106 The use of nonlinear mixed models for swine growth. A. P. Schinckel* and B. A. Craig, *Purdue University, West Lafayette, IN.*

Alternative versions of a three-parameter nonlinear growth function (Bridges, 1986; $BW_{i,t} = C(1 - \exp(-M\ t^A)) + \text{birthweight} + e_{i,t}$, where t is days of age for the ith pig) were evaluated on two groups of gilts. The gilts were randomly assigned to be reared under all-in, all-out (AIAO, n = 96) or continuous flow management (CF, n = 96). The fixed effects version assumes the BW of each pig deviates from the BW growth function and that these deviations (i.e., residuals) are independent with constant variance. Empirically, these assumptions are not reasonable. As an alternative, we propose the use of random effects and investigate both one and two random effect models. The inclusion of random effects provides a flexible method to better reproduce the underlying variance-covariance structure of the serial live weights while still assuming the residuals are independent with constant variance. These models are also easily adaptable to stochastic modeling. For these data, the AIC (Akaike's Information Criteria) values for the fixed effects model were 2176 and 4116 for the AIAO and CF gilts. By allowing the mature body weight to vary pig to pig (i.e., $C + c_i$) the AIC values are reduced to 1904 and 3633 respectively, and the RSD's, the standard errors of the M and A parameters were reduced by over 50%. The addition of a second random effect for M (i.e., $M + m_i$) further reduced the AIC values (1883, 3568 for AIAO and CF) and the RSD's. The inclusion of the second random effect accounts for different patterns of growth between pigs thereby allowing more flexibility to model the observed variance-covariance structure. Also, algebraically, the age required for each pig to reach a specific BW can be predicted. The CF gilts had slightly greater SD in BW at 153 and 174 d of age (9.0 and 10.0 kg) than the AIAO gilts (8.5 and 9.0 kg). However, the SD in predicted days of age required to achieve 110 kg was greater for CF gilts (19.3 vs. 11.3 d). These data demonstrate an improved fit of the two random effects model in comparison to the single random effects model.

Key Words: Mixed Effects Model, Nonlinear Growth Functions, Pig Growth

107 Evaluation of biases in predicting fat-free lean mass of pigs fed ractopamine. A. P. Schinckel*, C. T. Herr, J. C. Forrest, B. T. Richert, and M. E. Einstein, *Purdue University; West Lafayette, IN* .

Barrows (BW 69.6 ± 4.0 kg) were allotted by weight to evaluate the effects of dietary lysine levels while feeding ractopamine (RAC) on carcass composition and growth. Treatments (TRT) 1 and 2 were fed throughout the six-week trial, while TRT 3 changed weekly. Treatments were as follows: 1) 16% CP, .82% lys control diet; 2) 16% CP diet, .82% lys; 3) a phase fed diet sequence, 18% CP, 1.08% lys during wk 1 and 4, 20% CP, 1.22% lys during wk 2 and 3, 16% CP, .94% lys during wk 5, and a 16% CP diet .82% lys during wk 6. All diets for TRT 2 and 3 contained 20 ppm RAC. The four lean cuts from the right side of the carcasses (n = 15 per TRT) were dissected into lean and fat tissue. The other cuts soft tissue was collected from the jowl, ribs, and belly. Proximate analyses were completed on these three tissue pools and a sample of fat tissue from the other cut soft tissue to determine fat-free lean mass (FFLN). Prediction equations were developed for FFLN. Independent variables included carcass weight (CW), last rib midline fat depth (BFLR), 10th rib fat depth (FD), and 10th rib loin muscle area (LMA). Live measurements included ultrasonic 10th rib fat depth (UFD) and loin muscle area (ULMA). Also, dissected ham lean (HL) and loin lean (LL) were considered as independent variables. The mean residual values for the three TRT were evaluated as a measure bias. The FFLN was different ($P < 0.01$) for the RAC TRT (39.4, 42.4, and 46.5.3 kg). The prediction equations had significant TRT biases. The FFLN of TRT 1 pigs were overpredicted and TRT 3 pigs under predicted. Prediction equations underestimate the FFLN of pigs fed RAC with high lysine diets.

Equation	R^2	RSD, kg	Mean residual TRT 1	TRT 2	value TRT 3	Probability
CW, BFLR	0.49	3.11	-2.58	0.31	2.27	.001
CW, FD, LMA	0.62	2.55	-1.65	0.03	1.61	.001
BW, UFD, ULMA	0.59	2.61	-1.67	-0.09	1.75	.001
CW, FD, LL	0.74	2.15	-1.29	-0.02	1.31	.001
CW, FD, HL	0.75	2.06	-0.56	-0.62	1.18	.02
CW, FD, HL, LL	0.84	1.66	-0.39	-0.54	0.93	.02

Key Words: Pigs, Carcass Composition, Ractopamine

108 Effect of post-weaning growth rate, as affected by diet and floor space, on pig growth to slaughter in a wean-to-finish system. B. F. Wolter*[1], M. Ellis[1], S. E. Curtis[1], B. P. Corrigan[1], J. M. DeDecker[1], E. N. Parr[2], and D. M. Webel[2], [1]*University of Illinois, Urbana,* [2]*United Feeds, Sheridan, IN.*

The objective was to study the effect of early post-weaning growth rate, as affected by diet and floor space, on subsequent growth to slaughter in a wean-to-finish system. Pigs (n = 1,728) were used in a randomized block design with a 2 X 2 factorial arrangement of treatments: 1) diet (Complex vs Simple) and 2) floor space (Unrestricted vs Restricted). Treatments were imposed the first 8 wk post-weaning (Period 1) and growth was measured from weaning (5.0 0.01 kg BW; 17 d of age) to 23 wk post-weaning. The Simple treatment consisted of corn-soy based diets with minimal milk products, processed cereals, and animal protein-based ingredients compared to Complex. Floor- and feeder-space were 0.63 m^2 and 4 cm and 0.21 m^2 and 2 cm per pig, respectively, for Unrestricted and Restricted. From end of wk 8 to end of wk 23 (Period 2), pigs on all treatments had the same floor- and feeder-spaces and were fed a common diet program. There were no treatment interactions ($P > 0.05$). In Period 1, pigs assigned to the Simple diet program had similar ADFI (639 vs 650 5.4 g; $P > 0.05$), but reduced ADG (408 vs 424 3.8 g; $P < 0.01$), gain:feed (G/F; 0.64 vs 0.65 0.002; $P < 0.001$), and were lighter (2.8%; $P < 0.01$) than those on Complex. In Period 2, growth was not affected ($P > 0.05$) by previous diet program, and pig BW was similar (114.7 vs 115.0 0.50 kg; $P > 0.05$) at the end of wk 23. Pigs kept at Restricted compared to Unrestricted space were lighter at end of wk 8 (6.5%; $P < 0.001$), and had lower ADG (398 vs 434 3.8 g; $P < 0.001$), ADFI (621 vs 668 5.4 g; $P < 0.001$), and G/F (0.64 vs 0.65 0.002; $P < 0.01$) in Period 1. However, Restricted pigs had higher ADFI (2215 vs 2261 12.0 g; $P < 0.01$) and tended to have greater ADG (820 vs 836 5.6 g; $P = 0.06$), but similar ($P > 0.05$) G/F compared to Unrestricted in Period 2. Pig BW were similar (114.5 vs 115.2 0.50 kg; $P > 0.05$) between space treatments at end of wk 23. Mortality and morbidity and backfat and loin depths were not influenced ($P > 0.05$) by either diet program or space. Both the simple diet program and reduced space allowance used in the early period post-weaning resulted in reduced pig growth rate, but, early growth rate had little impact on pig BW or carcass measures at wk 23 post-weaning.

Key Words: Pigs, Diet Complexity, Floor Space

Nonruminant Nutrition

109 Effect of alpha-1,6-galactosidase, beta-1,4-mannanase, and beta-1,4-mannosidase on lactation performance in primiparous sows. S. W. Kim*, *Texas Tech University.*

Soybean meal contains 5.6% α-galactoside and 1.2% β-galactomannans that pigs can not utilize because of they lack appropriate enzymes, resulting in gas production. Twenty two primiparous sows (Newsham) were used to test a hypothesis that dietary supplementation of an enzyme mixture (mainly composed of α-1,6-galactosidase, β-1,4-mannanase, and β-1,4-mannosidase) reduces body weight loss and improves overall performance during lactation. On d 109 of gestation, sows were moved to farrowing crate. Immediately after farrowing (within 24 h), all sows and litters were weighed. Two sows with similar farrowing body weight were grouped and randomly allotted to one of two dietary treatments within a group. Sows in the control group were fed a diet containing 28% soybean meal and the enzyme was added at the level of 0.1% replacing corn. Within 48 h, litter size was standardized to 9 pigs by cross-fostering. Feed intakes of sows were measured individually on a daily basis. All the sows and litters were weighed on d 7, 14, and 21 after farrowing and all the litters were weaned on d 21. After weaning, sows were moved to gestation stalls and days return to estrus was recorded. At farrowing, sows from both treatments had the same body weight. However after a 21-d lactation, body weight loss from control group (12.8 kg) was greater ($P < 0.05$) than that from enzyme group

(2.1 kg). There was no difference in daily feed intake between treatments. Litter weight gain was not different between treatments. Days return to estrus was smaller ($P < 0.05$) for the enzyme treatment (4.68 d) than control treatment (5.94 d). Two sows from each treatment did not return to estrus until d 25 post weaning. Supplementing enzyme improved sow lactation performance by reducing body weight loss and days return to estrus whereas it did not improve litter weight gain and sows' feed intake.

Key Words: Lactation, Sows, Enzyme

110 Effect of added soybean oil or full-fat canola meal on sow and litter performance. B.S. Zimprich*, T.E. Socha, and R.L. Harrold, *North Dakota State University.*

Seventy-six sows were used to evaluate sow and litter performance, sow body condition, days to estrous, and milk composition when sunflower oil (SA) or canola meal (CA) were added to a control (C) diet of corn and soybean meal. Sows were randomly assigned to a diet at day 100 of gestation. Sows were measured for body condition by using real-time ultrasound on days 100 of gestation, day of farrowing, day 7, and at weaning. The sows were also weighed at these times. Milk samples were randomly taken from three sows per treatment per farrowing. Milk samples were analyzed for solids, protein, and fat at day 0, and 14. Litter weights were taken on days 0, 2, 7, and weaning. SA sows returned to estrous earlier than C sows (4.94 vs. 5.57; $P<.09$). Sows on diet C lost less weight than CA sows between day 100 pre-farrow and farrowing (-6.26 vs. -11.65 kg; $P<.01$). Sows on the SA and CA diets weaned heavier litters than the sows on diet C (51.36, 52.02 vs. 45.25 kg; $P<.03$). Sows on diet C ate more feed pre-farrow than sows on diet CA (39.5 vs. 35.5 kg; $P<.001$). Sows on diet SA ate more than sows on diets C and CA between farrowing, and day 7 (36.42 vs. 31.82 and 31.75 kg; $P<.06$). Between day 7 and weaning sows on diets CA and SA ate more than the sows on diet C (59.71, 54.77 vs. 47.24 kg; $P<.0008$). Overall feed intake data indicated that sows on diet SA consumed more than sows on diet C (129.59 vs. 118.64 kg; $P<.03$). Milk composition on day zero showed no differences between treatments, however, sows on SA had a higher fat content than sows on diets C and CA at day 14 (9.33 vs. 7.02, and 8.01%;$P<.004$). There were no differences in survival rate between treatments (86.4, 90.3, and 88.9%). Backfat on the sows of all treatments between days 100 pre-farrow and farrowing decreased 1.78 mm. Supplementing a corn soybean meal ration with sunflower oil or canola meal was beneficial.

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

111 Effects of dietary L-carnitine and chromium picolinate on sow reproductive performance. D. E. Real*[1], J. L. Nelssen[1], M. D. Tokach[1], R. D. Goodband[1], S. S. Dritz[1], and K. Q. Owen[2], [1]*Kansas State University, Manhattan,* [2]*Lonza Inc., Fairlawn, NJ.*

A total of 599 sows were used to determine the effects of dietary L-carnitine and/or chromium picolinate (Cr) on reproductive performance. Experimental treatments were arranged in a 2 X 2 factorial with main effects of L-carnitine (0 or 50 mg/kg) and Cr picolinate (0 or 200 mg/kg). Starting on the first day of breeding, all sows were provided a daily top dress containing the dietary treatments along with the normal diets. Dietary treatments were provided through the initial gestation, lactation, and through a second gestation period (2 parities). During the first parity, there was a carnitine X chromium interaction ($P < 0.01$) for first service farrowing rate with values of 82.9, 91.9, 95.5, and 92.2% for control, carnitine, Cr, and both, respectively. No differences ($P > 0.05$) were observed in number of pigs born alive, still born, mummies, or total born in the first parity. Added dietary L-carnitine decreased ($P < 0.05$) wean-to-estrus interval, and tended to increase ($P < 0.08$) the number of sows in estrus by d 7. In the second parity, a tendency ($P < 0.08$) for a carnitine X chromium interaction was found for first service farrowing rate. Adding carnitine and chromium together in the diet increased first service farrowing rate compared to the control or either product alone. Because of the change in wean-to-estrus interval and farrowing rate, feeding additional dietary carnitine and chromium increased ($P < 0.04$) the percentage of sows that were farrowed in parity 2. When calculating the total number of pigs born and born live based on all sows that were started on test, carnitine and chromium additively increased ($P < 0.02$) the number of pigs born and born alive (Total born: 15.3, 18.4. 18.8, and 19.7; born live: 13.9, 16.3, 16.2, and 17.0 for control, carnitine, Cr, and both, respectively). In conclusion, adding dietary carnitine and chromium improved wean-to-estrus interval and farrowing rate and, thus, total pigs born live over two parities.

Key Words: Sows, Carnitine, Chromium

112 A regional evaluation of chromium tripicolinate supplementation in sows. M. D. Lindemann*, S. D. Carter, L. I. Chiba, C. R. Dove, and L. L. Southern, *S-288 Regional Research Committee on Nutrition and Management of Swine for Increased Reproduction.*

Supplementation of sows with chromium tripicolinate has provided promising increases in litter size. However, varied levels of supplementation have not been examined with sows. This study was conducted to evaluate multiple levels of supplementation across a variety of conditions at five universities. Supplemental Cr levels of 0, 200, 600, and 1000 ppb from chromium tripicolinate were used. The rate of 600 ppb provides the mature animal with similar Cr supply per kg BW as a growing pig fed 200 ppb; the rate of 1000 ppb is 5X to the standard rate of 200 ppb. Participants were required to use at least three of the four levels, including 0 and 200 ppb. A total of 285 gilts and sows were allotted to treatment on the day of breeding. A common corn-soy diet formulation was used that met or exceeded NRC (1988) requirement estimates for reproduction. Only those sows completing at least two parities were considered in the data analysis. A total of 439 litters (litter was the experimental unit) were included in the analysis. The model included terms for station, treatment, study parity, and all possible interactions. There were significant station effects for all measured responses but no meaningful station X treatment interactions. With regard to litter size, the response of primary interest, a tendency for an increase in total pigs born/litter with increasing Cr supplementation was observed (10.17, 10.86, 11.09, and 10.53, respectively; $P=.14$). The litter size responses in live born (9.27, 9.59, 10.12, 9.71) and weaned (8.30, 8.47, 9.00, and 8.83) followed the same pattern but were not significant. In summation, supplementation of 200 ppb Cr from chromium tripicolinate yielded mean litter size increases similar to published literature. Numerical increases in litter size beyond that observed at 200 ppb may suggest merit to continued research to evaluate higher supplementation rates. Levels of 5X current supplementation rates, though they were fed for up to three parities in sows, were not detrimental.

Key Words: Sows, Chromium, Litter Size

113 Comparison of International Protein Corporation 740 and Super Select ^{TM} Menhaden fish meals in nursery pig diets. M. G. Young*, M. D. Tokach, R. D. Goodband, J. L. Nelssen, S. S. Dritz, and M. Cici[1], *Kansas State University, Manhattan,* [1]*International Protein Corporation, St. Paul, MN.*

One hundred and seventy five pigs (6.42 kg and 17 ± 2 d) were used in a 21 d growth assay to compare two menhaden fish meals (IPC 740, International Proteins Corp, St. Paul, MN or Special Select ^{TM} , Omega Proteins, Hammond, LA) on growth performance of nursery pigs. All pigs were fed a common diet for four days after weaning before allotment to dietary treatments. Dietary treatments were fed in meal form. Diets were formulated to contain 1.40% lysine, 0.84% Ca and 0.49% available P. In addition, 10% dried whey, 3% soybean oil and 0.13% L-lysine HCl was added to all diets. There were 5 experimental diets with a control diet (no added fish meal) and 2.5 and 5% fish meal from the two sources (IPC or Omega). From d 0 to 14, ADG improved linearly ($P< 0.05$) with increasing fish meal from either source (see Table below). No differences in performance were observed between the two fish meal sources. During the third week (d 14 to 21), there was no benefit to adding fish meal to the diet. For the overall trial, there were no differences in ADG, ADFI, or gain/feed. The best response to adding fish meal to the diet was obtained for the first 14 d of the test, coinciding with the time when fish meal would be fed in commercial production. These results indicate that IPC 740 and Special Select ^{TM} can be used interchangeably as Menhaden fish meal sources in starter diet formulation.

Fish Meal Source:	IPC			Special Select ^{TM}	
Level, %:	0	2.5	5	2.5	5
ADG, g	193	217	228	203	227
Gain/Feed	0.67	0.67	0.73	0.68	0.70

Key Words: Weanling Pig, Fish Meal

114 Comparison of yellow dent and NutriDense corn hybrids for nursery pig diets. C.W. Hastad*, M.D. Tokach, J.L. Nelssen, R.D. Goodband, S.S. Dritz, and C.M. Peter[1], *Kansas State University, Manhattan Kansas , [1]Exseed Genetics L.L.C. Owensboro, Kentucky.*

A total of 315 nursery pigs (BW = 15.2 kg) were used in a 21-d growth assay to determine the relative energy value of both NutriDense (ND) and NutriDense Low Phytate (NDLP) corn compared to normal yellow dent (YD) corn. The ND is a high-protein, high-oil variety; and NDLP is a high-protein, high-oil, low-phytate variety. Pigs were weighed and allotted to one of nine treatments with five pigs per pen and seven pens per treatment. Dietary treatments were arranged in a 3×3 factorial design, with corn source representing one factor (YD, ND, and NDLP) and supplemental fat level representing the other factor (0, 3, or 6%). No corn source × fat level interactions ($P > 0.10$) were observed for any of the performance criteria. Performance values for YD, ND, and NDLP were 750, 734, and 738 g/d for ADG and 0.645, 0.661, and 0.656 for gain/feed (G/F), respectively. No differences ($P > 0.11$) in ADG were observed among corn sources. Feeding pigs diets containing either ND or NDLP corn, however, reduced ADFI ($P < 0.02$) and improved G/F ($P < 0.05$) compared to those fed YD corn. Increasing dietary fat levels produced linear improvements in both ADG (726, 748, and 748 g/d; $P < 0.04$) and G/F (0.625, 0.656, and 0.681; $P < 0.001$), and reduced ADFI ($P < 0.01$). These data indicate the ME values for ND and NDLP corn are 5 and 3% higher, respectively, than for YD corn. These data are in agreement with the data of Peter et al. (2001; JAS 79: suppl. 2; abstract 236) wherein ND and NDLP corns were reported to contain 6.5 and 4% more ME, respectively, than YD corn, and the ME content of NDLP is 2% lower than that of ND corn. The lack of interaction between corn source and fat level also indicates that higher energy diets can be achieved through the use of ND or NDLP corn and fat to achieve further improvements in feed efficiency.

Key Words: Pigs, Corn Hybrids, Metabolizable Energy

115 Effect of pellet hardness on growth performance of weaned pigs. I. Mavromichalis*[1], D. R. Cook[2], M. M. Ward[2], and N. D. Paton[2], [1]*SCA Nutrition USA, Marion IA,* [2]*Akey, Inc., Lewisburg OH.*

Pellet hardness is closely associated with pellet durability, a desirable trait in nursery diets. Field observations, however, suggest weaned pigs exhibit an aversion to hard pellets by reducing consumption. We conducted two experiments to determine the effects of pellet hardness on growth performance during the postweaning period. In Exp. 1, 440 weaned pigs (5.4 kg; 18 d), in 10 replicates, were used to determine the effects of soft vs hard pellets on growth performance during an 11-d period. Pellet hardness was manipulated by replacing raw starch (soft) with gelatinized starch (hard). Diets were conditioned for 30 s at 59°C before pelleting (2.4 mm). Starch processing did not affect dietary energy use, as evidenced by comparable feed efficiency between treatments. Feed intake (-13%) and weight gain (-11%), however, were markedly reduced ($P < 0.02$) by increased pellet hardness. In Exp. 2, 880 weaned pigs (4.9 kg; 18 d), in 10 replicates, were used to determine the effects of increasing pellet hardness on growth performance during a 14-d period. Pellet hardness was progressively increased by replacing 0, 33, 66, and 100% of the raw starch (25%) in the basal diet with gelatinized starch. Pellet durability index was 67, 93, 92, and 97% for the four experimental diets. Feed manufacturing was as in Exp. 1. In agreement with Exp. 1, feed efficiency was not affected by pellet hardness, indicating that pellet quality and not starch processing was responsible for differences in growth performance. Indeed, feed intake ($P < 0.09$) decreased slightly (218, 214, 209, 197 g/d) in a linear pattern with increasing pellet hardness, whereas numerical differences in weight gain (203, 197, 192, and 181 g/d) were not significant. In conclusion, it appears increasing pellet hardness in diets for young pigs reduces feed intake during the first two weeks postweaning.

Key Words: Nursery Pigs, Pellet Hardness, Pellet Quality

116 Effects of soybean meal particle size on growth perfomance of nursery pigs. K. R. Lawrence, C. W. Hastad, R. D. Goodband, M. D. Tokach, J. L. Nelssen, S. S. Dritz, and M. J. Webster, *Kansas State University, Manhattan, KS.*

The objective of this study was to evaluate the influence of reducing particle size of extruded-expelled soybean meal and solvent extracted soybean meal on growth performance of nursery pigs. A total of 360 pigs were used in two 21-d growth assays with six pigs per pen and ten pens per treatment. Pigs were fed the same SEW diet for 7 d after weaning, followed by a common Phase 2 diet from d 7 to 14. On d 14, all pigs were weighed and allotted to one of three dietary treatments. All diets contained 61.9% corn and 34.4% soybean meal. Diets were formulated to 1.2% total lysine, 0.78% Ca, and 0.40% available P. In Exp. 1, pigs were fed diets containing a single lot of extruded-expelled soybean meal ground to 965, 742, or 639 microns, which resulted in whole diet particle sizes of 728, 719, and 697 microns. In Exp. 2, pigs were fed a diet containing one lot of solvent extracted soybean meal ground to 1226, 797, or 444 microns, which resulted in whole diet particle sizes of 732, 681, and 629 microns, respectively. In Exp. 1, reducing particle size of extruded-expelled soybean meal had no affect ($P>0.18$) on ADG (541, 537, and 540 g/d) and feed efficiency (G:F; .61, .61, .63) for pigs fed diets containing 965, 742, and 639 micron extruded-expelled soybean meal, respectively. In Exp. 2, reducing particle size of solvent extracted soybean meal had no affect ($P>0.61$) on ADG (483, 487, 481g/d) and G:F (0.66, 0.66, 0.65) for pigs fed diets containing 1226, 797, or 444 micron solvent extracted soybean meal, respectively. These results suggest that soybean meal particle size ranging from 1226 to 440 microns does not affect nursery pig growth performance.

Key Words: Pigs, Particle Size, Soybean Meal

117 Impact of stocking density/group size on the response to changes in dietary energy content by weanling pigs from 25 to 53 days of age. C.L. Levesque[1,2], J.F. Patience*[1], E. Beltranena[1], and R.T. Zijlstra[1], [1]*Prairie Swine Centre Inc.,* [2]*University of Saskatchewan, Saskatoon, SK, Canada.*

The primary limitation to growth in the young pig is gut capacity; however, increasing dietary digestible energy (DE) concentration did not previously result in improved pig performance to 56 d of age. The absence of response may have been due to lack of stressors, such as crowding. This experiment evaluated the interaction of dietary DE content and stocking density/group size (i.e. crowding) on weanling pig performance. A total of 600 pigs weaned at 19 d of age were assigned within 3 replicate groups to one of 10 treatments arranged in a 2 X 5 factorial with 2 stocking densities/group sizes (m^2/kg $BW^{.667}$; pigs per pen): LSD (0.0471;16) or HSD (0.0314:24) and 5 dietary DE levels (Mcal/kg): VLOW (3.19); LOW (3.33); MID (3.47); HIGH (3.61) or VHIGH (3.75). Diet DE content was altered by changing the relative concentrations of low (barley) and high (wheat, canola oil) energy ingredients. Pigs received experimental diets in mash form from 25 to 53 d of age. Body weight (BW) and feed disappearance were measured weekly. At 53 d of age, pig BW (20.15 kg 0.06 SEM) was not affected by diet or stocking density ($P>0.08$). ADFI decreased ($P<0.05$) and feed efficiency improved ($P<0.001$) with increasing dietary DE level. Overall, pig ADG did not improve ($P>0.10$) with dietary DE level, regardless of crowding. Daily DE intake was higher in LSD ($P=0.05$) versus HSD. At LSD, daily DE intake was greatest in pigs on the HIGH diet. At HSD, daily DE intake was lowest in pigs on the VLOW diet ($P<0.05$). Pigs on VLOW and HSD were lightest at 53 d of age compared to other treatment groups ($P<0.05$). The weanling pig was able to compensate for reduced dietary DE through increased feed intake; however, when crowded and fed very low dietary DE levels, the young pig's ability to compensate may be exceeded. In conclusion, growth limitations in the weanling pig may not be overcome simply by increasing dietary DE content.

Key Words: Digestible Energy, Pig, Stocking Density

118 Effects of sorting and penning pigs by BW vs. mixing pigs of different BW on post weaning growth performance. D. R. Cook, M. M. Ward, and N. D. Paton*, *Akey Inc. Lewisburg, OH.*

In Exp. 1, 880 pigs (18 d old; 0.25 m^2/pig) were weighed individually and allotted to one of 5 pre-determined weight classes: A (6.97 kg), B

(5.74 kg), C (5.18 kg), D (4.66 kg) and E (3.93 kg). Weight classes were based on historical distribution of pig weights in the facility. Pigs were allotted to one of two treatments: same weight (SW) with 22 pigs of the same weight class in a pen (22-A, 22-B, 22-C, 22-D or 22-E pigs) or mixed weights (MW) with 22 pigs from 5 different weight classes in a pen (4-A, 5-B, 5-C, 4-D and 4-E pigs). In SW pens, groups of 4 to 5 pigs were randomly allotted to arbitrary blocks to create an experimental unit of the same size as those present in MW pens. This allowed testing effect of treatment on BW and ADG coefficient of variation (C.V.). All pens received identical feed budgets. All pigs were individually weighed on d 0 and d 42 post-weaning. Pen weights and feed disappearance were collected on days 7, 14 and 21 post-weaning. There were no differences (P>.10) in ADG, ADFI or G/F for pigs sorted by SW or MW. Initial weight and final weight were different among the 5 weight classes (P<.001 and P<.01, respectively), but sorting method had no effect on BW or ADG C.V. (P>.10). In Exp. 2, two groups of 880 pigs each were visually sorted into 5 weight classes and allotted to treatment as in Exp. 1. Pens in the SW treatment were budget fed according to BW. Pens in the MW treatment all received the average budget of the SW treatment. From d 0 to 45, pigs in the MW group had greater ADG (P<.01) and ADFI (P<0.01) and were 0.53 kg heavier (P<.01) at the end of 45 days versus the SW group. Based on a similar magnitude of BW difference between MW and SW pigs at the conclusion of each Exp., and the statistical significance of this response when 40 replications were used (Exp.2), we conclude that providing some degree of BW variation in pigs post weaning improves growth performance vs. attempting to equalize pig BW within a pen.

Key Words: Pigs, Sorting, Nursery

119 Response of weaned pigs to increasing lysine:digestible energy ratio. T. F. Oresanya*[1,2], J. F. Patience[1], and A. D. Beaulieu[1], [1]*Prairie Swine Centre, Inc., Saskatoon, Canada,* [2]*University of Saskatchewan, Saskatoon, Canada.*

Lean growth potential of young pigs may be limited due to gut capacity for feed intake. Amino acids, therefore, should be defined in relationship to dietary energy content. However, there is no agreement on the correct lysine:DE ratio for high performing pigs. This experiment was conducted to investigate the effect of lysine/digestible energy ratio (g/Mcal) on the performance of weaned pigs. A total of 240 weaned pigs (20 1.4 d; 6.5 0.9 kg) were blocked by weight per day of age within sex and randomly allocated to pens of 4 pigs each (2 barrows and 2 gilts) and to one of 10 dietary treatments in a 2 x 5 factorial arrangement with 3 replicates. Factors were low energy (LE, 3.4 Mcal DE/kg) or high energy (HE, 3.6 Mcal DE/kg) and 5 lysine/DE ratios (3.7, 4.0, 4.3, 4.6, and 4.9 g total lysine/Mcal DE). Digestible energy was increased by increasing the levels of high energy ingredients and supplementing canola oil; and the lysine:DE ratio was increased by varying the levels of high lysine ingredients and supplementing crystalline amino acids. Pigs were fed a commercial starter diet from weaning until 27 d of age when the feeding of the experimental diet was initiated for a 28 d period. Pigs' individual BW and pen feed disappearance were measured weekly. Average daily feed intake (ADFI) was not affected by lysine:DE but was affected by DE such that pigs on LE diets had higher ADFI than HE diets (858 vs. 824 g/d; $P < 0.05$). Conversely, there was no effect of DE on ADG ($P > 0.05$), but ADG was increased by increasing the lysine:DE ratio up to 4.6 g lysine/Mcal (linear, quadratic, $P < 0.10$). Feed efficiency (G:F) was improved with the HE diets (0.626 vs. 0.656; $P < 0.05$). The highest ADG over the 28 d period for pigs growing from 7.5 to 22.5 kg was observed at 4.9 and 4.6 g lysine/Mcal for the LE and HE diets, respectively. This corresponds to 1.66% total lysine for both diets.

Key Words: Piglets, Lysine, Digestible Energy

120 Defining the tolerable level of ergot in weanling pig diets. T. F. Oresanya[1,2], J. F. Patience[1], R. T. Zijlstra[1], D. M. Middleton[2], B. R. Blakley[2], A. D. Beaulieu*[1], and D. A. Gillis[1], [1]*Prairie Swine Centre, Inc., Saskatoon, Canada,* [2]*University of Saskatchewan, Saskatoon, Canada.*

Ergot-alkaloids may cause significant economic losses when ergot-contaminated grains or by-products are fed to pigs. This study investigated the effect of ergot alkaloids on performance and clinical signs of weanling pigs. A total of 192 weanling pigs (20.4 3.4 d; 6.9 1.3 kg) were randomly allotted to pens (2 gilts; 2 barrows) in 2 replicates. Ground wheat ergot sclerotia (1880 mg alkaloid/kg) with ergocristine, ergotamine, ergosine, ergocryptine, and ergocornine constituting 40, 36, 11, 7, and 6%, respectively, were added on a weight basis to a basal diet (3.5 Mcal DE/kg and 1.35% total lysine) at 0.00 (control), 0.05, 0.10, 0.25, 0.50, and 1.00%. Thus, diets contained 0.00, 1.04, 2.07, 5.21, 10.41, and 20.82 mg alkaloid/kg, respectively. Pigs' BW and feed disappearance were measured weekly for 28 d. Nervous signs or cutaneous lesions associated with ergotoxicity were not observed. Average daily gain (ADG) was similar for diets that contained 0.00 to 2.07 mg alkaloid/kg but was depressed at 5.21 mg/kg and above (quadratic; $P < 0.001$). The effects were most pronounced in wk 1 and 2 with pigs fed the 20.82 mg/kg diet gaining 82 and 38% less than control (211 vs. 39 g/d, and 432 vs. 269 g/d, wk 1 and 2, respectively), for a 37%-reduction over the 28 d (472 vs. 298 g/d). Also, ADFI was decreased (quadratic; $P < 0.05$) for the entire period; however, ADFI was unaffected by alkaloids during the first two wk ($P > 0.20$). Gain/feed was decreased by alkaloids (0.572 vs. 0.143, wk 1; 0.607 vs. 0.308, entire period; control vs. 20.82 mg/kg; quadratic $P < 0.05$). Pig BW on d 28 was reduced by alkaloids (20.3 vs. 15.4 kg; control vs. 20.82 mg/kg; quadratic, $P < 0.001$). From these results, the maximum level of alkaloids in weanling pig diets without adverse effects on ADG and feed efficiency was 2.31 mg alkaloid/kg based on the alkaloid content and profile of ergot sclerotia used in this study. This corresponds to 0.12 g ergot sclerotia per 100 g diet.

Key Words: Piglets, Ergot, Performance

121 Tissue, sub-cellular and sub-mitochondrial location of lysine α-ketoglutarate reductase in piglets. N. J. Benevenga*, L. G. Haas, and T.D. Crenshaw, *University of Wisconsin-Madison.*

Earlier work in rats (J. Nutr. 106:1089-1096, 1976) found lysine α-ketoglutarate reductase activity in liver, kidney, pancreas and brain . Our work with rats showed the first two enzymes for lysine degradation (lysine α-ketoglutarate reductase and saccharopine dehydrogenase) were located exclusively in the matrix of liver mitochondria (J. Nutr. 124:1215-1221, 1994). The total organ distribution of mitochondrial lysine oxidation in 2-5 kg piglets, using the liver as a reference base (percent of liver = total organ/total liver x 100 SD, n=2) was liver 100; heart, 29.0 23.3; kidney, 24.3 0.8; small intestine, 17.8 10.3; longissimus dorsi, 3.4 1.9; lung, 3.5 0.7; spleen, 0.2 0.1 and pancreas, 0.1 0.0. When the sub-cellular distribution of lysine oxidation was investigated in nine tissues, the only site of $^{14}CO_2$ production from U-^{14}C-L-lysine was mitochondria. In another study with 4 piglets, the sub-cellular distribution of the first enzyme in the saccharopine dependent pathway of lysine catabolism (lysine α-ketoglutarate reductase) was measured in liver, kidney and heart. In all three tissues, the activity in mitochondria accounted for total tissue activity. The sub-mitochondrial location of an enzyme was identified by comparison to the location of marker enzymes. These enzymes, monoamine oxidase (outer membrane), cytochrome oxidase (inner membrane) and ornithine aminotransferase (matrix) allowed for identification of the sub-mitochondrial location of piglet liver lysine α-ketoglutarate reductase. The distribution of lysine α-ketoglutarate reductase was identical to ornithine aminotransferase indicating it is only located in the matrix of liver mitochondrion, an observation shown previously in rats. The sub-mitochondrial location of lysine α-ketoglutarate reductase suggests a role for transport control of lysine catabolism and may account for the unique nutritional responses, conservation and delayed supplementation, shown in rats fed diets limiting in lysine.

Key Words: Pig, Lysine, Mitochondria

122 Low phytate barley cultivars for growing pigs: Growth performance and bone strength. T. L. Veum*[1], D. W. Bollinger[1], D. R. Ledoux[1], M. S. Carlson[1], and V. Raboy[2], [1]*University of Missouri, Columbia, MO,* [2]*USDA-ARS National Small Grain Germplasm Research Facilty Aberdeen, ID.*

Crossbred barrows (n=45, average 9.5 kg BW) were fed individually to evaluate low phytate mutant barley cultivars compared to the normal Harrington check (HC) barley in a 4-wk experiment with growth performance and bone strength as the criteria. The barley cultivars were analyzed for nutrient content prior to diet formulation. Total P (tP) averaged 0.35% for the barley cultivars. Phytic acid P, as a % of tP, was determined for HC (66.7) and mutant (M) barley cultivars M422 (35.5), M635 (22.9), M955 (14.3), hull-less M422 (HM422, 35.3), and

SBM (61.4). Diets 1 to 4 were barley cultivars HC, M422, M635, and M955 without added inorganic P (iP). Diets 5 to 7 were the HC, M422, and M635 supplemented with iP to equal the calculated available P (aP,.29%) in M955. Diets 8 and 9 were HM422 and HM422+iP. Dried whey, blood cells, SBM and lactose were standardized in all diets. Pigs were killed on d 28 of the experiment, and the right radius (RB) and third metacarpal bones (MB) were removed. ANOVA included linear and quadratic contrasts for Diets 1 to 4 (HC, M422, M635 and M955) plus six other contrasts. There were linear increases (P <.05) in ADG and bone breaking strength (MB and RB) with decreasing concentration of phytic acid in the barley cultivars. There were no growth performance or bone strength differences (P >.5) between M955 and diets 5 to 7 containing iP to equal the aP in M955. The addition of iP to HC, M422 and HM422 increased (P < .05) growth performance and bone strength compared to the same barley cultivar without iP. In conclusion, growth performance criteria and the breaking strength of the metacarpal and radius bones improved as phytic acid concentration in the mutant barley cultivars declined. When iP was added to equalize estimated aP in the diets there were no differences in the criteria measured, indicating that nutritional value was also equalized.

Key Words: Barley, Phytic Acid, Pigs

123 Low phytate barley cultivars for growing pigs: Ca, P, and N utilization. T. L. Veum*[1], D. W. Bollinger[1], D. R. Ledoux[1], M. S. Carlson[1], and V. Raboy[2], [1]*University of Missouri, Columbia, MO,* [2]*USDA-ARS National Small Grain Germplasm Research Facility, Aberdeen, ID.*

Crossbred barrows were fed individually to evaluate low phytate mutant barley cultivars compared to normal Harrington check (HC) barley in a 4-wk experiment (9 treatments with 5 pigs/treatment) with Ca, P, and N utilization and excretion as the criteria (Growth performance and bone strength are reported in a companion abstract). Estimated % available P (aP), calculated by substracting % phytic acid P from % tP, was determined for HC (.12) and mutant (M) barley cultivars M422 (.20), M635 (.27), M955 (.30), hull-less M422 (HM422, .22), and SBM (.27). Diets 1 to 4 were barley cultivars HC, M422, M635, and M955 without added inorganic P (iP). Diets 5 to 7 were HC, M422, and M635 with added iP to equal the aP in M955. Diets 8 and 9 were HM422 and HM422+iP. Chromic oxide was added (.05%) to all diets. Fecal and total urine collections were made from d 22 to 26 of the experiment. ANOVA included linear and quadratic contrasts for Diets 1 to 4 (HC, M422, M635, and M955) plus six other contrasts. There were linear decreases (P<.01) in fecal excretion (g/d) of Ca and P, and linear increases (P<.01) in absorption and retention (g/d and %) of Ca and P with increasing concentrations of aP in the barley cultivars. Fecal excretion (g/d) of Ca and P was lower (P<.01) and absorption and retention (g/d and %) of P was higher (P<.01) for M955 than for the diets containing added iP to provide equal aP concentrations. The addition of iP to HC, M422, M635 and HM422 increased (P<.01) the absorption and retention of P (g/d) compared to the same barley cultivar without iP. Fecal excretion (g/d and %) of N was lower (P<.05) for M955 than for the diets containing added iP to equalize aP concentration. In conclusion, the excretion of Ca and P was reduced and the absorption and retention of Ca and P were increased as the phytic acid concentration in the mutant barley cultivars declined. The addition of iP to barley diets increased P excretion, absorption and retention.

Key Words: Barley, Phytic Acid, Pigs

124 Effects of Fibrozyme and phytase enzymes on growing-finishing pig performance in field pea-canola meal supplemented diets. D.G. Landblom*[1], R.L. Harrold[2], W.W. Poland[1], and K.A. Dawson[3], [1]*NDSU - Dickinson Research Extension Center, Dickinson, ND,* [2]*NDSU - Animal and Range Science Dept., Fargo, ND ,* [3]*Alltech Biotechnology,Inc., Nicholasville, KY.*

Supplemental phytase improves phosphorus availability and subsequent digestibility. Research with ruminants direct-fed protected fibrolytic enzymes has shown improved organic matter digestibility, growth performance in steers and milk production in dairy cattle. Field peas and canola meal have been proven to be complementing sources of protein and energy. The purpose of this study was to determine the potential for improved pig performance resulting from fibrozyme activity when fed with and without phytase enzyme in field pea-canola meal supplemented corn-based growing-finishing diets. Allzyme phytase and fibrozyme were furnished by Alltech Biotechnology, Inc. Ninety (PIC - C22 x 356) barrows and gilts were assigned to dietary treatments: 1) Corn-SBM control, 2) Corn-Pea-Canola meal, 3) Corn-Pea-Canola Meal + fibrozyme, 4) Corn-Pea-Canola Meal + phytase, 5) Corn-Pea-Canola Meal + phytase + fibrozyme. The corn-SBM control diet was pelleted and all other diets were prepared in meal form. Compared to diets prepared in meal form, pigs receiving the pelleted corn-SBM control diet consumed less feed (P= .0001), grew at the fastest rate (P=.001), were more efficient (P= .001), and had heavier hot carcass weight (P=.0001) . Diets with enzymes were formulated to contain 500 U/kg of phytase and 4000 IU/kg of fibrozyme. Correspondingly, in the presence of phytase, dietary available phosphorus requirement was reduced 0.1%. Growth performance and carcass characteristics among pigs receiving the corn-pea-canola control diet and the same diet with added phytase were similar. Fibrozyme addition in conjuction with phytase tended to improve ADG, improved gain to feed efficiency (P= .042), and improved hot carcass weight (P= .046). These data suggest fibrozyme+phytase enzyme addition can reduce supplemental phosphorus requirement, improve performance efficiency, and hot carcass hot weight.

Key Words: Peas and Canola Meal, Phytase, Fibrozyme

125 Efficacy of dietary phosphorus (P) sources for growth based on available P equivalency. T.S. Stahly*, T.R. Lutz, and R.D. Clayton, *Iowa State University, Ames, IA.*

The efficacy of a unit of available P(AP) from 2 sources of P provided at varying degrees of P adequacy and during different stages of pig development was evaluated. A basal, corn-SBM mixture fortified to meet or exceed all nutrient needs (except P) was fed to SEW reared, high lean strain pigs during four stages of growth (9-36, 36-64, 65-92, and 92-119 kg BW). The basal diet contained .16, .128, .102 and .082% available P (AP), respectively, during four stages of growth. In each stage, six incremental additions of AP provided by either mono-dical or a combination of phytase (up to .08% AP) and mono-dical P were added to the basal diet. The incremental additions of AP were .08, .064, .052 and .041% during the four stages of growth. AP concentrations were based on analyzed P content of each ingredient adjusted for NRC (1998) estimates of P bioavailability and the equivalency of .08% AP for 363 FTU of phytase (Natuphos 5000)/kg diet. The dietary Ca:AP ratio was maintained at 2.5, 2.25, 2.0 and 2.0 for the 4 growth stages. Ten individually penned pigs (5 barrows, 5 gilts) were randomly allotted to each dietary treatment. The diet was provided in a meal form. Daily BW gain improved quadratically (P<.01) as dietary AP concentrations increased independent of P source. Daily BW gains (pooled across P source and stage of growth) were 731, 866, 864, 865, 910, and 895 g, respectively, for the six AP concentrations and 857 and 853 g for the two AP sources. BW gain/feed ratios also improved quadratically (P<.01) as dietary AP increased (.390, .429, .434, .426, .434, and .424 kg/kg) independent of P source. Efficiency of feed utilization tended to be improved (P<.15) by the phytase-monodical AP source (.418 vs .426 kg/kg). Based on these data, growth responses of pigs fed equivalent dietary AP concentrations are largely independent of P source, P adequacy and stage of pig growth in animals fed corn-soy diets.

Key Words: Phosphorus, Phytase, Pigs

126 Iron sources and amounts fed to sows during the last trimester of gestation do not enhance the ability of piglets to sequester iron. N. J. Benevenga[1], D. K. Schneider[1], M. E. Glenn[1], T. M. Fakler[2], X. G. Luo[3], and T. D. Crenshaw*[1], [1]*University of Wisconsin, Madison,* [2]*Zinpro Corporation, Eden Prairie, MN,* [3]*Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, P.R. China.*

Earlier observations in day-old pigs revealed that iron-binding capacity was essentially saturated at birth. Increasing the capacity of newborn pigs to sequester free iron should reduce the potential for Fe toxicity. In the current project sows at d 70 of gestation were fed diets with control amounts of Fe (200 mg Fe/kg diet), and either an additional 40 or 80 ppm Fe from iron amino acid complex (Availa®-Fe 60), or 80 ppm Fe from ferrous sulfate. Blood samples were collected on d 0, 10, and 20 from 307 pigs sub-sampled from 37 litters. Pigs were used to assess effects of Fe sources fed to sows on the ability of pigs to sequester Fe during the first three weeks. Pigs from each litter were blocked by weight

into groups of three and given either no Fe injection, or injections of 100 mg Fe from iron dextran on d 10 or d 0. No differences were detected in pig growth, survival, hematocrit, serum iron, total iron binding capacity (TIBC), or percent Fe saturation due to sow gestation diet. Growth over a 20-day lactation period was suppressed in pigs given no Fe injection or an Fe injection on d 10 compared with injections on d 0 (177, 197 and 230 g/d respectively), but pig survival was not compromised (91.4, 91.0, and 92.2%). Pigs given Fe injections on d 0 had higher ($P \leq 0.05$) hematocrit and plasma Fe on d 10 and d 20 than pigs not given Fe injections, but TIBC was not different ($P \geq 0.10$). Hematocrit and plasma Fe values of pigs not given Fe injections until d 10 recovered by d 20 to equal values as those given Fe injections on d 0. In conclusion, the sources nor amounts of supplemental iron fed to sows during the last trimester of gestation altered the piglet's ability to sequester iron injections.

	Hematocrit, %			Plasma Fe, μg/dL			TIBC, μg/dL		
Pig Fe	d 0	d 10	d 20	d 0	d 10	d 20	d 0	d 10	d 20
No Fe	31.7	18.0	14.7	94.0	63.7	54.1	357	707	735
Day 10	31.6	18.9	26.1*	89.3	64.7	72.7	354	701	784
Day 0	31.7	28.9*	25.8*	95.0	107.9*	77.7	352	759	779
SD	5.6	6.5	4.8	45.9	53.1	77.5	153	162	210

* denotes difference ($P \leq 0.05$) within a column from No Fe treatment.

Key Words: Iron, Sow, Hematocrit

127 Assessment of the feeding value of South Dakota grown field peas for growing pigs. H. H. Stein*, R. A. Bohlke, V. Rayadurg, D. Peters, and R. C. Thaler, *South Dakota State University*.

Five experiments were conducted to evaluate the feeding value of South Dakota grown field peas (variety Carnival) for growing pigs. In exp. 1 and in exp. 2, 96 growing crossbred pigs (initial BW: 22.3 ±1.48 kg and 26.7 ±1.18 kg, respectively) were allotted to one of four treatment groups. In exp. 1, diets containing 0, 6, 12, or 18% peas were fed during the initial 6 wk of the experiment while 0, 12, 24, or 36% field peas were included in the finishing diets. In exp. 2, 0, 12, 24, or 36% peas were included in both the grower and the finisher diets. In both exp., ADG, ADFI, and GF were similar ($P > 0.1$) between the four treatment groups. At slaughter, larger ($P < 0.05$) loins were harvested from pigs fed diets containing 12% field peas in the finishing ration (exp. 1) or 12, 24, or 36% field peas (exp. 2). In both exp., the calculated lean meat percentage was similar ($P > 0.10$) between treatment groups. In exp. 3 and 4, field peas were included in phase 2 diets for nursery pigs (initial BW: 7.88 ±0.72 kg and 7.36 ±0.57 kg, respectively) at levels of 0, 6, 12, or 18% (exp. 3) or 0, 12, 24, or 36% (exp. 4). These diets were offered to the pigs during wk 3-5 post-weaning. In both exp., ADG, ADFI, and GF were similar ($P > 0.05$) between treatment groups. In exp. 5, the apparent (AID) and standardized (SID) ileal digestibility coefficients of crude protein and amino acids were determined for field peas and soybean meal in six growing barrows (Initial BW: 36.5 ±2.1 kg). AID for Met, Trp, Cys, and Ser were lower ($P < 0.05$) in field peas than in soybean meal. When calculating SID, only Met was lower ($P < 0.05$) for field peas than for soybean meal. Based on the results of these exp., it is concluded that South Dakota grown field peas provide a highly digestible source of amino acids that can replace soybean meal in diets for pigs. In phase 2 diets for nursery pigs and in diets for growing and finishing pigs, at least 36% field peas can be included without adverse effects on performance or carcass quality.

Key Words: Field Peas, Growing Pigs, Amino Acid Digestibility

128 A comparison of swine performance when fed diets containing Roundup Ready® (event NK603) or conventional corn lines. G. Bressner[1], Y. Hyun*[1], E. Stanisiewski[2], G. Hartnell[2], and M. Ellis[1], [1]*University of Illinois at Urbana-Champaign,* [2]*Monsanto Company, St. Louis*.

The objective of this study was to compare growth performance and carcass characteristics of growing-finishing pigs fed diets containing a Roundup Ready® corn hybrid (event NK603; line A), compared with a parental control line (line B) and two commercial lines of non-genetically modified corn (lines C and D). The study was carried out as a completely randomized design and compared four corn-line dietary treatments. A three-phase dietary program was used. Diets for the growing phase (30 to 50 kg BW) contained 1.02% total lysine; 18.5 % CP, and 3,370 kcal ME/kg. For the early- (50 to 80 kg) and late - (80 to 120 kg) finishing phases diets were formulated to contain 0.78 and 0.67 % lysine, 15.0 and 13.5% CP, and 3,383 and 3,395 kcal ME/kg, respectively. All diets were formulated with a fixed level of corn inclusion which was 65, 74, and 77% for the growing and early- and late-finishing phases, respectively. A total of 160 commercial hybrid pigs (equal numbers of barrows and gilts) were reared from 29.9 ± 3.08 to 119.4 ± 5.96 kg BW in single-sex groups of five pigs and given ad libitum access to feed and water throughout the study. Pigs were raised in a controlled environment finishing facility having part-slatted, part-solid concrete floors and a floor space allowance of 0.89 m^2. At the end of the test period, pigs were slaughtered at a commercial plant and standard carcass measurements were taken. Pigs fed the four corn lines had similar ($P > 0.05$) ADFI (2.45 to 2.54 kg; SEM 0.042), ADG (943 to 986 g; SEM 14.4), and gain:feed ratio (0.37 to 0.39; SEM 0.004). In addition, carcass measures (dressing percentage, carcass length, backfat thickness, and longissimus muscle area) were not different ($P > 0.05$) among corn lines. Subjective scores for longissimus muscle color, firmness, and marbling taken at the 10th rib, were similar ($P > 0.05$) among the corn lines. Gilts compared to barrows had lower ($P < 0.01$) feed intake, growth rate, and backfat thickness but greater gain:feed ratio ($P < 0.01$). The results of this study, carried out with growing-finishing swine, suggest that the Roundup Ready® (event NK603) corn hybrid tested is essentially equivalent in terms of nutrient composition and effects on growth and carcass characteristics to conventional corn hybrids.

Key Words: Roundup Ready® Corn, Growth Performance, Carcass Quality

129 Evaluation of copper chloride and copper sulfate as growth promoters in swine finishing diets. C.W. Hastad*, S.S. Dritz, J.L. Nelssen, M.D. Tokach, and R.D. Goodband, *Kansas State University, Manhattan*.

Two trials were conducted to determine the effects of added copper from copper sulfate or copper chloride on performance of growing-finishing pigs. In Exp 1, 1,100 pigs (initially 33.7 kg) were weighed and randomly allotted to one of five dietary treatments. Diets were fed on a feed budget from d 0 to 115. Within each phase, treatment diets consisted of diets with no added copper (control), 50, 100, or 200 ppm of added copper from copper chloride or 200 ppm of added copper from copper sulfate. In Exp 2, 1,177 pigs (initially 31.2 kg) were weighed and randomly allotted to one of seven dietary treatments in a randomized complete block design with seven pens per treatment. Diets were fed in two phases from d 0 to 27 and d 27 to 56. Treatments consisted of a control diet with no added copper or 50, 100, or 200 ppm of added copper from either copper chloride or copper sulfate. In Exp 1, adding either copper source to the diet reduced ($P<0.02$) ADFI and improved ($P<0.05$) gain/feed (G/F) from d 0 to 31. When copper chloride was added to the diet, the greatest response in ADFI and G/F occurred with the first 50 ppm of copper. Adding copper to the diets also reduced ($P<0.05$) ADFI and improved G/F from d 58 to 86. Overall, pigs fed either copper source had reduced ($P<0.06$) ADFI and improved ($P<0.003$) G/F. Pigs fed copper sulfate had improved ADG ($P<0.003$) and pigs fed copper chloride had a trend ($P<0.07$) for improved ADG compared to pigs fed the control diet. In Exp 2, pigs fed either copper source had greater ADG ($P<0.01$) during the first two weeks of the experiment compared to pigs fed the control diet with no differences observed between copper levels or sources. Adding copper sulfate to the diets reduced ADFI ($P<0.03$) and copper chloride tended ($P<0.07$) to improve G/F for d 0 to 14. From d 14 to 27 and d 27 to 56, ADG, ADFI or G/F were not improved with copper additions to the diet. Adding low levels (50 to 100 ppm) of copper during the first four weeks of the growing-finishing phase provide increase gain and improve feed efficiency.

Key Words: Copper, Pigs

130 Evaluation of ground corn germ as an energy source in nursery pig diets. C.W. Hastad*, M.D. Tokach, J.L. Nelssen, R.D. Goodband, and S.S. Dritz, *Kansas State University, Manhattan*.

Two hundred eighty nursery pigs (initially 14.0 kg) were used in a 21 d growth assay to compare ground corn germ as an energy source relative to corn oil in nursery pig diets. Pigs were blocked by weight and allotted to one of seven treatments. There were five pigs per pen and eight pens per treatment. Treatments included a corn-soybean meal control diet

with no added fat, additional diets included increasing amounts of oil (2, 4, and 6%) provided by either corn oil or corn germ. All diets were formulated to contain 3.82 g lysine/Mcal of ME. In diet formulation, corn germ was assumed to contain 50% of its weight as fat for an energy source. Pigs fed diets containing corn oil had improved (P<0.04) ADG, ADFI, and feed efficiency (G/F) compared to those fed diets containing ground corn germ. For the overall period, a fat source by level interaction was observed for G/F with G/F improved linearly when increasing levels of corn oil were added to the diet, whereas increasing fat from ground corn germ had no affect on performance. Pigs fed diets containing corn oil had decreased (P<0.005) ADFI and improved (P<0.001) G/F compared with pigs fed the control diet, however, ADG was not influenced (P>0.10). Pigs fed diets containing ground corn germ meal had growth performance similar to those fed the control diet with no added fat. These finding suggest that the energy in ground corn germ meal is not as available as the energy in corn oil for nursery pigs. Although corn germ would be expected to have a high energy value because of its fat content, it high fat content appears to be offset by a high fiber content (23.85% ADF and 43.36% NDF).

Fat Source			Corn Oil			Corn Germ	
Level	0	2	4	6	2	4	6
ADG, g	742	758	758	765	745	733	751
ADFI, g	1125	1139	1102	1077	1136	1124	1133
Gain/Feed	0.66	0.67	0.69	0.71	0.66	0.65	0.66

Key Words: Corn Oil, Corn Germ, Pigs

131 Growth performance and carcass characteristics of pigs fed diets containing a corn germ-corn bran product.

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

The objective of this experiment was to determine the feeding value of a corn germ-corn bran mixture. A total of 34 (initial BW = 23.5 kg) barrows were used in a randomized complete block design experiment. Pigs were assigned to corn-soybean meal (C-SBM; n = 11), corn-soybean meal-tallow (C-SBM-T; 4% Tallow; n = 11), or corn-soybean meal-corn germ-corn bran (C-SBM-GB; 8% corn germ-corn bran; n = 12) dietary treatments. Diets were formulated to contain a similar digestible lysine:NE ratio. Pigs were individually fed during the experimental period (93 d) in four phases (Phase 1, 23.5 to 37.5 kg; Phase 2, 37.5 to 59.5 kg; Phase 3, 59.5 to 86.5 kg; Phase 4, 86.5 kg to 112.0 kg). The true ileal digestible lysine:NE ratios (g/Mcal) were 4.40, 3.90, 3.14, and 2.31 for Phases 1 through 4, respectively. Diets were provided in meal form and pigs had ad libitum access to feed and water. For the entire experimental period, pigs fed the C-SBM-T diet had greater ADG than pigs fed the C-SBM-GB ($P \leq 0.05$; 0.98 kg vs 0.92 kg, respectively). No differences ($P \geq 0.26$) among treatments were observed for ADFI. Feed efficiency (ADG/ADFI) was different ($P \leq 0.001$) among treatments and was greatest for pigs fed C-SBM-T (0.43), intermediate for pigs fed C-SBM (0.40), and lowest for pigs fed C-SBM-GB (0.38). Longissimus muscle area of pigs fed C-SBM-T was greater ($P \leq 0.08$) than pigs fed C-SBM-GB. Pigs fed C-SBM tended to have greater ($P \leq 0.10$) backfat depth than pigs fed C-SBM-T (21.2 vs 18.1 mm). Pigs fed C-SBM-T and C-SBM-GB had greater ($P \leq 0.05$) lean percentage than pigs fed C-SBM. Fat-free lean gain was greater ($P \leq 0.05$) in pigs fed C-SBM-T than pigs fed C-SBM or C-SBM-BG (402 g, 369 g, 355 g, respectively). These data suggest that pigs consuming diets containing a corn germ-corn bran product have reduced growth performance compared to pigs consuming C-SBM and C-SBM-T diets. The reduction in performance was likely due to the greater fiber concentration in the C-SBM-GB diets.

Key Words: Corn Germ-Corn Bran, Growth Rate, Pigs

132 Use of poultry byproduct meal as an alternate protein source in swine starter rations.

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A total of 200 crossbred pigs (initial wt = 6.5, kg) were weaned (21 d) and randomly allotted to four treatment groups in two replicates. In each replicate, pigs were placed into 20 pens with five pigs per pen, based on sex, weight, and litter. Treatments were designed to test inclusion of poultry by-product meal (PBM) in place of more commonly used animal protein sources. The phase I diets (1.5% lysine) included a basal diet containing both fish meal (FM, 5%) and spray dried porcine plasma (SDPP, 3%), and three test diets made to substitute SDPP, FM, or both with PBM. Phase II diets (1.375% lysine) included a control diet with 2.5% blood meal (BM) and diets replacing BM, FM, or both with PBM. The phase I pelleted diets were fed for 5 days, the phase II pelleted diets were fed for 14 days, and a common phase III ground diet (1.25% lysine) was fed for 7 days. In phase I, ADG (211 vs. 158 g/d, $P < 0.01$), BW (7.61 vs. 7.34 kg, $P < 0.01$), and intake (205 vs. 175 g/d, $P < 0.001$) in pigs fed diets containing the SDPP were greater than those fed PBM. Average daily gain from d 5 -12 was greater in pigs fed PBM than BM (191 vs. 152 g/d, $P < 0.01$). Thus, differences in ADG for SDPP vs. PBM noted for phase I were negated by the end of the first week on the phase II diets. Overall (d 0-26), there was no difference in performance of pigs fed PBM in place of SDPP and BM. Substitution of PBM for FM in phase I or II had no effect on performance. These results indicate that PBM can be used in nursery diets in place of blood meal and fishmeal without affecting performance, but may not be equivalent to SDPP in phase I diets.

Key Words: Nursery, Pig, Poultry Byproduct Meal

133 Evaluation of pet food by-product as an alternative feedstuff in nursery pig diets.

E.A. Jablonski*, R.D. Jones, and M.J. Azain, *University of Georgia, Athens, GA.*

Early-weaned pigs (n=288, 5.2 kg at 14 days) were used in 2 replicates to evaluate pet food by-product (PFB) in nursery starter diets on growth performance. Pigs were allotted by sex, ancestry, and weaning weight to one of 4 dietary treatments in 32 pens with 8-10 pigs per pen, yielding a total of 8 pens per treatment. Using phase I and phase II diets, PFB (CP=22.1%, EE=8.29%, Ca=0.82%, P=0.84%) was substituted for more expensive animal-origin ingredients (plasma protein, fish meal, blood cells) at 0%, 10%, 30%, and 50% inclusion levels. Experimental diets were formulated to specific lysine requirements (1.50% and 1.35% for phase I and II, respectively) and to maintain relatively constant lysine to energy ratios, although protein increased with higher inclusion levels of PFB. Pigs were creep-fed a commercial pre-starter prior to phase I diets which were fed from days 0-7 post-weaning. Phase II diets were fed from days 14-21. On day 21, pigs were placed on a common phase III diet for 10 days. All experimental diets were fed in meal form. Blood samples were drawn from a total of 96 pigs in both replicates on day 14 and day 28. Serum was assayed for blood urea nitrogen levels to determine protein status. There were no treatment interactions across performance parameters. There was no effect of phase I diets on pig performance. In phase II diets, pigs that were fed PFB diets showed increased daily gain (P<.0001) compared to the control. Average daily gain was 180, 249, 240 and 223 g/d for 0%, 10%, 30%, and 50%, respectively. Feed intake was also significantly increased (P<.0001) during phase II (339, 431, 409, and 410 g/d for 0%, 10%, 30%, and 50%, respectively). There was a trend for improved feed/gain (P<.10) with values of 1.89, 1.74, 1.71, and 1.84 for 0%, 10%, 30%, and 50%, respectively. There was no effect of dietary treatment on blood urea nitrogen levels. It appears that substituting PFB into nursery diets to replace more expensive animal protein products typically used is feasible.

Key Words: Nursery Pigs, By-Products, Growth Performance

134 Efficacy of Luctaplus® in improving performance of conventionally and segregated early-weaned pigs fed simple or complex diets.

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Two experiments were conducted to determine the response of pigs reared in a conventional nursery (C) and segregated early-weaned (SEW) pigs to the addition of Luctaplus® (a combination of inorganic and organic acids, enzymes, and flavor) to diets varying in complexity. In Exp. 1, 216 barrows (5.7 kg BW; 19 d of age) were weaned, transported to off-site nursery facilities, blocked based on initial BW and penned in groups of six (9 pens/treatment). In Exp. 2, 96 pigs (6.7 kg BW; 19 d of age) were weaned in a C, blocked based on BW and sex and penned in groups of two (12 pens/treatment). In each experiment, treatments consisted of a 2 x 2 factorial arrangement of two levels of Luctaplus® (0 and 0.5%) added to either a simple or complex nursery diet. Treatments were fed throughout Phase 1 (10 d; 1.6% Lys), Phase 2 (14 d; 1.4% Lys), and Phase 3 (14 d; 1.25% Lys) of each experiment. In Exp. 1, G:F during Phase 1 improved ($P < 0.05$) when pigs were fed the simple diet with

Luctaplus® compared to those fed the simple diet without Luctaplus®, whereas G:F was similar when the complex diet was fed regardless of Luctaplus® level (interaction, P < 0.05). In the overall experiment (d 0 to 38), G:F improved (P < 0.05) when pigs were fed 0.05% Luctaplus® compared to pigs fed diets devoid of Luctaplus®. In Exp. 2, ADG and G:F improved during Phase 1 and in the overall experiment (d 0 to 38) when pigs were fed the simple diet containing Luctaplus®, but was similar when pigs were fed the complex diet with or without Luctaplus® (interaction, P < 0.05). Luctaplus® addition improved (P < 0.05) ADG during Phase 3 and G:F from d 0 to 38 compared to pigs fed diets devoid of Luctaplus®. The addition of Luctaplus® improved pig performance in SEW pigs fed the simple diet or C pigs fed simple or complex diets, however, the greatest magnitude of response was observed in pigs fed the simple diet in C.

Key Words: Nursery Pigs, Acidification, Enzymes

135 The effect of floor-feeding on post-weaning piglet weight gain.

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Two experiments were done to investigate means of increasing weight gain through floor-feeding of newly-weaned piglets. In both trials, piglets were offered a complex starter diet (3-mm pellet) on a rubber mat (55 cm × 55 cm × 1 cm) positioned in front of a five-hole self-feeder three times daily. The objective of Exp. 1 was to determine the effect of floor-feeding both pre- and post-weaning on piglet growth. One hundred ninety-two piglets (5.2 kg) from 24 litters, were used in a split-plot design with a 2 × 2 factorial arrangement of treatments. Litters of eight suckling pigs were paired and assigned to control or floor-feeding treatments from 18 to 21 d of age. The floor-mat was positioned at the front and to one side of the farrowing crate. After weaning, each litter was split according to body weight into two groups of four, which were allotted to either control or floor-feeding treatments for the first 3-d post-weaning, after which the only source of feed was the feeder. Floor-fed piglets were offered 250 g of diet on the floor-mat three times daily in each phase. Body weights were taken at weaning and at d-7 post-weaning. Floor-feeding in the crate did not affect piglet weight gain from d 18 to 21, although piglets that were floor-fed during lactation tended to have higher weight gains from d 18-28 (240 vs 213 g/d, P < .10). Piglet weight gain was not affected by floor-feeding in the nursery. Exp. 2 was designed to determine the effect of duration of post-weaning floor-feeding on weight gain of piglets. One hundred fifty newly-weaned pigs (6.0 kg) were randomly assigned (10 replicates/treatment and 5 pigs/pen) to one of three floor-feeding durations: zero, three or seven days. Floor-feeding was carried out as in trial 1, with the exception that 500 g of feed was fed at each feeding. Final body weights were measured on d 7. Weight gain of piglets from d 0 to 3 was numerically higher, albeit not significantly, for floor-fed piglets. Feed intake from feeders was reduced (P < .01) in floor-fed piglets. Floor-feeding did not significantly affect weight gain of piglets over the first week post-weaning. In these experiments, floor-feeding did not improve weight gain of piglets immediately post-weaning.

Key Words: Piglets, Floor-Feeding

136 The influence of dietary energy on the response to betaine in finishing pigs.

M. G. Young*, S. S. Dritz, M. D. Tokach, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan*.

A total of 800 pigs (PIC barrows) were used to evaluate the influence of dietary energy on the response to betaine in finishing pig diets. Pigs were housed in a 48-pen curtain-sided, total slatted, commercial research, finishing barn with 0.67 m^2 pig, 25 pigs/pen, and 7 pens/treatment. Treatments were arranged in a 2 × 2 factorial with or without betaine and two energy densities. All diets were corn-soybean meal based with the low energy diet containing no added fat and the high-energy diet containing 5 or 6% added fat depending on the phase. Betaine was included at 0.14% of the diet replacing corn in the treatment diets to provide 1,000 ppm of betaine (FinnFeeds International). Diets were fed in three phases from 23 to 43 kg, 43 to 68 kg and 68 to 95 kg. Each phase was fed for approximately 28 days. No betaine by energy interactions (P > 0.11) were observed. Adding betaine to the diet did not affect (P > 0.05) pig performance. Pigs fed diets without and with betaine had ADG of 0.874 and 0.862 kg/d and gain/feed of 0.44 and 0.43, respectively. From 23 to 43 kg, ADFI decreased (P < 0.01) and feed efficiency improved (P < 0.01) with increasing dietary energy density. From 43 to 68 and 68 to 95 kg, increasing the energy density increased (P < 0.05) ADG, and improved (P < 0.01) feed efficiency. For the overall experiment, pigs fed the high-energy diet had (P < 0.05) higher ADG (0.889 vs 0.847 kg/d), lower ADFI (1.95 vs 2.06 kg/d), and improved G/F (0.46 vs 0.41) compared with pigs fed the low energy diets. Adding fat to the diet from 23 to 95 kg resulted in 5 and 10% improvements in ADG and F/G, respectively. In conclusion, we failed to observe improvements in growth performance when adding betaine to corn-soybean meal or corn-soybean meal added fat diets regardless of dietary energy concentration.

Key Words: Betaine, Energy, Finishing Pigs

137 Influence of dietary supplementation with β-mannanase on performance of finishing pigs in a commercial system.

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Pigs (n = 5,350) from a six barn commercial finishing facility were used to determine the efficacy of supplemental dietary β-mannanase. This source of β-mannanase (Hemicell®) was supplied by ChemGen Corp., Gaithersburg, MD. Pigs (initially 18.8 kg) of Dekalb genetics were balanced for sex, and fed a corn-soybean meal based diet in meal form throughout the 20-wk growing period. β-mannanase was included at the rate of 0.05% in the experimental diets; assays were conducted to verify proper inclusion. Diets were delivered by separate feed lines within each barn, resulting in six replications per treatment. Benefits of feeding β-mannanase were observed in percentage mortality and culls/lightweights. Mortality tended (P = 0.09) to be reduced; the reduction was 23.7%. Similarly, culls and lightweight pigs were reduced (P < 0.001) by 59.6%. Pigs fed β-mannanase had increased ADG (P = 0.04). ADFI was increased by 3.2% (P = 0.004), while G/F was unaffected (P = 0.22) by dietary treatment. Based on the processing data from 3,975 pigs, it appears the additional gain was primarily in the form of fat, as fat depth was increased (P = 0.005) and calculated percentage lean was decreased (P = 0.002) in pigs fed β-mannanase. This may indicate a need to reduce the dietary energy content when feeding β-mannanase. Dressing percentage tended to be increased (P = 0.08) by feeding β-mannanase. Loin depth was unaffected (P = 0.18). As expected, gilts had less fat thickness (P = 0.001) and more loin depth (P = 0.001) than barrows regardless of dietary treatment. Total payment per pig tended (P = 0.11) to be higher for pigs fed β-mannanase. The base pay for carcass weight was higher and the lean premium was slightly lower. These data indicate that supplemental dietary β-mannanase may be beneficial for commercially reared finishing pigs.

Key Words: Pigs, β-mannanase, Growth Performance

138 Bone integrity in response to changes in dietary energy intake.

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One hundred sixty-six growing pigs (83 gilts and 83 barrows) from the Prairie Swine Center in Saskatoon were subjected to five levels of diet restriction (72, 79, 86, 93, or 100% of ad libitum) and slaughtered at five target weights (25, 50, 75, 100, or 120 kg) to validate the accuracy of a growth model in the prediction of swine body composition. Sixteen pigs slaughtered at 25 kg served as a baseline. After slaughter, hind feet were collected and shipped to Wisconsin for assessment of skeletal integrity. Fourth metatarsals were collected from each foot for geometric measures, ash content, subjective assessment of OCD lesions, and mechanical properties determination. A three-point bending test was used to establish the mechanical properties. After the mechanical tests were conducted, a cross section of the mid-diaphysis was cut in order to determine the area moment of inertia. Metatarsal bone length, mid-diaphysis diameter, cortical thickness, ash weight, and percent ash increased as target slaughter weight increased (P < 0.01). Bending moment and stress at both the yield point and the ultimate point increased linearly as target weight increased (P < 0.001). The modulus of elasticity reflected patterns similar to bending moment and stress. There were no differences detected in bone strength due to diet restriction, this may be related to the differences in animal age at slaughter. The older animals (i.e. diet restricted) killed at the same target weight, as ad libitum fed animals, had longer bones and a greater ash content (P < 0.01).

Based on results, the quality of bone produced by rapidly growing pigs was the same as bones from animals that were restricted-fed; however, these results were confounded with animal age.

Key Words: Bone, Diet Restriction, Mechanical Properties

139 Effectiveness of Tylan or a direct fed microbial to reduce pig variation. C.A. Elmore*, G.A. Apgar, and K.E. Griswold, *Southern Illinois University, Carbondale*.

One hundred and eight pigs (crossbred sow x PIC 337) were used to evaluate the effect of an antimicrobial (Tylan) or a direct fed microbial (*B. coagulans*) to pig to pig variation during finishing. Pigs were weighed and allotted to outcome groups based on sex (approximately 4 females and 5 males per pen), weight and genetic background, and were randomly assigned to one of three dietary treatments. Treatments were as follows: 1) control, 2) Control + Tylan (40 g/ton), and 3) Control + *B. coagulans* (9.98 x 10^{11} CFU/ton). Pigs were allowed ad libitum access to feed and water at all times. All pigs were weighed and feed intake and feed efficiency calculated bi-monthly, or intermittently depending upon diet change. Data were analyzed using the GLM procedure of SAS and differences among dietary treatments were analyzed using contrast statements. There were no significant differences between dietary treatments during the first 8 d for weight, ADG or G:F. Coefficients of variation for these criteria also were not altered by dietary treatment. From d 8 to d 19, pigs fed diet 3 tended ($P < .07$) to be heavier, than pigs fed the control treatment,with pigs fed diet 2 falling intermediate. Average daily gain was numerically greater for pigs fed diet 3 as compared with controls. Coefficients of variation tended ($P < .08$) to be lower for ADG during this period for pigs fed treatment 3 when compared with pigs fed the control. Pigs fed treatment 2 were intermediate. Variation in BW for pigs fed the control treatment numerically increased over time, while BW of pigs fed treatments 2 and 3 numerically decreased. Our initial data suggest feeding a direct-fed microbial may reduce variation in growth rate.

Key Words: Finishing, Direct Fed Microbial, Tylan

140 Influence of crystalline or protein-bound lysine on lysine utilization for growth 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 of crystalline lysine relative to the lysine in soybean meal for growth performance and effects on plasma urea concentrations in nursery pigs. Pigs were 23 to 24 d old and had an initial BW of 6 kg. Pigs were blocked by sex and weight (three blocks of barrows and three blocks of gilts) and randomly allotted to one of five dietary treatments. Pigs were individually penned in two nursery facilities and each treatment was replicated six times. 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 soybean meal (SBM) or L-lysine·HCl (CRYST). Average daily gain and ADFI were measured weekly. Blood samples were collected on the last day of the experiment and plasma was analyzed for urea concentration. Data were analyzed as a randomized complete block design with repeated measurements in time. Feed efficiency (ADG/ADFI) was similar ($P > 0.1$) among treatments. By the 4^{th} wk, ADG was greater ($P < 0.05$) for pigs fed the diet supplemented with 1.15% lysine from SBM in comparison with pigs fed the diet supplemented with 1.25% lysine from CRYST. In addition, ADFI was greater ($P < 0.1$) for pigs fed the 1.25% lysine supplemented from SBM vs CRYST (1.20 vs 1.06 kg). Pigs fed diets supplemented with SBM had greater ($P < 0.001$) plasma urea concentrations than pigs supplemented with CRYST. Although preliminary data (not shown) and lysine requirements derived from NRC (1998) support that the aforementioned lysine concentrations were within the deficient range for nursery pigs (5 to 10 kg), data from this experiment do not indicate that lysine intake was limiting growth. Therefore, conclusions regarding the efficiency of lysine utilization for growth from L-lysine·HCl and soybean meal can not be made.

Key Words: Pigs, Lysine, Growth

141 Evaluation of the lysine requirement for 11 to 25 kg barrows. D. C. Kendall*[1], G. Yi[1], A. M. Gaines[1], G. L. Allee[1], J. L. Usry[2], M. Steidinger, and W. Cast, [1]*University of Missouri-Columbia,* [2]*Ajinimoto Heartland Inc.*

A 21d experiment was conducted to determine the lysine requirement for 11 to 25 kg barrows (n=252, Dalland x PIC C-22). Pigs were allotted in a randomized complete block design and were fed one of 7 dietary treatments with 9 replicates/treatment and housed at 4 pigs/pen. Dietary true ileal digestible (TID) lysine levels were 1.05, 1.13, 1.19, 1.26, 1.33, and 1.40% TID lys with all diets containing the same inclusion of soybean meal (33.1%). Dietary lysine content was increased by adding Lys-HCl (0, .09, .178, .267, .356 and .445%, respectively). A positive control diet was formulated at 1.40% TID lys, containing .15% added Lys-HCl and 42.0% soybean meal. All diets were formulated to be equal on a ME basis (3.42 Mcal ME/kg) with additional synthetic amino acids supplied as necessary to meet minimum amino acid ratio requirements. Pigs were weighed weekly to determine average daily gain, average daily feed intake and feed efficiency. During d 0-7, there was a linear improvement in ADG and G:F ($P< .05$) with increasing TID lysine level, up to 1.33%. During d 7-14, there was a linear improvement in G:F ($P< .05$) with a plateau occurring at 1.33% TID lys. From d 14-21, a linear trend ($P< .10$) existed for ADG and G:F with improvements up to 1.19% TID lys. For the overall period, ADG and G:F were linearly improved ($P< .05$) with increasing lysine levels, up to 1.33% TID lys. The 1.40% TID lys diet did not differ from the positive control diet in any criteria measured. This experiment demonstrates that the lysine requirement for pigs from 11 to 25 kg BW may be as high as 1.33% TID lys and the inclusion Lys-HCl up to .445% does not affect performance of nursery pigs.

Key Words: Pigs, Lysine, Nursery

142 Effects of plasma grade, irradiation or formaldehyde treatment of plasma, or whole diet irradiation on growth performance of weaned pigs. D. R. Cook*, M. M. Ward, and N. D. Paton, *Akey Inc. Lewisburg, OH*.

Two experiments were conducted to determine the impact of reducing colony-forming units (CFU) in plasma or whole diet on weaned pig growth performance. In Exp. 1 (1760 18-d old pigs, 5.4 kg, 22 pigs/pen, 0.25 m^2/pig), two sources of plasma (human grade, HGP; and technical grade, TGP), and three processes (non-processed, NP; irradiated, IR; or Termin-8, T8) were tested in a 2 x 3 factorial arrangement of treatments. Plasma sources were added to diets on an equal protein basis at approximately 5% and 2% of the diet from 0-7 and 8-14 d post weaning, respectively. Irradiation for IR treatment was 5-20 kGy. T8 (a formaldehyde product) was atomized and added directly to the plasma at 0.3% for the T8 treatment. Pigs were blocked based on BW and sex and pens were allotted to treatment within block. TGP and HGP had pre-IR total CFU/g of 21,700 and 375, respectively. IR reduced CFU/g to 135 and 60 for TGP and HGP, respectively. Pigs fed TGP plasma tended to have greater ADG ($P<.10$) and ADFI ($P<.08$) versus pigs fed HGP. There were no significant performance differences ($P>.10$) among NP, IR or T8-fed pigs during the 14 d feeding period. No interactions were observed between plasma source and processing method. In Exp. 2, 880 pigs were reared under the same conditions as in Exp. 1. Pigs were fed NP or IR diets for 22 d followed by a common NP diet. Irradiating whole diet reduced CFU/g but also decreased growth performance d 0 to 5 post-weaning (ADG 159 vs. 174 g; $P<.10$) and feed intake (149 vs. 165 g/d; $P<.06$). Similar results were observed d 15 to 23 post-weaning for ADG (365 vs. 379 g; $P<.08$) and G/F (0.73 vs. 0.76; $P<.001$). For the 45-d trial, IR did not alter growth performance. In conclusion, irradiation of plasma was an effective tool in reducing microbial contamination but did not improve growth performance in these experiments. Whole diet IR appears to have a negative impact on early nursery growth performance.

Key Words: Pigs, Irradiate, Termin-8

143 Effects of ingredient and whole diet irradiation on nursery pig performance. J.M. DeRouchey*, M.D. Tokach, J.L. Nelssen, R.D. Goodband, S.S. Dritz, J.C. Woodworth, M.J. Webster, and B.W. James, *Kansas State University, Manhattan*.

A total of 880 pigs (15 ± 2 d of age) were used in two experiments to determine the effects of irradiation of individual ingredients or whole diet

on growth performance of nursery pigs. Pigs had an initial BW of 4.9 kg in Exp. 1 and 5.1 kg in Exp. 2. There were eight pigs/pen in both experiments with five pens/treatment in Exp. 1 and six pens/treatment in Exp 2. Pigs were blocked by weight and allotted to one of ten dietary treatments. Both experiments contained similar treatments that first included a control diet that contained ingredients that were not irradiated. Other treatments included diets that had specific ingredients irradiated:corn, soybean meal, spray-dried whey, spray-dried animal plasma, fishmeal, soybean oil, or all microingredients combined (antibiotic, vitamins, minerals, crystalline amino acids). The final two treatments included a diet that contained all ingredients that had been irradiated and a diet that was manufactured with nonirradiated ingredients and subsequently irradiated. An average irradiation dose of 8.5 kGy was used. No experiment × treatment interactions were observed. Overall (d 0 to 14 in trial 1 and d 0 to 12 in trial 2), pigs fed diets containing irradiated spray-dried animal plasma or soybean meal had increased ($P < 0.05$) ADG compared to the control diet with no irradiated ingredients and the complete diet that was irradiated. Also, ADFI ($P < 0.05$) was greater for pigs consuming the diet with irradiated soybean meal compared to those fed the irradiated whole diet. Finally, pigs fed irradiated spray-dried animal plasma had improved gain/feed ($P < 0.05$) compared to those fed diets containing irradiated microingredients or if all ingredients had been irradiated before manufacturing. In summary, irradiation of certain feed ingredients (spray-dried animal plasma or soybean meal in these experiments) can improve growth performance in nursery pigs, whereas irradiation of all ingredients or the whole diet does not enhance performance.

Key Words: Nursery Pig, Feed Ingredients, Irradiation

144 Comparison of irradiated feed and food grade spray-dried animal plasma on nursery pig performance. J.M. DeRouchey*, M.D. Tokach, J.L. Nelssen, R.D. Goodband, S.S. Dritz, J.C. Woodworth, and C.W. Hastad, *Kansas State University, Manhattan*.

A total of 535 weanling pigs (17 ± 2 d of age) were used (initial BW of 6.3 kg in Exp. 1 and 6.1 kg in Exp. 2) to determine the effects of initial bacterial concentrations of spray-dried animal plasma on growth performance. Previous research indicates that pigs fed irradiated feed-grade animal plasma (initially high bacteria) have improved growth performance compared to those fed non-irradiated feed-grade animal plasma. Therefore, we hypothesized that irradiation of food grade plasma (initially low bacteria) may lead to a lower growth performance response. All pigs were blocked by weight with five pigs per pen and six and seven pens/treatment in Exp. 1 and 2, respectively. In Exp. 1, pigs were allotted to one of nine treatments including a control diet or the control with 5% plasma from one of four different sources either fed irradiated or as-is. Plasma sources were from American Protein Corporation, Ames, IA (feed grade, AP 920 and AP 820; and food grade, source 1 and 2). In Exp. 2, five diets were used from Exp. 1, which included the control, and plasma sources, AP 820 and food grade, fed irradiated or as-is. Pigs fed animal plasma had increased ADG (Exp. 1 & 2), ADFI (Exp. 1) and G:F (Exp. 2; $P < 0.05$) compared to pigs fed the control diet. In Exp. 1, pigs fed irradiated AP 920 feed grade plasma had increased ADG ($P < 0.05$) compared to those fed the control diet. Also, pigs fed irradiated AP 920, regular AP 820, regular and irradiated source 1 food grade and regular source 2 food grade had improved ADFI compared to pigs fed the control diet. In Exp. 2, pigs fed irradiated AP 820 had increased ADG ($P < 0.05$) compared to those fed the control diet and pigs fed regular AP 820. Irradiation of food grade plasma did not influence ($P > 0.12$) pig performance in either experiment. These studies indicate that reducing initial bacterial levels in animal plasma leads to increased growth of nursery pigs, and may explain the variation in response when animal plasma is included in diets for nursery pigs.

Key Words: Nursery Pig, Animal Plasma, Irradiation

145 The effect of varying levels of spray-dried animal plasma in nursery pig diets. C. S. Stovall*, G. A. Apgar, and K. E. Griswold, *Southern Illinois University, Carbondale*.

A total of 193 crossbred weanling pigs (avg 24 ± 0.5 d and 6.5 ± 1.5 kg in Trial 1, and 19 ± 0.7 d and 5.6 ± 0.9 kg in Trial 2) were used in two trials to determine the effect of adding varying levels of spray-dried animal plasma (SDAP) to phase one nursery diets. Pigs were blocked by initial weight, sex and litter, and were randomly assigned to one of four treatment diets. Pigs were housed in an environmentally controlled modular nursery with 12 pens and an average of 12 pigs per pen (Trial 1) and 7 pigs per pen (Trial 2). Pigs were allowed ad-libitum access to feed and water for the duration of each trial. All diets met or exceeded current nutrient requirement estimates (NRC, 1998). Lysine levels were equalized across dietary treatments by substitution with blood meal. Choice white grease was added when needed to make the diets isocaloric. The dietary treatments were as follows: 1) 0% SDAP (control), 2) 3% SDAP, 3) 6% SDAP, 4) 9% SDAP. Pigs were weighed, feed intake and feed efficiency calculated weekly. The treatment diets were fed from d 0-14 post-weaning after which a common corn-soybean meal diet was fed to all pigs d 14-35 post-weaning. Data from the two trials were analyzed using the GLM procedure of SAS and orthogonal contrasts were used to estimate linear, quadratic and cubic treatment effects and individual means were separated by the LSD procedure. In Trial 1, there were no significant effects of SDAP addition on ADG or ADFI. Feed efficiency was affected in a quadratic manner ($P < .05$) during wk 3, 5 and 3 through 5 with pigs fed 0 and 9% SDAP having numerically similar G:F and pigs fed 3% and 6% SDAP having numerically lower efficiencies. In Trial 2, ADG and ADFI were improved linearly ($P < .05$) during wk 1, and ADFI was improved linearly ($P < .05$) during wk 4. Efficiency of gain was improved in a linear manner ($P < .05$) during wk 1, 1 through 2 and 1 through 5. These data suggest that SDAP addition improves performance of pigs weaned at 19 days of age as compared with pigs weaned at 24 days of age.

Key Words: Spray-Dried Animal Plasma, Weanling Pig, Performance

146 A comparison of roller-dried whey and spray-dried whey in swine starter diets. G. F. Yi*[1], G. L. Allee[1], A. M. Gaines[1], D. C. Kendall[1], K. M. Halpin[2], and M. Trotter[2], [1]*University of Missouri-Columbia,* [2]*International Ingredient Corporation, Inc.*

A total of 200 weaned barrows and gilts (5.360.3kg, 100 each) at 19 2 days of age were used to compare the effects of roller-dried whey (RDW) and extra grade spray-dried whey (SDW) on the growth performance of young pigs. The pigs were randomly allotted by initial BW and sex to five dietary treatments in a RCBD, with ten replicate pens per trt and four pigs per pen. During day 0 14, 14 28 and 28 42, the pigs were fed Phase I, Phase II and Phase III diets respectively. During Phase I, a corn-soy diet without any whey product served as a control (Trt A). Treatments B to E contained 10%SDW, 10%RDW, or 20%SDW or 20%RDW respectively. In Phase II treatments B to E contained 5%SDW, 5%RDW, or 10%SDW or 10%RDW respectively with a corn-soy diet without any whey as the control (Trt A). In Phase III, all the pigs were fed the common diet. Pigs were weighed and feed intake recorded on d 7, 14, 28, and 42. BW, ADG, ADFI and G:F were used to evaluate growth performance. In the first week, ADFI and ADG were increased by whey addition, with the 20% whey diets, resulting in a greater response than that of 10% whey ($P<0.05$). There were no differences due to whey source (RDW vs. SDW) ($P>0.05$). During Phase I, compared to the control, the ADFI was linearly increased with the increasing level of either RDW or SDW ($P<0.05$). In Phase II, there were no differences in growth performance ($P>0.05$). However, in Phase III, pigs fed 10% or 20% whey in Phase I tended to gain faster ($P<0.10$) with an improved feed efficiency ($P<0.05$) compared to the pigs fed the control diet. Overall, pigs fed 20% whey in Phase I diets were approximately 1.0 kg heavier after the 42 d nursery period compared to the pigs fed the control diet. These results indicate that both RDW and extra grade SDW improved the growth performance of weaned pig with no differences between whey processing methods.

Key Words: Weaned pigs, Whey, Starter diets

147 Non-pasturized, spray-dried egg treated with Termin-8 as a protein source for phase 1 nursery diets. M.E. Davis*[1], C.V. Maxwell[1], Z.B. Johnson[1], D.C. Brown[1], S. Singh[1], K.J. Touchette[2], and J.A. Coalson[2], [1]*University of Arkansas, Fayetteville,* [2]*Merrick's Inc., Union Center, WI.*

A conventional nursery trial with 144 crossbred weanling pigs was conducted to determine the efficacy of non-pasteurized, spray-dried egg product (EGG) with and without treatment with Termin-8 (a formaldehyde-based antimicrobial preservative; T-8) to replace spray-dried plasma (SDP) in the Phase 1 (d 0 to 14) nursery diet. Pigs (21 ± 1 d of age; 6.6 kg BW) were assigned by initial weight and sex to 1

of 8 treatments in a randomized complete block designed experiment. There were 6 blocks with 3 pigs/pen and 6 pens/treatment. Eight diets were fed during phase 1: 1) a negative control diet devoid of egg product and SDP, 2) a positive control diet containing 5% SDP added at the expense of soybean meal, 3, 4, 5) as 2 with EGG treated with T-8 replacing 25, 50 or 75% of the SDP, 6, 7, 8) as 2 with EGG not treated with T-8 replacing 25, 50 or 75% of the SDP. All diets were formulated on an equal lysine basis (1.5% lysine). Upon completion of the Phase 1 diet, a common Phase 2 diet (1.35% lysine) was fed from d 14 to 28 postweaning. Treatment means and interactions ($P < 0.05$) are presented. Pigs fed the negative control diet in Phase 1 had a reduced ADG compared to those fed all EGG treatments (115 vs. 153 g/d, $P < 0.03$). During Phase 2, pigs previously fed the positive control diet had reduced G:F when compared to those previously fed EGG (0.747 vs. 0.780, $P < 0.02$). These results indicate that ADG is enhanced in Phase 1 nursery diets with low inclusion levels of EGG and that the efficacy of EGG is enhanced with T-8 treatment.

Item	Neg. Cont.	Pos. Cont.	EGG 25%	with 50%	T-8 75%	EGG 25%	W/O 50%	T-8 75%	SEM
ADG, g									
Phase 1[ab]	115	185	194	149	158	148	116	155	15
Phase 2	592	590	569	561	556	566	563	565	28
G:F									
Phase 1[a]	0.56	0.75	0.73	0.64	0.66	0.59	0.56	0.59	0.04
Phase 2[a]	0.84	0.75	0.76	0.78	0.78	0.78	0.89	0.77	0.01

[a]Neg. control vs Pos. control ($P < 0.01$). [b]Egg source x level effect ($P < 0.02$).

Key Words: Egg Product, Diet, Nursery Pigs

148 Effects of mannanoligosaccharides in diets for nursery pigs.

J. D. Hancock*, C. L. Jones, and C. W. Starkey, *Kansas State University*.

A total of 168 weanling pigs (average initial BW of 6.0 kg) were used in a 35-d experiment to determine the effects of mannanoligosaccharides on growth performance of nursery pigs. The diets were corn-soy-based and formulated to 1.8% lysine for d 0 to 7, 1.6% lysine for d 7 to 21, and 1.4% lysine for d 21 to 35. Treatments were: 1) a positive control with carbadox (55 g/ton of diet); 2) a negative control without antibiotic; 3) the negative control with mannanoligosaccharides from dried saccharomyces cerevisiae fermentation solubles (Bio-Mos); and 4) the negative control diet with mannanoligosaccharides from the cell walls of yeast (Safmannan). For d 0 to 7 and 7 to 21, the diets were pelleted and for d 21 to 35, the diets were fed in meal form. As for growth performance, ADG and gain/feed were not different ($P > 0.36$) for pigs fed the diet with antibiotic vs the other treatments for d 0 to 7. However, this lack of difference was the result of good growth performance among pigs fed the diets with mannanoligosaccharides vs the negative control (i.e., $P < 0.07$ for ADG and $P < 0.02$ for gain/feed). Overall (d 0 to 35), ADG was greater ($P < 0.02$) for pigs fed diets with antibiotic vs the other treatments and for pigs fed diets with mannanoligosaccharides vs the negative control ($P < 0.04$). Pigs fed diets with mannanoligosaccharides had greater gain/feed than pigs fed the negative control ($P < 0.002$), but there were no differences in ADG, ADFI, or gain/feed among pigs fed diets with the two different sources of mannanoligosaccharides ($P > 0.49$). Analyses of fecal samples collected on d 38 and 39 indicated no effect of any treatment on colony forming units of total coliform or ecoli ($P > 0.54$). In conclusion, mannanoligosaccharides had a positive effect on growth performance of weanling pigs. Those effects were not associated with changes in coliform concentrations in the feces and apparently were caused by other physiological effects.

						Contrast		
Item	Anti	None	B-Mos	Saf	Se	Anti vs others	None vs mann	B-Mos vs Saf
d 0 to 35								
ADG, g	460	397	426	425	10	0.002	0.04	-
ADFI, g	606	562	562	557	15	0.02	-	-
Gain/feed, g/kg	759	706	758	763	8	0.11	0.001	-

Key Words: Pig, Mannanoligosaccharide, Growth

149 Effect of dietary mannanoligosaccharide (MOS) and sodium chlorate (CHL) on growth performance of 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*.

Concern about the use of antimicrobials in livestock feed has lead to a search for alternatives. Our study was conducted to evaluate two additives, MOS and CHL, as alternative growth promotants in weaned pigs undergoing ST disease challenge. Weaned pigs (n=96; 6.8±1.3 kg initial weight) were blocked by weight and assigned to four treatments. The negative control diet contained no additive (CON), while the positive control contained carbadox (CARB; 55 ppm). Test diets contained MOS (1500 ppm) or CHL (800 ppm). There were 12 pens/treatment with 2 pigs/pen. Pigs were fed diets for 2 wk. Then, all pigs were given ST orally, and the study continued for an additional 2 wk. Body weights and feed intake were measured weekly to calculate average daily gain (ADG), feed intake (ADFI) and feed efficiency (G/F). ADG was greater in pigs fed CARB during wk 1 and 2 compared to MOS- and CHL- treated pigs ($P<.05$), and was greater than CON pigs during wk 2 ($P<.05$). During wk 3 (ST challenge week), ADG did not differ between CON (.15±.04 kg/d), MOS (.22±.04 kg/d) and CHL (.24±.04 kg/d), but all were less ($P<.05$) than CARB (.37±.04 kg/d). This advantage in ADG continued for the CARB treatment into the final week of the study ($P<.05$). ADFI was lower in pigs fed MOS ($P<.06$) and CHL ($P<.05$) in wk 1 and also during wk 2 ($P<.05$) compared to CARB. Following ST challenge, CARB-fed pigs maintained an advantage in ADFI over the other treatments in wk 3 and 4 ($P<.01$). In wk 1, G/F was greater ($P<.05$) for CARB-fed pigs (.61±.04) than for CON (.49±.04), MOS (.49±.04) and CHL (.42±.04) treatments. During wk 3, immediately following ST, both CARB and CHL treatments had greater G/F than CON ($P<.05$), and pigs fed MOS tended to have greater G/F compared to CON ($P<.08$). We conclude that feeding MOS and CHL prior to ST may support improved gut function immediately following treatment as evidenced by improved G/F. However, neither additive enhanced growth relative to the complete absence of dietary antimicrobials, and neither was as effective as CARB in the weeks following ST.

Key Words: Carbadox, Sodium Chlorate, Mannanoligosaccharide

150 Supplemental B-vitamins in pig nursery diets.

T. Cline*, S. Carter, G. Hill, S. Kim, A. Lewis, D. Mahan, H. Stein, and T. Veum, *NCR-42 Swine Nutrition Committee*.

Eight universities participated in a regional study to determine the efficacy of supplemental B-vitamins (BV) in starter diets. The basal phase 1 diet (fed for two weeks) contained corn, soybean meal, dried plasma, dried whey and lactose and was formulated to contain 1.5% lysine. The phase 2 diet (fed for three weeks) contained corn, soybean meal, dried blood cells and dried whey and was formulated to contain 1.3% lysine. A mixture of eight BV (niacin, riboflavin, pantothenic acid, B_{12}, thiamin, biotin, folic acid and B_6) was supplemented at levels of 0 (negative control), NRC suggested requirements for the 5 kg pig (X), 2X and 4X. A total of 760 pigs in 35 replications at the eight stations were fed their diets ad libitum in meal form. ADG, ADFI and G/F calculations were made for phase 1, phase 2 and for the overall period. There was a significant station effect ($P < 0.01$) for all measurements, but the station x treatment interaction was not different for any criterion at any time period. ADG was not different among treatments during phase 1, but a quadratic effect ($P < 0.01$) was observed during phase 2. Phase 1 and 2 means were 236, 250, 240 and 246 g/d and 478, 536, 534 and 525 g/d for the 0, X, 2X and 4X levels of BV, respectively. The quadratic effect was also significant ($P < 0.01$) for the combined periods (381, 421, 417 and 413 g/d, respectively). Treatment had a minimal effect on feed intake with an unexplained cubic effect during phase 1 ($P < 0.01$) but no statistical effect during phase 2 or overall. As with the gain data, G/F was not different in phase 1, but a quadratic ($P < 0.01$) effect occurred in phase 2. Phase 1 and 2 G/F means were 768, 741, 754 and 765 g/kg and 575, 626, 626 and 612 g/kg for the 0, X, 2X and 4X levels, respectively. The combined data were also different (quadratic, $P < 0.02$; 611, 647, 649, and 640 g/kg). We conclude that the NRC suggested requirement level of B-vitamins supplemented to nursery diets is adequate to maximize growth performance.

Key Words: Nursery, B-Vitamins, Pigs

151 Response of weanling pigs to niacin and vitamin B_{12} supplementation. S.S. Blodgett*, P.S. Miller, A.J. Lewis, and R.L. Fischer, *University of Nebraska, Lincoln*.

A 35-d experiment was conducted to assess the response of weanling pigs (n = 96) to supplemental niacin and vitamin B_{12}. The purpose was to determine whether the niacin and vitamin B_{12} requirements of nursery pigs are greater than the NRC (1998) recommendations for 5- to 10-kg pigs. Pigs (initial BW = 4.3 kg) were assigned to a 2 × 2 factorial arrangement of four diets: 1) no added niacin or vitamin B_{12}; 2) 50 mg/kg added niacin; 3) 80 μg/kg added vitamin B_{12}; and 4) 50 mg/kg added niacin and 80 μg/kg added vitamin B_{12}. Pigs were housed in an environmentally controlled room (mean temperature = 25.5°C). Each pen contained three barrows and three gilts. The four treatments were replicated four times. Diets were in meal form and pigs had ad libitum access to feed and water throughout the experiment. Pigs were weighed weekly to determine ADG, ADFI, and ADG/ADFI. Pigs were visually scored to assess any niacin and vitamin B_{12} deficiencies on d 14, 21, 28, and 35. No niacin × vitamin B_{12} interactions were observed. During Phase I (d 0 to 14), supplemental niacin increased ADFI ($P < 0.01$); negative control = 307 g vs niacin = 329 g). During Phase II (d 15 to 35), supplemental vitamin B_{12} increased ADG ($P < 0.001$; negative control = 441 g vs B_{12} = 539 g) and ADFI ($P < 0.01$; negative control = 679 g vs B_{12} = 818 g). For the entire 35-d period, supplemental vitamin B_{12} increased ADG ($P < 0.001$; negative control = 348 g vs B_{12} = 409 g), ADFI ($P < 0.01$; negative control = 525 g vs B_{12} = 606 g), and ADG/ADFI ($P < 0.05$; negative control = 662 g vs B_{12} = 675 g). There were no differences ($P > 0.1$) in vitamin deficiency symptoms among groups. Based on these results, supplemental niacin did not have an effect on growth performance, however vitamin B_{12} supplementation increased growth performance of 5- to 10- kg pigs.

Key Words: Pigs, Nursery, Vitamin B Complex

152 Evaluating the antioxidant status of the weaned pig from supplemental vitamin C and vitamin E. S. Ching and D.C. Mahan*, *The Ohio State University*.

Postweaning declines in serum α-tocopherol and Se, and their apparent inadequacy have been associated with the sudden deaths of pigs within a few weeks postweaning. Because ascorbic acid regenerates oxidized α-tocopherol and ascorbic acid synthesis increases during the early postweaning period, the antioxidant status of the pig may be compromised and be a contributing factor to the sudden death problem. A 2 x 2 x 2 factorial experiment, in a RCB design, conducted in 8 replicates evaluated the role of dietary vitamin E (0 vs 60 IU/kg), vitamin C (0 vs 1000 ppm) with fat (0 vs 5%) added to exacerbate the antioxidant problem in the weaned pig. A total of 232 crossbred pigs weaned at 19 d, weighing 6.7 kg BW were fed typical nursery diets for each of the 0-10 d, 10-24 d, and 24-38 d periods with the above nutrients added at the treatment levels indicated. Pigs on 4 replicates were bled at the end of each period with α-tocopherol, ascorbic acid, and triglyceride concentrations measured. During the 0-10 d period, ascorbic acid addition increased daily gains (152 vs 173 g/d; $P < 0.01$), vitamin E tended to increase gains (156 vs 170 g/d; $P < .10$), but there was no effect of dietary fat on daily gains. Gain:feed ratio was greater with added ascorbic acid ($P < 0.01$), vitamin E ($P < 0.05$), and fat ($P < 0.05$) during the Phase 1 period. During the Phase 2 and 3 periods there was no effect of ascorbic acid or vitamin E on pig performances, nor was there any interaction response. The addition of fat resulted in increased gain ($P < 0.10$), lowered feed intake ($P < 0.05$), improved gain:feed ratio ($P < 0.01$), and higher blood triglycerides ($P < 0.01$) for the last 2 periods. Serum ascorbate and α-tocopherol increased as the dietary levels of each increased ($P < 0.01$), but serum α-tocopherol tended to be higher ($P < 0.10$) only at 38 d postweaning when 1000 ppm ascorbic acid was fed. These results suggest that dietary vitamin C and vitamin E improved postweaning pig gain responses the initial 10 d postweaning, but there was no effect on serum α-tocopherol concentrations.

Key Words: Ascorbic Acid, α-Tocopherol, Pig

153 Evaluating the influence of B vitamin supplementation on growth and carcass composition of growing and finishing swine. B.V. Lawrence*[1], J.D. Hedges[1], J.D. Hahn[1], M.B. Coelho[2], B.W. Cousins[2], and S. Haye[2], [1]*Hubbard Feeds, Inc.*, [2]*BASF Corporation*.

An experiment was conducted with growing and finishing pigs (n=896; initial BW = 14.5 kg) to determine the effect of B vitamin (riboflavin, pantothenic acid, niacin, folic acid and B12) fortification levels (NRC, 4X, 8X or 16X NRC) and gender (barrow or gilt) on growth and carcass composition. A commercial wean-finish facility was used. Pigs were housed in groups of 28 pigs/pen (4 pens/treatment/sex). At trial initiation, pigs were 47 days of age and had been fed a commercial nursery feed for 27 days. Experimental diets were corn-soybean meal based and did not contain supplemental fat. A six-phase feeding program was utilized and diets were fed ad libitum in meal form. Pen growth rate (834 vs. 789 g/day) was higher ($P<.05$) for the pigs fed the 8X NRC that resulted in an additional 5.4 kg of gain compared to pigs fed NRC B vitamin supplementation level. A sex X treatment interaction ($P<.05$) was detected with gilts demonstrating a more consistent weight gain response to B vitamin supplementation at day 109. Increasing B vitamin supplementation tended to increase ($P<.10$) empty body protein and fat-free total lean, which was greater for gilts than barrows. The potential gross income increase from feeding 8X NRC B vitamin fortification was $2.00/pig in this study with a potentially greater advantage obtained by gilts over barrows. These results suggest that the B vitamin requirement of growing and finishing pigs may be greater than that suggested by NRC (1998).

Key Words: Swine, Vitamins, Performance

154 Feeding high levels of natural or synthetic vitamin E to grower-finisher pigs. N. D. Fastinger*, T. G. Wiseman, and D. C. Mahan, *The Ohio State University*.

Feeding high dietary levels of vitamin E has not resulted in any toxic responses, but the levels fed may have been too low. Research has also suggested that natural vitamin E (RRR-α-tocopherol) may be more bioavailable than the synthetic (*all-rac*-α-tocopherol) form. Different tissue retentions may result and be dependant upon the form and level of the vitamin fed. This study evaluated the effects of the two forms of vitamin E (RRR- or *all-rac*-α-tocopherol) when provided at high dietary levels (0, 300, 900, and 2,700 IU/kg) on their potential toxicity and tissue retentions. Pig performance, tissue α-tocopherol, and blood-clotting time were the criteria evaluated. The experiment was a 2 X 4 factorial, in a RCB design conducted in three replicates using 5 pigs per pen. Animals were fed treatment diets from 25 to 110 kg BW. Samples of liver, loin, spleen, brain, lung, perirenal and subcutaneous fat were collected at 110 kg and analyzed for α-tocopherol. Blood-clotting time was performed at the end of the trial. Data were analyzed using the pen mean as the experimental unit. Daily gains and feed intakes were similar between 0 to 900 IU/kg, but reduced at the 2,700 IU level ($P < 0.05$) for both vitamin E forms. Tissue α-tocopherols were higher in the following order: subcutaneous fat > perirenal fat > liver > spleen > lung > brain > loin. Tissue α-tocopherol levels increased quadradically ($P < 0.05$) as both forms of vitamin E level increased. The form of vitamin E fed to the pigs did not result in different tissue concentrations of α-tocopherol when fed at $\leq$ 900 IU/kg, but at 2,700 IU level natural (RRR-α-tocopherol) vitamin E had higher ($P < 0.05$) tissue concentrations than the synthetic (*all-rac*-α-tocopherol) form. Blood-clotting time was similar when 0 to 900 IU/kg diet was fed, but increased at the 2,700 IU/kg level for both forms. These results suggest that either form of dietary vitamin E or levels $\leq$ 900 IU/kg diet had no adverse effect on grower finisher pig performance and that tissue levels of both forms of vitamin E increased as dietary levels increased.

Key Words: Vitamin E, Toxicity, Pigs

155 Effects of removing vitamin and trace mineral premixes on growth and carcass measurements in finishing pigs housed in a moderately stressful environment. C. W. Starkey*, J. D. Hancock, J. S. Park, C. L. Jones, and J. D. Hancock, *Kansas State University, Manhattan*.

A total of 432 pigs were used in two experiments to determine the effects of omitting vitamin and trace mineral premixes (VTM) from diets of pigs in late and early finishing. The pigs were housed in moderately stressful housing conditions with crowding (2.03 m^2/pig), large pens (3.7 m × 4.9 m), and maximum available variation in BW (20 kg to 25 kg between the lightest and heaviest pig in each pen). Treatments for Exp. 1 (late finishing) were corn-soy diets without or with vitamin and trace mineral premixes fed from 90 to 115 kg BW. No differences were observed for ADG ($P > 0.18$), ADFI ($P > 0.48$), gain/feed ($P > 0.23$), or within pen variation in final BW ($P > 0.32$) at completion of the growth assay. Upon slaughter, no differences were observed for HCW ($P > 0.56$), dressing percentage ($P > 0.9$), last rib backfat thickness

(P > 0.13), or vertebral breaks (P > 0.49). For experiment two (early finishing to slaughter) treatments were corn-soy diets without or with vitamin and trace mineral premixes fed from 68 to 115 kg. There were no differences in ADG (P > 0.69), ADFI (P > 0.85), gain/feed (P > 0.7), or within pen variation in final BW (P > 0.37). Upon slaughter, there were no differences for HCW (P > 0.62), dressing percentage (P > 0.98), last rib backfat thickness (P > 0.58), or vertebral breaks (P > 0.44). In conclusion, deletion of vitamin and trace mineral premixes during finishing (68 to 115 kg) did not affect growth performance, within pen weight variation in BW at slaughter, carcass leanness, or integrity of vertebrae.

	Exp. 1			Exp. 2		
Item	Control	w/o VTM	SE	Control	w/o VTM	SE
ADG, kg	0.84	0.81	0.01	0.88	0.88	0.01
Gain/feed	0.299	0.289	0.007	0.292	0.292	0.007
Weight variation, kg[a]	6.2	6.5	0.5	5.9	6.3	0.4
Last rib backfat thickness, mm	23	24	0.3	20	20	0.7
No. of vertebral breaks/pig[b]	0.8	0.9	0.2	0.3	0.4	0.1

[a] Absolute values for deviation from the average slaughter weight within each pen. [b] Total number of vertebral separations on both sides of the split carcass.

Key Words: Pigs, Vitamins, Trace Minerals

156 Acidulated soapstock and restaurant grease in diets for finishing pigs.

C. W. Starkey*, J. D. Hancock, D. H. Kropf, C. L. Jones, K. H. Hachmeister, and J. D. Dunn, *Kansas State University, Manhattan*.

A total of 360 pigs were used in a 70-d growth assay to determine the effects of adding acidulated soybean oil soapstock and restaurant grease to diets for finishing pigs. Treatments were: 1) corn-soy-based control with no added fat; 2) soybean oil; 3) acidulated soapstock; 4) choice white grease; and 5) restaurant grease. All fat sources were added at 6% of the diet. For d 0 to 35 and overall (d 0 to 70), diets with added fat supported greater ADG (P < 0.05) and gain/feed (P < 0.001) compared to the control diet without added fat. However, there were no differences in growth performance among pigs fed the various fat sources (P > 0.3). No differences were observed for HCW or dressing percentage among pigs fed the various treatments (P > 0.08), but pigs consuming diets with added fat had greater last rib backfat thickness (P < 0.001) and lower fat free lean index (P < 0.001). Belly firmness was greater for pigs fed the control treatment (P < 0.001) compared to pigs fed diets with added fat. Also, pigs consuming diets with fat of plant origin (soybean oil and soapstock) had softer bellies (P < 0.001) compared to pigs consuming animal fats (choice white grease and restaurant grease). In conclusion, adding fat to diets for finishing pigs improved growth performance with no differences among pigs fed the various fat sources. Plant oils resulted in softer bellies than animal fats, but responses in pigs fed diets with soy oil soapstock and restaurant grease were comparable to those in pigs fed diets with soy oil and choice white grease. Soy oil soapstock and restaurant grease are economically attractive fat sources for use in diets of finishing pigs.

Item	Control	Soy oil	Soap-stock	Choice white grease	Restaurant grease	SE
ADG, kg	0.90	0.92	0.94	0.93	0.93	0.03
Gain/feed	0.352	0.386	0.387	0.385	0.384	0.009
Last rib backfat thickness, mm	22	24	24	24	24	1
Belly firmness, [a]	5.9	3.5	3.4	5.1	5.2	0.2

[a] Scored on a scale of 1 to 9

Key Words: Pigs, Restaurant Grease, Acidulated Soapstock

157 The influence of tylosin or rotational antibiotic use on apparent ileal and total tract digestion by growing pigs.

M. R. Smiricky*, D. M. Albin, J. E. Wubben, V. M. Gabert, C. T. Collier, and H. R. Gaskins, *University of Illinois*.

The extent to which the intestinal microbiota and the inclusion of antibiotics in the diet affect the nutritional efficiency of the pig is not clear. Therefore, the objective of this study was to determine the influence of continuous tylosin, rotational antibiotic, or no antibiotic supplementation to the diet on apparent ileal and total tract digestion by growing pigs. 15 pigs (avg. initial BW = 15 kg) were surgically fitted with a prececal simple-T cannula. Pigs were fed a corn-soybean meal-based diet containing no antibiotics for 14 d post-surgery. On d 14, pigs were randomly allotted to 3 dietary treatments, a continuous tylosin (CT) diet, a rotational antibiotic (RA) diet, or a control diet containing no antibiotics. The experimental diets were formulated to contain 21% CP. Chromic oxide (0.3%) was added as an indigestible marker for determination of nutrient digestibilities. The antibiotics were added to the control diet at the expense of cornstarch. The CT diet contained 44.2 mg tylosin/kg diet and the RA diet sequence was CSP (276.3 mg/kg diet), bacitracin (33.2 mg/kg)-roxarsone (37.6 mg/kg diet), lincomycin (22.1 mg/kg diet), carbadox (27.6 mg/kg diet), and virginiamycin (11.1 mg/kg diet). Pigs were fed 0.76, 0.92, 1.08, 1.24, 1.36, and 1.52 kg/d for periods 1-6, respectively, in 2 equal feedings at 0800 and 2000 h. The experimental period lasted 7 d, with 5 d of diet adaptation, fecal collection on d 6, and ileal digesta collection on d 7. Diets, feces, and digesta samples were analyzed for DM, OM, CP, AA, and chromic oxide concentrations. Continuous tylosin consumption improved (P < 0.07) apparent ileal and total tract Ile, Lys, Thr, and Val digestibilities. Apparent ileal digestibility of Arg and Met, and total tract digestibility of DM and His, tended to improve (P < 0.15) by continuous tylosin supplementation. The RA diet improved (P < 0.05) apparent ileal and total tract digestibilities of DM, OM, N, Arg, His, Ile, Leu, Lys, Met, Phe, Thr, and Val when compared to the control diet. In conclusion, both continuous tylosin and this rotational antibiotic sequence improved apparent ileal and total tract nutrient digestion by the growing pig.

Key Words: Pigs, Antibiotics, Digestibility

158 Efficacy of betaine in diets for uncrowded and crowded finishing pigs.

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Betaine addition to diets has been shown to spare energy. A study was conducted to determine if betaine would overcome the depression in growth observed when pigs are crowded and unable to consume adequate feed (energy). Treatments were arranged as a 2 x 3 factorial with three replications to assess betaine at three degrees of crowding. Crossbred pigs (n=126) averaging 33 kg BW were allotted to pens (4.97 m^2/pen) in a temperature-controlled, partially slotted floor building in groups of five, seven, or nine pigs/pen, resulting in 0.99, 0.71, and 0.55 m^2/pig. Each pen had a two-hole feeder. Corn-soy diets containing 0.90, 0.80, and 0.65% lysine were fed during three phases with lysine reduced at 55 and 86 kg BW. Diets were a control or betaine added at 1.14 g/kg (0.125% Betafin®; Finnfeeds Intl., Ltd, Marlborough, U.K.). The experiment was conducted from December to April and the mean temperature in the building was 16.8°C. All pigs were scanned by real-time ultrasound at termination (116 kg mean BW). Growth rate and feed intake decreased linearly (P < 0.001) with increased crowding (881, 855, 809 g/d; 2,606, 2,495, 2,391 g/d) but feed:gain was unaffected (2.96, 2.92, 2.96). Scanned 10th rib backfat, loin eye area, and percent fat-free lean (adjusted for final BW) tended to improve in crowded pigs due to reduced energy intake (22.8, 22.6, 20.9 mm; 39.3, 39.8, 41.4 cm^2, 50.3, 50.5, 51.8%,), but fat-free lean gain decreased linearly (P < 0.01) with crowding (338, 329, 319 g/d). Betaine had no effect on gain (858 vs 839 g/d for control vs betaine), feed intake (2,519 vs 2,475 g/d), feed:gain (2.93 vs 2.95), backfat (22.1 vs 22.1 mm), fat-free lean (51.1 vs 50.7%), or lean gain (335 vs 323 g/d), but it reduced loin eye area (41.0 vs 39.4 cm^2, P < 0.03). Response to betaine was similar in uncrowded and crowded pigs as evidenced by a non-significant betaine x crowding interaction (P > 0.25) for all traits except loin eye area. In this study, the effects of betaine did not overcome the negative growth effects of crowding in finishing pigs.

Key Words: Pigs, Betaine, Crowding

159 Effect of oral glycerol administration with and without dietary betaine on carcass composition and meat quality of late-finishing barrows. J.C. Airhart*, T.D. Bidner, and L.L. Southern, *LSU Agricultural Center, Baton Rouge*.

An experiment was conducted to determine the effects of oral glycerol administration with and without dietary betaine on carcass composition and meat quality in late-finishing barrows. Crossbred barrows (initial and final BW of 96 and 111 kg) were allotted to four treatments: 1) corn-soybean meal (C-SBM) diet, 2) C-SBM + 0.25% dietary betaine, 3) C-SBM + oral glycerol (1g/kg BW), or 4) C-SBM + 0.25% betaine + glycerol (1g/kg BW). Each treatment was replicated with six barrows penned individually in 1.1 X 3.7 m pens with solid concrete floors. Dietary betaine was provided in the diets for 20 d before slaughter. Feed and water were provided on an ad libitum basis. Diets were formulated to provide 0.60% total Lys and met or exceeded all other nutrient requirements for finishing pigs. The glycerol was administered orally at 24 h and 3 h before slaughter at the rate of 1 g/kg BW each time. Daily gain, ADFI, and gain:feed were not affected ($P > 0.10$) by betaine during the feeding period. At slaughter, plasma urea N concentrations were decreased ($P < 0.01$) by dietary betaine but not affected ($P > 0.10$) by oral glycerol administration. Plasma lactate was not affected ($P > 0.10$) by treatment. Tenth rib fat thickness, loin muscle area, dressing percentage, fat-free lean, percentage lean, objective color, shear force, 45-min and 24-h pH, and purge loss were not affected by treatment. Loin muscle drip and total losses were increased ($P < 0.10$) by dietary betaine. Although the effects were not significant, glycerol administration tended to decrease drip, cook, and total losses.

Key Words: Glycerol, Betaine, Pigs

160 Effect of dietary manipulation of the starter feeding program on subsequent performance and carcass characteristics of finishing pigs. A.M. Gaines*, G.L. Allee, J.W. Frank, D.C. Kendall, J.D. Spencer, and G.F. Yi, *University of Missouri-Columbia*.

A trial using 240 weanling pigs (EB x Genepacker 34) was conducted to determine the effects of the starter feeding program on the subsequent performance and carcass characteristics of finishing pigs. Pigs (15 d and 4.9 kg) were weaned into a SEW facility and given free access to a complex diet for seven days postweaning. At 7 d postweaning, pigs (barrows and gilts) were weighed and allocated to one of three dietary treatments (Trt) in a randomized complete block design with 10 replications/Sex/Trt (60 pens). Trt included a complex diet (CS), a simple diet (SS) with no specialty ingredients, or a low protein complex diet (LP) with dietary protein reduced 20%. Pigs were fed in two dietary phases (P1: 7-21 d; and P2: 21-42 d). Performance parameters of ADG, ADFI, and G:F were measured. At 42 d, pigs were moved to an off-site finishing facility to evaluate subsequent performance and carcass characteristics with 5 replicate pens/Sex/Trt (30 pens). Pigs were fed fortified corn-soybean meal diets in four dietary phases with sexes fed separately. Performance parameters of ADG, ADFI, and G:F were measured. Real time ultrasound was used to determine 10th rib backfat (BF) and loin-eye area (LEA). Initial weights (6.68 ± 0.02 kg) at 7 d did not differ among Trt ($P > 0.41$) or between sexes ($P > .15$). At the end of the nursery phase (42 d), there was a Trt effect for BW, ADG, and G:F with pigs fed CS and SS pigs being heavier ($P < 0.01$), gaining faster ($P < 0.01$) and more efficiently ($P < 0.01$) than LP pigs. The BW at 42 d for the CS, SS, and LP pigs were 26.3, 26.4, and 24.4 kg, respectively. For the overall finishing period (42-142 d), there were no Trt differences for pig performance, with the BW at 142 d for pigs from CS, SS, and LP being 111.9, 113.6, and 110.7 kg, respectively. Initial ultrasound measurements (42 d) showed LP pigs to have increased BF depths ($P < 0.01$) and less lean ($P < 0.01$) compared to CS and SS pigs. However, no Trt differences were observed at the end of the finishing period. This study suggests that early short-term restriction of growth due to an 20% restriction of protein does not affect subsequent performance or carcass characteristics and that simple diets during the starter period may have a place in high-health operations.

Key Words: Pigs, Starter Diets, Performance

161 Evaluating phase feeding of gilts and barrows during the grower-finisher period. D.C. Mahan*, S.D. Carter, T.R. Cline, G.L. Cromwell, G.M. Hill, and G.R. Hollis, *NCR-42 Committee*.

The dietary protein (lysine) requirement declines as the pig progresses toward market weight, suggesting that properly formulated diets at various phases would result in greater efficiencies. NCR-42 Swine Nutrition Committee members from 6 stations (IL, IN, KY, MI, OH, OK) evaluated this concept using 649 crossbred pigs in a 2 x 5 factorial, RCB design in 14 replicates. Gilts and barrows were fed C-SBM mixtures with 1, 2, 3, 4, or 5 dietary lysine levels from 23 to 115 kg BW. Diets were calculated to meet the average lysine requirement for the single phase and for each dietary phase. Dietary lysine (total) for gilts fed the 5 sequences were: 1) 0.88; 2) 1.03, 0.75; 3) 1.17, 0.88, 0.60; 4) 1.17, 0.98, 0.78, 0.60; and 5) 1.17, 1.03, 0.88, 0.75, 0.60%. Barrows were fed similar sequences, but lysine levels were lower by 0.15% for each phase, respectively. Diets were changed at equally spaced intervals within each treatment group. Carcass or real-time measurements were collected at the trials' end. Daily gains (881, 892, 852, 863, 854 g) declined ($P< 0.01$) as the no. of dietary sequences increased. Barrows gained faster and were less efficient than gilts ($P< 0.01$), with responses to dietary sequences similar for each gender. Days to 115 kg were greater as the no. of dietary changes increased ($P< 0.05$); gilts averaged 3.8 d longer on test ($P< .01$) than barrows. Average daily lysine intake declined (20.9, 20.1, 19.4,19.4,19.0 g/d) as the no. of diet changes increased ($P<0.01$); gilts had higher lysine intakes (20.6 vs 18.9 g/d; $P< 0.01$) than barrows. Carcass measurements were influenced ($P< 0.05$) by dietary sequence, particularly the loin eye area and fat-free lean gain (335, 337, 323, 325, 324 g/d) as dietary sequence increased. Gilt fat-free lean averaged 337 and barrows 320 g/d. These results suggest that growing-finishing pig performances and carcass characteristics were not improved by providing several dietary sequences, and that inadequate lysine during the finisher period may have caused the lowered performances of the latter groups.

Key Words: Grow-Finish, Lysine, Pig

162 Effect of wheat middlings, enzyme supplement, and dietary lysine level on growing-finishing pig performance, carcass measurements, and amino acid digestibility. J.C. Peters*, D.C. Mahan, N.D. Fastinger, and T.G. Wiseman, *The Ohio State University*.

Wheat middlings are frequently used in grower-finisher diets but the fiber fraction is considered poorly digested. Previous attempts to add enzymes to wheat middling diets have been inconsistent. An experiment evaluated the effects of wheat middlings and an enzyme supplement fed to grower-finisher pigs on pig performance and carcass measurements. Normal and low lysine levels were fed to better evaluate if supplemental enzymes improved performance. A 2 x 2 x 2 factorial, in a RCB design used 336 crossbred pigs in 6 replicates. Corn-soy diets contained wheat middlings (0, 20%), a combination or protease and xylanase enzymes (Vegpro) at 0 or 10%, and 2 lysine levels (NRC, NRC minus 0.1% lysine). Treatment diets were fed from 27 to 107 kg BW. The middlings did not affect average daily gain (877 vs 869 g/d), but feed intake was higher ($P < 0.01$) only between 80 and 107 kg BW. Daily gains were lower (903 vs 843 g/d; $P < 0.01$) when the lower lysine level was fed, with no interaction between lysine level and enzyme supplement. Backfat thickness decreased ($P < 0.01$) when wheat middlings were fed, but loin muscle area and lean gain increased ($P < 0.05$). An interaction between wheat middlings and added enzymes resulted in improved fat-free lean gain ($P < 0.05$) when middlings were fed. Enzyme addition did not affect ($P > 0.15$) growth performance or carcass measurements. A second 2 x 2 factorial experiment in a RCB design (5 reps), evaluated the effects of enzyme supplementation (0, 0.10%) and wheat middlings (0, 20%) on amino acid and energy digestibility. Amino acid digestibility ($P < 0.01$) and digestible energy were both lower ($P < 0.05$) with added wheat middlings. Enzyme addition did not affect amino acid digestibility ($P > 0.10$), but digestible energy was improved ($P < 0.05$). These results suggest that feeding 20% wheat middlings did not decrease pig gain but increased carcass lean. Enzyme addition seemed to improve digestible energy but not animal performance.

Key Words: Pigs, Enzyme, Lysine

163 Effect of dietary particle size and nutrient supply on nitrogen excretion of grower pigs. M. A. Oryschak[1,2] and R. T. Zijlstra*[1], [1]*Prairie Swine Centre Inc.*, [2]*University of Saskatchewan, Saskatoon, Canada*.

Nitrogen (N) output of the pork industry is a public concern. Previously, reducing dietary particle size reduced fecal N excretion, but increased urinary N excretion. In the present study, four diets (barley, soybean meal, peas; chromic oxide as marker) with two particle sizes (600 or 900 μm) and two nutrient supplies (DE-limiting: 2.8 g dig. Lys/Mcal DE, 3.15 Mcal DE/kg; or AA-limiting: 1.8 g dig. Lys/Mcal DE, 3.40 Mcal DE/kg) were used in a 2 x 2 factorial arrangement. Nine pigs (25 $\pm$ 2 kg) had T-cannulas installed in the ileum; six observations were obtained per diet in three 12-d periods. Pigs were housed in individual metabolism pens, with restricted access to feed (3 $\times$ maintenance DE). Feed, feces, digesta, and urine were analyzed to determine apparent ileal and total-tract digestibility of N and energy, and total, fecal, and urinary N excretion. Particle size did not interact with nutrient supply for any variable ($P > 0.10$). Reducing particle size from 900 to 600 μm did not alter urinary or total N excretion ($P > 0.10$), reduced fecal N excretion 11%, increased total-tract digestibility of N 3% and energy 3%, and increased ileal digestibility of N 9% and energy 11% ($P < 0.05$). Particle size reduction may improve overall energy utilization more than explained by improvements in total-tract energy digestibility. Pigs fed DE-limiting diets excreted 29% more N, but also retained 31% more N than pigs fed AA-limiting diets ($P < 0.05$). Total N excretion and N retention (as % N intake) were not different between nutrient supplies ($P > 0.10$). For DE-limiting diets, energy did not limit N retention, because increased energy availability caused by particle size reduction did not increase N retention. In the present study, reducing particle size appeared to have a greater impact on efficiency of digestion for energy than N. Reducing particle size was effective in reducing fecal but not total N excretion; however, nutrient supply had a greater impact on N excretion.

Key Words: Particle Size, Nitrogen Excretion, Pig

164 Development of an Isoleucine Deficient Diet in Growing and Finishing Pigs. Brian Kerr*[1], T. M. Parr[2], B. S. Borg[3], J. M. Campbell[3], K. L. Bryant[4], and M. T. Kidd[5], [1]*USDA-ARS-SOMMRU*, [2]*University of Illinois*, [3]*American Protein Corporation*, [4]*Akey Incorporated*, [5]*Mississippi State University*.

Two, 28 d trials were designed to define an isoleucine (Ile) deficient diet in growing (23 to 45 kg) and finishing (77 to 95 kg) pigs utilizing red blood cells (RBC) as a deficient Ile protein source. In trial 1, eight replications of four pigs/pen were fed a diet containing 4.2% RBC with or without crystalline (c) Ile, a diet containing 8.4% RBC with or without cIle, a low CP+AA control, or a high CP control. Diets were formulated to contain .90% digestible (d) lysine (dLys) with the unsupplemented 4.2% and 8.4% RBC diets formulated to a dIle:dLys ratio of .50 and .23, respectively. All other diets were formulated to a dIle:dLys ratio of .63. Average daily gain (ADG), average daily feed intake (ADFI) and gain:feed ratio (G:F) did not differ between pigs fed the high or low CP+AA diets ($P>0.05$). Utilization of 4.2% RBC had no effect on ADG or ADFI ($P>0.10$), but reduced G:F ($P<0.06$) which was alleviated by cIle supplementation. Utilization of 8.4% RBC reduced pig performance ($P<0.01$) and although performance was improved with cIle supplementation ($P<0.01$), performance remained lower than pigs fed the low CP+AA diet ($P<0.10$), but not pigs fed the high CP diet ($P>0.10$). In trial 2, six replications of four pigs/pen were fed a diet containing 2.9% RBC with or without cIle, a diet containing 5.8% RBC with or without cIle, a low CP+AA control, or a high CP control. Diets were formulated to contain .67% dLys with the unsupplemented 2.9% and 5.8% RBC diets formulated to a dIle:dLys ratio of .55 and .31, respectively. All other diets were formulated to a dIle:dLys ratio of .63. Performance did not differ between pigs fed the high or low CP+AA diets ($P>0.05$). Feeding 2.9% RBC, with or without cIle supplementation, had no effect on pig performance ($P>0.10$). Utilization of 5.8% RBC reduced pig performance ($P<0.01$), with cIle supplementation improving pig performance ($P<0.01$) to a level not different from pigs fed either control diet ($P>0.10$). Utilization of RBC offers a unique opportunity to evaluate Ile nutrition of growing and finishing swine.

Key Words: Isoleucine, Red Blood Cells

165 Plasma urea nitrogen as an indicator of the isoleucine requirement of grower pigs. T.M. Parr*[1], B.J. Kerr[2], and D.H. Baker[1], [1]*University of Illinois, Urbana, IL*, [2]*Nutriquest, Inc., Chesterfield, MO*.

Two trials were undertaken to verify the isoleucine (Ile) requirement of growing (25 to 45 kg) pigs. A previous growth trial in our laboratory had suggested a true digestible Ile requirement of between 0.44 and 0.47% of the diet. In the first study, a replicated 5 x 5 latin square design was used to determine the Ile requirement. Five barrows (square one) and five gilts (square two) were fed corn-red blood cell diets containing five graded increments of L-Ile to accomplish true digestible Ile levels of 0.35%, 0.39%, 0.43%, 0.47% and 0.51%. Pigs received each test diet for a period of 4 d, with blood being drawn at 0900 on the 5th d. Samples were analyzed for plasma urea nitrogen (PUN). Barrows had higher ($P < 0.01$) PUN values than gilts, and PUN decreased linearly ($P < 0.01$) in both sexes as Ile was incremented. The data suggested, however, an apparent plateau in both sexes at 0.47% digestible Ile. In the second trial, 100 pigs were assigned one of five diets formulated to test the pigs' response to Ile in the presence and absence of excess leucine (Leu) and valine (Val). The basal diet contained 0.38% true digestible Ile, with Leu and Val formulated to be just above the requirement, at 0.97 and 0.63%, respectively. Treatments were: 1) corn-soybean meal positive control, 2) Ile-deficient basal, 3) as 2 + 0.10% L-Ile, 4) as 2 + 1.0% L-Leu + 0.50% L-Val, and 5) as 2 + 0.10% L-Ile + 1.0% L-Leu + 0.50% L-Val. Pigs (26.0 kg initial body weight) were fed the experimental diets for 20 d, after which all pigs were bled for PUN assessment. Whether Ile-deficient (diets 2 and 4) or adequate (diets 3 and 5), excess Leu and Val depressed ($P < 0.03$) both feed intake and weight gain, and tended to increase PUN. This suggested that excess Leu and Val may antagonize Ile when diets contain minimal levels of Ile. In conclusion, the true digestible Ile requirement of grower pigs appears to be in the range of 0.44 to 0.47%, which is in close agreement with the NRC (l998) estimate of 0.45%.

Key Words: Pig, Isoleucine, Plasma Urea Nitrogen

166 Crystalline amino acid supplementation of grain sorghum-based, low protein diets for growing and finishing swine. R. O. Myer* and D. W. Gorbet, *University of Florida*.

Three trials were conducted to evaluate the effectiveness of crystalline lysine, threonine, methionine, and tryptophan supplementation of grain sorghum-based, low protein diets for G-F pigs. Each trial involved a comparison of grain sorghum-based diets formulated with 1) soybean meal (48%) as the supplemental source of amino acids (control) or 2) L-lysine HCl, L-threonine, DL-methionine, and L-tryptophan with enough soybean meal to meet the requirements of the other amino acids (AA). Amino acid supplementation reduced CP level of the diets by four percentage units. The trials were similar but conducted at different times and each utilized 60 crossbred pigs (5 reps) with avg initial weights of 35, 29, and 30 kg, respectively, for the three trials. For each trial, grower diets (.80% estimated digestible lys) were fed from 31 to 53 kg avg BW, finisher I (.68% dig lys) to 84 kg and finisher II (.55% dig lys) to 114 kg. The grain sorghum utilized was a blend of commercial, low tannin hybrids; a different crop of grain was used in each trial. At the end of the trials, all pigs were scanned to estimate carcass lean content. Overall results over the three trials for the control and AA treatments, respectively, were: 1.01 and .99 kg ADG ($P>.10$; SE = .01), 2.69 and 2.67 kg ADF ($P>.10$; SE = .03), 2.68 and 2.69 F/G ($P>.10$; SE = .02), 51.0 and 50.6% estimated carcass lean ($P>.10$; SE = .3), and .383 and .374 kg avg lean gain/d ($P=.09$; SE = .003). There was no grain crop (trial) x diet effects ($P>.10$). Results indicated that upon supplementation with crystalline lysine, threonine, methionine, and tryptophan, the protein level of grain sorghum based diets can be reduced by four percentage units with very little or no effect on growth perfomance or carcass lean yield of growing and finishing pigs.

Key Words: Pigs, Amino Acids, Grain Sorghum

167 Differences in apparent and standardized crude protein and amino acid digestibility coefficients among low phytate corn, normal corn, and soybean meal in growing pigs. R. A. Bohlke*, H. H. Stein, A. R. Wirt, and R. C. Thaler, *South Dakota State University*.

Nine crossbred growing barrows (BW=29.3 ± 1 kg) were fitted with T-cannulas in the distal ileum to determine crude protein (CP) and amino acid (AA) digestibility coefficients of low phytate corn (LPC), normal corn (NC), and soybean meal (SBM). Three diets containing either LPC, NC, or SBM as the sole source of CP and AA were formulated, as was a nitrogen-free diet (N-free). Chromium oxide was included in each diet as an inert marker. Each diet was fed to the pigs for nine days with digesta being collected from 0800 to 2000 on d 8 and d 9. At the end of the experiment, apparent (AID) and standardized ileal CP and AA digestibility coefficients (SID) were calculated for each ingredient. The AID for CP and all indispensable AA except leucine (Leu) and methionine (Met) were higher ($P < 0.05$) for SBM compared to NC and LPC. The AID of arginine (Arg), lysine (Lys), and valine (Val) were higher ($P < 0.05$) in LPC than in NC, but no differences ($P > 0.05$) were found for CP and the other indispensable AA. The SID were calculated by correcting the AID for the endogenous losses of CP and AA determined after feeding the N-free diet. The SID of isoleucine (Ile), Lys, phenylalanine (Phe), and threonine (Thr) were higher ($P < 0.05$) in LPC than in NC. Likewise, a tendency for higher ($P < 0.07$) SID in LPC than in NC was observed for CP, and Val, while no differences ($P > 0.05$) were observed for the remaining indispensable AA. The SID for CP, Thr, Lys, histidine (His), Arg, Ile, and tryptophan (Trp) were higher ($P < 0.05$) in SBM than in NC, but when comparing SBM to LPC, differences ($P < 0.05$) were found only for Lys and His. In conclusion, the results of the current experiment demonstrate that both apparent and standardized ileal AA digestibility coefficients are at least as high in LPC as they are in NC.

Key Words: Pigs, Digestibility, Amino Acids

168 Determining an optimum lysine:calorie ratio for 35 to 60 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, Kansas*.

Our objective was to determine the optimum lysine:calorie ratio (g total dietary lysine/Mcal of ME) for gilts (48 kg midpoint; PIC L337 # C22) in a commercial finishing environment. Forty-two pens (1,176 pigs; initially 35.1 ± .16 kg) were used in a randomized complete block design. Treatments included feeding six lysine:calorie ratios (2.55, 2.89, 3.23, 3.57, 3.91, and 4.25 g lysine / Mcal of ME) for a 28 day feeding period. There were 28 pigs per pen and 7 pens per treatment. All diets were corn-soybean meal based with 6% choice white grease. Dietary lysine:calorie ratios were attained by adjusting the corn:soybean meal inclusion rates, and no crystalline lysine was used to ensure lysine was first limiting. Five pigs per pen were individually weighed and scanned with ultrasound on d 0 and 28 as used to measure tenth rib fat depth and loin eye area. Quadratic improvements were observed ($P \leq 0.04$) for pigs fed increasing levels of total dietary lysine (0.91, 1.04, 1.16, 1.28, 1.40, or 1.52 %) for daily gain (895, 909, 930, 907, 905, 890 ± 12 g/day) and feed efficiency (G:F; 0.46, 0.47, 0.48, 0.47, 0.48, 0.47 ± 0.006). Tenth rib fat depth on d 28 (8.4, 8.8, 8.4, 8.4, 8.0, 7.7 ± 0.26 mm) and change in fat depth (2.5, 2.5, 2.3, 2.1, 1.9, 1.5 ± .18 mm) were linearly decreased ($P \leq .01$) as dietary lysine increased. Loin eye area measurements were not ($P \geq .36$) affected by dietary treatment. Economic analysis indicated that gilts fed the lowest dietary lysine level had the lowest feed cost per unit of gain. However, margin over feed cost responded in a quadratic manner with the greatest return for gilts fed 3.23 g lysine/ Mcal of ME. These data indicate that gilts from 35 to 60 kg required 3.23 g of lysine / Mcal of ME (1.16 % total dietary lysine, 3,578 kcal/kg diet) for maximal growth rate, feed efficiency, and marginal return.

Key Words: Lysine, Requirement, Finishing

169 Effects of pharmacological concentrations of zinc oxide and phytase on zinc excretion and performance in the nursery pig. M.M. Martnez*, G.M. Hill, J.E. Link, J.G. Greene, and D.D. Driksna, *Michigan State University, East Lansing, MI*.

The benefits of feeding pharmacological concentrations of zinc (Zn) as oxide (ZnO) in the first 14 d post-weaning are well documented. However, the effects pharmacological dietary concentrations have on excreted minerals is an environmental concern. Exogenous phytase in pig diets results in an increase of P and Zn retention. The objective of this experiment was to evaluate the effects of three concentrations of Zn (150 ppm, 1,000 ppm or 2,000 ppm as ZnO) with and without the addition of phytase (500 PTU/kg of Natuphos^{TM}) on Zn excretion and performance of nursery pigs. Twenty-four crossbred barrows (7.1 kg and 22 d of age) were placed in individual stainless steel metabolism crates for a 21 d balance study. Pigs were fed 2 phase experimental diets from d 1-7 and d 8-14. During d 15-21 the animals were fed a common diet, which had adequate Zn (150 ppm) and no added phytase. Urine, feces and orts were collected twice a day and pigs were weighed weekly. Growth performance (ADG, ADFI or G:F) did not differ among treatments. In the first period of the study (d 2-7), fecal Zn concentrations from pigs fed 2,000 ppm Zn ranged from 63.4 mg/d to 337.6 mg/d and were 14 times greater ($P < 0.01$) than the fecal Zn concentrations of animals fed 150 ppm Zn (11.8 mg/d to 17.9 mg/d). During the second period (d 8-14) the range of Zn fecal excretion of pigs fed 2,000 ppm Zn, decreased from 347.0 mg/d to 277.0 mg/d and plateaued. The amount of Zn excreted was 30 times greater ($P < 0.01$) than that excreted when pigs were fed 150 ppm. During the last period (d 15-21), all the pigs excreted comparable amounts of Zn. Animals fed 2,000 ppm Zn for growth promotion excreted approximately 203.1 mg/d of Zn during the 14 d post-weaning period. Pigs fed 150 ppm Zn were in neutral balance during the 21 d study and did not differ from those pigs fed 1,000 ppm Zn. Barrows fed 2,000 ppm Zn were in a positive balance from d 1-14, but were in a negative balance from d 15-21 when dietary Zn was reduced to 150 ppm.

Key Words: Zinc, Phytase, Nursery Pig

170 Effects of the addition of phytase and pharmacological concentrations of zinc oxide on phosphorus excretion in the nursery pig. M.M. Martínez*, G.M. Hill, J.E. Link, J.G. Greene, and D.D. Driksna, *Michigan State University, East Lansing, MI*.

Around 80% of the phosphorus (P) found in cereal grain diets is bound to phytate, which is unavailable to non-ruminants leading to higher mineral excretion and environmental concerns. Furthermore, many post-weaning swine diets contain pharmacological concentrations of zinc oxide (ZnO) for growth enhancement. Exogenous phytase increases mineral availability for absorption. The objective of this 3 x 2 factorial study was to determine the effects of adequate and pharmacological Zn (150 ppm, 1,000 ppm and 2,000 ppm) and phytase (0, 500 PTU/kg of Natuphos^{TM}) on P excretion. Twenty-four crossbred barrows (7.1 kg and 22 d of age) were placed in individual metabolism cages for a 21 d mineral balance study. Pigs were fed 2 phase experimental diets twice a day for d 1-7 and d 8-14. During d 15-21 the animals were fed a common diet, which had adequate Zn (150 ppm) and did not contain phytase. Urine, feces and orts were collected twice a day. Concentrations of P were determined by a colorimetric method of Gomorri (1942). Pigs fed phytase supplemented diets had 1.2 times lower ($P < 0.0001$) fecal P (15.1 mg/d vs 17.7 mg/d), and 1.5 times greater ($P < 0.05$) urinary P (0.00038 mg/d vs 0.00023 mg/d) than non-supplemented diets. Pharmacological Zn supplementation had no effect on fecal P concentrations ($P > 0.05$). Barrows fed 2,000 ppm Zn plus phytase had a more positive P balance (2193.3 mg/d; $P < 0.04$) when compared to 2,000 ppm Zn without phytase (1820.1 mg/d). This effect was not seen with the other Zn treatments. Regardless of dietary treatment, P balance was positive throughout the 21 d of the study. In conclusion, the addition of phytase to nursery diets has a beneficial effect on reducing fecal, but not urinary concentrations of P. This practice could be incorporated into dietary formulation of nursery pig diets to reduce P loading of soils.

Key Words: Phosphorus, Phytase, Nursery Pig

171 Effect of phytase dosage and source on growth performance of nursery pigs. B. W. James*[1], M. D. Tokach[1], R. D. Goodband[1], J. L. Nelssen[1], S. S. Dritz[1], and G. L. Lynch[2], [1]*Kansas State University, Manhattan,* [2]*BASF Corporation, Mount Olive, NJ.*

A 28-d growth assay was conducted to determine the effect of phytase dosage and source on growth performance of nursery pigs. A total of 342 pigs (initially 11.0 kg, PIC C22 × 326) were blocked by weight and allotted randomly to nine dietary treatments. Each treatment had eight replications and four or five pigs per pen. The basal diet was corn-soybean meal based and was formulated to contain 5% added fat, 1.4% total lysine, and 0.13% available P. Monocalcium phosphate was substituted for sand to form the other control diets (0.18 and 0.23% available P). Phytase (100, 225, or 350 FTU or FYT/kg) from either Natuphos® or Ronozyme™ P was added to the 0.13% available P diet at the expense of sand. Calcium to total P ratio was maintained at 1.12:1 in all diets. All ingredients were analyzed for phosphorus before diet formulation and analyzed diet values agreed with formulated values. Increasing available P linearly ($P < 0.01$) improved ADG and feed efficiency. There were no phytase source × level interactions ($P > 0.23$) or differences between phytase sources ($P > 0.27$). Increasing phytase level linearly ($P < 0.01$) increased ADG and feed efficiency. Regression analysis of the ADG response indicated that, when adding less than 350 phytase units/kg, each 100 phytase units/kg will release 0.022 and 0.017% available P for Natuphos® and Ronozyme™ P, respectively.

	Available P, %			Ronozyme, FYT/kg			Natuphos, FTU/kg		
	0.13	0.18	0.23	100	225	350	100	225	350
ADG, g	602	650	694	623	642	659	624	669	667
Gain/feed	0.639	0.655	0.673	0.668	0.663	0.673	0.650	0.655	0.680

Key Words: Phytase, Phosphorus, Nursery Pigs

172 Response of barrows to phytase in pelleted diets. M. C. Brumm*[1], [1]*University of Nebraska.*

Crossbred barrows (n=288, 20.5 kg BW) were used to evaluate pre-pelleting additions of 2 phytase sources in diets fed to slaughter weight (111.8 kg BW). There were 4 pens of 12 pigs/pen/treatment. Treatments were: 1) control formulated to University of Nebraska (UNL) recommendations for available P (0.29%, 20-36 kg BW; 0.22%, 36-59 kg BW; 0.19%, 59-86 kg BW; and 0.16%, 86 kg to market), 2)UNL formulated to 0.1% lower available P (NEG), 3)Ronozyme P CT (R) added to NEG at 500 FYT/kg (R500), 4)R added to NEG at 750 FYT/kg (R750), 5)Natuphos 10000G (N) added to NEG at 500 FTU/kg (N500) and 6)N added to NEG at 750 FTU/kg (N750). All diets contained 10% wheat midds with a pellet exit temperature of 65.5 to 71.1^o C. Contrasts to separate treatment means were: 1)UNL vs NEG, 2)UNL vs 500 phytase (FYT or FTU) units, 3)UNL vs 750 phytase units, 4)500 versus 750 phytase units and 5)R versus N. Compared to UNL, pigs fed NEG had decreased daily gain (809 vs 886 g/d, $P<0.01$), decreased daily feed (2.32 vs 2.46 kg/d, $P<0.05$) and gain:feed (0.351 vs 0.364, $P<0.05$). Similar responses were observed ($P>0.2$) when comparing 500 or 750 phytase units to UNL on daily gain, daily feed, gain:feed, carcass lean and daily lean gain. There was no difference ($P>0.2$) between 500 vs 750 phytase units on daily gain, daily feed, gain:feed or carcass lean percentage. There was no effect ($P>0.2$) of R vs N on daily gain or daily feed (2.43 vs 2.49 kg/d). However, the numeric difference in gain and feed resulted in a difference in gain:feed for R vs N (0.360 vs 0.352, $P<0.05$). Feeding NEG diets resulted in a decrease ($P<0.01$) in bone ash (59.5 vs 61.5%) and bone breaking strength (186 vs 244 kg) versus UNL. While bone ash decreased ($P<0.1$) going from 500 to 750 phytase units (61.2% vs 60.4%), there was no effect ($P>0.2$) of phytase level on bone breaking strength (230 vs 240 kg). There was no difference ($P>0.2$) in R vs N for bone ash or breaking strength. Phytase from either source added prior to pelleting was effective in preventing the decrease in performance associated with diets formulated to contain 0.1% lower available P than current UNL recommendations.

Key Words: Pigs, Phosphorus, Phytase

173 Phytase additions to conventional and low-phytate corn for pigs. E. G. Xavier*, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky.*

Two experiments were conducted to assess the efficacy of phytase (Natuphos®, 600 units/kg) addition on bioavailability of P in corn and corn-soybean meal (SBM) for growing pigs. In Exp. 1, a low P (0.11%), phytate-free basal diet (1.2% lysine, 0.8% Ca) consisted of casein (15%), dextrose-sucrose (1:1), and supplemental AA, minerals (except P), and vitamins. In Diets 2 and 3, monosodium phosphate (MSP) provided 0.10 and 0.20% added P. Diet 4 was a 3:1 blend of corn and SBM substituted for the sugars to provide 0.27% added P. Diet 5 was as Diet 4 with phytase. Diets 6 and 7 included phytase addition to Diets 1 and 3. Each diet was fed to four individually penned pigs for 28 d, from 12 to 28 kg. Breaking strength of metatarsals, metacarpals and femurs were regressed on added P intake and single-point, slope-ratio procedures were used to assess P bioavailability in the corn-SBM mix. Bone responses in Diets 1-3 were linear ($P < 0.001$) with a good fit (r^2=0.99). Gain and relative bone strength of pigs fed Diets 1-7 were: 436, 519, 580, 588, 730, 413, 613 g/d; 100, 199, 301, 159, 328, 95, 285 (both $P < 0.01$), respectively. Bioavailability of P increased from 24% in the corn-SBM diet to 79% when phytase was added. In Exp. 2, the efficacy of phytase was assessed in diets containing low-phytate (LP) corn or a near-isogenic, normal (N) corn. The N- and LP-corn contained 0.25 and 0.26% total P and 0.21 and 0.09% phytate P, respectively. Diets were the basal with (1) no added P, and 0.20% P added as (2) MSP, (3) N-corn, and (4) LP-corn. Diets 5 and 6 were as Diets 3 and 4, but with added phytase. Each diet was fed to six pigs (one/pen) for 28 d, from 11 to 27 kg. Gain and relative bone strength were: 584, 732, 653, 623, 623, 691 g/d; 100, 313, 143, 217, 253, 288 (both $P < 0.01$). Bioavailability of P was estimated at 29 and 70% for the N- and LP-corn, and they increased to 91 and 103%, respectively, when phytase was added. The results indicate that phytase is efficacious when added to diets containing high- or low-phytate corn, but its efficacy is approximately twice as great in high- vs low-phytate diets.

Key Words: Pigs, Phosphorus, Phytase

174 Effect of low phytate corn and dietary phytase addition on pig growth and fecal phosphorus excretion in a commercial environment. G. Gourley*[1], T.E. Sauber[2], D.B. Jones[2], D. Kendall[3], and G. Allee[3], [1]*Swine Graphics Enterprises,* [2]*Pioneer-A DuPont Company,* [3]*University of Missouri-Columbia.*

Eight hundred thirty-two pigs housed in a commercial research facility were utilized to evaluate the effects of low phytate corn and phytase enzyme on pig growth and fecal phosphorus excretion. Pigs were randomly allocated by gender to thirty two pens of 26 pigs. One of four corn source/phytase treatments was randomly assigned to each pen: typical corn (TC), typical corn plus 300 FTU phytase (TC+300), low phytate corn (LP) and LP plus 300 FTU phytase (LP+300). From 28 to 127 kg BW pigs were fed fortified corn-soybean diets in a five phase feeding program. Within a phase, diets were formulated to contain equal nutrient and available phosphorus contents by altering the ratios of energy, amino acids and available phosphorus sources. Fecal grab samples were collected from each pen. The right front legs from 5 pigs per pen were collected at slaughter. Initial weight, final weight, ADF, ADG, G:F, HCW, BF, loin depth and calculated lean % did not differ between treatments. Addition of phytase enzyme or substitution of LP for TC reduced fecal phosphorus content 25%, while the combination of LP corn plus phytase reduced fecal phosphorus 54%. Force required to break the MC/MT bones was similar for all treatments. These results indicate that the effects of low phytate corn and phytase enzyme on fecal phosphorus content are similar and additive.

Criteria	TC	TC+300	LP	LP+300	SEM
Initial W, kg	28.3	28.3	28.4	28.4	0.04
Final W, kg	127.1	126.0	126.8	127.5	0.82
ADF, kg	2.23	2.22	2.20	2.23	0.02
ADG, kg	0.85	0.84	0.84	0.85	0.01
G:F	0.378	0.377	0.380	0.377	0.003
Carcass Characteristics					
HCW, kg	95.4	94.5	95.4	95.6	0.68
BF, mm	16.3	16.3	16.5	16.5	0.25
Loin depth, cm	6.88	6.83	6.78	6.78	0.05
Lean, %	55.76	55.61	55.46	55.48	0.15
Fecal Composition					
Moisture, %	71.32	70.71	71.08	70.09	0.94
Phosphorus, % of DM	2.27^a	1.69^b	1.71^b	1.05^c	0.05
Bone breaking force, kg	209	202	212	198	5.70

Means in same row with unlike superscripts differ (P < .05)

Key Words: Low Phytate Corn, Phytase Enzyme, Phosphorus Excretion

175 Efficacy of different phytase products for young chicks and pigs.

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Two chick trials and one pig trial were done to investigate the phosphorus-releasing efficacy of different phytase products when added to corn-soybean meal diets containing no supplemental inorganic P (Pi). All phytase premixes were assayed (Na-phytate assay) for phytase activity (U/g) prior to use. In the chick trials, five pens of four chicks were fed each diet from 8 to 22-d posthatching. The first chick assay involved feeding five levels of Pi (0, 0.10, 0.20, 0.30, 0.40%) from KH_2PO_4 with and without 500 U/kg of Natuphos® in diets containing 1.0% Ca. Broken-line least-squares regression analysis of tibia ash (mg) vs dietary available P (%) for each series resulted in good fits (r^2 = 0.98). Inflection points occurred at 0.347% and 0.314% available P for chicks fed diets without and with Natuphos®, respectively. The data also showed constant phytase-induced Pi-release at all levels of available P up to 0.30% of the diet. In the second chick assay, graded levels of Pi (0, 0.05, 0.10, 0.15%) from KH_2PO_4 were fed and compared to two sources and levels (U/kg) of supplemental phytase in diets containing 0.75% Ca. Linear (P < 0.01) responses in tibia ash and weight gain resulted from Pi supplementation. Tibia ash regressed on supplemental Pi intake (r^2 = 0.95) provided a standard curve from which bioefficacy (Pi release) could be calculated for each phytase product. At 500 U/kg diet, Natuphos® released 0.032% Pi whereas Ronozyme® released 0.028% Pi. At 1,000 U/kg, Pi-release values were 0.048% for Natuphos® and 0.038% for Ronozyme®. The pig trial involved 10 individually-fed pigs (9 kg) per diet, and all phytase products were supplemented to provide 400 U/kg in diets containing 0.60% Ca. Based on the linear regression of fibula ash on supplemental Pi intake (r^2 = 0.87), Pi-release values were calculated to be 0.081% for Natuphos® and 0.043% for Ronozyme®. Three experimental E. coli phytase products (expressed in yeast) were also evaluated: ECP1, ECP2, and ECP3 released 0.116%, 0.136%, and 0.108% Pi, respectively. All three of the E. coli phytases released more (P < 0.05) Pi than either Natuphos® or Ronozyme®. An in vitro enzymatic Pi-release assay showed promise in predicting phytase efficacy values that were in good agreement with in vivo efficacy values.

Key Words: Phytase, Chicks, Pigs

176 Release of phosphorus from two phytase products.

G. L. Lynch*, W. F. McKnight, and B. W. Cousins, *BASF Corporation.*

Phytases are a group of enzymes that degrade phytate to yield inorganic phosphorus and various isomers of inositol. Microbial phyatse enzymes are known to differ in their ability to react with phytate and to release phosphorus. A series of studies, three consecutive trials identical in design were conducted to determine the relative efficacy of phytase from *Aspergillus niger* (Natuphos) and from *Peniophora lycii* (Ronozyme). For each trial, 400 male broiler chicks were randomly placed in 40 battery cages and assigned to one of ten treatments (4 replications). An industry-typical corn/soy basal diet was formulated to be adequate in all nutrients except phosphorus and calcium, mixed and subdivided into ten aliquots. The basal diet contained 0.20% aP and 0.5% calcium. Treatments 1-4 were created by adding monocalcium phosphate (MCP) to yield diets containing 0, 0.05%, 0.10% and 0.15% added aP. Limestone was added to maintain Ca at a 2.5:1 ratio with aP. Each enzyme product was analyzed for phytase and added at levels of 150, 300 and 450 FTU/kg diet. (Treatments 5-7 and 8-10 for Natuphos and Ronozyme, respectively). Data from the three trials were combined and treatment responses evaluated using the slope ratio procedure. Significant linear responses for bone ash were found for MCP (R^2 = 0.983, P = 0.008) and for Natuphos (R^2 = 0.986, P = 0.007). For Ronozyme the linear response was not significant (R^2 = 0.779, P = 0.117). A prediction of aP release for Ronozyme was not made based on the non-linearity of the response. Based on these data, the calculated release of available phosphorus relative to MCP for 450 FTU from Natuphos is 0.109%.

Key Words: Phytase, Natuphos

177 Available phosphorus requirement for 33 to 55 kg pigs reared in commercial facilities.

C. W. Hastad*, S. S. Dritz, J. L. Nelssen, M. D. Tokach, and R. D. Goodband, *Kansas State University, Manhattan Kansas.*

Two experiments were conducted in commercial research barns to determine the appropriate dietary phosphorous level for pigs from 33 to 55 kg. In Exp 1, 600 gilts (initially 43.2 kg) were randomly allotted by weight to one of two dietary treatments (high or low P) for a 98 d trial. Diets where calculated to have low (.30, .28, .27, .27, .24, and .19%) or high (.37, .33, .30, .28, .27, or .26%) available P (aP) in six phases and diets were fed according to a feed budget. There were 25 pigs per pen, and 12 pens per treatment. In Exp 2, 1,260 gilts (initially 33.8 kg) were blocked by weight and randomly allotted to one of five dietary treatments for a 26-d experiment. The corn-soybean meal based diets contained 6% added fat and were formulated to 1.25% total lysine. Available P levels were 0.5, 0.6, 0.7, 0.8, or 0.9 g aP/Mcal ME (.18, .22, .25, .29, or .32% aP). A constant Ca:P ratio (1.1:1) was maintained in all diets. On d 26, one pig from each pen was randomly selected for harvest of the right femur, third and fourth metatarsals (MT3 & MT4), and sixth rib to determine bone properties. In Exp 1, there were no differences (P>0.15) in overall ADG, ADFI or feed efficiency. In Exp 2, from d 0 to 14, ADG increased linearly (P<0.02; 794, 839, 825, 853, and 839 g/d) and gain/feed increased quadratically (P<0.05; .53, .58, .56, .59, and .57) with increasing available P. There were no differences (P>0.69) in ADFI. From d 14 to 26 or overall, there were no differences in growth data between treatments. There were no differences (P>0.66) in bone properties for MT4; however, strain for MT3 was quadratic (P<0.05) with increasing levels of available P (.80, .71, .73, .69, and .79). Bending moment increased (P<0.01) for both the 6th rib (18.7, 25.5, 24.8, 27.7, and 27.6 kg-cm) and femur (289, 338, 319, 339, and 338 kg-cm) with increasing available P. These results indicate that 0.6 aP/Mcal of ME is adequate to promote growth and maintain bone strength for finishing pigs from 33 to 55 kg. This is equivalent to 8 g/d of total P or 3.2 g/d of available P.

Key Words: Phosphorus, Bone Strength, Pigs

178 Effect of zinc oxide and copper sulfate interactions with sodium chloride in nursery pig diets.

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Previous research suggested that the addition of NaCl to nursery diets improved pig performance, largely due to the Cl ion improving N digestibility. Other research has demonstrated that the addition of dietary zinc oxide or copper sulfate can also enhance pig growth during the postweaning period. Because the Cl ion can alter the pH in the intestinal tract, it could affect the microbial population and mineral status in the intestinal tract. Therefore an experiment was conducted using a 2 X 2 X 2 factorial arrangement in a RCB design conducted in 5 replicates to evaluate if an interaction exists between added dietary levels of NaCl (0 or 0.30%), zinc oxide (0 or 2000 ppm) or copper sulfate (0 or 250 ppm). A total of 176 pigs weaned at 17±2 d of age averaged 6.27 kg BW, and were housed with 4 to 5 pigs per pen in an off-site nursery. Diets for Phase 1 (0-14 d) and Phase 2 (14-28 d) were formulated using feeds typically used for nursery pigs. Dietary treatment levels of NaCl, zinc oxide and copper sulfate were constant during the 28 d trial period. The results showed that the addition of NaCl had no effect (0 vs 0.30%) on daily gain, feed intake or gain: feed ratio. Zinc oxide at 2000 ppm did appear to improve daily gain and daily feed, particularly during the initial 0-14 d period, but responses were not significant (P > 0.15), nor

was there a response during the Phase 2 period. There was an interaction ($P < 0.05$) between NaCl and zinc oxide where an improved daily gain occurred when diets were without added NaCl, but when NaCl was added, the response to zinc oxide was not present. Copper sulfate improved daily gains ($P < 0.01$) during both the 0-14 and 14-28 d periods. There was an interaction between NaCl and copper sulfate where daily gains were improved more ($P < 0.05$) during each phase when added NaCl was provided. No interaction occurred between zinc oxide and copper sulfate. These results suggest that the dietary level of NaCl may influence the performance responses to zinc oxide or copper sulfate.

Key Words: Salt, Zinc, Copper

179 Evaluating growth performance, plasma and feces of nursery pigs fed organic zinc polysaccharide complex.

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This experiment was conducted to evaluate the effects of feeding titrated concentrations of organic zinc in the form of a polysaccharide complex (SQM-Zn: Quali Tech, Inc., Chaska, MN) on growth performance, plasma Zn and Cu concentrations, and fecal Zn and Cu excretion of nursery pigs. One hundred ninety eight crossbred (PIC: C22 X TF4) pigs were weaned (17 2 d of age; avg. wt. 5.6 .02 kg) and allotted to dietary treatment based on weight and sex. Pigs were housed in an environmentally regulated building with 3 pigs/pen (1.2 x 1.2 m) and 11 pens (replications)/treatment. The experimental Phase 1 nursery diet was fed as crumbled pellets from d 0 to 14. Common diets were fed during Phase 2 (d 15 to 28) and Phase 3 (d 29 to 42). Total lysine concentrations were 1.5 % in Phase 1, 1.25 % in Phase 2, and 1.1 % in Phase 3. All dietary phases contained 135 ppm Zn as $ZnSO_4$, 165 ppm Fe as $FeSO_4$, and 16.5 ppm Cu as $CuSO_4$. Pigs were bled on d 14 to measure plasma Zn and Cu concentrations. The Phase 1 diet utilized 6 dietary Zn treatments: (1) 135 ppm Zn as $ZnSO_4$, (2) 125 ppm Zn as SQM-Zn (organic polysaccharide complex), (3) 250 ppm Zn as SQM-Zn, (4) 375 ppm Zn as SQM-Zn, (5) 500 ppm Zn as SQM-Zn, and (6) 2,000 ppm Zn as ZnO. Pigs fed 2,000 ppm Zn as ZnO had higher ($P<.03$) ADG during Phase 2 (d 15 to 28) compared to pigs fed the control or SQM-Zn treatments. During Phase 1, Phase 3 and over the entire 42-d study, pigs had similar ADG ($P>.05$). Dietary treatment had no affect ($P>.05$) on ADFI and feed efficiency in any phase of the experiment. Pigs fed 2,000 ppm Zn as ZnO had the highest plasma Zn concentrations ($P<.01$) compared with all other treatments. Plasma and fecal Cu concentrations were not affected ($P>.05$) by Phase 1 dietary Zn treatments. At the end of Phase 1, pigs fed 2,000 ppm Zn as ZnO had the highest fecal Zn excretion (g/d and %; $P<.0001$) compared to the other dietary treatments. These results indicate that feeding lower concentrations of Zn may not affect nursery pig performance, but will reduce the amount of Zn excreted.

Key Words: Zinc, Copper, Pigs

180 Iron bioavailability of humate in young pigs.

S. W. Kim*, L. E. Hulbert, H. A. Rachuonyo, and J. J. McGlone, *Texas Tech University*.

Humate is derived from mineral humic substances that include several biologically active and inactive compounds which are commonly used for improving soil fertility. Use of humate in swine diets is a relatively new concept. A series of research projects has been conducted to evaluate the efficacy of humate as a feed additive for swine. As a first approach, a study was conducted to test the bioavailability of iron in humate for nursery pigs. Humate contained 8,700 ppm of iron as determined by atomic absorption spectrophotometry. One hundred fifty pigs (Newsham, Colorado Springs, CO) were not given supplemental iron while nursing for 21 d. Pigs were weaned on d 21 and allotted to five treatments (four control treatments with different levels of supplemented iron; 0, 12, 54, and 69 ppm from FeSO4 and one treatment with 88 ppm iron from humate). Pigs were fed diets for 5 wk ad libitum and water was accessible freely. Body weight and feed intake were measured weekly. Blood samples were taken from pigs on d 28 to determine the number of red blood cells and hemoglobin concentration. Pigs fed a diet with the humate grew faster ($P < 0.05$) during the first week postweaning, but performance was not different during the entire period. Feed intake and gain:feed ratio were the same among treatments. Slope ratio technique was used for the data analysis. The concentration of blood hemoglobin did not respond to dietary iron levels using this model. However, the number of red blood cells (106/L) was modeled by 4.438 + 0.017 x ⁄Fe (ppm) from FeSO4⁄ + 0.012 x ⁄Fe (ppm) from the humate⁄. Based on the comparison between the slopes (0.012/0.017), iron in humate was 71% as available as the iron in FeSO4. However, there was no difference between the slopes for dietary FeSO4 and humate iron ($P > 0.05$). Humate can replace FeSO4 as an alternative iron source for pigs at 71% relative bioavailability.

Key Words: Nursery Pigs, Iron Bioavailability, Humate

181 Timing of magnesium supplementation through drinking water to improve fresh pork quality.

B. R. Frederick*, E. van Heugten, and M. T. See, *North Carolina State University*.

Thirty-two pigs were used to determine the timing effect of Mg supplementation through drinking water on fresh pork quality. Pigs (16 castrated males, 16 females) were individually penned, provided 2.7 kg of feed (0.12% Mg) daily, and allowed free access to water via a nipple waterer for the duration of the study. After 5 d of adjustment, pigs (119 ± 4 kg BW) were randomly allotted by weight and sex to 900 ppm supplemental Mg in drinking water for 0, 2, 4, or 6 d prior to slaughter. Pigs were then transported, approximately 110 km, to the abattoir and slaughtered approximately 45 min after arrival. At 24 h post-mortem, *Longissimus dorsi* and *Semimembranosus* chops were placed on Styrofoam trays with absorbent pads and wrapped in oxygen permeable film for retail fluid loss and color determination at 0, 2, 4, 6, and 8 d of storage at 4°C. Approximately 60 g of each muscle was suspended in a covered plastic container, stored for 48 h at 4°C to determine drip loss. Magnesium did not affect loin pH at 45 min or 24 h post-mortem. However, ham pH tended to be greater in pigs offered Mg supplementation for 2 d than those not supplemented, 5.71 vs. 5.62 ± 0.03, respectively ($P = 0.08$). Drip loss from the loin (3.29, 2.46, 3.16, and 3.55 ± 0.42%) and ham (3.33, 3.26, 3.83, and 3.36 ± 0.30%) were not affected by Mg supplementation for 0, 2, 4, and 6 d, respectively. Furthermore, loin retail fluid loss was not affected by Mg supplementation during retail storage. However, ham retail fluid loss from pigs provided supplemental Mg for 2 d, but not 4 or 6 d, was lower after 4 d (4.15 vs. 6.08 ± 0.52%, $P < 0.05$) and 8 d of storage (6.25 vs. 8.22 ± 0.62%, $P \leq 0.05$) than pigs without Mg supplementation. Minolta L∗, a∗, and b∗ color measurements of the loin were not affected by Mg supplementation. Magnesium supplementation for 2 d, but not 4 or 6 d, decreased initial yellowness (b∗) of the ham compared to no added Mg, 6.85 vs. 8.95 ± 0.59 ($P < 0.04$). These data suggest Mg supplementation through drinking water for 2 d can improve color and reduce retail fluid loss of ham.

Key Words: Pork Quality, Magnesium Sulfate, Water

182 Effects of ractopamine dose and feeding duration on pig performance 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 evaluate the impact of ractopamine HCl (Paylean®, Elanco Animal Health) dose and feeding duration on growth performance and carcass composition. Forty-five pens (1,035 gilts; initially 103.2 ± 0.62 kg) were alloted to one of 9 treatments. Treatments included pigs fed 5 or 10 ppm ractopamine for the last 7, 14, 21, or 28 days prior to market and a control treatment without ractopamine. There were 23 pigs per pen and 5 pens per treatment. Diets were corn-soybean meal based, formulated to contain .75 and 1.00 % total dietary lysine for the control and ractopamine supplemented diets, respectively. At slaughter, fat and loin depth were measured to calculate lean percentage. Daily gain (0.66, 0.76, 0.77, 0.77 kg/d for 5 ppm and 0.78, 0.81, 0.78, 0.80 kg/d for 10 ppm for 7, 14, 21, or 28 d) and feed efficiency (G:F; 0.27, 0.31, 0.31, .30 for 5 ppm and .31, .32, .31, .31 for 10 ppm for 7, 14, 21, or 28 d) were increased ($P\leq.04$) for pigs fed 5 ppm ractopamine for 14, 21, or 28 days as well as pigs fed 10 ppm for all durations compared to the control (ADG, 0.60 kg/d; G:F, 0.25). The 5 ppm, 7 day treatment was intermediate in both daily gain and feed efficiency. Ractopamine dose (5 vs.10 ppm) did not affect ($P\geq.16$) carcass parameters measured. Fat depth decreased (16.3, 15.7, 15.3, 14.8 ± .36 mm) and lean percentage (56.0, 56.6, 56.8, 57.0 ± .15%) increased linearly ($P\leq.01$) as ractopamine feeding duration increased from 7 to 28 days. However, the control treatment was intermediate to all other treatments. Ractopamine feeding duration did not affect ($P\geq.93$) yield (76.9, 76.9, 77.0, 76.7 ± .3 %) or loin depth (67.7, 67.1, 67.4, 67.7 ± 1.5 mm). Feeding

ractopamine supplemented diets at 5 ppm 14 to 28 days and 10 ppm 7 to 28 days prior to slaughter improved growth rate and feed efficiency. Ractopamine feeding duration (in conjunction with increased dietary lysine level) also linearly reduced fat depth and increased lean percentage in this study.

Key Words: Ractopamine, Dose, Duration

183 Effect of ractopamine (Paylean®) feeding program on growth performance and carcass value. M. T. See*[1], T. A. Armstrong[2], and W. C. Weldon[2], [1]*North Carolina State University,* [2]*Elanco Animal Health.*

To determine if ractopamine (RAC) response can be enhanced by changing the levels in the diet during different phases of feeding, 100 barrows and 100 gilts (initial BW = 71 kg) were randomly allotted to one of four dietary treatments. Treatments were: 1) Control diet containing no RAC wk 0-6; 2) Step-up RAC: 5 ppm wk 1 and 2; 10 ppm wk 3 and 4; and 20 ppm wk 5 and 6; 3) Step-down RAC: 20 ppm wk 1 and 2; 10 ppm wk 3 and 4; and 5 ppm wk 5 and 6; and 4) Average RAC: 11.7 ppm wk 0-6. All diets were formulated to contain 1.2% lysine. Overall, ADG was increased (1.0 vs. .93 kg/d; $P < .05$) and feed/gain decreased (2.77 vs. 3.21; $P < .01$) for pigs fed RAC compared to the control. Feed cost/kg gain did not differ between dietary treatments but total feed cost/pig was greater ($21.67 vs. $19.44; $P < .01$) for pigs fed RAC. Loin muscle area, kg of boneless trimmed ham and % fat free lean increased ($P < .01$) in pigs fed RAC. Carcass value was calculated using a common North Carolina pricing system and lean value of the carcass was based on USDA reported prices for boneless pork primal cuts. When value was adjusted to a common final weight, carcass value/pig did not differ ($P > .10$) among treatments but lean value/head was increased by $4.69 ($P < .01$) for pigs fed RAC. When value was not adjusted for final weight allowing a comparison of equal time on feed, a treatment x sex interaction ($P < .01$) was observed for carcass value with control gilts having the least value ($114.86) and barrows fed the average RAC treatment having the greatest value ($132.07) but not significantly different from control barrows ($130.59). Lean value per head was greater for the Step-up and Average RAC treatments than the Step-down or Control ($129.27^a, $128.11^a, $127.35^b, $123.49^c; $P < .01$) treatments. Ractopamine resulted in a favorable response in growth performance and yielded more lean pork at a greater feed cost. Carcass and lean value data indicate that the decision to feed RAC and the feeding program used with it should be made based on marketing plans. Economic benefits from RAC feeding may be achieved if pigs are sold on pounds of lean pork and not on a typical carcass value basis. Economic benefits of RAC feeding may also be achieved for pigs fed to a constant age rather than a constant weight.

Key Words: Ractopamine, Growth Performance, Economics

184 Evaluation of the effects of dietary fat, conjugated linoleic acid, and ractopamine on growth performance and carcass quality in genetically lean gilts. T. E. Weber*, B. T. Richert, and A. P. Schinckel, *Purdue University.*

Gilts (n=180; Newsham XL sires x Newsham parent females; initial BW 59 kg) were assigned to a 2 x 2 x 3 factorial arrangement consisting of ractopamine (RAC; 0 or 10 ppm), conjugated linoleic acid (CLA; 1% of a product containing 60% CLA isomers or 1% soybean oil) and dietary fat in an 8 wk feeding trial. Dietary fat treatments consisted of : 1) 0% added fat; 2) 5% choice white grease (CWG); and 3) 5% beef tallow (BT). RAC treatments were imposed when the gilts reached an average BW of 85.5 kg and lasted for the duration of the final 4 wk until carcass data were collected at an average BW of 112 kg. Gilts fed CLA had greater (0.40 vs 0.38; $P < 0.01$) G/F wk 0 to 8 than gilts not fed CLA. Fat provided as CWG or BT tended to increase ADG (0.98 vs 0.95 kg; $P < 0.10$), decreased ADFI (2.45 vs 2.55 kg; $P < 0.02$) and increased G/F ($P < 0.01$) as compared to gilts fed 0% added fat. RAC increased ADG (1.05 vs 0.87; $P < 0.01$) and G/F (0.42 vs 0.35; $P < 0.01$) wk 4 to 8. Gilts fed RAC had greater ($P < 0.01$) dressing percentages than gilts fed no RAC. Added dietary fat tended ($P < 0.06$) to increase dressing percentage. Tenth rib backfat (BF) tended ($P < 0.06$) to be decreased by feeding CLA. Gilts fed RAC tended ($P < 0.10$) to have lower 10th rib BF than gilts fed diets devoid of RAC. Gilts fed CWG had greater ($P < 0.05$)10th rib BF and last rib BF than gilts fed BT. Feeding RAC increased (57.8 vs 56.2; $P< 0.01$) predicted percent lean. Predicted percent lean was also increased by feeding CLA (57.5 vs 56.5; $P < 0.03$) Gilts fed CLA tended to have greater loin eye areas (LEA; $P < 0.06$) than gilts fed no CLA. Feeding RAC or 5% fat increased ($P < 0.01$) LEA. Gilts fed either CLA or fat tended ($P < 0.10$) to have greater marbling scores than gilts fed diets devoid of CLA or fat. Gilts fed CLA had greater ($P < 0.01$) belly firmness than gilts fed no CLA. These results demonstrate that RAC, CLA, and added fat each enhance certain growth performance and carcass characteristics when used alone or in conjunction with one another.

Key Words: CLA, Ractopamine, Dietary Fat

185 Effects of ractopamine and carnitine in diets containing 5% fat for finishing pigs. S. A. Trapp*[1], B. T. Richert[1], A. P. Schinckel[1], and K. Q. Owen[2], [1]*Purdue University, West Lafayette, IN,* [2]*Lonza, Inc., Fair Lawn, NJ.*

To study the effect of ractopamine (RAC) in conjunction with carnitine in elevated fat diets, three hundred gilts (avg. initial BW = 85.4 kg) of two terminal crosses (European, ET; and US, UST) were assigned diets fed for the last four weeks before slaughter. Five dietary treatments (TRT) were used: 1) control; 2) 50 ppm carnitine; 3) 5 ppm RAC; 4) 50 ppm carnitine and 5 ppm RAC; and 5) 10 ppm RAC. All diets were formulated to 1.15% lysine and contained 5% added choice white grease. The gilts were weighed and feed intake was recorded on d 0, 14, and 28. In addition, 3 gilts/pen (36/TRT) were ultrasonically scanned on d 0, 14, and 28 for backfat and loin eye area to estimate composition and tissue accretion curves. Individual hot carcass weight and carcass ultrasound of loin and backfat depth measurements were taken at a commercial pork processor. Pigs fed TRTs 4 and 5 had greater ADG during d 0-14 (834, 866, 952, 1052, 1073 g/d, $P<.001$, TRTs 1-5, respectively) and d 0-28 (854, 845, 907, 960, 943 g/d, $P<.01$, TRTs 1-5, respectively) compared to pigs fed treatments 1 and 2. No difference was found in ADFI between diets. Gilts fed TRTs 3, 4, and 5 had greater gain:feed ($P<.01$) from d 0-14 (375, 379, 430, 451, 466 g/kg, TRTs 1-5, respectively) and d 0-28 (357, 348, 391, 399, 398 g/kg, treatments 1-5, respectively) compared to pigs fed TRTs 1 and 2. Pigs fed diets with RAC had increased carcass loin depths (67.8, 66.4, 70.6, 70.5, 71.7 mm; $P<.05$, TRTs 1-5 respectively). However, only TRTs 3 and 5 had increases in plant measured percent lean ($P<.01$) compared to the other TRTs. The UST gilts tended to have greater ADG d 0-28 (922 vs 885 g/d; $P<.07$), but had increased plant fat depth (15.5 vs 13.4 mm; $P<.001$) with reduced plant percent lean (56.0 vs 56.6%; $P<.01$) and reduced carcass yield (75.2 vs 76.1%; $P<.01$) compared to the ET gilts. This data indicates that during the first 14 days while feeding ractopamine, carnitine may enhance the ractopamine response with increased body weight gain and improved feed efficiency.

Key Words: Carnitine, Ractopamine, Pigs

186 Interactive effects between Paylean® (Ractopamine HCl) and dietary lysine on pork quality and loin, belly, and ham composition. M. J. Webster*, R. D. Goodband, M. D. Tokach, J. A. Unruh, J. L. Nelssen, S. S. Dritz, D. E. Real, J. M. DeRouchey, J. C. Woodworth, and T. A. Marsteller[1], *Kansas State University, Manhattan, KS,* [1]*Elanco Animal Health, Indianapolis, IN.*

A total of 432 pigs was used to evaluate the effects of Paylean and dietary lysine on pork quality and loin, belly, and ham composition. The 12 dietary treatments included Paylean (0, 5, and 10 ppm) and 4 levels of lysine. For pigs fed no Paylean, lysine levels were 0.6, 0.8, 1.0, and 1.2%. For pigs fed Paylean, lysine levels were 0.8, 1.0, 1.2, and 1.4%. The dietary treatments were fed to pigs from 79 to 109 kg. There were three pigs per pen and 12 pens per treatment (six pens of each sex). One pig per pen was harvested on d 14 and d 28 of the experiment. At 24 h postmortem, carcasses were fabricated into the primal cuts. After a 30 min bloom, the loin surface at the 10^{th} rib was analyzed for color (Hunter $L^*a^*b^*$ values), drip loss, ultimate pH, visual color, firmness, and marbling. After spareribs were removed and the belly trimmed, belly firmness was evaluated by suspending the belly perpendicularly over a bar (skin side up) and the distance was recorded between the belly ends initially and after a five-minute period. A sample from each loin (9^{th} rib), ham (biceps femoris), and belly, from the same anatomical region, was collected, frozen, and analyzed for protein, lipid, ash, and moisture content. For the endpoint data, increasing Paylean decreased (linear, $P< .0001$) initial and 5-minute belly firmness. Visual marbling score decreased (linear $P < .05$) as lysine increased for pigs

fed Paylean. As Paylean dosage increased, loin fat percentage decreased (linear, P< .04) and loin crude protein percentage increased (linear, P< .01). In addition, as Paylean dosage increased, belly moisture and crude protein percentage increased (linear, P < .05) while belly fat percentage decreased (linear, P< .001). The results indicate that pigs fed Paylean and increasing levels of lysine will have less loin marbling and belly firmness compared to control pigs.

Key Words: Paylean®, Lysine, Finishing Pigs

187 Interactive effects between Paylean® (Ractopamine HCl) and dietary lysine on finishing pig growth performance, carcass characteristics and tissue accretion. M. J. Webster*, R. D. Goodband, M. D. Tokach, J. A. Unruh, J. L. Nelssen, S. S. Dritz, D. E. Real, J. M. DeRouchey, J. C. Woodworth, and T. A. Marsteller[1], *Kansas State University, Manhattan, KS,* [1]*Elanco Animal Health, Indianapolis, IN.*

A total of 432 pigs was used to evaluate the effects of Paylean and dietary lysine on finishing pig growth performance, carcass characteristics and tissue accretion. The 12 dietary treatments included Paylean (0, 5, and 10 ppm) and 4 levels of lysine. For pigs fed no Paylean, lysine levels were 0.6, 0.8, 1.0, and 1.2%. For pigs fed Paylean, lysine levels were 0.8, 1.0, 1.2, and 1.4%. Dietary treatments were fed from 79 to 109 kg. There were three pigs per pen and 12 pens per treatment (six pens of each sex). Pigs were weighed and feed disappearance was recorded every 7 d for the 28 d period. One pig per pen was harvested on d 14 (midpoint) and d 28 (endpoint) of the experiment. Carcass parameters were taken at 24 h postmortem and one side of each carcass was ground and sampled for proximate analysis. At the beginning of the experiment, twelve pigs (6 of each sex) were harvested, ground, and sampled for proximate analysis. In the 28 d period, there was an increase (linear, P<.001) in ADG and G/F as Paylean increased. For pigs fed Paylean, increasing dietary lysine increased and improved (quadratic, P<.07 and P<.04) overall ADG and G/F, respectively. Pigs fed increasing Paylean had increased (linear, P<.01) live weight, yield, hot, and cold carcass weights, lean percentage, and loin eye area. Furthermore, as Paylean levels increased, leaf fat, tenth rib backfat, and average backfat thickness decreased (linear, P<.01). Additionally, by adding Paylean or lysine to the diet, there was an increase (linear, P<.0001 and quadratic, P<.02, respectively) in moisture and protein accretion and a decrease (linear, P<.01) in fat accretion. The results indicate that pigs fed Paylean need at least 1.0% dietary lysine to optimize growth, carcass parameters, and tissue accretion.

Key Words: Paylean®, Lysine, Finishing Pigs

188 Effects of lysine and energy density of performance and carcass traits of finishing pigs fed ractopamine. D.C. Brown*[1], J.K. Apple[1], C.V. Maxwell[1], K.G. Friesen[1], M.E. Davis[1], R.E. Musser[2], Z.B. Johnson[1], and T.A. Armstrong[3], [1]*University of Arkansas,* [2]*The Pork Group, Rogers, AR,* [3]*Elanco Animal Health, Greenfield, IN.*

A total of 216 crossbred barrows and gilts (Yorkshire x Landrace females mated to Dekalb EB sires) were used to test the effects of energy density (E) and lysine-to-energy ratio (Lys) on performance and carcass characteristics of finishing pigs fed ractopamine. Pigs, with an average initial BW of 84 kg, were blocked by weight and sex and assigned to one of 36 pens. Pens were randomly assigned to 1 of 6 dietary treatments arranged in a 2 x 3 factorial design, with two levels of E (3.30 or 3.48 Mcal/kg of ME) and three lysine-to-energy ratios (1.7, 2.4, or 3.1 g lysine/Mcal). Ractopamine was included in all diets at a level of 10 mg/kg, and pigs were fed the experimental diets for 28 d prior to harvest. Individual pig weights and feed disappearance were recorded weekly to calculate ADG, ADFI, and G:F. Upon completion of the feeding trial, pigs were transported to a commercial pork harvest/processing plant, and hot carcass weight (HCW) was recorded. After the 24 h chilling period, fat and LM depths at the 10^{th} rib were measured with a Fat-O-Meater, and used to calculate standardized lean yield (SLY). Overall main effects means are reported where no E x Lys interaction (P > 0.05) was observed. Results indicate that to optimize lean tissue deposition in pigs fed ractopamine, 3.3 Mcal/kg is sufficient energy ,and the Lys to energy ratio may be higher than reported in the literature and higher than levels currently utilized in the industry.

	Energy (Mcal/kg)			Lysine (g/Mcal)			
Item	3.30	3.48	SE	1.7	2.4	3.1	SE
ADG, kg	0.640	0.679	0.02	0.579	0.660	0.741[c]	0.03
ADFI, kg	2.15	2.08	0.04	2.12	2.13	2.09	0.05
G:F	0.298[a]	0.326[b]	0.01	0.272	0.310	0.355[c]	0.01
HCW, kg	78.3	78.5	0.50	76.3	79.5	79.2[c]	0.63
Fat depth, mm	19.1[a]	20.2[b]	0.39	20.7	19.3	19.0[d]	0.49
LM depth, mm	59.1	58.7	0.69	56.7	59.3	60.7[c]	0.85
SLY, %	51.4[a]	50.6[b]	0.30	50.1	51.2	51.7[c]	0.37

[ab]E effects (P < 0.05). [c]Linear Lys effect (P < 0.01).
[d]Linear Lys effects (P < 0.02).

Key Words: Swine, Ractopamine, Energy x Lysine Level

189 The efficacy of Paylean® (ractopamine hydrochloride) addition to late-finishing swine diets in a controlled cycling hot environment. J.D. Spencer*[1], C.A. Stahl[1], A.M. Gaines[1], D.C. Kendall[1], G.F Yi[1], J.W. Frank[1], E.P. Berg[1], D.J. Jones[2], and G.L. Allee[1], [1]*University of Missouri, Columbia, MO,* [2]*Elanco Animal Health, Greenfield, IN.*

To determine the efficacy of Paylean addition to late-finishing swine diets during high ambient temperatures, seventy-two barrows (Newsham x PIC 327) (81 kg) were utilized in a growth study with a 2 x 2 factorial arrangement of treatments with two controlled environments (constant 21^{o}C, 50% relative humidity (TN), or a cycling temperature 27 to 35^{o}C (HS)) and two levels of Paylean addition (0 or 10 ppm). Nutrient content was the same in both diets (1.15% lysine, 3513 kcal ME/kg). There were six replicate pens/treatment with three pigs/pen. Pigs were weighed and scanned via real-time ultrasound for measurement of 10^{th} rib backfat (BF) and loin eye area (LEA) weekly. Pigs were harvested at approximately 105 kg for pH and color measurement of the ham and loin. During the growth trial (d 0-26), there was no interaction between temperature and Paylean level (P > .15). HS reduced ADFI (HS vs. TN) (1.78 vs. 2.58 kg/d; P < .01), ADG (.54 vs. .88 kg/d; P < .01) and G:F (.30 vs. .34; P < .01). Paylean addition, independent of environmental temperature, improved ADG (0 vs. 10 ppm) (.67 vs. .75 kg/d; P < .09) and G:F (.30 vs. .34; P < .01). Paylean addition did not significantly affect feed intake (P > .10). Additionally, HS reduced BF accretion (+.05 vs. +.25 cm; P < .01) and LEA gain (+3.56 vs. +7.50 cm^2; P < .01). Paylean addition also reduced BF accretion (+.20 vs. +.10 cm; P < .08) but increased LEA gain (4.64 vs. 6.43 cm^2; P < .08), regardless of temperature. Paylean had no affect on meat quality. Hams and loins from pigs reared in the hot environment had a significantly higher ultimate pH (P < .05). Supplementing late-finishing swine diets with 10 ppm Paylean resulted in similar improvements in ADG (10 and 14%) and GF (14 and 18%) (TN, HS, respectively) in both environments. Paylean addition also reduced BF and increased LEA accretion in both environments with no affect on meat quality attributes.

Key Words: Swine, Ractopamine, Temperature

190 Effect of ractopamine on optimum dietary phosphorus regimen for pigs. T.R. Lutz* and T.S. Stahly, *Iowa State University, Ames, IA.*

Ten replications of individually-penned gilts from a high-lean strain were utilized to determine the effect of ractopamine (RAC) on the optimum dietary available phosphorus (AP) regimen. At 70 kg BW, pigs were randomly allotted to a corn-soybean meal basal diet (.08% AP) adequate in all nutrients except AP. The basal diet was supplemented with mono-dicalcium phosphate to create six AP concentrations (.08, .13, .18, .23, .28, .33%) and ractopamine HCL to create two RAC concentrations (0 vs. 20 ppm). A constant Ca/AP ratio of 2.5:1 was maintained in each diet. BW gain and feed intake were recorded weekly for 5 weeks and total urine output was collected via urinary catheter the last two days of each 7-day period. Over the five periods, RAC improved (P<.01) BW gain (1075 vs. 934 g/d) and gain/feed ratio (431 vs. 371 g/kg), but lowered (P<.01) P content of BW gain (4.66 vs. 4.05 g/kg) and urinary P excretion (219 vs. 67 mg/d) independent of dietary AP. The magnitude of change in BW gain and P content of BW gain was reduced in later periods of growth. Dietary AP additions also improved (P<.01) daily BW gains and P accretion, P content of BW gain, and efficiency of feed utilization (P<.07). To achieve maximum BW gain, the amount of AP needed was not altered by RAC. However, when defining P needs as

the inflection point at which urinary P excretion increases (as indicator of when absorbed P exceeds metabolic needs), an additional .05% to .15% AP was needed in RAC pigs depending on the stage of growth. To achieve the same P content of BW gain, an indicator of the adequacy of the bone mineral content of gain, an additional .05% AP was needed in the RAC pigs. Based on these data, RAC does not alter the amount of AP needed to optimize rate and efficiency of BW gain but does increase the AP needed to maintain P content of body growth equivalent to non-RAC pigs.

Key Words: Ractopamine, Phosphorus, Pig

191 Effect of nutritional levels while feeding ractopamine on carcass composition and growth. A. P. Schinckel*, C. T. Herr, D. C. Kendall, J. C. Forrest, and B. T. Richert, *Purdue University, West Lafayette, IN.*

Barrows (BW = 69.6 kg) were allotted by weight to evaluate the effects of dietary lysine levels while feeding ractopamine (RAC) on carcass composition and growth. Treatments (TRT) 1 and 2 were fed throughout the six-week trial, while TRT 3 changed weekly. Treatments were as follows: 1) 16% CP, .82% lys control diet; 2) 16% CP diet, .82% lys; 3) a phase fed diet sequence, 18% CP, 1.08% lys during wk 1 and 4, 20% CP, 1.22% lys during wk 2 and 3, 16% CP, .94% lys during wk 5, and a 16% CP diet .82% lys during wk 6. Diets for TRT 2 and 3 contained 20 ppm RAC. Diets for TRT 3 were designed to meet the predicted lys requirements. Pigs were marketed when the mean block weight reached 108.8 kg. Initial carcass composition was predicted from live weight and live ultrasonic tenth rib backfat, last rib backfat, and loin eye measurements. The four lean cuts from the right side of the carcasses (N = 15 per TRT) were dissected into lean and fat tissue. The other cut soft tissue was from the jowl, ribs, and belly. Proximate analyses were completed on the three tissue pools and a sample of fat tissue from the other cut soft tissue. Percent lipid was lower in the dissected lean (5.25, 5.39, and 4.44; TRT 1, 2, and 3 respectively) and other cut soft tissue (29.4, 27.9, 23.5) for TRT 3 pigs ($P < .05$). Pigs fed RAC had greater fat-free lean (39.4, 42.4, 46.5 kg; $P < .01$) and lipid free soft tissue mass (46.6, 49.5, 53.5 kg; $P < .01$). Pigs on TRT 3 had lower fat tissue (21.5, 21.3, 19.0 kg; $P < .05$) and soft tissue lipid mass (14.2, 14.2, 12.0 kg; $P < .05$) than TRT 1 pigs. Ractopamine and phase fed lysine increased fat-free lean gain (374, 448, 563 g/d; $P < .01$) and lipid-free soft tissue gain (431, 501, 613 g/d; $P < .01$). Pigs from TRT 3 had decreased fat tissue gain (242, 221, 177 g/d; $P < .05$) and soft tissue lipid gain (155, 142, 97 g/d; $P < .05$) than TRT 1 pigs. This trial indicates that carcass tissue and compositional growth are affected by both the dietary lysine and RAC levels.

Key Words: Pigs, Ractopamine, Carcass Tissue Growth

192 Development of a swine growth model to describe the compositional growth of pigs fed ractopamine. A. P. Schinckel*, N. Li, P. V. Preckel, B. T. Richert, and M. E. Einstein, *Purdue University; West Lafayette, IN.*

The objective of this research was to utilize recent ractopamine (RAC) research data and develop an updated growth model to describe the daily growth of pigs fed RAC. Six parameters were taken into account. Increases of 19.4, 22.6, and 26.2% for daily protein accretion (PA) were assumed for 5, 10, and 20 ppm RAC level (RL, ppm) for an overall 40 kg feeding period. The relative ractopamine response (RR) described the rapid increase and subsequent decline in the RAC response as a function of weight gain on test (BWG). The reduction in feed intake was modeled as .04 $(RL/20)^{.7}$ for the first 20 kg of BWG and then increasing to .08 $(RL/20)^{.7}$ at 40 kg BWG on RAC. The ratio of fat-free lean gain to PA was modeled to increase an average of 14.1% over the 40 kg feeding period; and to increase slightly when lysine and essential amino-acid requirements were met. The ratio of carcass fat gain to empty body lipid gain was modeled to increase when lysine and essential amino-acid levels were met. The model predicted the PA and fat free lean given the dietary lysine intakes. The percent lysine in PA was model to increase with the feeding of RAC from 6.8 to about 7.2% depending on RAC level and BWG. Equations predicting carcass measurements such as fat depth and loin muscle depths were modified to incorporate prediction biases produced by RAC. The model was compared to recent research results. The model predicted changes for a 28 d feeding period starting at 78 kg in the growth rate (1.01, 1.13, 1.14, and 1.15 kg/d), feed efficiency (0.37, 0.41, 0.42, and 0.43), dressing percentage (74.9, 76.1, 76.3, and 76.6), and percent fat-free lean (49.4, 51.1, 51.6 and 52.2), loin muscle area (38.3, 42.3, 43.1, 44.1 cm^2), 10th rib fat depth (20.8, 19.8, 19.5, and 19.0 mm), fat free lean gain (325, 443, 465, 492 g/day) comparable to recent research data for 0, 5, 10, and 20 ppm. The model allows the RAC response to be added to farm specific pig growth curves.

Key Words: Pigs, Ractopamine, Compositional Growth

193 Managing the gilt for maximum lifetime production. G. R. Foxcroft*, J. Patterson, H. Willis, and F. Aherne, *Swine Research and Technology Centre, Edmonton, Alberta, Canada.*

Two key issues need to be considered in the selection and conditioning of gilts for entry to the breeding herd. Firstly, their inherent genetic merit for reproductive traits. Secondly, environmental influences that might affect gilt development and subsequent reproductive performance. Development of specific dam-line females has addressed the first issue, but this has occurred against ongoing selection pressure for growth and carcass traits that may have indirect and negative outcomes for breeding performance. Nevertheless, the performance of contemporary dam-line females is impressive, given the increases in lean growth performance of their offspring. Litter of origin has a major impact on subsequent reproductive performance and the physiological basis for these differences seem to be as diverse as those reported for genotypes with differences in embryonic survival. However, the uterine environment in which the gilt develops, as much as inherent genetic merit of littermate females, may influence sexual maturation and subsequent fertility. Postnatal nutrition, and interactions between growth, puberty onset, and lifetime reproductive performance have been extensively studied. A minimum growth threshold exists, below which growth and metabolic state will delay the onset of boar-induced puberty. More limited data suggest an upper threshold, above which very high growth rates may also delay the onset of puberty. Within these growth thresholds, there is no consistent evidence that any particular age or weight at breeding confers a production advantage in terms of lifetime reproductive performance; however, potential economic and welfare disadvantages of breeding at heavier weights need to be considered. The well documented benefits of identifying, and capitalizing on, early sexual maturation to enhance lifetime performance, provide a convincing case for important refinements in gilt management.

Key Words: Gilt, Management, Reproduction

194 Relationship of protein and amino acid nutrition to reproduction in sows. R.D. Boyd*, M.E. Johnston, and R.A. Cabrera, *PIC USA, Inc. Franklin KY.*

Prolific females require better nutrition and feeding practice because of larger litter size. Life-time pig output will be compromised if body protein and fat are not properly managed. First litter females are especially vulnerable because thay can lose $\geq$15% of whole body protein. Conservation of body protein mass during first lactation minimizes wean to estrus interval and increases second litter size by up to 1.2 pigs per litter. The ability to influence litter-size by amino acid nutrition is a new dimension in our understanding. Nutritional strategy during first pregnancy may impact reproductive ability for first litter females since there appears to be a minimum body size needed to support a rapid return to estrus. Nutrient needs increase exponentially in late pregnancy. An increase in feed level will prevent loss of maternal body protein that would otherwise be mobilized to support fetal and mammary growth. Nitrogen retention is estimated to increase from 9-10 g/d at mid-pregnancy to 17-18 g/d in late pregnancy. In a recent study, first litter females averaged 9.82 kg milk/d for a 21 day lactation. Second and third litter sows averaged 10.35 kg/d. Milk production was 95% of peak by day 10 of lactation and sows were in greatest negative lysine balance during the first 6 days. Nearly 45% of the total loss in body protein occurred within the first 6 days. This could be reduced to 30-35% by using a more aggressive feeding strategy after parturition. There appear to be 2 phases in lactation for lysine need (day 2-12 *vs* 12-21). The lysine requirement for lactation can be predicted with accuracy, but we are not able to predict the second limiting amino acid. Threonine and valine could be co-limiting for corn-soy diets for prolific sows nursing 10-11 pigs. Empirical studies are needed to refine the ideal pattern so that synthetic lysine can be used with more confidence. A phase feeding strategy during pregnancy and lactation is advised.

Key Words: Sow, Nutrition, Amino Acids

195 Relationship of carbohydrate and lipid nutrition to reproduction in sows. Bas Kemp* and Henry Van den Brand, *Wageningen University, Wageningen, The Netherlands*.

Due to the high demands for milk production and a low feed intake capacity, sows lose considerable amounts of body reserves during lactation. Especially in the first litter sow this results in an impaired reproductive functioning after lactation. One approach that has been followed to reduce mobilisation of body stores is increasing the dietary fat content. Several reviews state that ME intake can be increased by about 3-32% when using high fat diets. However, fat as an energy source also seems to increase milk fat content. To study the effects of high fat diets on partitioning of energy over sows and piglets our laboratory has conducted several experiments in which fat and carbohydrate rich diets were compared. Generally, it was found that high fat diets increase fat content of the milk, result in fatter piglets at the end of lactation and result in an increased body fat loss in the sows when diets are fed on an isocaloric basis. Fat rich diets may be beneficial in a hot climate since heat production of sows is lower when fat is used for milk production instead of carbohydrates. However the milk fat driving effect of the fat rich diet makes it unlikely that fat rich diets will help the sow to prevent loss of body condition even when the energy intake is higher. It may be that carbohydrate rich diets would positively influence reproductive characteristics of sows during lactation. Carbohydrate rich diets stimulate insulin and IGF-1 production and these hormones are believed to stimulate LH release from the pituitary gland and to stimulate growth of follicles. In the catabolic first litter sow, however, insulin stimulating diets fed during lactation only resulted in small effects on reproductive characteristics like LH release during and after lactation, peri-ovulatory reproductive hormone profiles, ovulation rate and embryonic survival. However, after weaning, feeding of carbohydrate rich diets instead of a fat-rich diet can result in a shorter weaning to estrus interval.

Key Words: Nutrition, Reproduction, Sows

196 Feeding and managing the boar for optimal reproductive capacity. M. E. Wilson*, *Minitube of America, Inc.*

Breeding boars and AI boars are a relatively small part of the pig population. Because of this fact, little attention and testing has been done to determine the specific dietary needs of working boars. This paper will review the limited published nutritional data with boars and try to correlate this with field studies on nutrition and management that have been conducted by industry to impact optimal production of the boar. One key to profitability in a boar stud is feeding a diet that allows boars to produce large quantities of high quality semen and maintain respectable body condition and soundness. Restricted feeding programs are used to maintain boars for semen collection over a longer period of time. Since boar turnover in most studs is relatively rapid due to replacement with higher indexing boars, the restricted feeding program may not provide the best economic return for the boar stud. Increasing feed intake has a positive effect on sperm production while severe restriction adversely affects sperm output and libido of the boar. Boars that gain weight will have higher sperm production than boars maintaining or losing weight. A body condition score of 3 on a scale from 1-5 is desirable. Factors of production such as age, collection frequency, ambient temperature, genetics, and health status all have an important impact on making nutritional decisions regarding the boar diet. It is still important to take care of the basics when evaluating boar nutrition. Further investigation is required regarding the influence of nutrition on sperm production under different environmental conditions. More concerted effort is needed to research techniques to track fertility of semen in relationship to dietary ingredients. The role of fatty acids, such as DHA, appears to have an effect on fecundity in sows when they are inseminated with semen from boars fed specific fatty acid supplements. It is important to find these correlations to fertility to justify costs of specialty ingredients going into boar diets.

Key Words: Boar, Nutrition, Sperm Output

197 Feeding management of the breeding herd: A systems approach. D. S. Pollmann*, *Murphy Farms, LLC, Ames, IA*.

Although nutritional concepts that affect sow productivity are commonly researched, the implementation of science-based feeding programs for the breeding herd is a major challenge, especially in large-scale pork production systems. Numerous factors (facility design, feed delivery systems, genetic differences, varying seasonal challenges, program variances and interpretation of the prescribed standard operating procedures) add to the complexity of implementation of well-managed feeding programs. Key performance indicators will be discussed as monitoring tools to ensure that the desired feeding program is effectively implemented. Commonly observed symptoms due to marginal gestation and lactation feeding program implementation will be discussed. Nutritional recommendations will be provided on feeding programs for gilt development, prebreeding strategies, and ways to enhance feeding during gestation, lactation, and post-weaning. Methods will be reviewed of effective ways to have production personnel understand the science of the nutritional programs and the importance of monitoring and adhering to the prescribed feeding programs. The blending of known nutritional concepts in a labor efficient and easily understood feeding program is of critical nature for successful pork production. The true value of well-conducted research is the ability to enhance productivity and profitability.

Key Words: Breeding Herd Nutrition, Sow Productivity, Feeding Program Implementation

Odor And Nutrient Management

198 Intrinsic phytase reduces excretion of volatile organic compounds in pigs. A. Woldeghebriel*[1], A Koenigsfeld[1], and A. Mathew[2], [1]*Lincoln University, Jefferson City MO,* [2]*University of Tennessee, Knoxville TN*.

A study involving three wk-old pigs (n=84) was conducted to evaluate the efficacy of intrinsic phytase (IP) from wheat middlings (WM) on BW gain of pigs, and ammonia and VFA excretion in feces. IP was provided by substituting 25% of WM for an equal part of corn in the corn-soybean meal based diets. The pigs were housed in pens (7/pen), with diets randomly assigned to pens (3 pens/diet). Diets used were:corn soybean meal-based control diet (D-1), D-1 plus microbial phytase (MP; Natuphos, 1,200 PU/g; D-2), D-1 plus IP (D-3), and D-3 plus MP (D-4). The diets were also designated as either low (D-1 and D-2), or high (D-3 and D-4) fiber diets. Feed was offered once/d on a regular (D-1, D-3) or, phase-fed (D-2, D4) basis with free access to water 24 h/d. Fresh fecal samples collected from pens were used to determine VFA, and ammonia concentrations. Results from the study indicated that pigs fed diets containing MP consumed more feed (P<.05), gained faster (P<.05), and were 14.5% more efficient than D-1 fed pigs. Pigs fed high-fiber diets with/without MP consumed more, and gained faster (P<.05) than D-1 fed pigs. VFA concentration in feces from pigs fed D-1 or D-2 was greater (P< .01) than in pigs fed D-3 or D-4. Also, VFA in feces from pigs fed D-4 was greater (P<.01) than in D-3 fed pigs. The level of ammonia in feces within each fiber category was not affected by treatment. However, ammonia in feces from pigs fed D-3 or D-4 was greater (P< .05) than from pigs fed D-1 or D-2. In conclusion, addition of MP, or IP to the corn soybean meal-based diet improved feed intake, feed efficiency, and weight gain of pigs, and reduced ammonia and VFA excretion in feces. IP can not substitute MP in a 1:1 ratio however,it is a cheaper but less effective alternative to MP.

Key Words: Phytase, VFA, Ammonia

199 Effects of phytase on nutrient digestibility and amount of odorous compounds in slurries of weaned pigs. Q.M. Yang* and S.K. Baidoo, *Southern Research and Outreach Center, University of Minnesota*.

Crossbred weaned pigs (n=216, BW of 5.8kg and 20 d of age) were randomly allotted to 3 dietary treatments with 9 pen replicates per treatment. The dietary treatments were (1) Control: Corn-SBM with 100% dicalcium phosphate; (2) Treatment 1: with 50% dicalcium phosphate + 500 phytase ((Natuphos#, BASF) units (PU/kg diet); (3) Treatment 2: without dicalcium phosphate + 500 phytase units/kg diet. The pH, ammonia emission and volatile fatty acids (VFAs) in slurries, and the digestibility of nutrients in the diets were determined. The results indicated that phytase supplementation in diets improved the digestibility