C. Hastad*, M. Tokach, J. Nelssen, S. Dritz, R. Goodband, and J. DeRouchey, *Kansas State University, Manhattan*.

Two studies were conducted to evaluate the effects of increasing energy density in nursery pig diets. In Exp. 1, 200 pigs with an initial BW of 13.7 kg were used in a 21-d growth assay. Pigs were allotted to one of five dietary energy levels of 3,047, 3,157, 3,268, 3,378, and 3,489 kcal of ME/kg. Energy densities were achieved by substituting wheat bran or soybean oil for corn in the corn-soybean meal based diets. All diets were formulated to 1.30% true digestible lysine. Overall, increasing dietary ME resulted in a linear increase in ADG ($P < 0.02$; 703, 714, 728, 735, and 753 g/d) and gain/feed ($P < 0.01$; 0.64, 0.63, 0.67, 0.67, 0.69). Experiment 2 was conducted at a commercial nursery facility in southeast MN. We used 1,415 pigs with an initial BW of 11.8 kg in a 21-d growth assay. Pigs were fed corn-soybean meal diets with increasing amounts of choice white grease (0, 1.5, 3, 4.5, and 6%). All diets were formulated to contain 4.5 g total lysine/Mcal ME. From d 0 to 7, ADG increased (quadratic $P < 0.01$; 495, 531, 564, 544, 522 g/d) with increasing dietary energy with the largest improvement observed when 1.5% fat was added to the diet. Feed intake decreased (linear, $P < 0.02$; 714, 716, 725, 695, 678 g/d) and G:F improved (linear, $P < 0.01$; 0.69, 0.74, 0.78, 0.78, 0.77) with increasing energy. For d 7 to 14 and 14 to 21, increasing energy reduced ($P < 0.01$) ADFI and improved G:F ($P < 0.01$); however, there was no difference ($P > 0.23$) in ADG. Overall, increasing dietary energy reduced ADFI (linear, $P < 0.01$; 887, 876, 856, 834, 822 g/d) and improved feed efficiency (linear, $P < 0.01$; 0.64, 0.67, 0 .68, 0.70, 0.71); however, ADG was not affected ($P > 0.26$; 564, 583,583, 580, 582 g/d). These studies indicate that increasing dietary energy for nursery pigs during the late nursery phase linearly improves feed efficiency; however, the effect on ADG is less consistent.

Key Words: Pigs, Energy, Fat

174 Monitoring the effects of ractopamine in market hogs, the effects on barrows and gilts. B. S. Zimprich* and M. J. Marchello, *North Dakota State University, Fargo*.

Twenty-four crossbred barrows and twenty-four crossbred gilts were randomly assigned to diets at 86 kg BW. The pigs were housed in individual pens in a climate-controlled room. Corn-soybean meal diets for the barrows contained 14% CP and 0.7% Lys (BLL); 14% CP and 1.2% Lys (BHL); 14% CP and 1.2% Lys plus ractopamine at 10 ppm (BHLR); or 16% CP and 1.05% Lys plus ractopamine at 10 ppm (BR). Diets for the gilts consisted of 15% CP and 0.7% Lys (GLL); 15% CP and 1.2% Lys (GHL); 15% CP and 1.2% Lys plus ractopamine 10 ppm (GHLR); or 16% CP and 1.05% Lys plus ractopamine at 10 ppm (GR). Pigs were maintained on the respective treatment diets for four wk, pigs were then slaughtered and carcass data was collected. Barrows on BHLR diet ended the collection period heavier than barrows on diet BLL (117 vs 111.62 kg, $P < 0.01$). Pigs on BHLR and the BR diets had a higher ADG than pigs on the BLL diet (0.92, 0.90 vs 0.75 kg; $P < 0.04$). Barrows on BHLR and BR diets had a more desirable g:f than barrows on BLL treatment (310.7, 310.7 vs 262.2 g/kg; $P < 0.005$). Gilts on GHLR and GR treatments also had a higher improvement in g:f than gilts on GLL diet (326.3, 331.1 vs 381.7 g/kg; $P < 0.02$). Barrows on treatments BHLR and BR had an increase in loin eye area over barrows on treatments BLL and BHL (56.58, 51.74 vs 44.26, 46.19 cm^2; $P < 0.05$). BHLR barrows had a higher percent lean than barrows on treatments BLL and BHL (58.69 vs 54.64, 55.32%; $P < 0.03$). BR and GR were identical diets and there were no differences found between barrows and gilts fed those respective diets. We have found that protein levels can be reduced if lysine levels are maintained with the result of obtaining performance and carcass results comparable to those achieved when manufacture recommendations are followed.

Key Words: Ractopamine, Lysine, Growth Performance

175 Effects of ractopamine and β-mannanase addition to corn-soybean meal diets on growth performance and carcass traits of finishing pigs. J. D. Schneider*, S. D. Carter, T. B. Morillo, and J. S. Park, *Oklahoma State University, Stillwater*.

An experiment using 96 pigs (avg BW = 79.1 kg) was conducted to evaluate the effects of ractopamine (RAC; Paylean®, Elanco Animal Health) and β-mannanase (Hemicell®, HC; ChemGen Corp.) addition to corn-soybean meal diets on growth performance and carcass traits of finishing pigs. Previous research from our lab suggest that HC increases growth performance in pigs. Pigs were blocked by weight and sex, and allotted randomly to four dietary treatments (6 pens/trt). Dietary treatments were: 1) a fortified corn-soybean meal diet, 2) as Diet 1 with 10 ppm RAC, 3) as Diet 1 with 0.05% HC, and 4) as Diet 1 with 10 ppm RAC and 0.05% HC. All diets were formulated to 1.0% Lys, .60% Ca, and .50% P. Pigs were housed (4 pigs/pen) in a temperature-controlled finishing facility and allowed ad libitum access to feed and water. Pigs and feeders were weighed at 7-d intervals. Average daily gain and gain:feed (G:F) for the four treatments were, respectively: 0.81, 0.94, 0.79, 0.95 kg/d and 0.28, 0.35, 0.28, 0.34 kg/kg. Addition of RAC increased ($P < 0.01$) ADG and G:F, but HC had no effect ($P > 0.10$) on growth performance. There were no differences ($P > 0.10$) in ADFI, and no interactions ($P > 0.10$) were noted for growth performance. At approximately 113 kg BW, pigs were killed and carcass measurements were recorded. Tenth rib fat depth (FD), average backfat (ABF), longissimus muscle area (LMA), and % lean were, respectively: 1.68, 1.52, 1.63, 1.45 cm; 2.18, 2.13, 2.21, 1.98 cm; 45.9, 48.8, 46.2, 50.3 cm^2; and 55.0, 56.1, 55.4, 57.1%. Addition of RAC decreased ($P < 0.02$) ABF and FD, and increased ($P < 0.01$) LMA and % lean. Hemicell had no effect ($P > 0.10$) on carcass traits. Although there were numerical improvements in carcass traits when HC was added to the RAC diet, there were no interactions (RAC × HC, $P > 0.12$). These results suggest that Hemicell had no effect during the late-finishing phase. However, ractopamine markedly improves growth performance and carcass traits.

Key Words: Pigs, Ractopamine, β-mannanase

176 Effects of reducing metabolizable energy concentration in diets containing spray-dried porcine plasma on weanling pig performance. T. B. Morillo*, S. D. Carter, S. Genova, J. S. Park, and J. D. Schneider, *Oklahoma State University, Stillwater*.

Two experiments were conducted to determine the effects of reducing the ME concentration of diets containing spray-dried porcine plasma (SDPP) on weanling pig performance. In both experiments, pigs (avg BW = 5.8 kg) were weaned at approximately 21 d and housed (6-7 pigs/pen) in a temperature-controlled nursery for 18 d. Pigs and feeders were weighed on d 0, 7, 14, and 18 to determine ADG, ADFI, and gain:feed (G:F) ratio. In Exp. 1, 232 pigs were blocked by weight and randomly allotted to four dietary treatments (9 pens/trt). Diet 1 (3,471 kcal ME/kg) was composed primarily of corn, soybean meal, dried whey, lactose, soy protein concentrate (SPC), fish meal, and soybean oil. Diet 2 (3,471 kcal/kg) was similar to Diet 1 with the exception that SDPP replaced SPC. Diets 3 and 4 were similar to Diet 2 except that soybean oil decreased to provide 3,371 and 3,271 kcal ME/kg, respectively. All diets contained 1.35% digestible Lys. Pigs fed SDPP had greater ($P < 0.01$) ADG, ADFI, and G:F than pigs fed SPC from d 0 to 18. Decreasing the ME in SDPP diets had no effect ($P > 0.10$) on growth performance, but it increased (linear, $P < 0.01$) gain/ME intake. In Exp. 2, 168 pigs were allotted to four dietary treatments (7 pens/trt) in a 2 × 2 factorial design with two CP sources (SPC vs SDPP) and two ME levels (3,523 vs 3,323). Diet composition was similar to Exp. 1. Pigs fed SDPP tended to have greater ($P < 0.08$) ADG, ADFI, G:F, and gain/ME intake than pigs fed SPC from d 0 to 18. Reducing ME had no effect ($P > 0.10$) on growth performance, but it increased ($P < 0.10$) gain/ME intake. The improvements in G:F and gain/ME intake associated with reducing ME of the diet tended to be greater for pigs fed SPC than for pigs fed SDPP (CP source × ME level, $P < 0.10$). These results suggest that lowering ME in SDPP diets does not affect growth performance of weanling pigs; however, the source of dietary protein may affect energy (fat) utilization.

Key Words: Pigs, Plasma Protein, Metabolizable energy

177 Factors related to insulin function in sows: response to chromium-L-methionine. V. G. Pérez-Mendoza*[1], J. A. Cuarón[1], T. L. Ward[2], and T. M. Fakler[2], [1]*C.N.I. Fisiología y Mejoramiento Animal, INIFAP, Queretaro, Mexico*, [2]*Zinpro Corp., Eden Prairie, MN*.

Metabolic response to insulin is naturally diminished during gestation and it could be aggravated by over-feeding of carbohydrates, particularly from soluble sources. Results of two experiments are presented to

contribute to the distinction of the response of sows to the correction of a Cr deficiency. In Exp. 1, 36 sows were fed 3 isoenergetic (ME, 3.3 Mcal/kg), isolysinic (0.8% digestible Lys) diets to challenge the response in feed intake. Diets were: Control (CTR), 12% sucrose (SUC) and a sweetened Control (artificial flavoring agent, AFA), to equal the sweetening power of sucrose and molasses. Feed intake was improved (P < 0.14) by SUC (5.4 kg), but not by AFA (4.9 kg) over CTR (4.7 kg). Litter weaning weight tended to increase as a direct response to feed intake: CTR, 52.5; SUC, 58.7 and AFA, 52.3 kg, but prolificacy in the subsequent farrowing was unchanged (9.5 live pigs). In Exp. 2, obesity was induced from Day 70 of gestation by feeding 10 vs. 5.9 Mcal of ME/d. Chromium from chromium-L-methionine (CrMet; MiCroPlex®, Zinpro Corp.) was added (400 ppb Cr) from Day 109 of gestation until the subsequent mating for the CrMet treatment group. A total of 144 sows were used in the factorial arrangement of treatments (main effects of diet energy level and Cr addition). Lactation diets were formulated to contain 3.3 Mcal of ME/kg, 0.85% digestible Lys, and 12% sucrose. Diets were fed *ad libitum*. Over-fed sows were heavier (P < 0.04) at farrowing (233 vs. 209 kg) and had smaller (P < 0.02) litter size at weaning (8.6 vs. 9.4 piglets). Main effects of Cr supplementation were greater (P < 0.01) feed intake in lactation (5.4 vs. 4.6 kg/d); lower (P < 0.10) lactation weight loss (18.6 vs. 25.4 kg) and greater (P < 0.16) litter weight gain to weaning (45.3 vs. 42.2 kg). Obesity and Cr interacted (P < 0.03) in backfat change during lactation: obese-control sows lost 12 mm, which was prevented by CrMet supplementation (-4.6 mm), while non-obese sows were unaffected (-7.1 mm). Feeding chromium-L-methionine to sows improves reproductive performance.

Key Words: Sows, Chromium, Obesity

178 Lactating and rebreeding sow performance in response to chromium-L-methionine. V. G. Pérez-Mendoza*[1], J. A. Cuarón[1], C. J. Rapp[2], and T. M. Fakler[2], [1]*C.N.I. Fisiología y Mejoramiento Animal, INIFAP, Queretaro, Mexico,* [2]*Zinpro Corp., Eden Prairie, MN.*

Productive performance of lactating and rebreeding sows (182 Duroc-Landrace sows) was measured in response to Cr supplementation from chromium-L-methionine (CrMet; MiCroPlex®, Zinpro Corp.). At Day 109 of gestation, sows were moved to the farrowing house, where pelleted lactation diets were fed at 2.0 kg/d prior farrowing and *ad libitum* during lactation. Lactation diets were based on sorghum-soybean meal with added fat formulated to contain 3.31 Mcal of ME/kg and 0.85% digestible Lys. Treatments were the addition of CrMet, to the lactation diet at 0, 200 and 400 ppb Cr from farrowing until rebreeding (up to 24 d postweaning). Litter size was adjusted to a minimum of 10 piglets within 48 h postfarrowing. Lactation length was an average of 20.7±2 days in an all in-all out system. Creep feed was not offered to the piglets. After weaning, all animals were fed 2.0 kg/d of the appropriate lactation diet in collective breeding pens. After breeding, sows were fed the gestation diet (meal form). Days to estrus and days to conception were recorded. Sows that failed to exhibit estrus in 21 d after weaning were considered anestrus. Prolificacy at the subsequent farrowing was measured. Data were analyzed as a randomized block design; farrowing group was the blocking criteria. Parity effects were considered in the model. There were no interactions (P > 0.30) with sow parity. Sow body weight and composition (backfat and muscle depth) were not affected by Cr (P > 0.42), although lactation feed intake was increased (P < 0.15) by Cr (5.6 vs. 5.9 kg/d), as were piglets weaned (0, 8.8; 200, 9.4 and 400, 9.1; P < 0.16), litter weaning weight (0, 52.2; 200, 55.8 and 400, 55.3 kg; P < 0.2) and days to estrus (0, 6.9; 200, 6 and 400, 6.1; P < 0.16). Chromium supplementation improved (P < 0.01) prolificacy at the subsequent farrowing (0, 9.6; 200, 11; and 400, 10.9 piglets born alive per litter). Chromium-L-methionine is an available source of Cr, improving reproductive performance of sows.

Key Words: Sows, Chromium, Prolificacy

179 Effects of short chain fructooligosaccharides and tylosin (Tylan®) on performance and fecal bacterial populations of nursery pigs. M. Howard* and E. Wojcik, *National Swine Research & Information Center, USDA/ARS, Ames, IA.*

An experiment using 480 weaned pigs (average initial BW = 6.7 kg) entering a conventional nursery facility was conducted to evaluate the effects of graded levels of short chain fructooligosaccharides (SCFOS) fed alone or in combination with tylosin (Tylan®). The objective was to compare performance and fecal bacterial populations between pigs consuming either a prebiotic (SCFOS)or a sub therapeutic level of antibiotic (tylosin). Pigs were weighed, ranked according to BW, and assigned to pens. One of six treatments was randomly assigned to a pen. Treatments were a 2 x 3 factorial arrangement of two levels of tylosin (0 or 100 g/907 kg of feed) and three levels of SCFOS (0%, 0.1%, 0.2%). Each treatment was replicated four times. Data was analyzed as a 2 × 3 factorial using the SAS mixed model. The 43-d experiment was divided into 3 phases of 14 d, 14 d, and 15 d, respectively. Diets were complex and were changed at the beginning of each phase. Feed intake was affected by SCFOS in Phase 1 and for the entire study (P = 0.10 and P = 0.07, respectively). Pigs fed 0% or 0.1% SCFOS had higher ADFI than pigs fed 0.2% SCFOS. Average daily gain was affected by SCFOS for the entire study (P = 0.08) with 0.1% SCFOS pigs having higher ADG than 0.2% SCFOS pigs; however, ADG of 0% SCFOS pigs was intermediate to the other two treatments. Consumption of tylosin improved ADFI (P = 0.0006) and ADG (P = 0.02) during Phase 2 and tended to increase ADG (P = 0.12) in Phase 1 and for the entire experiment (P = 0.18). Pigs fed tylosin also tended to have improved feed efficiency (P = 0.18) during Phase 1. Fecal samples were collected at the end of the study and analyzed for *Lactobacilli*, *Bifidobacterium* and *Salmonella* species. Level of SCFOS tended (P = 0.17) to affect concentration of *Lactobacilli*, with 0% SCFOS having a higher concentration than 0.1% and 0.2% SCFOS. No *Salmonella* were detected and the presence of *Bifidobacterium* could not be verified. These data suggest that sub therapeutic antibiotics and prebiotics may have limitations in boosting performance of nursery pigs.

Key Words: Prebiotic, Tylosin, Nursery Pigs

180 Evaluation of commercial nursery starter programs on early nursery performance. R. E. Musser*[1], J. D. Hahn[1], S. Hansen[1], K. Ferrell[2], J. Hedges[1], E. Hansen[1], and B. Lawrence[1], [1]*Hubbard Feeds, Inc., Mankato, MN,* [2]*MFA, Columbia, MO.*

An experiment was conducted to determine if differences existed in pig performance due to different nursery starter recommendations. A total of 644 Genetiporc pigs weighing 5.02 kg were allotted to 7 programs (n = 9). Pigs were fed according to manufacturer recommendations with 4 of the 7 starter programs having an equivalent amount of feed budgeted (Trt A, B, C, and D; budgeted .45 kg, 1.36 kg, and 5.44 kg/pig of the Nursery 1, Nursery 2, and Nursery 3 diets, respectively). Nursery diets ranged in CP content from 22.2% in the Nursery 1 diet to 20.6% in the Nursery 4 diet. All nursery diets were similar for Ca (1.09%) and P (0.83%). Pigs were approximately 20 d of age at weaning, and allowed ad libitum access to feed and water. Pigs were weighed at d 0, 4, 11, and 25 postweaning. Treatments B, D, and E had similar performance overall, with treatments C and F, which were not fed a prestarter, having the lowest performance overall. Average daily gain ranged from 193 g to 300 g from d 0 to 11 in the nursery, with pigs gaining at a higher rate having a higher feed intake. Gains from d 11 to 25 were more similar with ADG ranging from 373 g to 489 g, with ADFI being higher for those pigs gaining the fastest. Overall performance d 0 to 25 in the nursery resulted in a spread of d 25 BW between the programs with values represented being (14.23, 14.55, 12.90, 14.64, 14.70, 13.49, and 13.93 kg, respectively). The results of this experiment suggest that even in fast growing, high feed intake pigs, differences between commercial nutrition programs can be observed.

	Trt A	Trt B	Trt C	Trt D	Trt E	Trt F	Trt G
# Observations	9	9	9	9	9	9	9
Days 0 to 25 Postweaning							
ADG, g	368.9	382.2	315.9	384.7	386.8	338.3	356.1
ADFI, g	484.8	514.3	430.9	478.3	504.9	485.3	459.7
GF	0.76	0.75	0.73	0.81	0.77	0.70	0.78
Total Gain, kg	9.22	9.56	7.89	9.62	9.67	8.46	8.90

$P < .001$.

Key Words: Starter, Nursery, Pigs

181 Evaluation of prestarters from d 0 to 4 post-weaning. R.E. Musser*, J.D. Hahn, S. Hansen, J. Hedges, E. Hansen, and B. Lawrence, *Hubbard Feeds, Inc., Mankato, MN*.

Two experiments were conducted to determine prestarter influence on nursery pig performance. Experiment 1 used a total of 280 Genetiporc pigs weighing 4.7 kg, allotted to one of two commercial prestarters (n = 14). Pigs were fed the prestarters from d 0 to 4 in the nursery, and had ad libitum access to feed and water. Gain was higher for prestarter B than in Prestarter A (222 vs 183 g/d; P = .06). No differences were observed for G:F, but ADFI was higher for Prestarter B than Prestarter A (202 vs 183 g; P = .05). Experiment 2 used a total of 644 Genetiporc pigs weighing 5.02 kg, allotted to one of 7 treatments, 5 prestarters (A, B, D, E, and G) and 2 Nursery 1 diets (C and F, not classified by manufacturer as a prestarter), as recommended from d 0 to 4. All diets were fed based on manufacturer recommendations from d 0 to 4. Prestarter A and B were the same prestarters fed in Exp. 1. All pigs except for treatments E and F had switched to the second phase diet by d 4. Pigs fed the 5 prestarters had greater gains (292.8 vs 255.4 g/d, respectively) and G:F (1.68 vs 1.49, respectively), than pigs fed the Nursery 1 diets. Intakes were similar (176 vs 172 g/d). Similar differences in ADG between Prestarters A and B were observed in both Exp. 1 and 2 (39 g/d and 37 g/d; respectively). These results indicate that differences exist in high quality Prestarters that can influence performance from d 0 to 4 post-weaning.

Exp. 2	Trt A	Trt B	Trt C	Trt D	Trt E	Trt F	Trt G	P <
# Observations	9	9	9	9	9	9	9	
D 0 to 4								
ADG, g	286	323	276	250	289	234	316	.01
ADFI, g	178	195	178	149	166	166	194	.001
G:F	1.64	1.67	1.57	1.71	1.45	1.41	1.63	.18
Total gain, kg	1.14	1.29	1.11	1.00	1.16	0.94	1.27	.01

Key Words: Prestarter, Nursery, Pigs

182 The effect of feed intake on amino acid digestibility in growing pigs. V. Rayadurg* and H. H. Stein, *South Dakota State University, Brookings*.

Six growing barrows (initial BW = 108 kg) were used in an experiment to determine the effect of level of feed intake on the digestibility of CP and amino acids (AA). All pigs were equipped with a T-cannula in the distal ileum. Two experimental diets were formulated. Diet 1 was a soybean meal cornstarch-based diet. Diet 2 was a cornstarch dextrose-based N-free diet used to estimate the endogenous flow of CP and AA to the distal ileum. Chromium oxide (0.25%) was included in both diets as an inert marker. Each diet was fed at a level calculated to equal the maintenance requirement of the pig (M1), at two times the maintenance requirement (M2), and at three times the maintenance requirement (M3) providing for a total of six different dietary treatments. The pigs were arranged in a 6 × 6 Latin square design with six periods and six dietary treatments. Each period lasted 7 d with the initial 5 d being an adaptation period to the treatment. Samples of ileal digesta were collected for two 12-h periods on d 6 and 7. Results of the experiment showed that the apparent ileal digestibility coefficient (AID) for CP and all indispensable AA except Lys, Met, and Val were higher (P < 0.05) for pigs fed at M2 as compared to M1. Higher AID for M2 compared to M1 were also calculated for Cys, Gly, Ser, and Tyr (P < 0.05) while there were no differences (P > 0.05) between the two feeding levels for the remaining dispensable AA. Likewise, there were no differences in AID for CP or any of the AA between M2 and M3 (P > 0.05). The endogenous flow to the distal ileum calculated as g/kg DM intake decreased linearly (P < 0.01) for CP and all AA except Pro as feed intake increased from M1 to M3. Likewise, the standardized ileal digestibility coefficients (SID) for diet 1 decreased linearly (P < 0.05) for CP and all AA except Arg, Trp, Asp, Pro, and Tyr as feed intake increased from M1 to M3. In addition, the SID for CP and all indispensable AA except Arg, His, and Trp were lower (P < 0.05) at M3 than at M2. The current results demonstrate that the level of feed intake significantly influences the calculated values for AID, SID, and endogenous losses. Therefore, pigs used to measure AA digestibility coefficients and endogenous losses should be fed at a level that is close to what is used under practical conditions.

Key Words: Amino Acid Digestibility, Feed Intake, Endogenous Losses

183 Effects of lysine level fed from 10 to 20 kg on growth performance of barrows and gilts. N. A. Lenehan*[1], S. S. Dritz[1], M. D. Tokach[1], R. D. Goodband[1], J. L. Nelssen[1], and J. L. Usry[2], [1]*Kansas State University, Manhattan.*, [2]*Ajinomoto-Heartland Lysine, Chicago*.

A total of 1,440 pigs (initially 10.2 kg and 21 d after weaning) were used in a 21-d growth assay to determine the optimal lysine level to maximize growth performance of 10 to 20 kg pigs. Pigs (PIC) were blocked by gender in a completely randomized block design with 24 pigs per pen and 2 pens per experimental unit. Five levels of true ileal digestible lysine (1.1, 1.2, 1.3, 1.4 and 1.5%) were fed from d 21 to 42 after weaning. Total lysine levels were 1.24, 1.34, 1.44, 1.54, and 1.64%. All diets had the same soybean meal level with crystalline amino acids added to achieve the lysine levels while maintaining a minimum ratio of all other amino acids. Pigs were weighed and feed intake determined weekly. Both ADG and gain/feed improved linearly (P < 0.01) with increasing dietary lysine. The greatest response in growth performance was obtained as true digestible lysine increased to 1.4%. The results of this trial indicate that pigs weighing between 10 and 20 kg require approximately 1.4% true digestible lysine.

	True digestible lysine, %						P<	
Item	1.1	1.2	1.3	1.4	1.5	SEM	Lin.	Quad.
ADG, g	468	476	494	518	515	14	0.01	0.76
ADFI, g	706	697	704	710	710	17	0.71	0.78
Gain/feed	0.66	0.68	0.70	0.73	0.73	0.01	0.001	0.24

Key Words: Pigs, Lysine, Growth

184 Effects of feeding commercially grown gilts below or above the lysine requirement in early and late finishing on overall performance. R. G. Main, S. S. Dritz, M. D. Tokach, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan*.

Our objective was to determine the effects of feeding gilts (PIC 337 × C22) below (d 0 to 27 = 2.75 g, d 27 to 55 = 2.25 g total lysine/Mcal ME) or at (d 0 to 27 = 3.30, d 27 to 55 = 2.75 g lysine/Mcal ME) the estimated lysine:calorie ratio required for optimal performance in early finishing (32 to 77 kg). Additionally, we observed the effects of feeding gilts within each early finishing treatment below, at, or above (1.75, 2.25, 2.75 g lysine/Mcal ME, respectively) the estimated lysine requirement in late finishing (77 to 115 kg). Forty-two pens (1,154 gilts; initially 32.8 ± .8 kg) were used in a split-plot design. Diets were corn-soybean meal based with 6% choice white grease. Lysine:calorie ratios were attained by adjusting corn and soybean meal. No crystalline lysine was used. In early finishing, gilts fed at the lysine requirement had improved (P < 0.01) ADG (791 vs. 827 ± 7 g/d), feed efficiency (0.447 vs. 0.467 ± 0.002) and income over marginal feed cost (IOMFC; $25.65 vs. 26.55 ± 0.26/gilt). In late finishing, increasing lysine:calorie ratio improved (quadratic, P < 0.02) ADG (768, 834, 843 ± 9 g/day), feed efficiency (0.342, 0.370, 0.376 ± 0.003), and lean percentage (54.7, 55.7, 55.9 ± 0.12%). Gilts fed below the lysine requirement in early finishing had improved (P < .01) feed efficiency (0.368 vs. 0.357 ± 0.002) and feed cost per kg of gain ($0.355 vs. 0.365 ± .002) in late finishing, as compared to gilts fed adequate lysine in early finishing. Overall, gilts fed diets below requirements in early finishing, and subsequently at the estimated lysine requirement in late finishing had lower (P < 0.03) feed cost per kg of gain ($0.319 vs. 0.325 ± 0.002) and similar (P > 0.70) IOMFC ($83.46 vs. 82.97 ± 1.33), as compared to gilts fed at the estimated lysine requirement in both early and late finishing. These results suggest that as long as lysine requirements are met in late finishing for gilts, feeding slightly below the lysine requirement in early finishing decreases input cost without sacrificing overall IOMFC.

Key Words: Lysine, Finishing, Economics

185 Free and peptide-bound amino acids in small intestinal mucosa of growing pigs fed low-protein diets supplemented with amino acids. F. Guay* and N. L. Trottier, *Michigan State University, East Lansing*.

The objective of this study was to determine if reduced-protein amino acid (AA) supplemented diets alter peptide-bound (PB) and free (F) AA profiles in small intestinal mucosa of growing pigs. Twenty-four Yorkshire-Landrace growing pigs (37.0 ± 1.5 kg) were assigned to one of 4 diets in a randomized block design: 15% CP (15CP), 12CP+synthetic amino acid (SAA), 9CP+SAA and 6CP+SAA. Levels of SAA added were calculated to meet true digestible AA requirements for the growing pig. Diets were offered twice daily for 24 d. At slaughter, mucosal samples from duodenum, jejunum and ileum were collected two h postmeal. In the duodenum, free alanine was the only dispensable (D) AA to increase with reduction in dietary CP ($P < 0.05$). Reducing CP increased free lysine, methionine and threonine concentration ($P < 0.05$) but had no effect on other free indispensable (I) AA concentration. For PBAA, only lysine increased with decreased dietary CP, especially for 12 and 9CP+SAA diets ($P < 0.05$). In the jejunum, reducing CP had no effect on free DAA and IAA, except for cystine and glycine ($P < 0.05$). Lowering CP led to lower peptide-bound histidine, isoleucine, leucine, phenylalanine and valine concentration ($P < 0.05$). In the ileum, free asparagine, serine and tyrosine decreased with lowering CP ($P < 0.05$). For free IAA, reducing dietary CP decreased arginine, histidine, leucine, phenylalanine, isoleucine, tryptophan and valine concentration ($P < 0.05$). For PBAA, glycine, serine, isoleucine, leucine, lysine, phenylalanine and valine tended to decrease with decreased dietary CP ($P < 0.10$). These results show that decreasing dietary CP affected FAA and PBAA profiles in small intestinal mucosa of growing pigs. Results indicate that specific adaptation may be involved to maintain mucosal function.

Key Words: Amino Acids, Small Intestinal Mucosa, Growing Pigs

186 Influence of crystalline or protein-bound lysine on lysine utilization for growth in pigs. J. J. Colina*, P. S. Miller, A. J. Lewis, and R. L. Fischer, *University of Nebraska, Lincoln*.

Two 4-wk experiments were conducted to determine lysine utilization for growth in barrows and gilts fed individually or in groups. One hundred twelve growing pigs (56 barrows and 56 gilts; average initial BW of 18.6 kg) were used in each experiment. Pigs were fed individually or in groups of three. There were 28 pigs individually penned and 84 pigs in 28 pens (three pigs/pen). There were two replications per treatment in each experiment for a total of four replications. Dietary treatments consisted of a basal diet (0.55% lysine) and diets containing 0.65, 0.75, and 0.85% lysine that were achieved by adding lysine to the basal diet from either soybean meal (SBM) or L-lysine·HCl (crystalline). Average daily gain and ADFI were recorded. At the end of the experiments, all pigs were scanned using real-time ultrasound to determine tenth-rib backfat depth and longissimus muscle area (LMA) to calculate fat-free lean gain. Average daily gain was affected by dietary lysine concentration ($P < 0.01$), but was similar for both sources of lysine (SBM vs crystalline, respectively) at the same concentration (0.65% lysine: 524.5 vs 516.2; 0.75% lysine: 603.2 vs 616.3; 0.85% lysine: 635.2 vs 623.7 g/d). Pigs fed individually had a greater ($P < 0.05$) ADG than pigs fed in groups (586.7 vs 556.6 g). No differences among dietary treatments were observed for ADFI. However, pigs fed individually had a greater ADFI ($P < 0.05$) than pigs fed in groups (1,362 vs 1,290 g). Feed efficiency improved as the lysine concentration increased ($P < 0.01$). Backfat depth was similar among treatments. Pigs fed crystalline diets had a greater ($P < 0.05$) LMA than pigs fed SBM (15.7 vs 14.7 cm^2) at 0.85% total lysine. Gilts had a greater LMA ($P < 0.01$) than barrows (14.3 vs 13.6 cm^2). Fat-free lean gain increased ($P < 0.001$) as dietary lysine concentration increased, regardless of lysine source. Gilts had a greater ($P < 0.001$) fat-free lean gain than barrows (264.4 vs 245.2 g/d). The results suggest that lysine from SBM-bound and crystalline sources was utilized similarly for growth.

Key Words: Pigs, Lysine, Growth

187 Influence of crystalline or protein-bound lysine on body protein deposition in growing pigs. J. J. Colina*, P. S. Miller, A. J. Lewis, and R. L. Fischer, *University of Nebraska, Lincoln*.

Two 4-wk experiments were conducted to determine lysine utilization for protein deposition (PD) in barrows and gilts. Thirty-two growing pigs (16 barrows and 16 gilts; average initial BW of 18.3 kg) were used in each experiment. Pigs were randomly allotted to one of seven dietary treatments. Four pigs (two barrows and two gilts) were killed at the start and the remaining pigs were killed at the end of the experiments to determine body composition. There were two replications per treatment in each experiment for a total of four replications. Dietary treatments consisted of a basal diet (0.55% lysine) and diets containing 0.65, 0.75, and 0.85% lysine that were achieved by adding lysine to the basal diet from either soybean meal (SBM) or L-lysine·HCl (crystalline). Blood samples were taken from all pigs weekly to determine plasma urea concentration (PUC). Body protein concentration was greater ($P < 0.01$) in pigs fed the 0.75% crystalline-supplemented diet than pigs fed SBM at the same concentration (152.9 vs 160.4 g/kg). Body PD was affected by dietary lysine concentration ($P < 0.01$), but was not different between the two sources of lysine (SBM vs crystalline, respectively) at the same concentration (0.65% lysine: 77.9 vs 68.3; 0.75% lysine: 88.3 vs 96.2; 0.85% lysine: 97.3 vs 90.5 g/d). Barrows tended to have greater PD ($P = 0.08$) than gilts (88.2 vs 78.8 g/d) regardless of lysine source. Body fat concentration decreased ($P < 0.001$) as the dietary lysine concentration increased for both lysine sources at the same concentration; however, fat deposition was not affected by diet. Water deposition increased with dietary lysine concentration ($P = 0.05$). Ash variables were similar for both sources of lysine. There was a diet × week effect ($P < 0.05$) for PUC. The PUC decreased for pigs consuming crystalline-supplemented diets and increased for pigs consuming SBM-supplemented diets during the 4-week experimental period. The results suggest that PD of growing pigs fed lysine from SBM is similar to that of pigs fed crystalline lysine.

Key Words: Growing Pigs, Lysine, Protein Deposition

188 The performance of grower-finisher pigs fed diets formulated to meet amino acid requirements but with declining crude protein content. J. F. Patience[1], A. D. Beaulieu*[1], R. T. Zijlstra[1], D. A. Gillis[1], and J. Usry[2], [1]*Prairie Swine Centre, Inc., Saskatoon, SK, Canada,* [2]*Heartland Lysine, Inc., Chicago*.

A changing price structure for synthetic amino acids (AA) combined with a mounting desire to reduce nitrogen excretion is increasing interest in lower CP diets. This study examined the performance and carcass composition of grower-finisher pigs fed conventional diets or those formulated to a lower CP content. The study was divided into Phase 1 (35 to 60 kg BW), phase 2 (60 to 90 kg BW) and phase 3 (90 to 115 kg BW). Diets were pelleted and based on barley, wheat and SBM. The high CP treatment (HiCP) contained less than 0.1% L-lysine·HCl while a low CP treatment (LoCP) was formulated to meet AA requirements using maximal amounts of synthetic L-lysine·HCl, L-threonine, and DL-methionine without using L-tryptophan or other synthetic AA. A third series of diets (MedCP) was formulated to be intermediate between the HiCP and LoCP diets. Diets were formulated to contain 2.32 Mcal NE/kg (NRC, 1998). The experiment was analyzed as a factorial with 2 genders and 3 treatments using 5 pens/(trt·gender) and 22 pigs/pen (0.64 m^2/pig). Treatment did not affect ADG, ADFI, feed efficiency (gain:feed) or days to reach market weight ($P > 0.05$). Gilts gained less than barrows (0.945 vs 0.973 kg/d, $P < 0.03$), consumed less feed (2.57 vs 2.78 kg/d, $P < 0.001$) and had an improved feed efficiency ($P < 0.001$). A gender × treatment interaction for neither ADG nor ADFI was observed ($P > 0.05$). Feeding a LoCP AA supplemented diet resulted in 2 mm greater loin thickness ($P < 0.004$) relative to the HiCP diet. Treatment did not affect lean yield, fat thickness, premiums or final carcass value ($P > 0.05$). Growth performance and carcass value can be maintained while feeding low CP, AA-supplemented diets formulated on the basis of net energy.

	CP, % DM (analyzed)		**g dLys/Mcal NE** (calculated)	
	HiCP	LoCP	HiCP	LoCP
Phase 1	25.4	23.1	3.8	3.8
Phase 2				
Barrows	19.6	18.2	3.2	3.2
Gilts	21.7	19.0	3.4	3.4
Phase 3				
Barrows	17.8	15.5	2.9	2.9
Gilts	19.3	16.6	3.0	3.0

Key Words: Swine, Crude Protein, Synthetic Amino Acids

189 Influence of crystalline or protein-bound lysine on body protein deposition and lysine utilization in nursery pigs. J. J. Colina*, P. S. Miller, A. J. Lewis, and R. L. Fischer, *University of Nebraska, Lincoln*.

A 4-wk experiment was conducted to determine the efficiency of utilization for protein deposition (PD) in nursery pigs of crystalline lysine relative to the lysine in soybean meal (SBM). Pigs were 23 or 24-d-old and had an initial BW of 6 kg. Pigs were blocked by sex and weight and randomly allotted to one of five dietary treatments. Pigs were individually penned in two nursery facilities and each treatment was replicated six times. Six pigs were killed at the start and the remaining were killed at the end of the experiment to determine body composition. The dietary treatments consisted of a basal diet (1.05% lysine) and diets containing 1.15 and 1.25% lysine that were achieved by adding lysine to the basal diet from either SBM or L-lysine·HCl (crystalline). Body protein concentration was greater ($P < 0.01$) in pigs consuming the diet with 0.10% added (1.15% total lysine) crystalline lysine, than in pigs supplemented with 0.10% added lysine from SBM (159.2 vs 147.3 g/kg). However, PD was similar for both supplemented-diets with values between 80.4 and 88.8 g/d. Body fat concentration and body fat deposition were affected ($P \leq 0.07$) by diet, but were similar between the two sources of dietary lysine at the same concentration. No differences were observed among treatments for body lysine concentration or lysine deposition rate. Ash concentration was greatest ($P < 0.05$) in pigs fed 0.10% added crystalline lysine vs SBM at the same concentration (26.5 vs 24.0 g/kg). No differences were observed for body water variables among diets. The efficiency of lysine utilization for PD was greatest ($P = 0.08$) in pigs fed the basal diet and the 0.10% added crystalline lysine (50.2 and 48.5%, respectively). However, at the concentration of 1.25% lysine, the efficiency was similar between sources (44.3 vs 44.5%). The results suggest that there are no differences in the efficiency of utilization between SBM-bound lysine and lysine from L-lysine·HCl for PD in nursery pigs.

Key Words: Nursery Pigs, Lysine, Protein Deposition

190 Determining an optimum lysine:calorie ratio for 40 to 120 kg barrows in a commercial finishing facility. R. G. Main*, S. S. Dritz, M. D. Tokach, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan*.

Our objective was to determine the optimum lysine:calorie ratio (g total dietary lysine/Mcal ME) for 40 to 120 kg barrows (PIC L337 × C22) in a commercial finishing environment. Three trials were conducted using randomized complete block designs (42 pens/trial, 3,281 pigs). Six treatments of increasing lysine:calorie ratio were used in each study. Diets were corn-soybean meal-based with 6% choice white grease. Lysine:calorie ratios were attained by adjusting the amount of corn and soybean meal. No crystalline lysine was used. In trial 1 (43 to 70 kg), increasing lysine:calorie ratio (2.21, 2.55, 2.89, 3.23, 3.57, and 3.91) increased (quadratic, $P < 0.01$) ADG (913, 970, 992, 966, 963, 943 ± 22 g/day), feed efficiency (0.44, 0.46, 0.47, 0.47, 0.47, 0.47 ± 0.006), income over marginal feed costs (IOMFC; \$15.00, 16.11, 16.33, 15.73, 15.28, 14.83 ± 0.43/pig), feed cost per kg of gain (\$0.30, 0.29, 0.29, 0.30, 0.32, 0.32 ± 0.004), and decreased (linear, $P < 0.01$) 10th rib backfat as measured by ultrasound. In trial 2 (69 to 93 kg), increasing lysine:calorie ratio (1.53, 1.78, 2.03, 2.28, 2.53, and 2.78) improved (linear, $P < 0.01$) ADG (818, 828, 893, 902, 916, 946 ± 18 g/day), feed efficiency (0.36, 0.36, 0.39, 0.38, 0.40, 0.40 ± 0.005), IOMFC (\$12.06, 12.03, 13.35, 13.21, 13.63, 13.92 ± 0.35/pig), and decreased (quadratic, $P < 0.01$) backfat. In trial 3 (102 to 120 kg), increasing lysine:calorie ratio (1.40, 1.60, 1.80, 2.00, 2.20, and 2.40) improved (linear, $P < 0.03$) ADG (808, 818, 857, 864, 868, 877 ± 23 g/day), feed efficiency (0.31, 0.31, 0.32, 0.32, 0.33, 0.34 ± 0.005), and (quadratic, $P < 0.01$) lean percentage (53.9, 53.9, 53.6, 53.6, 54.2, 54.2 ± 0.15 %). Numeric improvements (linear, $P = 0.12$) in IOMFC (\$106.64, 106.66, 106.98, 107.09, 107.60, 107.81 ± 1.40/pig) were observed as lysine increased. The equation (lysine:calorie ratio = -0.0133 × BW, kg + 3.6944) describes the lysine:calorie ratio that optimized performance and IOMFC from 40 to 120 kg.

Key Words: Lysine, Pigs, Economics

191 Determining an optimum lysine:calorie ratio for 35 to 120 kg gilts in a commercial finishing facility. R.G. Main, S.S. Dritz, M.D. Tokach, R.D. Goodband, and J.L. Nelssen, *Kansas State University, Manhattan*.

Our objective was to determine the optimum lysine:calorie ratio (g total dietary lysine/Mcal ME) for 35 to 120 kg gilts (PIC L337 × C22) in a commercial finishing environment. Four trials were conducted using randomized complete block designs (42 pens/trial, 4,520 pigs). Six treatments of increasing lysine:calorie ratio were used in each study. Diets were corn-soybean meal-based with 6% choice white grease. Lysine:calorie ratios were attained by adjusting the amount of corn and soybean meal. No crystalline lysine was used. As in trial 1 (35 to 60 kg, reported in 2002), increasing lysine:calorie ratio (1.96, 2.24, 2.52, 2.80, 3.08, and 3.36) in trial 2 (60 to 85 kg) increased (quadratic, $P < 0.02$) ADG (916, 935, 960, 973, 951, 936 ± 12 g/d), feed efficiency (0.40, 0.41, 0.41, 0.43, 0.40, 0.41 ± .005), income over marginal feed costs (IOMFC; \$14.42, 14.68, 14.90, 15.14, 14.13, 13.80 ± .27/hd), feed cost per kg of gain (\$0.32, 0.32, 0.32, 0.33, 0.35, 0.36 ± .004), and reduced (linear, $P < 0.01$) backfat. In trial 3 (78 to 103 kg), increasing lysine:calorie ratio (1.53, 1.78, 2.03, 2.28, 2.53, and 2.78) improved (quadratic, $P < 0.02$) ADG (807, 813, 900, 917, 912, 897 ± 18 g/d), feed efficiency (0.32, 0.32, 0.35, 0.36, 0.36, 0.36 ± 0.005), IOMFC (\$11.32, 11.24, 13.18, 13.41, 13.20, 12.56 ± .36), feed cost per kg of gain(\$.381, .388, .359, .361, .365, .382 ± .006), and reduced (linear, $P < 0.01$) backfat. In trial 4 (100 to 120 kg), increasing lysine:calorie ratio (1.40, 1.60, 1.80, 2.00, 2.20, and 2.40) improved (linear, $P < 0.02$) ADG (722, 725, 767, 837, 880, 879 ± 19 g/d), feed efficiency (0.30, 0.30, 0.33, 0.35, 0.36, 0.36 ± 0.007), IOMFC (\$105.66, 106.19, 107.46, 108.87, 109.64, 109.64 ± 1.57), feed cost per kg of gain (\$0.40, 0.40, 0.38, 0.36, 0.36, 0.37 ± .008), and (quadratic, $P < 0.04$) lean percentage (54.7, 55.1, 54.6, 55.1, 55.3, 55.5 ± .15%). The equation (lysine:calorie ratio = -0.0164 × BW, kg + 4.004) describes the lysine:calorie ratio that met biological requirements and optimized IOMFC from 35 to 120 kg.

Key Words: Lysine, Pigs, Economics

192 Evaluation of the lysine requirements for barrows fed ractopamine HCl (Paylean®) under conditions of heat stress. D. C. Kendall*, J. W. Frank, A. M. Gaines, G. F. Yi, and G. L. Allee, *University of Missouri, Columbia*.

Two experiments were conducted to evaluate the lysine requirement of barrows fed ractopamine HCl (Paylean®, RAC) under heat-stress conditions. Exp. 1 was conducted in the Brody environmental chambers at the University of Missouri. Seventy-two barrows (TR-4 x PIC C-22) were subjected to a controlled cycling heat stress (cycling from 27 C at 2400 h to 35 C maintained from 1100 to 1900 h; HS) and fed corn-soy meal diets containing 10 ppm RAC and 3.51 Mcal ME/kg. Pigs were fed one of three dietary Lys levels (0.70, 0.95, or 1.20% total Lys) for 20 days to 6 replicate pens of 3 pigs/pen. An additional treatment consisted of pigs housed at thermoneutral conditions (21 C; TN) and fed a diet containing 10 ppm RAC and 1.20% total Lys. There was a linear improvement in ADG ($P < 0.05$) and feed efficiency ($P < 0.05$) with increasing Lys level (593, 633, and 782 g/d, respectively; 0.178, 0.218, and 0.255, respectively). Pigs fed the 1.20% total Lys diet in the TN environment had higher ADG ($P < 0.01$), ADFI ($P < 0.01$) and tended to be more efficient (0.371 vs 0.340, $P < 0.07$) than pigs fed 1.20% total Lys in HS. In Exp. 2, 210 barrows (TR-4 x PIC C-22) were housed in a cycling heat stress environment (28 to 34 C) and fed corn-soy meal diets containing 10 ppm RAC and 3.47 Mcal ME/kg. Pigs were fed one of four dietary Lys levels (0.90, 1.10, 1.30, or 1.50% total Lys) for 25 d to 6 replicate pens of 7 pigs/pen. A fifth treatment consisted of the 0.90% total Lys diet without RAC. There were no differences in ADG or loin eye area accretion among the RAC fed treatments; however, ADFI ($P < 0.01$) and tenth rib backfat accretion ($P < 0.05$) decreased linearly with increasing Lys level. Therefore, feed efficiency linearly ($P < 0.01$) and quadratically ($P < 0.05$) improved with increasing Lys level (0.399, 0.414, 0.441, and 0.421, respectively). Pigs fed diets with 10 ppm RAC and 0.90% total Lys had greater ADG ($P < 0.02$), feed efficiency ($P < 0.001$), and loin eye area accretion ($P < 0.03$) than non-RAC fed pigs. These experiments demonstrate that feeding Paylean® improves the growth performance of heat-stressed pigs and that the lysine requirement of barrows fed Paylean® may be as high as 1.30% total lysine under heat-stress conditions.

Key Words: Pigs, Ractopamine, Lysine

193 The effects of environmental housing conditions on two ractopamine use programs in finishing pigs. S. A. Trapp*, B. E. Hill, S. L. Hankins, A. P. Schinckel, and B. T. Richert, *Purdue University, West Lafayette, IN.*

Littermate barrows (93) and gilts (96) were used in a 6-wk study evaluating the effect of environmental housing conditions on two ractopamine use programs for late finishing pigs. All pigs were weaned into an SEW nursery. Following the nursery period, they were sorted into two environments: an all-in-all-out grow/finish facility with high bio-security measures in place (AIAO) or into a continuous flow system for the grow/finish phase (CF). At an average initial BW = 72.1 kg, pigs were allotted by weight, sex and ancestry to one of three ractopamine (RAC) treatments (trt): 1) control, no RAC; 2) 5 ppm RAC wks 0-3, 10 ppm RAC wks 4-6; 3) 10 ppm RAC wks 0-6. Barrows were fed a 1.05% Lys diet wks 0-3 and a 1.00% Lys diet wks 4-6; gilts were fed a 1.15% Lys diet wks 0-3 and a 1.10% Lys diet wks 4-6. Pigs fed RAC had increased ADG (1022 vs 867 g/d; $P < 0.05$) and increased G:F (0.416 vs 0.359; $P < 0.05$) compared to the control trt during wk 0-3. Overall, pigs fed RAC had increased ADG (958 vs 872 g/d, $P < 0.05$) and increased G:F (0.378 vs 0.338, $P < 0.05$) compared to the control trt. Additionally, pigs fed trt 2 had greater ADG (990 vs 926 g/d, $P < 0.05$) than trt 3 during wk 0-6. Pigs fed trt 2 also had increased final BW (109.0, 114.0, 110.8 kg; trt 1-3 respectively, $P < 0.05$) than the control trt. Real-time ultrasound data indicate that pigs fed RAC had increased loin eye area (LEA) (42.8, 45.8, 46.0 cm^2; trt 1-3 respectively, $P < 0.05$) and decreased 10^{th} rib backfat (20.4, 18.5, 18.4 mm; trt 1-3 respectively, $P < 0.05$). No significant differences between housing systems or interactions between grow/finish environments and treatments were found for overall ADG, ADFI, G:F, or carcass characteristics ($P > 0.05$). However, pigs in the CF environment were 11 d older at the start of the experimental BW. Both RAC use programs had increased pig growth rate and feed efficiency with nearly identical LEA and backfat depths over the control. Additionally, the step-up RAC trt had greater final BW and ADG than the constant RAC trt, while utilizing less RAC in the late finishing period.

Key Words: Ractopamine, Pigs, Environment

194 Interactive effects between dietary L-carnitine and ractopamine HCl (Paylean®) on finishing pig growth performance. B. W. James*[1], M. D. Tokach[1], R. D. Goodband[1], J. L. Nelssen[1], S. S. Dritz[1], K. Q. Owen[2], and J. C. Woodworth[2], [1]*Kansas State University, Manhattan,* [2]*Lonza, Inc., Fair Lawn, NJ.*

A total of 2,152 pigs were used in four experiments to determine the interactive effects of dietary carnitine and ractopamine HCl (Paylean®, RAC). All trials were arranged as factorials with main effects of carnitine (0, 25, or 50 ppm in Exp. 1 and 2 and 0 or 50 ppm in Exp. 3 and 4) and RAC (0, 5, or 10 ppm in Exp. 1 and 0 or 10 ppm in Exp. 2, 3, and 4). Dietary carnitine was fed from 38 kg to market (Exp. 1 and 3) or for the last 3 or 4 wk before market (Exp. 4 and 2, respectively). Ractopamine was fed prior to market for 4 wk in Exp. 1, 2, and 3, and 3 wk in Exp. 4. Experiments 1 and 2 were conducted in university research facilities and Exp. 3 and 4 in commercial research barns. All diets were formulated to 1.0% Lys during the last phase of each experiment. In all experiments, pigs fed RAC had increased ($P < 0.05$) ADG and feed efficiency (G:F) compared to pigs not fed RAC. Feeding carnitine prior to the RAC feeding period did not affect ($P > 0.25$) pig performance. In Exp. 1 and 2, carnitine did not affect ($P > 0.46$) ADG during the 4 wk prior to market; however, G:F tended (quadratic; $P < 0.07$) to improve with increasing carnitine in Exp. 2. In Exp. 3, a carnitine × RAC interaction was observed ($P < 0.04$) for ADG and G:F. Both carnitine and RAC improved performance, but not additively. In Exp. 4, pigs fed carnitine had increased ($P < 0.04$) ADG (0.88 vs 0.84 kg) and G:F (0.36 vs 0.35) compared to pigs not fed carnitine and the response was additive to that of RAC. In analysis of the treatments common to all experiments, pigs fed diets containing RAC had increased ($P < 0.01$) ADG (1.03 vs 0.93 kg) and G:F (0.40 vs 0.35) compared to pigs not fed RAC. Carnitine tended to increase ($P < 0.07$) ADG (1.00 vs 0.96 kg) and improved ($P < 0.01$) G:F (0.38 vs 0.37) compared to pigs not fed carnitine. These results suggest that carnitine and RAC improve growth performance of finishing pigs with the greatest response to carnitine occurring in commercial environments.

Key Words: Carnitine, Ractopamine, Pigs

195 Interactive effects of dietary L-carnitine and ractopamine HCl (Paylean®) on finishing pig carcass characteristics and meat quality. B. W. James*[1], M. D. Tokach[1], R. D. Goodband1[1], J. L. Nelssen[1], S. S. Dritz[1], K. Q. Owen[2], and J. C. Woodworth[2], [1]*Kansas State University, Manhattan,* [2]*Lonza, Inc., Fair Lawn, NJ.*

Three experiments utilizing 1,356 pigs were conducted to determine the interactive effects of dietary carnitine and ractopamine HCl (Paylean®, RAC) on carcass and meat quality. Experiments were arranged as factorials with main effects of carnitine and RAC. Carnitine levels were 0, 25, or 50 ppm in Exp. 1 and 2 and 0 or 50 ppm in Exp. 3. Ractopamine levels were 0, 5, or 10 ppm in Exp. 1 and 0 or 10 ppm in Exp. 2, and 3. Dietary carnitine was fed from 38 kg to market (Exp. 1 and 3) or for 4 wk before market (Exp. 2). Ractopamine was fed for 4 wk. Experiments 1 and 2 were conducted at university research facilities and Exp. 3 in a commercial research barn. A carnitine × RAC interaction ($P < 0.02$) was observed for visual color, L*, and a*/b* in Exp. 1. In pigs fed RAC, increasing carnitine decreased L* and increased visual color scores and a*/b* compared to pigs not fed RAC. Ultimate pH tended to increase (linear, $P < 0.07$) with increasing carnitine. Drip loss decreased (linear, $P < 0.04$) in pigs fed increasing carnitine. In Exp. 2, a carnitine × RAC interaction was observed ($P < 0.04$) for visual firmness and drip loss. Visual firmness scores decreased in pigs fed increasing carnitine and no RAC, but increased with increasing carnitine when RAC was added to the diet. Drip loss decreased with increasing levels of carnitine when fed with RAC. Percentage lean was higher ($P < 0.01$) for pigs fed RAC. A carnitine × RAC interaction ($P < 0.03$) was observed in Exp. 3 for fat thickness and percentage lean. Fat thickness decreased and lean percentage increased in pigs fed carnitine or RAC, but the responses were not additive. Pigs fed carnitine tended ($P < 0.06$) to have decreased drip loss. Pigs fed RAC had decreased ($P < 0.05$) 10th rib and average backfat and decreased drip loss compared to pigs not fed RAC. These results suggest that ractopamine increases carcass leanness and supplemental carnitine reduces drip loss when fed in combination with ractopamine.

Key Words: Carnitine, Ractopamine, Pigs

196 Effects of fish oil on growth performance, immune, adrenal and somatotrophic responses of weanling pigs after lipopolysaccharide challenge. Y. L. Liu[1], D. F. Li*[1], L. M. Gong[1], G. F. Yi[2], and A. M. Gaines[2], [1]*China Agricultural University, Beijing,* [2]*University of Missouri, Columbia.*

Seventy-two crossbred pigs weaned at 28 d of age were used to investigate the effects of fish oil on growth performance, immune, adrenal, and somatotrophic responses following E. coli lipopolysaccharide (LPS) challenge in a 2 × 2 factorial arrangement of treatments. The main factors consisted of oil type (7% corn oil or fish oil) and immune challenge (LPS or saline). Pigs were randomly assigned to treatments. On d 14 and 21 postweaning, pigs were i.p. injected with either 200 μg/kg BW of LPS or an equivalent amount of sterile saline. At 3 h postinjection, blood plasma samples were collected for analysis of IL-1β, cortisol (CS), GH, and IGF-I. On d 2 after LPS challenge, blood samples were collected for lymphocyte proliferation and antibody responses to Albumin Bovine V Boehringer (BSA). The performance parameters of ADG, ADFI, and G:F were also evaluated during the 28 d experiment. Our results indicated that LPS-challenge depressed ADG ($P \leq 0.05$) from d 14-28 and ADFI ($P \leq 0.05$) from d 14-21. On both d 14 and 21, plasma IL-1β ($P \leq 0.01$), CS ($P \leq 0.001$), and blood lymphocyte proliferation ($P \leq 0.05$) were increased, whereas IGF-1 ($P \leq 0.01$) was decreased after LPS-challenge. LPS-challenge also resulted in decreased plasma GH ($P \leq 0.05$) on d 14. Neither LPS-challenge or oil type affected serum antibody response to BSA ($P \geq 0.10$). Fish oil did improve ADG and ADFI during the first LPS-challenge period (d 14-21; $P \leq 0.10$). No LPS-challenge × oil type interactions were observed for any of the growth performance parameters during the 28 d period ($P \geq 0.10$). Fish oil decreased blood lymphocyte proliferation incubated with 16 μg/mL concanavalin A during the first challenge period ($P \leq 0.10$); however, no LPS-challenge × oil interaction was observed ($P \geq 0.10$). On both d 14 and 21, feeding fish oil decreased plasma CS ($P \leq 0.05$) and plasma IL-1β ($P \leq 0.10$) in LPS-challenged pigs. Pigs fed fish oil also had higher plasma IGF-1 ($P \leq 0.10$) as compared to pigs fed the corn oil diet on both d 14 and 21. No LPS-challenge × oil interaction was observed for plasma GH ($P \geq 0.10$). These data suggest that fish

oil alters indices of the immune axis that may lead to improved growth performance during an inflammatory challenge.

Key Words: Pigs, Fish Oil, Lipopolysaccharide

197 Evaluation of a botanical extract in non-medicated diets for pigs 15 to 113 kg body weight. B. V. Lawrence*[1], J. D. Hahn[1], S. Hansen[1], J. Hedges[1], E. Hansen[1], R. Musser[1], and J. Corley[2], [1]*Hubbard Feeds Inc., Mankato, MN,* [2]*Prince Agri Products, Inc., Quincy IL.*

A botanical extract (Xtract) addition to antibiotic free diets was evaluated in 3 trials. In Exp. 1, 549 pigs (15.1 ± 0.82 kg) were allotted to 1 of 3 treatments (n = 8), either non-medicated diet (Non-Med), Non-Med + 182 g/t Xtract, or medicated with Tylan at 44 g/t (Med). During the 21-d trial, ADG tended to be lower ($P < 0.10$) for the Non-Med (571 g/d) compared with Xtract (610 g/d) and Med (615 g/d) pigs. Intake was similar ($P > 0.10$) across treatments (927 ± 59.9 g/d) resulting in an improvement in gain/feed ($P < 0.01$) for the Xtract (0.65) compared with Non-Med (0.62) treatments. Gain/feed was highest ($P < 0.05$) for the Med (0.68) treatment. In Exp. 2, 254 pigs (30.2 ± 1.46 kg) were used to evaluate Xtract vs. Non-Med in a 91-d trial (n = 6). No treatment differences were detected ($P > 0.10$). Pigs had an ADG of 914 ± 41.8 g/d with a gain/feed of 0.39 ± 0.03. In Exp. 3, 351 pigs (24.3 ± 0.76 kg) were allotted to Non-Med, Xtract, or Med treatments (n = 6) in a 100-d trial. In Exp. 3, the Med group consisted of a rotation of 660 g/t chlortetracyline for 7 d followed by 44 g/t of Tylan for 21 d. Cumulative ADG (885 ± 29.6 g/d) and gain/feed (0.39 ± 0.02) were not different ($P > 0.10$) across treatments. However, during period 3 (day 43 to 64) an undiagnosed digestive disturbance occurred. During this period, gain/feed was improved ($P < 0.05$) for the Xtract (0.42) and Med (0.42) treatments compared with Non-Med (0.38). The improvement in gain/feed was the result of a numerical improvement ($P > 0.20$) in ADG (889 vs 928 and 942 g/d) and numerical decrease ($P > 0.31$) in intake (2.38 vs 2.25 kg/d). Results of these experiments suggest that during periods of disease challenge, Xtract may improve ADG and gain/feed compared with Non-Med pigs. This improvement may be intermediate to, or equal to that observed with in-feed antibiotics. When no disease challenge is present, pig performance may not be improved by either Xtract or the antibiotic programs evaluated in these trials.

Key Words: Botanical Extract, Pigs, Antibiotics

198 Effect of milk supplementation with *Lactobacillus brevis* 1E-1 on intestinal microflora, intestinal morphology, and pig performance. D. C. Brown*[1], M. E. Davis[1], C. V. Maxwell[1], Z. B. Johnson[1], T. Rehberger[2], K. J. Touchette[3], and J. A. Coalson[3], [1]*University of Arkansas, Fayetteville,* [2]*Agtech Products, Inc., Waukesha, WI,* [3]*Merrick's, Inc., Union Center, WI.*

Two experiments were conducted to determine the effect of milk supplementation with *Lactobacillus brevis* 1E-1 on pig performance, intestinal microflora, and gut morphology. Litters were allotted to two treatments at farrowing: 1) control milk supplement, and 2) as 1 with 1E-1. At weaning, pigs from the two lightest blocks were offered the control treatment for 5 d. One pig/litter was sacrificed at 10, 22 (weaning), and 28 d of age to assess gut morphology and intestinal microflora populations. In Exp. 1, pigs fed 1E-1 had a greater ADG ($P \leq 0.05$) compared to the control in the first 5 d postweaning. Small pigs provided milk supplement also had increased ADG ($P \leq 0.05$) in the first 5 d postweaning compared to normal-sized pigs. Gain:feed was greater ($P \leq 0.05$) from d 0 to 14 after weaning when small pigs were previously fed 1E-1 compared to control pigs, while previous supplementation did not affect performance of normal-sized pigs (interaction, $P \leq 0.05$). Data previously reported from this experiment indicated that 1E-1 decreases *E. coli* populations in the jejunum pre-weaning and at weaning compared to control pigs. In Exp. 2, 1E-1 addition did not affect pig performance. Similar to Exp. 1, 1E-1 decrease coliform populations in the jejunum ($P = 0.07$) and ileum ($P \leq 0.01$) at weaning; however, populations in control pigs were about 2 logs lower than in Exp. 1. Pigs provided 1E-1 had greater ($P \leq 0.01$) ileal villus:crypt ratio at 10 d of age compared to control pigs, although there was no difference at 21 and 28 d of age (interaction, $P \leq 0.05$). The number of duodenal sulfuric goblet cells was less ($P = 0.06$) when pigs were provided 1E-1 compared to control pigs at 10 d of age, although there was no difference at 21 and 28 d of age (interaction, $P = 0.06$). These data indicate that milk supplementation with 1E-1 during lactation improves subsequent nursery performance and may provide a healthier intestinal environment.

Key Words: Swine, Milk Substitutes, Lactobacillus

199 Evaluation of BioPlus 2B in non-medicated diets for pigs from 15 to 113 kg body weight. B. V. Lawrence*, J. D. Hahn, S. Hansen, J. Hedges, E. Hansen, and R. Musser, *Hubbard Feeds Inc., Mankato, MN.*

Two experiments were conducted to evaluate *Bacillus* spp. from BioPlus 2B in corn-soybean meal antibiotic-free diets. In Exp. 1, 935 terminal Duroc pigs (Compart Boar Store Line 442 X D100) weighing 14.5 ± 0.87 kg were allotted to 1 of 5 dietary treatments. Diets were either non-medicated (Non-Med), medicated with Tylan at 44 g/t (Med), or supplemented with 1 X 10^6 cfu/g of *Bacillus* spp. with 0, 2.5, or 5% lactose (n = 8). Pigs were housed in 2.44 X 2.44 m pens with 23 or 24 pigs/pen. During the 21-d trial, no treatment differences ($P > 0.10$) were detected. Pigs gained 553 ± 37.8 g/d, consumed 872 ± 47.7 g/d with a gain/feed of 0.63 ± 0.01. In Exp. 2, 256 terminal Duroc pigs (Compart Boar Store Line 442 X D100) weighing 29.9 ± 1.58 kg were used in a 91-d trial to evaluate the influence of the addition of 1 X 10^6 cfu/g of *Bacillus* spp. to a Non-Med diet on gain, intake, and gain/feed (n = 6). Pigs were housed in 2.74 X 5.48 m pens with 21 or 22 pigs per pen. Pigs were weighed on days 0, 22, 43, 63, 77 and 91. Gain, intake and gain/feed were calculated for each time period. No differences ($P > 0.10$) in dietary treatments were detected during any growth period. Cumulative gain averaged 912 ± 27.4 g/d with an intake of 2.33 ± 0.14 kg/d resulting in a gain/feed of 0.39 ± 0.02. During the 21-d nursery trial, no response was observed to either Tylan or *Bacillus* spp., thus suggesting a low digestive disease presence in the pigs used in this experiment. These results, therefore, indicate that during a low disease challenge from 15 to 27 kg BW, no growth promoting effect can be anticipated from either Tylan at 44 g/t or 1 X 10^6 cfu/g of *Bacillus* spp.from BioPlus 2B. The results of Exp. 2 suggest that during periods of low disease challenge in the growing-finishing period, *Bacillus* spp. in BioPlus 2B may not provide any improvement in either gain or gain/feed.

Key Words: *Bacillus* spp, Pigs, Antibiotics

200 Corn particle size and pelleting influence on fecal shedding and enteric colonization of Salmonella entericia serotype Typhimurium. M. R. Barker*, S. S. Dritz, J. C. Nietfeld, J. E. Minton, J. M. DeRouchey, K. M. Bond, D. J. Lee, and T. E. Burkey, *Kansas State University, Manhattan.*

Evidence indicates that diets fed in pellet form are associated with a higher prevalence of Salmonella shedding and is hypothesized to affect the colonic microenvironment in a way that is conducive to Salmonella growth. Since the grain used in pelleted diets is usually finely ground, our objective was to evaluate the interactive effects between diet form and grain particle size on Salmonella entericia serotype Typhimurium (ST) shedding and colonization in a young growing pig model. A total of 96 weaned pigs (6.3 kg BW) were blocked by weight in a randomized complete block design with a 2 × 2 factorial treatment arrangement of treatments. The main effects were corn particle size (500 or 1000 microns) and diet form (pellet or meal) using the same diet formulation. There were 12 pens/treatment and two pigs/pen. Pigs were fed the diets 7 d before oral inoculation with 1.9×10^7 CFU of ST. Fecal samples were cultured on d 7, 14, and 21, and mesenteric lymph nodes on d 21 after inoculation to categorize relative presence of ST using semi-quantitative methods. Cultures were scored 0 (no ST detected) to 3 (most abundant ST). Body weight and feed intake were measured to calculate ADG, ADFI, and feed efficiency (G/F). As expected, pigs fed the 500 micron corn had better G/F ($P < 0.02$) than pigs fed 1000 micron corn. Unexpectedly, the pigs fed meal feed had better G/F ($P < 0.01$) than pigs fed diets in pellet form. This was the result of meal fed pigs having better growth rate with slightly higher feed intake. There was no evidence ($P > 0.22$) of differences in fecal shedding score (1.0, 1.0, 0.9, 0.7 0.2 for pigs fed diets with 500 micron meal or pellet or 1,000 micron meal or pellet, respectively) or mesenteric lymph node culture score (0.4, 0.5, 0.5, 0.5 0.2, respectively). Using this model, we were

unable to detect influences of feed processing on fecal shedding or colonization of mesenteric lymph nodes with Salmonella entericia serotype Typhimurium.

Key Words: Weanling Pigs, Salmonella, Particle Size

201 Evaluation of BioSaf and Safmannan in non-medicated diets for pigs 15 to 113 kg body weight.

B. V. Lawrence*, J. D. Hahn, S. Hansen, J. Hedges, E. Hansen, and R. Musser, *Hubbard Feeds Inc., Mankato, MN.*

Two experiments were conducted to evaluate *Saccaromyces cerevisiae* as BioSaf yeast and Safmannan, a mannanoligosacharide from *Saccaromyces cerevisia*, in corn-soy antibiotic-free diets. In Exp. 1, 732 terminal Duroc pigs (Compart Boar Store Line 442 X D100) weighing 15.2 $\pm$ 0.68 kg were allotted to 1 of 4 dietary treatments. Diets were either non-medicated diet (Non-Med), medicated with Tylan at 44 g/t (Med), supplemented with 5 X 10^6 cfu/g of *Saccaromyces cerevisiae* (BioSaf), or 0.10% Safmannan (n = 8). During the 21-d trial, ADG was lower ($P < 0.01$) for the Non-Med pigs (571 g/d) than for the Med (615 g/d), BioSaf (622 g/d) and Safmannan (631 g/d) treatments. Growth rate of the Med, BioSaf, and Safmannan treatments were similar ($P > 0.10$). Intake was not different across treatments (934 $\pm$ 51.1 g/d). Gain/feed was lowest for the Non-Med group (0.62) and was improved ($P < 0.001$) for the Med, BioSaf, and Safmannan treatments. The Med pigs had the highest gain/feed (0.68), with 0.10% Safmannan resulting in a gain/feed similar to that observed for the Med pigs (0.66). The pigs fed diets containing BioSaf gain/feed (0.65) which was greater ($P < 0.05$) than that observed for the pigs fed Non-Med diets, but less ($P < 0.05$) than that observed for the pigs fed the Med diets. In Exp. 2, 256 terminal Duroc pigs (Compart Boar Store Line 442 X D100) weighing 29.8 $\pm$ 1.16 kg were fed either a Non-Med or BioSaf diet (n = 6) During the 91-d trial pigs were weighed on d 0, 22, 43, 63, 77 and 91. Gain, intake, and gain/feed were calculated for each growth period. No treatment differences were detected ($P > 0.10$). Cumulative ADG was 919 $\pm$ 24.9 g/d with an intake of 2.31 $\pm$ 0.15 kg/d resulting in a gain/feed of 0.39 $\pm$ 0.02. The results of these experiments suggest that during periods of disease challenge from 15 to 28 kg BW, both BioSaf and Safmannan may result in an improvement in ADG and gain/feed. Additionally, results of Exp. 2 indicate that from 30 t 113 kg BW, BioSaf may not result in an improvement in pig performance in the absence of disease challenge.

Key Words: Yeast, Pigs, Antibiotics

202 Effect of altered dietary n6/n3 fatty acid ratios and endotoxin injection on performance and immune parameters in nursery pigs.

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A total of 72 weanling pigs (23 d of age, 7.6 kg) were used in two 5-wk trials to evaluate if performance and immune function of pigs fed varied dietary n6/n3 fatty acid ratios (n6/n3) are altered in response to lipopolysaccharide endotoxin (LPS [50 g/kg BW]). Diets contained 1.22% lysine, and other nutrients met or exceeded NRC (1998) requirement estimates. Three diets contained 5% menhaden and(or) corn oil with resultant n6/n3 of 1.2, 6.8, and 34.8. Pigs were blocked by weight and age and randomly allotted to pens (two/pen) and diet. Each pen of pigs received either an LPS or saline i.p. injection after 4 wk. Pig weights and feed intake were recorded weekly for 4 wk, and every 6, 12, and 24 h post-injection. Blood was collected at 0, 2, and 4 h post-injection to analyze serum TNF-α and cortisol levels. Rectal temperatures were recorded at 0 h, every 2 h post-injection for 12 h, and at 24 h. The treatment means for overall 4-wk or Wk 5 ADG and F/G (0.61 and 0.68 kg; 1.46 and 1.97, respectively) did not differ ($P \geq 0.06$) among treatments. ADFI (0.82, 0.90, 0.92 kg) increased (linear, $P \leq 0.05$) for the overall 4-wk period with increasing n6/n3. A Wk 5 saline vs LPS effect ($P \leq 0.01$) occurred for ADG and F/G (0.85 vs 0.52 kg; 1.79 vs 2.15). A Wk 5 diet by injection interaction ($P \leq 0.05$) occurred in ADFI for saline (1.56, 1.49, 1.51 kg) and LPS (0.99, 1.16, 1.11 kg) pigs fed increasing n6/n3. The 2-h serum TNF-α (5.8, 5.2, 3.3 ng/ml) decreased (linear, $P \leq 0.05$) with increasing n6/n3. The serum cortisol difference at 4-h post-injection increased (linear, $P \leq 0.05$) with increasing n6/n3 (4.1, 5.1, 7.7 μg/dl) and by LPS vs saline (13.9 vs -2.6 μg/dl). Body temperature increased (linear, $P \leq 0.01$) with increasing n6/n3 with the LPS (39.5, 39.8, 39.9°C) but not the saline (39.6, 39.6, 39.7°C) injections, with differences ($P \leq 0.05$) between injections at the higher two n6/n3 diets. Dietary n6/n3 did not affect ADG ADFI, F/G or immune parameters in response to an immune challenge.

Key Words: Pigs, Fatty Acids, Endotoxin

203 Responsiveness of weanling pigs to Carbadox (Mecadox®) and vitamin B_{12} supplementation.

S. S. Blodgett*, P. S. Miller, and R. L. Fischer, *University of Nebraska, Lincoln.*

An experiment was conducted to assess the responsiveness of weanling pigs (96 barrows and gilts) to supplemental antibiotics (Carbadox) and vitamin B_{12}. Pigs (initial weight 5.13 kg) were fed one of four diets for a total of 35 days: 1) negative control, common nursery diet with no added Carbadox or vitamin B_{12}; 2) antibiotic, common nursery diet with 55 ppm added Carbadox; 3) vitamin B_{12}, common nursery diet with 80 μg/kg added vitamin B_{12}; and 4) positive control, common nursery diet with 55 ppm added Carbadox and 80 μg/kg added vitamin B_{12}. The study was conducted as a 2 $\times$ 2 factorial with 4 replications (pens; 6 pigs/pen) per treatment. Pig weights and feed disappearance were measured weekly to determine ADG, ADFI, and feed efficiency (ADG/ADFI). Pigs were visually scored to assess any potential vitamin B_{12} deficiencies on d 14, 21, 28, and 35. No Carbadox $\times$ vitamin B_{12} interactions were observed ($P > 0.10$). During Phase I (d 0 to 14), pigs fed Carbadox had a greater ADG (223.5 vs 195.6 g, $P < 0.02$) and ADFI ($P < 0.003$) versus pigs not fed supplemental antibiotics. During Phase II and the overall experimental period, pigs fed vitamin B_{12} had greater ADG (558.1 vs 505 g and 418.6 g vs. 386.9 g, respectively; $P < 0.003$), ADFI ($P < 0.04$), and improved feed efficiency ($P < 0.006$ and $P < 0.03$, respectively) compared to pigs not fed supplemental vitamin B_{12}. During Phase II (d 15 to 35), pigs fed Carbadox had greater ADFI ($P < 0.02$) versus pigs not fed Carbadox. For the overall experimental period, pigs fed Carbadox had greater ADG (414 vs 391.9 g; $P < 0.02$) and ADFI ($P < 0.004$) versus pigs not fed Carbadox. During Phase II and overall, pigs supplemented with Carbadox had lower ADG/ADFI ($P < 0.02$ and $P < 0.04$, respectively). There were no differences among groups for visual assessment of B-vitamin deficiencies. Pigs responded to vitamin B_{12} in the absence of antibiotic in the diet. The results from this study indicate that the vitamin B_{12} requirement of 10- to 20-kg pigs may be greater than the current NRC requirement recommendation.

Key Words: Nursery Pigs, Antibiotic, Vitamin B_{12}

204 Vitamin B_{12} requirement of weanling pigs.

S. S. Blodgett*, P. S. Miller, and R. L. Fischer, *University of Nebraska-Lincoln.*

An experiment was conducted to help define the vitamin B_{12} requirement of the 5- to 20-kg pig. A total of one hundred and fourty-four pigs(barrows and gilts; initial weight = 5.08 kg) were fed one of six diets (4 pigs/pen; 6 reps/treatment) for a total of 35 days: 1) negative control, common nursery diet with no added vitamin B_{12}; 2) 1X, addition of 100% the 1998 NRC-requirement for a 5- to 10-kg pig for vitamin B_{12} (17.5 μg/kg of diet), 3) 2X, addition of 200% the 1998 NRC-requirement for a 5- to 10-kg pig for vitamin B_{12} (35 μg/kg of diet), 4) 4X, addition of 400% the 1998 NRC-requirement for a 5- to 10-kg pig for vitamin B_{12} (70 μg/kg of diet), 5) 8X, addition of 800% the 1998 NRC-requirement for a 5- to 10-kg pig for vitamin B_{12} (140 μg/kg of diet), 6) 16X, addition of 1,600% the 1998 NRC-requirement for a 5- to 10-kg pig for vitamin B_{12} (280 μg/kg of diet). Pig weights and feed disappearance were measured weekly to determine ADG, ADFI, and feed efficiency (ADG/ADFI). Pigs were visually scored to assess any potential vitamin B_{12} deficiencies on d 14, 21, 28, and 35. During Phase I (d 0 to 14), there were no growth or feed intake responses to supplemental vitamin B_{12}. During Phase II (d 15 to 35), ADG and ADG/ADFI responded quadratically to vitamin B_{12} supplementation ($P < 0.007$ and $P < 0.02$, respectively). Pigs fed 8X the NRC requirement for the 5- to 10-kg pig had the greatest ADG (609 g) and pigs fed 4X the NRC requirement had the greatest ADG/ADFI (0.721 g/g). For the overall experimental period, there was a trend for a linear growth response ($P < 0.07$). Pigs fed 8X the NRC requirement had the greatest ADG (477 g). Also, there was a quadratic ADG/ADFI response ($P < 0.02$). Pigs supplemented with 4X the NRC requirement had the greatest ADG/ADFI (0.718 g/g). Feed intake did not respond to vitamin B_{12} supplementation. Based on these results, the vitamin B_{12} requirement of the 5- to 10-kg pig is similar to that recommended by the 1998 NRC (17.5 μg/kg). The 10- to 20-kg pig responded to vitamin B_{12} supplementation between 4.5 and 9

times the dietary concentration that is currently recommended by the 1998 NRC (15 μg/kg of diet).

Key Words: Nursery, Pigs, Vitamin B_{12}

205 Effects of different wheat gluten sources on nursery pig growth performance. K. R. Lawrence*, R. D. Goodband, M. D. Tokach, S. S. Dritz, J. L. Nelssen, J. M. DeRouchey, C. W. Hastad, S. H. Hanni, M. R. Barker, and B. W. James, *Kansas State University, Manhattan*.

Four experiments were conducted to determine the effects of different wheat gluten (WG) sources compared to soybean meal (SBM) or spray-dried animal plasma (SDAP) on growth performance of nursery pigs. In Exp. 1, 220 pigs (6.1 kg BW; 8 pens/trt; 6 pigs/pen) were fed a control diet containing 6% of either SDAP, enzymatically hydrolyzed WG, or non-hydrolyzed WG. The WG and L-lysine HCl replaced 50% or 100% of the SDAP. From d 0 to 21, increasing WG (either source) decreased ADG and ADFI (linear, $P < 0.01$), but improved G/F (linear, $P < 0.04$). In Exp. 2, 252 pigs (6.2 kg BW; 6 pens/trt; 6 pigs/pen) were fed a negative control containing no SDAP or WG, 9% WG, 6.75% WG & 1.25% SDAP, 4.5% WG & 2.5% SDAP, 2.25% WG & 3.75% SDAP, or a positive control containing 5% SDAP. From d 0 to 14, pigs fed increasing WG had decreased ADG (linear, $P < 0.05$) and ADFI (linear, $P < 0.10$). In Exp. 3, 240 pigs (7.0 kg BW; 7 pens/trt; 5 pigs/pen) were fed a negative control diet containing no WG or SDAP, the control diet containing either 3, 6, 9, or 12% spray-dried WG, or a positive control diet containing 5% SDAP. The diets containing 9% WG and 5% SDAP had the same amount of SBM. From d 0 to 7, pigs fed 5% SDAP had greater ($P > 0.05$) ADG than pigs fed the diet containing 9% WG. Overall (d 0 to 14), increasing WG had no effect ($P > 0.05$) on ADG, ADFI, or G/F. In Exp. 4, 200 pigs (6.0 kg BW; 8 pens/trt; 5 pigs/pen) were fed a negative control diet, which contained no SDAP or WG, the control diet with 4.5% or 9.0% enzymatically hydrolyzed WG, or the control diet with 2.5% or 5.0% SDAP. Diets containing WG and SDAP had similar SBM levels. From d 0 to 14, increasing SDAP improved (linear, $P < 0.06$) ADG, but increasing WG had no effect. There were no differences ($P > 0.05$) in ADG, ADFI, or G/F between the wheat gluten sources used in these trials. The results of these studies suggest that increasing WG in diets fed immediately after weaning did not improve growth performance.

Key Words: Pigs, Wheat Gluten, Spray-dried Animal Plasma

206 An evaluation of barley, corn or wheat-based diets, with and without glucanase and xylanase addition, on the nitrogen balance and ammonia emission of finishing boars. A.B.G. Leek*[1], V. E. Beattie[2], W. Henry[2], and J. V. O'Doherty[1], [1]*University College Dublin, Ireland,* [2]*Devenish Nutrition Ltd., Belfast, Northern Ireland*.

Finishing boars (67 kg) were used in a 3 x 2 factorial arrangement of treatments to investigate the interaction between cereal-soybean- (Cereal: barley (B), maize (M) and wheat (W)) based diets and non-starch polysaccharide (NSP) enzyme inclusion (with (+) or without (-) a xylanase and glucanase combination) on nitrogen (N) balance and ammonia nitrogen (NH_3-N) emission. The diets were formulated to have similar concentrations of DE (13.2 MJ DE/kg) and amino acids (11 g Lys/kg, 180 g CP/kg). The NSP contents of the diets were; B = 138 g/kg, M = 104 g/kg and W = 86 g/kg. Following diet adaptation, boars were housed in metabolism crates fitted with urine and feces separators for 12 d (5 d adaptation and 7 d N balance). An *in-vitro* measurement of NH_3-N emitted over 10 d and recovered from the headspace-air drawn over the surface of a fresh slurry sample collected during the N balance experiment, was performed. Volatile fatty acid (VFA) content in feces was quantified and qualified by HPLC. Boars fed B- or M-based diets had lower digestibility of ($P < 0.05$) DM (DMD), GE (GED) and lower urinary N to fecal N excretion ratio than boars fed W-based diets. Apparent digestibility of N was lower ($P < 0.02$) in B- compared to W-. N retention was not affected by cereal type. The addition of enzymes reduced ($P < 0.05$) DMD and GED in B and M, however there was no effect in W. The addition of enzymes reduced the digestibility of acid detergent fibre ($P < 0.001$) and total VFA concentration ($P < 0.05$) in B but had no significant effect in M and W. Both urinary and faecal pH were lower ($P < 0.05$) in B- compared to M- and W-, however enzyme addition increased fecal and urinary pH ($P < 0.05$) in B+. NH_3-N from B- was lower ($P < 0.05$) than M- and W-. Enzyme addition increased ($P < 0.05$) NH_3-N by 58% in B and reduced ($P < 0.05$) NH_3-N by 27% in W. In conclusion, there appears to be interaction between cereals and enzymes in terms of nitrogen efficiency.

Key Words: Boars, Nitrogen Balance, Ammonia

207 Effects of increasing calcium:phosphorus ratio in diets containing phytase on growth performance of grow-finish pigs. S. M. Hanni*, M. D. Tokach, R. D. Goodband, S. S. Dritz, and J. L. Nelssen, *Kansas State University, Manhattan*.

Our objective was to determine the effects of increased total calcium to phosphorus (Ca:P) ratio on growth performance of grow-finish pigs with diets containing phytase. A total of 144 grow-finish pigs (72 barrows and 72 gilts; initially 38.6 kg BW) were blocked by weight and sex, and then allotted to one of four dietary treatments. Each treatment had nine replications per sex and two pigs per pen. Diets were corn-soybean meal-based and fed in three phases. In each phase, diets were formulated to have Ca:P ratios of 1:1, 1.25:1, 1.5:1, or 2:1. Diets were formulated to contain 0.44, 0.39, and 0.34% phosphorus from 32 to 59, 59 to 86, and 86 to 113 kg, respectively. All diets contained 0.05% phytase from Natuphos®, providing 300 FTU/kg. For the overall experiment, increasing Ca:P ratio decreased ADG (linear $P < 0.002$) and ADFI (linear $P < 0.05$). However, the greatest decrease was observed when Ca:P ratio increased from 1.5:1 to 2:1. Feed efficiency was not affected by Ca:P ratio. As Ca:P ratio increased from 1.5:1 to 2:1 ratio, carcass weight decreased (linear $P < 0.005$). There were no differences in percent yield, backfat, loin eye area, and fat free lean index. In conclusion, these data suggest that diets containing 300 FTU/kg phytase should not have total calcium to phosphorus ratio of greater than 1.5:1 when fed to growing-finishing pigs.

	Ca:P Ratio				
	1.0:1	1.25:1	1.5:1	2:1	SED
ADG, kg	0.89	0.88	0.90	0.83	0.02
ADFI, kg	2.49	2.46	2.51	2.39	0.05
Gain/feed	0.36	0.36	0.36	0.35	0.008

Key Words: Calcium, Phosphorus, Phytase

208 Current status and review of factors involved in nutritional immunology of swine. M. E. Spurlock*, *Purdue University, West Lafayette, IN*.

Currently, pigs reared commercially achieve 70% or less of their genetic potential for growth and efficiency. The consensus opinion is that pathogenic and nonpathogenic disease factors culminate in a series of stress and immunological responses that attenuate the animals' ability to grow. Thus, a detailed understanding of immunology and stress biology may offer new strategies for improving growth and efficiency. Recent discoveries have established a new paradigm for the adipocyte that extends well beyond the simple storage of excess energy. This cell produces a myriad of hormones and cytokines that regulate energy balance, glucose and fatty acid utilization, and specific immune response pathways. Of particular interest, the adipocyte expresses the lipopolysaccharide receptor (Tlr-4) and the lipopolysaccharide binding protein. These critical signaling proteins enable the adipocyte to respond directly to lipopolysaccharide. Indeed, lipopolysaccharide signaling in pig adipocytes results in translocation of nuclear factor kappa-B to the nucleus and altered gene expression profiles. Energy balance and adiposity have been linked to the production of certain immune modulators in the adipocyte, and may influence the functionality of key pathways. This new paradigm for adipocyte biology, energy balance, and immunity will be discussed in light of the marked reduction in adiposity achieved in commercial genotypes in the past decade.

Key Words: Growth, Immune Function, Stress

209 Involvement of trace metals in immunocompetence. M. L. Failla*, *The Ohio State University, Columbus*.

Experimental, field and clinical trials with laboratory rodents, domestic animals and humans during the past several decades have clearly shown that both deficiencies and excesses of the essential trace metals impair

defense against infectious agents. Both the innate and acquired branches of the immune system are susceptible to trace metal malnutrition. Descriptions of processes associated with the maturation, activation and effector activities of immune cells that are compromised in response to such malnutrition clearly demonstrate the central importance of these micronutrients in maintaining a robust host defense. Encouraging results from some trials also support the potential benefits of judicious supplementation for the prevention and reduction in severity of selective infectious diseases. However, insights regarding specific biochemical events that are dependent on an adequate supply of trace elements remain limited. The application of cellular and molecular methods are beginning to yield novel information about the importance of the micronutrients for the regulation of immune cell development and early events in host responses to infectious insults. In addition, the elegant studies of Beck and associates have provided a clear demonstration that changes in trace metal status have the potential to enhance the fitness of the infectious agent as well as to compromise host immune function. Changes in cellular redox status associated with deficiencies of micronutrients participating in the antioxidant defense system or excess levels of oxidative metals facilitate genotypic changes that induce virulence. Elucidation of biochemical events that are dependent on specific trace elements in host defense cells and the regulation of the transport and metabolism of these elements in health and disease provide intriguing challenges directed at defining optimal trace metal nutrition for immunocompetence (Supported by USDA NRICGP).

Key Words: Trace minerals, Immune function

210 Involvement of vitamins in immunocompetence. R. W. Johnson*, *University of Illinois, Champaign-Urbana*.

Animals live surrounded by pathogenic microorganisms#bacteria, viruses, and parasites that can cause infectious disease. In spite of everything, animals become ill infrequently because they are equipped with a highly evolved immune system that affords protection against infectious microorganisms. Nutrition can profoundly impact both innate and adaptive immune responses of animals and thus their resistance to infectious disease. This presentation examines the effects of vitamins on immunocompetence. Special attention is given to antioxidants such as α-tocopherol and selenium. Supplementation of animals with antioxidant vitamins has been shown to potentiate antibody responses to a variety of killed preparations or live organisms. Recent evidence suggests that vitamin E, as well as other antioxidants, may reduce inflammatory cytokine production in sick animals. The potential of vitamin supplementation to prevent infectious disease or to reduce the severity and duration of infectious disease is discussed.

Key Words: Vitamins, Immune Function

211 Involvement of fatty acids in immunocompetence. K. L. Fritsche*, *University of Missouri, Columbia*.

The two major objectives of this presentation will be (1) to review the evidence that dietary fat affect the immune system and infectious disease resistance in domestic animals; and (2) to describe our current understanding of the mechanisms underlying these effects. This review will focus on animal feeding trials with poultry and swine. The current data suggest that the addition of certain fatty acids, particularly omega-3 polyunsaturated fatty acids (i.e., n-3 PUFA), to standard livestock rations can significantly alter in vivo inflammatory responses and improve host resistance to some pathogens. However, the data are still quite limited. An important area of research at present is defining the immunological parameters which predict the impact that diet manipulations have on host disease resistance. The current view for how fatty acids affect the immune system is centered on the ability of some to alter cytokine and eicosanoid production. The role of a novel family of transcription factors (i.e., peroxisome-proliferator activated receptors, PPARs) as conveyors of fatty acid modulation of immune cell function will be described. While much less in known about how fat might impact the immune system in ruminants, opportunities for future research in this area will be presented as well.

Key Words: Fatty Acids, Immune Function

212 Effect of dietary bilobalide on mitochondrial bioenergetics and body growth in rats. T. R. Lutz* and T. S. Stahly, *Iowa State Univeristy, Ames*.

Proton leak accounts for up to 20% of the standard metabolic rate in rats with skeletal muscle having a particularly high proportion (50%) of its energy lost as proton leak at steady state conditions. Therefore, identifying compounds with the ability to reduce the proportion of energy lost due to proton leak could improve the efficiency of mitochondrial energy metabolism and body growth. The objective of this study was to determine the effects of dietary addition of bilobalide on muscle and liver mitochondrial bioenergetics and body growth in rats. Weanling rats (16/trt) were individually penned and allowed ad libitum access to a diet containing either 0 or 78 ppm bilobalide for 22 d postweaning. Gastrocnemius (16/trt) and liver mitochondria (8/trt) were isolated and State 3 (maximal rate of respiration) and State 4 (proton leak-dependent respiration) oxygen consumption rates and the respiratory control ratio (RCR=State3/State4), an index of respiratory chain coupling, were measured. Bilobalide addition did not ($P > 0.10$) alter gastrocnemius weight or mitochondrial protein content, State 3 (158 vs 147 nmol $O \cdot min^{-1} \cdot mg\ protein^{-1}$) or State 4 rates or the RCR (6.1 vs 5.8). However, dietary bilobalide addition resulted in increased liver weights (12.0 vs 10.8 g; $P < 0.01$) and mitochondrial protein contents (11.6 vs 9.7 mg/g of liver; $P < 0.01$). Bilobalide addition also increased liver mitochondrial State 3 rates (33 vs 28 nmol $O \cdot min^{-1} \cdot mg\ protein^{-1}$; $P < 0.05$) and RCR (5.3 vs 4.5; $P = 0.08$), but State 4 rates were unaltered. Dietary bilobalide did not alter daily body weight gain, feed intake, efficiency of feed utilization or the weight of the epididymal fat pad. Based on these data, bilobalide, ingested orally, minimizes the proportion of energy in liver lost due to proton leak, but does not alter muscle mitochondrial bioenergetics or rate and efficiency of body growth.

Key Words: Mitochondria, Bilobalide, Bioenergetics

213 Dietary fat sources for weanling pigs. R. Sulabo* and H. H. Stein, *South Dakota State University, Brookings*.

The effect of including three different fat sources in diets for newly weaned pigs was evaluated in a five wk experiment. A total of 96 pigs were weaned at an average age of 20 d and allotted to four different treatment groups based on BW, ancestry, and sex. There were four pigs/pen and six replicate pens/treatment group. A phase 1 control diet (1.5% Lys, 3,281 kcal ME/kg) based on corn, soybean meal, whey powder, fish meal, and protein plasma, was formulated. The phase 2 control diet (3,296 kcal/kg, 1.15% Lys) contained corn, soybean meal, and fish meal. The control diets were fed to pigs on treatment group 1. Diets for pigs on treatment groups 2, 3, and 4 were identical to the control diets with the exception that 6% fat was added to each of the diets at the expense of corn. The fat sources used were animal fat (treatment group 2), soybean oil (treatment group 3), and sunflower oil (treatment group 4). To maintain a constant Lys concentration, the inclusion of soybean meal was slightly increased in the diets containing the supplemental fat sources. The phase 1 diets were provided during the initial 2 wk postweaning while the phase 2 diets were fed during the remaining 3 wk of the experiment. Average daily gain, ADFI, and gain:feed ratios (G:F) were calculated for each of the two phases and overall for the entire period. The ADG during phase 1, phase 2, and phase 1 and 2 combined were not affected ($P > 0.05$) by dietary treatments (184, 168, 190, 199; 338, 354, 382, 353; and 277, 280, 305, 291 g/day for pigs on treatment groups 1, 2, 3, and 4, respectively). Likewise, ADFI was not affected by dietary treatments, for phase 1, phase 2, or phase 1 and 2 combined ($P > 0.05$). The values calculated for G:F were 0.68, 0.66, 0.70, and 0.72 (phase 1), 0.55, 0.59, 0.62, and 0.56 (phase 2) and 0.58, 0.61, 0.64, and 0.59 (entire period) for pigs on treatment groups 1, 2, 3, and 4, respectively). Within each phase, none of these values were different ($P > 0.05$). The results of this experiment indicate that pig performance during the immediate post-weaning period is not improved significantly by the inclusion of dietary fat. Furthermore, no differences between the three fat sources evaluated in this experiment were detected.

Key Words: Dietary Fat, Pigs, Energy Concentration

214 Effects of fat encapsulation and pelleting on weanling pig performance and nutrient digestibility. J. J. Xing[1,2], E. van Heugten[1], D. F. Li[2], K. J. Touchette[3], J. A. Coalson[3], and J. Odle*[1], [1]*North Carolina State University, Raleigh,* [2]*China Agriculture University, Beijing,* [3]*Merrick's, Inc., Union Center, WI.*

The objective of this study was to evaluate the effects of encapsulated fat (EF) processed by spray drying on growth and nutrient digestibility in weanling pigs. A total of 144 pigs (6.04 kg BW, weaned at 21 d) were allotted to 1 of 6 treatments in a 3 x 2 factorial arrangement with 3 levels/sources of fat (1 or 6% fat from unprocessed lard, or 6% fat from EF) and 2 diet forms (mash vs pellet). Pigs were fed a 2-phase diet program, with phase 1 diets fed from d 0-14 and phase 2 diets fed from d 14-35. Total-tract digestibilities were computed using chromic oxide as marker. Fat addition to the diet reduced ($P < 0.05$) ADFI from d 0 to 14, with no effect on ADG or G/F. From d 14 to 28, EF improved ADG ($P < .005$) and G/F ($P < 0.01$) each by greater than 10%, with no effect on ADFI. For the entire 35 d trial, fat supplementation decreased ADFI by 6% ($P < 0.05$), with no effects on ADG or G/F, while EF did not affect pig performance. Pelleting improved ADG ($P < 0.01$) and G/F ($P < 0.05$) during phase 1, with no effect on ADFI. During phase 2, and overall (d 0-35), pelleting decreased ADFI ($P < 0.06$) and improved G/F ($P < 0.01$) by 5-8%, with no effect on ADG. Fat level/source did not affect ($P > 0.05$) DM or organic matter (OM) digestibility; however, pelleting improved ($P < 0.001$) DM, OM and fat digestibility of all diets. Fat addition improved fat digestibility compared to 1% lard ($P < 0.001$). Pellet durability index was numerically higher (96.2% vs 85.6%) in the EF phase 2 diet compared to the lard diet. In conclusion, the EF improved growth and feed efficiency in weaned pigs, with d 14 to 28 being most beneficial. Encapuslated fat may improve pellet quality of phase 2 nuresery pig diets containing high levels of fat and low levels of whey. Additionally, pelleting improved digestibility and feed efficiency during the post-weaning period in pigs.

Key Words: Encapsulated Fat, Pigs, Fat Digestibility

215 Growth performance of nursery pigs fed diets containing increasing levels of corn distiller's dried grains with solubles. M. H. Whitney* and G. C. Shurson, *University of Minnesota, St. Paul.*

Two trials were conducted to determine the effects of including increasing levels of corn distiller's dried grains with solubles (DDGS) in Phase II and Phase III diets for early-weaned pigs on growth performance to determine a recommended maximum DDGS inclusion rate. A high quality DDGS source, produced by a modern MN ethanol plant, was used. Ninety-six crossbred pigs (BW = 6.18 ± 0.14 kg) were blocked by gender and ancestry, and blocks randomly assigned to one of six dietary treatments (4 pigs/pen, 4 pens/treatment) in each trial. Pigs in Trial 1 were slightly older (19.0 vs. 16.9 d of age) and heavier (7.10 vs. 5.26 kg) at the beginning of the trial compared to pigs in Trial 2. Dietary treatments consisted of including 0, 5, 10, 15, 20, or 25% DDGS in typical Phase II and Phase III diets in a 3-phase nursery feeding program. All pigs were fed a commercial Phase I pelleted diet for the first 4 d post-weaning. Pigs were subsequently fed their respective Phase 2 experimental diets for 14 d, followed by their respective Phase 3 experimental diets for an additional 21 d feeding period. Experimental diets were formulated to contain equivalent apparent ileal digestible Lys (1.35 and 1.15%) and Met + Cys (0.80 and 0.65%), ME (3340 and 3390 kcal/kg), calcium (0.95 and 0.80%), and total phosphorus (0.80 and 0.70%) within Phases 2 and 3, respectively. Overall ADG, final BW, and G/F were similar regardless of dietary DDGS level in both trials ($P > 0.10$). In Trial 1, feed intake was unaffected by dietary level of DDGS ($P > 0.10$). However, in Trial 2, increasing levels of DDGS linearly reduced average daily feed intake ($P < 0.05$) during Phase II, resulting in a slight overall depression in voluntary feed intake ($P < 0.10$) for the entire length of the trial. These results suggest that using high quality DDGS, and formulating diets using the University of Minnesota apparent amino acid digestibility values for DDGS, provides satisfactory growth performance when included at rates up to 25% in Phase III nursery diets. It appears that feeding DDGS at levels up to 25% of the diet may also be satisfactory in Phase II for pigs weaned at 19 d of age or older and weighing > 7 kg, but initial feed intake may be depressed during Phase II when DDGS is fed to pigs weaned at younger ages (17 d of age or less).

Key Words: Distiller's Dried Grains with Solubles, Swine, Nursery

216 Feed intake and energy digestibility among wheat classes fed to weaned pigs. R.T. Zijlstra*[1], D. Overend[2], D. R. Hickling[3], P. H. Simmins[4], and J. F. Patience[1], [1]*Prairie Swine Centre Inc., Saskatoon, SK,* [2]*Ridley Inc., Mankato, MN,* [3]*Canadian International Grains Institute, Winnipeg, MB,* [4]*Danisco Animal Nutrition, Marlborough, UK.*

The nutritional quality of wheat is expected to vary among classes; therefore, Soft and Durum wheat are separated. A range in wheat CP and non-starch polysaccharide (NSP) partly causes the variation in quality. Two cultivars from each of six classes (Soft White, Soft Red, Durum, Hard Red Spring (HRS), Hard Red Winter (HRW) and Hard White (HW)) were collected. Crude protein (as-is) ranged from 12.2 to 17.4% for all, 12.4 to 16.1% for Soft, and 16.3 to 16.8% for Durum. Total NSP ranged from 9.0 to 11.5% for all, 11.0 to 11.4% for Soft, and 9.0 to 10.1% for Durum. A 3-wk growth and digestibility study was conducted with 12-kg weaned pigs (PIC; 39-d-old; 4 pigs/pen, 12 pens per cultivar) fed 65%-wheat diets (3.5 Mcal DE/kg; 3.4 g digestible Lys/Mcal). For d 0 to 21, ADG, ADFI, and feed efficiency did not differ among wheat classes ($P > 0.10$). For d 0 to 7, ADG for Durum was 9% lower than for HRW ($P < 0.05$), and similar among other classes. For d 8 to 14, ADG did not differ among classes ($P > 0.10$). For d 0 to 7, ADFI for HW was 7% lower than for HRW ($P < 0.05$), and similar among other classes. For d 8 to 14, ADFI for Soft White was 5% lower than for HRS ($P < 0.05$), and similar among other classes. For d 0 to 7, feed efficiency was 4% lower for Durum than for Soft Red, HRS, and HRW ($P < 0.05$). Diet total-tract energy digestibility was lowest for Soft Red (86.5%), intermediate for Soft White, HRS and HW (87.2 to 87.5%) and highest for HRW and Durum (88.6 and 88.9%; $P < 0.05$); diet DE content followed a similar pattern. In summary, protein but not NSP content varied among 12 wheat cultivars harvested in 2001; wheat DE content ranged 7% and was highest for Durum. Decreases in ADFI and ADG for Durum and Soft wheat were limited to the first two wk, and did not exist after 3 wk. In conclusion, despite variations in DE content among wheat classes, young pigs fed all classes of wheat, including Soft and Durum, may grow adequately.

Key Words: Wheat, Pigs

217 Particle size, mill type, and added soy oil influence flowability of ground corn. C. N. Groesbeck*, R. D. Goodband, S.S. Dritz, M. D. Tokach, J. L. Nelssen, and C. W. Hastad, *Kansas State University, Manhattan.*

Decreasing particle size and adding fat to diets can improve pig performance and profitability. Limits to reducing grain particle size and amount of added fat are frequently based on the ability of the feed to flow through feed delivery systems and feeders. Additionally, grain ground with a roller mill typically has a more uniform particle size than that ground with a hammer mill. Thus, type of grinding is expected to affect feed flowability. Therefore, our objective was to evaluate the effects of mill type, particle size and added soy oil on the flowability of ground corn. Six different particle size samples were evaluated for each mill type. The particle size mean and standard deviation for the corn ground with a roller mill ranged from 1,235 (1.98) to 502 (1.97) and for the hammer-milled corn ranged from 980 (2.52), to 390 (2.12) microns. All samples were dried overnight and equilibrated to equal moisture content. Soy oil was then added at 0, 2, 4, 6, and 8 % to portions of each sample. Flowability was determined by measuring angle of repose (the maximum angle measured in degrees at which a pile of grain retains its slope). A large angle of repose represents a steeper slope and poorer flowability. There was a three way interaction between particle size, soy oil, and mill type ($P < 0.05$). Corn ground with a hammer mill without added soy oil had a similar angle of repose as the corn ground with a roller mill that had 6 % added soy oil. Angle of repose was increased as particle size was decreased and more soy oil was added. However, the rate of increase was lower as particle size was decreased and at reduced particle sizes the rate of increase was greater for hammer-milled corn compared to roller-milled corn. These data indicate that corn ground with a roller mill that has 6 % added soy oil should have similar flowability as hammer-milled corn without added soy oil.

Key Words: Particle Size, Hammer Mill, Roller Mill

218 Evaluation of dehulled, degermed corn for swine. D. C. Kendall*[1], A. M. Gaines[1], J. W. Frank[1], G. L. Allee[1], M. Bertram[2], and T. E. Sauber[3], [1]*University of Missouri, Columbia,* [2]*Pork Technologies, LLC, Ames, IA,* [3]*Pioneer-Dupont, West Des Moines, IA.*

Three experiments were conducted to determine the feeding value of dehulled, degermed (DD) corn for swine. In Exp. 1, 12 barrows (TR-4 × PIC C-22) were placed in metabolism crates and used in two 4-d collection periods to determine digestible energy (DE) values and apparent fecal digestibility in DD compared to normal corn. The dietary treatments were composed of 97.2% of either DD corn or normal corn and 2.8% of a mineral and vitamin premix. In Exp. 2, 98 barrows (TR-4 × PIC C-22) were used to determine if DD corn could be fed to pigs throughout the growing-finishing phase. Pigs were housed at 7 pigs/pen (7 reps/diet) and fed pelleted diets formulated to meet or exceed NRC (1998) recommendations for each phase of growth. Dietary phases occurred at 32-45, 45-64, 64-82, 82-100, 100-118 kg BW. In Exp. 3, 20 crossbred growing and 12 finishing barrows (TR-4 × PIC C-22) were used to determine the apparent fecal energy digestibility and fecal DM output of the diets from each phase in Exp. 2. In Exp. 1, apparent energy digestibility values were higher for pigs fed DD corn than normal corn (96.6 vs 88.3%, $P < 0.001$). DE values were higher for DD corn than for normal corn (4051 vs 3791 kcal/kg, $P < 0.001$). In Exp. 2, performance for the overall finishing period showed ADG was similar between the two corn sources, but ADFI was 6.3% lower ($P < 0.02$) and G:F was 5.4% higher ($P < 0.001$) for pigs consuming DD corn compared to normal corn. There was also higher mortality for pigs fed DD corn (18.4 vs 0%; $P < 0.004$), caused by gastric ulcers. The increased mortality can partially be attributed to small particle size (310 microns), a pelleted diet, and prolonged feeding of the DD corn. In Exp. 3, apparent fecal digestibility of energy was higher ($P < 0.001$) in each phase of growth for pigs fed DD corn compared to normal corn (0.96, 0.964, 0.971, 0.975, and 0.978 vs 0.924, 0.933, 0.922, 0.951, and 0.958%, respectively). The decrease in fecal DM output ranged from 42 to 60% ($P < 0.001$) when pigs were fed DD corn. These experiments demonstrate that DD corn can be utilized to increase diet digestibility and decrease fecal output, but factors contributing to gastric ulcers must be considered.

Key Words: Pigs, Dehulled Degermed, Corn

219 Comparison of grain sources (barley, white corn, and yellow corn) for swine diets and effects on performance and carcass traits. J. F. Lampe*, T. J. Baas, and J. W. Mabry, *Iowa State University, Ames.*

An experiment was conducted to evaluate the effect of energy source on performance and carcass traits of pigs. Dietary treatments (primary energy source) were: 1) yellow corn, 2) white corn, 3) 1/3 yellow corn, 2/3 white corn, 4) 2/3 yellow corn, 1/3 white corn, 5) barley. Pigs were from two sires lines, Duroc and Hamp x Duroc, on PIC 1055 females. Pigs were randomly allocated to pens based on genetic type and gender using a 2 x 2 x 5 factorial arrangement with two genetic types, two sexes (barrows and gilts) and five dietary treatments. There were 8 pens per treatment with 26 pigs per pen. Diets were fed in four phases: phase one (27.6 to 49.3 kg), phase two (49.3 to 67.2 kg), phase three (67.2 to 103.3 kg), and phase four (103.3 to 130.2 kg). Diets were formulated to contain 1.12% Lys, 0.83% Ca, and 0.71% P; 0.93% Lys, 0.73% Ca, and 00.56% P; 0.71% Lys, 0.65% Ca, and 0.52% P; 0.65% Lys, 0.63% Ca, and 0.46% P for phases 1 to 4, respectively. Diets were supplemented with choice white grease, to maintain an iso-caloric status through phases one and two (67.2 kg). Choice white grease was limited to 1% in phases three and four (67.2 to 130.2 kg). Backfat (BF) and loin muscle area (LMA) were estimated one d prior to harvest by a trained technician using real-time ultrasound. Diet had no effect ($P > 0.05$) on ADG, ADFI, feed conversion (FG), ultrasound BF, or percent fat-free lean (FFL). Pigs fed diet 5 had a smaller ($P < 0.05$) LMA than pigs fed the other four diets. Pigs fed diet 5 had lower lean gain on test (LGOT) than pigs fed diets 1, 2 and 4, although diet 3 was not different ($P > 0.05$) from all treatment means. Duroc-sired pigs had greater ($P < 0.05$) LMA, LGOT, FFL, ADFI, and FG than Hamp x Duroc-sired pigs. Duroc-sired pigs had less ($P < 0.05$) BF than Hamp x Duroc-sired pigs. Results suggest that yellow or white corn, or barley as the primary energy source did not effect pig growth performance; however, pigs fed barley as the primary energy source had smaller LMA than pigs fed yellow or white corn.

Key Words: Pigs, Energy Sources, Carcass

220 Comparison of Grain Sources (Barley, White Corn, and Yellow Corn) for Swine Diets and Their Effect on Meat and Eating Quality Traits. J.F. Lampe*[1], T.J. Baas[1], and J.W. Mabry[1], [1]*Iowa State University.*

An experiment was conducted to evaluate the effect of energy source on meat and eating quality characteristics of the longissimus muscle of pigs. Diet treatments (primary energy sources) were: 1) yellow corn, 2) white corn, 3) 1/3 yellow corn, 2/3 white corn, 4) 2/3 yellow corn, 1/3 white corn, 5) barley. Pigs were from two genetic sire lines, Duroc and Hamp x Duroc sires (HD) on PIC 1055 females. A total of 999 pigs were included in the trial in a 2 x 2 x 5 factorial arrangement with two genetic types, two sexes (barrows and gilts) and five treatments. Eight pigs were randomly selected from each pen of 26 (n= 319) for meat and eating quality evaluation. Pigs were placed on test at 27.6 kg and fed to 130.2 kg. The final phases of the finishing diets (67.2 to 130.2 kg) included 1% supplemented choice white grease. All animals were held overnight at a commercial abattoir before harvest. One whole skin-on, boneless loin was collected from each carcass and held at -1 degree Celsius in a cryovac sealed bag at the Iowa State University Meat Lab. At 25 to 27 days post-harvest, loins were analyzed for meat and eating quality. Diet treatment had no effect ($P > 0.05$) on 24 hour pH, sensory tenderness, sensory chewiness, Instron tenderness, loin purge, and cook loss. Pigs fed diet 4 had a higher ($P< 0.05$) loin pH than pigs fed diet 1 at 25 to 27 days post-harvest, although diets 2, 3, and 5, were not different from all treatment means. Pigs fed diet 4 had a higher ($P < 0.05$) Japanese color score than pigs fed diets 2, 3, and 5, although diet 1 was not different from all treatment means. Pigs fed diet 3 had a higher percent intramuscular fat than diets 1 and 2, although diets 1, 4, and 5, and diets 1, 2, and 5, were not different ($P > 0.05$). Duroc-sired pigs had a higher ($P < 0.05$) 24 hour pH and Japanese color, and lower ($P < 0.05$) hunter color values than HD-sired pigs. Results suggest that different energy sources evaluated in this study have little effect on eating quality of pork that is held for 25 - 27 days post harvest.

Key Words: Pigs, Energy Sources, Quality

221 Effects of a white versus yellow corn variety on growth performance and carcass characteristics of growing-finishing pigs. R. W. Fent*[1], G. L. Allee[1], S. N. Carr[2], F. K. McKeith[2], G. F. Hartnell[3], and P. D. Matzat[3], [1]*University of Missouri, Columbia,* [2]*University of Illinois, Urbana-Champaign,* [3]*Monsanto Company, St. Louis, MO.*

A total of 340 pigs (170 gilts, 170 barrows) initially averaging 27.0 kg BW were utilized in a growing-finishing experiment to evaluate the effect of two corn genotypes on growth performance and carcass composition. Pigs were allotted by sex to one of two treatments using a completely randomized design with twenty pens per treatment containing eight or nine pigs per pen. Treatments consisted of either a yellow or white corn variety substituted for one another as the sole grain source in corn-soybean meal-based diets fed in a five-phase split-sex feeding program. Pig weight, real-time ultrasound measures, and feed intake were determined at dietary phase changes and at the experiment completion. At termination of the experiment (116 kg BW), eighty pigs (two/pen) were utilized for in-depth carcass analysis. The white corn diet resulted in slightly greater ADG (0.91 vs 0.89 kg/d; $P < 0.02$), but ADFI (2.46 vs 2.43 kg/d) and gain:feed were similar ($P > 0.05$) for both treatments (0.368 vs 0.370). Ultrasound tenth rib fat depth and loin eye area were similar ($P > 0.05$) across dietary treatments at both initiation and termination of the experiment. No differences ($P > 0.05$) were observed between treatments for lean color, marbling, firmness, and pH measures. In general, backfat fatty acid profiles and backfat color were similar ($P > 0.05$) for both dietary treatments. However, backfat from pigs consuming white corn had greater ($P < 0.03$) linoleic acid content versus those fed yellow corn. Shear force ($P < 0.08$) tended to be greater in loins from pigs fed yellow corn versus those fed white corn-based diets. Taste panel analysis indicated that although no differences ($P > 0.05$) were observed for juiciness or off-flavor intensity, loins from pigs fed white corn tended ($P < 0.07$) to be more tender than those fed yellow corn. These data suggest that growth performance, carcass parameters, and meat quality were generally similar for growing-finishing pigs fed either the white corn variety or the yellow variety with only minor differences occurring in fat quality and loin measurements.

Key Words: White Corn, Growing-Finishing Pigs, Carcass

222 Virginiamycin influences mineral digestibility of pigs. J. H. Agudelo*[1], M. D. Lindemann[1], G. L. Cromwell[1], and R. D. Nimmo[2], [1]*University of Kentucky, Lexington,* [2]*Phibro Animal Health, Fairfield, NJ.*

A balance study was conducted to evaluate the effect of virginiamycin on the absorption and retention of minerals (P, Ca, K, Fe, Mg, Zn, Cu and Mn) in finishing pigs. Ten crossbred barrows (53.9 kg and 84 d of age) were paired and randomly assigned to two treatments (0 or 10 g/ton virginiamycin). The corn-soybean meal diet without supplemental P met all NRC (1998) requirement estimates, except for P. The pigs were placed in individual metabolism crates for a 7-d adaptation and 5-d collection period, and fed at 3% of BW/d in two meals. Water was supplied ad libitum during non-feeding times. The beginning and end of the collection phases were marked by the addition of indigo blue dye to the diet. After the first collection phase, pigs were switched to the alternate diet, provided a 3-d respite from the crates, and then the adaptation-collection procedure was repeated. Orts were obtained only during the initial 2 to 3 days of the adaptation periods but did not occur during collections. ADG (1.03 vs 1.14 kg) and F/G (2.33 vs 2.01) did not differ during the collection period ($P > 0.1$) for pigs fed the control and virginiamycin diets, respectively. The apparent digestibilities (%) of P (30.4 vs 38.8, $P < 0.01$), Ca (51.5 vs 57.3, $P < 0.01$), Mg (55.1 vs 58.2, $P < 0.02$), and Zn (23.6 vs 27.5, $P < 0.01$) were improved by virginiamycin. Apparent digestibilities of other minerals (K, Fe, Cu and Mn) were not affected ($P > 0.1$). Absolute retention of P (2.4 vs 3.2 g/d), Ca (3.5 vs 4.2 g/d), Mg (1.1 vs 1.2 g/d) and Zn (14 vs 17 mg/d) was improved ($P < 0.05$) with virginiamycin addition while other minerals were not affected. Increases in retention were the sole result of increases in digestibility with the exception of phosphorus, where both retention as a percentage of intake and retention as a percentage of absorption were improved ($P < 0.02$) by virginiamycin. These results indicate that virginiamycin improves the digestibility of several minerals, most notably phosphorus, in finishing pigs.

Key Words: Minerals, Virginiamycin, Phosphorus

223 Effects of lowering dietary trace mineral (Fe, Zn and Cu) concentrations on trace mineral retention and excretion by young pigs fed diets containing low-phytic acid barley. T. L. Veum[1], D. W. Bollinger[1], M. S. Carlson*[1], D. R. Ledoux[1], and V. Raboy[2], [1]*University of Missouri, Columbia,* [2]*USDA-ARS National Small Grains Germplasm Research Facility, Aberdeen, ID.*

The nutritional effects of a genetically enhanced, low-phytic acid mutant barley (MB) compared to the near-isogenic normal Harrington barley (HB) on trace mineral absorption, retention and excretion were evaluated in growing swine. The estimated percentage availability of P was 90 to 95% in MB and 30% in HB. The effects on growth performance and bone strength have been reported (JAS 79, Suppl.2, p 71). Fifty crossbred barrows with an average BW of 9.94 kg were kept in individual stainless steel metabolism pens during the 28-d experiment. The two barley cultivars (MB and HB) and the five additions of a trace mineral premix (0, 25, 50, 75 and 100% of NRC for Fe and Zn) created ten dietary treatments in a 2 x 5 factorial arrangement of the treatments in a completely randomized design. Premix at 100% provided 160% of Cu (NRC, 1998) for 10-20 kg pigs. The Fe, Cu and Zn were sulfate salts. All other nutrients, including I, Se and Mn, were adequate. Diets containing chromic oxide (0.05%) were fed to appetite twice daily in stainless steel feeders. On days 22 to 26, total urine collections (acidified) and fecal grab samples were made twice daily. There were no interactions ($P \geq 0.2$) for barley source by Cu level criteria, with similar Cu balance responses for MB and HB. However, Zn absorption and retention was higher ($P \leq 0.01$), and Zn excretion was lower (mg/d and %), for MB than for HB at 0% Zn premix (Zn source by Zn level interaction, $P \leq 0.01$). For MB and HB, there were linear increases ($P \leq 0.01$) in the amounts of Zn absorbed, excreted and retained with increasing Zn premix. Bone Zn and Cu concentrations were similar ($P \geq 0.7$) for all ten treatments. In conclusion, Zn and Cu balance responses were similar for MB and HB at 25 to 100% trace mineral supplementation, but Zn absorption and retention were higher for MB than HB at 0% supplementation.

Key Words: Swine, Trace Minerals, Barley

224 The effect of increasing dietary zinc concentration in phase 2 and 3 nursery diets on the growth performance of weanling pigs. C. R. Dove*, *University of Georgia, Tifton.*

A total of 300 pigs (two trials of 150 pigs each) were used to determine the effect of supplemental dietary Zn on the growth performance of weanling pigs during phase 2 and 3 of the nursery. Pigs were weaned at 21 d of age and placed on experimental treatments immediately. Pigs were housed in an environmentally controlled, slatted floor nursery with ad libitum access to feed and water. Diets were corn-soybean meal based with whey, fish meal, blood plasma and lactose added. Dietary treatments included either 200 ppm of Zn (control diet) or 3000 ppm of Zn (diets 2-6) during phase 1 (days 1-11). During phases 2 (days 12-21) and 3 (days 22-35) the control diet and diet 2 contained 200 ppm of Zn; diet 3, 500 ppm of Zn; diet 4, 1000 ppm of Zn; diet 5, 1500 ppm of Zn; and diet 6, 2000 ppm of Zn. Zinc was fed as ZnO in all diets. Pigs were weighed and feed intake recorded at the end of each phase. Data was analyzed using mixed model procedures with the pen as the experimental unit. During phase 1, the addition of 3000 ppm of Zn to the diet increased ($P < 0.05$) ADG and feed efficiency, but had no effect on ADFI intake compared to those pigs receiving 200 ppm dietary Zn. During phase 2, the addition of 2000 ppm of Zn to the diet increased ADG and ADFI ($P < 0.05$), but had no effect on feed efficiency compared to the control diet. Pigs fed 200 or 500 ppm Zn during phase 2 (diets 2 and 3) had a decreased ADG ($P < 0.05$) compared to the control diet. Average daily gain for phase 2 was 439, 387, 378, 395, 447, and 492 g/d for diets 1 through 6, respectively. During phase 3, the addition of Zn had no effect on ADG or feed efficiency. During phase 3, the addition of 1000-2000 ppm of Zn increased ADFI ($P < 0.05$) compared to the control diet. Over the 35-day study, the addition of 1500 or 2000 ppm of Zn during phases 2 and 3 increased ADG and ADFI ($P < 0.05$), but had no effect on feed efficiency compared to the control diet and those pigs fed 200 to 1000 ppm of Zn. These data confirm previous reports of the role of Zn on performance in phase 1 and indicate that additional Zn may be needed in phase 2 and 3 nursery diets to optimize the growth performance of nursery pigs.

Key Words: Zinc, Pigs, Nursery

225 Effect of phytase on tissue trace mineral concentrations, growth performance, plasma metabolites, carcass traits, and pork quality in growing-finishing pigs. J. L. Shelton*, F. M. LeMieux, L. L. Southern, and T. D. Bidner, *Louisiana State University Agricultural Center, Baton Rouge.*

An experiment was conducted to determine the interactive effects of phytase (Natuphos®) and removing the trace mineral (TM) premix in diets for growing-finishing pigs. Pigs (initial and final BW of 22 and 109 kg, respectively) were allotted to four treatments with six replications (three barrow and three gilt) of four pigs per replicate in a randomized complete block design. The four dietary treatments were with and without the TM removed and with or without phytase in a 2×2 factorial. The Ca and aP were reduced by 0.10% in diets with phytase. Blood was collected on d-29 and at slaughter. Three pigs per replicate were randomly selected for slaughter. Overall growth performance and pork quality were not affected ($P > 0.10$) by phytase with or without the TM removed. Fasting glucose was increased ($P < 0.09$) in pigs fed the diets with the TM removed. Tenth-rib backfat thickness and liver weight were increased ($P < 0.04$) and carcass length and ham weight were decreased ($P < 0.06$) in pigs fed the diets with the TM removed. Liver weight was decreased ($P < 0.01$) in pigs fed the diets with phytase, but the decrease was greater in pigs fed the diets with the TM removed (phytase × TM, $P < 0.03$). Copper and Fe levels in the bile, Cu and Zn levels in the liver, and Zn levels in the muscle were decreased ($P < 0.06$) in pigs fed the diet with the TM removed. Phytase addition decreased ($P < 0.04$) Fe levels in the bile, increased ($P < 0.10$) Cu levels in the muscle and Zn and P levels in the liver. Manganese levels in the bile and Cu and Mn levels in the liver were decreased in pigs fed phytase in the diets with the TM removed (phytase × TM, $P < 0.04$). These data indicate that removing the TM in diets for growing-finishing pigs had no negative effects on growth performance or pork quality, but it did have negative effects on carcass traits. The addition of phytase had no negative effects on growth, carcass traits, or pork quality.

Key Words: Phytase, Pigs, Trace Minerals

226 Pharmacological zinc and phytase enhance renal and intestinal mucosa cell metallothionein protein and relative mRNA abundance in the nursery pig. M. M. Martínez*, G. M. Hill, J. E. Link, N. E. Raney, and C. W. Ernst, *Michigan State University, East Lansing, MI*.

Metallothionein (MT) is a protein that is physiologically induced by several factors, such as dietary zinc (Zn) and stress. The swine industry adds pharmacological Zn in the oxide form (ZnO) to the diets of weaned pigs as an anti-diarrheal agent. However, due to the increasing environmental concern of excessive mineral excretion and low Zn absorption caused by the high phytic acid content of plant-based diets, adding phytase has been proposed to address these concerns. The hypothesis of this study is that diets containing pharmacological Zn and phytase will increase renal and intestinal mucosa Zn, MT, and MT mRNA abundance compared to diets containing only adequate Zn. Twenty-four pigs (5.5 kg, 21 d) were fed adequate (150 ppm) Zn or one of two pharmacological concentrations (1,000 ppm; 2,000 ppm) as ZnO, without or with phytase (0, 500 FTU/kg, Natuphos®BASF). All pigs were killed after 14 d of dietary intervention. Kidney tissue was collected for analysis of Zn and MT concentrations and for RNA isolation. Duodenal intestinal mucosa cells were collected for MT analysis and for RNA isolation. Relative MT mRNA abundance was determined by dot blot analysis. Renal Zn ($P < 0.0001$) and MT ($P < 0.0003$) increased with an increase in dietary Zn. The pigs receiving phytase-supplemented diets, regardless of the dietary Zn concentration, also had an increase ($P < 0.04$) in kidney Zn. Intestinal mucosa MT protein ($P < 0.05$), and renal ($P < 0.005$) and intestinal mucosa ($P < 0.002$) relative MT mRNA abundance were greater in animals fed 2,000 ppm Zn with phytase compared to the pigs in the other dietary treatments. This study suggests that a pharmacological Zn diet supplemented with phytase enhances Zn concentration and MT synthesis in both kidney and intestinal mucosa. Furthermore, it demonstrates the regulatory role of dietary Zn on MT at the transcriptional level in the pig.

Key Words: Pharmacological Zinc, Metallothionein, Phytase

227 Body mineral composition of gilts and barrows from two genotypes of pigs from 18 to 127 kg body weight. T. G. Wiseman*, D. C. Mahan, J. C. Peters, N. D. Fastinger, S. Ching, and Y. Y. Kim, *The Ohio State University, Columbus*.

Two genotypes of pigs with different lean gain potentials [300 g vs. 400 g fat-free lean (FFL)/d], with an equal distribution of gilts (60) and barrows (60), were used to evaluate body mineral composition during the grower-finisher period. Both genotypes were housed at a single site and fed common diets during the nursery period to adjust the animals to common environmental conditions. At an average 18 kg BW the pigs were moved to a complete confinement facility and split sex fed a corn-soybean mixture that met or exceeded NRC (1998) amino acid and mineral requirements for each genotype for their lean gain potential. Six pigs for each treatment group were killed initially and at an additional four equally distributed weight intervals to 127 kg BW. The experiment was therefore a 2 × 2 × 5 factorial arrangement of treatments in a randomized complete block design conducted in two replicates. Analysis of data used the animal as the experimental unit and contrasted genotype, gender, and weight periods. The results demonstrated a quantitative linear increase ($P < 0.01$) in all macro- and micro-minerals from 18 to 127 kg BW. Pigs of higher lean gain potential had higher Zn ($P < 0.05$), Cu ($P < 0.05$), S ($P < 0.01$), and K ($P < 0.01$) body contents than those pigs with a lower FFL/d. Gilts had higher Cr ($P < 0.05$), and Fe ($P < 0.05$) contents than barrows. The differences between minerals seemed to be more pronounced and different between the groups after 100 kg BW for both genotype and sex, however, only the sex by weight interaction for Cr was significant ($P < 0.05$). These results suggest that pigs of higher lean gain potential and gilts have higher body concentrations of minerals, particularly those minerals associated with lean tissue deposition.

Key Words: Mineral, Composition, Pigs

228 Evaluation of selenium yeast (Sel-Plex^{TM}) as a selenium source in diets for 6 to 20 kg pigs. J. D. Hahn*[1], G. D. Dial[2], E. L. Hansen[1], S. A. Hansen[1], J. D. Hedges[1], B. V. Lawrence[1], and R. E. Musser[1], [1]*Hubbard Feeds, Inc., Mankato, MN,* [2]*New Fashion Pork, Jackson, MN*.

An experiment was conducted to evaluate the value of Sel-Plex^{TM} (**S-P**) as a replacement for sodium selenite (**SSE**) as the supplemental Se source in swine nursery diets. A total of 672 pigs (C22 x TR4) weighing 5.9 kg ±0.12 kg were allotted to two dietary treatments (n = 12). Pigs were housed in a conventional nursery facility at 28 pigs/pen. A three phase feeding program was used which included a 1.50% Lys phase 1 diet from day 0-7 post-weaning, a 1.40% Lys phase 2 diet from day 8-21 post-weaning, and a 1.30% Lys phase 3 diet from day 22-35 post-weaning. The control and experimental diets contained 0.3 ppm supplemental Se provided by **SSE** or **S-P** , respectively. During the day 0-7 period, a trend toward decreased ADG ($P < 0.20$) and ADFI ($P < 0.10$) was observed for the pigs fed **S-P**. Gain/feed was similar between treatments ($P > 0.50$). From day 8-21 pigs receiving the **S-P** showed a trend for improved ADG ($P = 0.20$) and gain/feed ($P < 0.10$). For the day 0-21, 22-35, and 0-35 periods, ADG, ADFI, and gain/feed were similar ($P > 0.10$) between treatments. Substitution of **S-P** for **SSE** resulted in similar performance in 6 to 20 kg pigs.

Source	SSE	S-P	CV	P<
# pens	12	12		
# pigs	336	336		
In. wt.	5.88	5.90	2.0	.73
D 0-7				
ADG, g	154.7	144.5	11.5	.18
ADFI, g	163.8	155.7	6.2	.07
GF, g/g	.94	.93	9.6	.68
D 8-21				
ADG, g	370.9	383.7	6.1	.20
ADFI, g	447.5	451.7	3.5	.52
GF, g/g	.83	.85	3.1	.06
D 0-21				
ADG, g	298.9	302.1	5.5	.64
ADFI, g	352.8	351.5	3.1	.78
GF, g/g	.85	.86	2.9	.21
D 0-35				
ADG, g	391.7	394.8	2.7	.49
ADFI, g	510.1	512.8	2.9	.68
GF, g/g	.77	.77	1.4	.34

Key Words: Selenium, Selenium Yeast, Swine

229 Use of a natural carbon-mineral supplement in swine diets: effects on pig growth and carcass characteristics. S. W. Kim[1], F. Ji*[1], R.A.M. Schmitt[2], and J. J. McGlone[1], [1]*Texas Tech University, Lubbock,* [2]*Seaboard Farms, Inc.*.

Two experiments were conducted to characterize the effects of naturally sourced iron oxide with natural, carbon-mineral characteristics (FeNCM) on growth performance and carcass characteristics as feed additives in swine diets. Four FeNCM products (DPX46162, DPX48162, DPX4600, and DPX5600) from HumaTech (Houston, TX) were evaluated. Exp. 1 used 192 pigs from weaning (3 wk of age) to market weight (102.8±2.3 kg) to test the supplemental effects of DPX46162 and DPX48162. There were three treatments (control, DPX46162, and DPX48162) with 8 pens and 8 pigs per pen in each treatment. All pigs were fed based on the 6-phase feeding program as suggested in the 1998 NRC. Body weight and feed intake were measured during each phase. Pigs were transported to Seaboard Packing Plant (Guymon, OK) when the pigs reached 102.8 kg to measure carcass characteristics. Loin pH and color were measured from the middle part of loineye at 24 h after slaughter. Pigs fed diets with DPX46162 and DPX48162 had higher ADG ($P < 0.05$) and gain/feed ($P < 0.05$) during the whole experimental period and had leaner ($P < 0.05$) carcass and higher ($P < 0.05$) loin pH 24-h postmortem than pigs from control group. Pigs fed diet with DPX had darker loin color ($P < 0.05$) and improved pass rate of loins for the Japanese market. Exp. 2 used another group of 192 pigs

from weaning (3 wk of age) to market weight (112.6±2.1 kg) to test the supplemental effects of DPX4600 and DPX5600 compared with the control group. Each treatment had 8 replicate pens with 8 pigs per pen. Other design and methods were identical to those of Exp 1. There were no differences in ADG and gain/feed between control and DPX 4600 treatment. However, pigs fed DPX5600 had lower ($P < 0.05$) ADG and gain/feed than pigs fed the control diet or DPX4600. Loins from pigs fed diets with DPX4600 or DPX5600 had higher pass rates based on meat color preference for the Japanese market than loins from pigs fed the control diet. Loin pH was higher ($P < 0.05$) for pigs fed diets with DPX4600 and DPX5600 than pigs fed the control diet. These results suggest that supplementing selected FeNCM (except for DPX5600) in swine diets may improve growth performance as well as carcass characteristics.

Key Words: Pigs, Natural Carbon Mineral, Growth

230 Effects of vitamin C supplementation on plasma ascorbic acid and oxalate concentrations and meat quality in swine. S. J. Pion*, E. van Heugten, and M. T. See, *North Carolina State University, Raleigh*.

Two experiments were conducted to determine the effects of vitamin C supplementation on plasma ascorbic acid and oxalate concentrations and its effect on pork quality. In Exp. 1, 16 pigs (81.6 kg BW) were blocked by sex and weight and randomly assigned within block to one of three treatments: 1) control; 2) 1,000 mg/L vitamin C; or 3) 2,000 mg/L vitamin C supplemented in the drinking water for a 48 h period. Supplementing vitamin C increased plasma ascorbic acid (AA) levels (23.4, 19.5 and 11.6 μg/mL; $P \leq 0.05$) within 6 h of supplementation. Plasma AA levels from treated pigs declined and did not differ from the levels of the control pigs (18.6, 18.2 and 13.7 μg/mL; $P \geq 0.05$) within 2 h of ending supplementation. No differences in plasma AA levels ($P \geq 0.05$) were found between the two levels of supplementation. Vitamin C intake resulted in no differences ($P \geq 0.05$) in plasma oxalate and cortisol levels. In Exp. 2, 30 pigs (118.2 kg BW) were blocked by sex and weight and randomly assigned within block to one of three treatments: 1) control; 2) 500 mg/L vitamin C; or 3) 1000 mg/L vitamin C supplemented in the drinking water 48 h pre-slaughter. Pigs were slaughtered 4 h after vitamin C supplementation ended. Loin samples were collected for measurement of pH, color, fluid loss and oxidative stability (TBARS). Loin chops were stored at refrigerated temperatures, similar to retail display, for 4 and 8 d for analysis of color, fluid loss and oxidative stability (TBARS). At time of slaughter no differences in plasma AA, oxalate and cortisol or muscle AA and lactic acid ($P \geq 0.05$) were observed between treatments. No differences ($P \geq 0.05$) were observed in pH values between carcasses from treated or control pigs. Vitamin C supplementation failed to improve color, decrease fluid loss or improve oxidative stability. The lack of elevated plasma AA and oxalate levels at slaughter implies that timing of slaughter relative to vitamin C supplementation may be critical in order to observe potential improvements in pork quality.

Key Words: Swine, Pork Quality, Vitamin C

Abstract 366 can be found on page 91.

Odor and Nutrient Management

231 Physiological and biological limitations for nutrient utilization in farm animals. B. J. Kerr*[1], [1]*USDA-ARS-MWA-SOMMRU*.

Optimizing nutrient utilization by farm animals is vital in maintaining economical animal production in light of environmental concerns associated with agriculture. In an effort to optimize nutrient utilization, however, there are numerous physiological and biological factors preventing complete nutrient use. Except for gut fill, it was not long ago that the gastrointestinal tract was hardly considered as an organ of metabolic concern. Glutamine, a dispensable amino acid, has long been known to be a key energy substrate for the gastrointestinal tract. Only recently has Thr, an indispensable amino acid, been shown to be highly metabolized by gastrointestinal tissue. The metabolic fate of Thr is further complicated by the fact that crystalline Thr, which is a readily available feed ingredient, is more rapidly absorbed than protein-bound Thr. Consequently, these two metabolic conditions prevent complete utilization of dietary amino acids to be deposited into edible animal product. Another factor that impacts nutrient utilization is the relationship between diet and gastrointestinal physiology and microbial ecology. It is well known that changing dietary forage has a tremendous impact on rumen microbial ecology. The understanding of this relationship in monogastrics is lacking and complicated by sizeable microbial population that inhabit the lower gastrointestinal tract of pigs. Past research in monogastrics dealt mainly with the impact of fiber addition on animal performance with little data describing physiological or microbiological changes. In addition, characterization of the fiber type was lacking such that the changes in dietary fiber(s) consumed could not be calculated. With the current emphasis on supplementing feed ingredients or neutraceuticals targeted for selective hind gut microbial fermentation, more information is needed on the metabolic and physiological changes in the animal due to fiber supplementation. An additional area of nutrient utilization interest is the low retention of various minerals commonly supplemented in livestock feed, either due to their inability to be adequate digested or their controlled metabolic regulation. Improved utilization of nutrients will lead to a more sustainable livestock production.

Key Words: Nutrient Utilization, Amino Acids, Microbiology

232 Enhancing nutrient efficiency through genetic selection: Opportunities and challenges. M.T. See*, *North Carolina State University, Raleigh NC*.

Intensive animal agriculture has led to public and legislative concern about environmental and health risks from manure. Genetic selection for increased efficiency of production is one of many tools that can be used to decrease the amount of nutrients excreted in urine and feces. Genetic reduction of nutrient excretion from animal production systems has occurred from improved feed conversion and increased nutrient utilization. In addition, genetic improvement of reproduction optimizes the production system and leads to decreased nutrient excretion when we assume that a fixed number of animals units are produced in a location annually. Tremendous genetic progress has been observed historically for growth rate and lean composition in swine and poultry resulting in indirect improvement for feed conversion. In both industries there has been a significant reduction in days to market and increased lean yield. The annual genetic trend for milk yield has also accelerated with time producing a more efficient industry. However, intense selection for increased efficiencies has not been without challenges. Selection for efficiency has resulted in negative complications, such as reduced product quality, reduced reproductive performance, reduced appetite, and skeletal abnormalities. Genetic improvement of milk yield has likely resulted in negative effects on cow reproduction and intense selection has led to an accumulation of genetic relationships within the Holstein breed. In addition to negative genetic correlations associated with selection, production environments and production systems do not always allow animals to express their genotypes. For example, chronic heat stress, disease and other factors will result in poorer efficiency regardless of genetic merit. There is additional opportunity to enhance nutrient efficiency by directly selecting on lean tissue feed efficiency and taking into consideration not only feed costs but manure costs in developing breeding objectives. Additional genetic progress can also be made in the reproductive rates and health of all species. Improved understanding of how to profitably maximize the expression of genetic potential in commercial production situations can also enhance nutrient efficiency.

Key Words: Genetics, Efficiency, Manure

233 Reducing nutrient excretion and odor: a production system approach. G. G. Gourley*, *Swine Graphics Enterprises, Webster City, IA*..

Although extensive research has been conducted on reducing nutrient excretion and odor, the implementation and economic considerations of applying the research and technologies are unique to every production system. Some of the various products, programs, techniques, designs and technologies for dealing with nutrient excretion and odor will be reviewed. Two examples of the economic considerations and the steps in the decision process will be presented for the extensively researched feed