

141 Effect of early-weaning (14 vs 19 d) on sow lactation performance during heat stress. I. Tissue loss, milk production, and subsequent reproduction. J. D. Spencer^{*1}, R. Cabrera², R. Graves², R.D. Boyd², J. Vignes², and G.L. Allee¹, ¹University of Missouri-Columbia, ²PIC USA.

To determine how lactation length changes the response to heat stress on sow performance to weaning and subsequent reproduction, 39 first and 100 two plus litter PIC C 22 females were used in a 2x2 factorial arrangement: 14 vs. 19 d wean, 21 vs 32°C. All sows were fed the same diet (1.07% total lysine, 3365 kcal ME/kg), and all litters were standardized to 10-11 pigs/litter. Body weight (BW), real-time ultrasound backfat (BF) and loin eye area (LEA) were taken at farrowing and weaning (14 or 19 d). Milk was analyzed on ten 3+ parity sows in both environments on days 0, 5, 10, 15, and 19 of lactation. Heat stress reduced feed intake 40% compared to sows lactating in 21°C ($P \leq .05$). For heat stressed sows, 19 d lactation increased BW loss 64% over 14 d ($P \leq .05$). Parity 1 females lost more BF than 2+ sows in both environments and lactation lengths (2.7 vs 1.6 mm) ($P \leq .05$). However, first litter and 2+ sows both lost 13% and 74% more BF ($P \leq .07$), respectively, and more than twice as much LEA ($P \leq .05$) when lactating for 19 d in heat stress. Milk yield decreased by 30% in the 32°C environment ($P \leq .05$), but milk composition was identical ($P \geq .10$). However, 32°C sows had elevated levels of cortisol in their colostrum (45 vs 25 ng/ml) ($P \leq .05$). Heat stressed gilts weaned on d-14 returned to estrus sooner (9.2 vs 22.8 d) than gilts lactating for 19 d ($P \leq .10$) in heat stress. Heat stress decreased subsequent litter size ($P \leq .05$) for both first litter and 2+ sows. Although 14 d weaning appeared to compromise subsequent litter size for 2+ sows lactated at 21°C (10.68 vs 11.53), the opposite response appeared to occur in gilts and 2+ sows weaned on d-14 under heat stress (14 d: 9.23, 10.45 vs 19 d: 8.18, 9.75, respectively). This study shows that reduced lactation length is a powerful method of reducing the impact of extreme heat stress on sow tissue loss and future reproductive performance, especially in the first litter female.

Key Words: Sow, Lactation, Heat stress

142 Effect of early-weaning (14 vs. 19 d) on sow lactation performance during heat stress. II. Effect of milk replacer on piglet growth to weaning and 66 d of age. J.D. Spencer^{*1}, R. Cabrera², R. Graves², R.D. Boyd², J. Vignes², and G.L. Allee¹, ¹University of Missouri-Columbia, ²PIC USA.

The benefit of using a milk replacer (MR) to enhance pig weaning weight (PWW) was studied with 139 PIC C 22 mixed parity females (1 or 2+). A 2x2 factorial arrangement of room temperature (21°C or 32°C) and sow lactation length (14 or 19 d) was used. Thus, pigs were either sow-reared to 19 d or early weaned at 14 d and reared to 19 d by MR (Advanced Birthright Nutrition[®]). MR was made available at d 10 to acclimate pigs prior to weaning. Pig weights were taken on d-19, and after a 47-d nursery period. Piglets from first litter and parity 2+ sows provided MR under heat stress had a heavier PWW than piglets nursing the sow to 19-d (MR-7.38 and 8.14 vs. 5.58 and 6.05 kg, respectively; $P \leq .05$). On d 14, pigs in 32°C were lighter (4.5 vs 5.12 kg/pig; $P \leq .05$) than those in 21°C. By d 19, PWW of pigs receiving MR in 32°C was similar to those provided MR in 21°C (7.98 vs 8.34 kg/pig; $P \geq .10$). MR reduced the difference normally observed in PWW between first litter and 2+ reared pigs (sow: 6.29 vs. 7.74 kg/pig at d 19) vs. (MR; 7.72 vs. 8.1 kg/pig at d 19) at 21°C. Over 70% of the pigs provided MR in both the control and 32°C had PWW above 6.8 kg. Only 50 and 27% of the pigs nursing sows for the entire 19-d had final PWW above 6.8 kg in 21 and 32°C environments, respectively. During the nursery period, parity 2+ reared pigs had a higher ADG ($P \leq .05$) than gilt reared pigs. Piglets receiving MR also had higher ADG during the nursery period ($P \leq .05$) than those nursing to d 19. Pigs receiving MR and nursing first litter females in 32°C benefited the most (14 d: .409 vs. 19 d: .368 kg/d). After 47 d in the nursery, 67 and 54% of the pigs provided MR in the control and heat stress environment preweaning weighed over 27.3 kg, compared to 52 and 34% of the pigs nursing the sow for 19-d, respectively. These results, and the previous abstract, show the benefit of early sow weaning in combination with MR to preserve the sow and prevent lower weaning and nursery weights under heat stress.

Key Words: Lactation, Heat stress, Milk replacer

143 True ileal digestibility of amino acids in sow's milk for 17-day-old pigs. I. Mavromichalis^{*}, T.M. Parr, V.M. Gabert, and D.H. Baker, *University of Illinois at Urbana-Champaign.*

The digestibility of amino acids in sow's milk consumed by young pigs is currently unknown because of difficulties associated with collecting an adequate quantity of milk, and also problems in cannulating suckling pigs. A total of 14 kg of sow's milk was collected, two soluble indigestible markers (Co-EDTA and YbCl₃) were added, and the milk was fed to four pigs at 17 d of age that were fitted with a simple T-cannula at the terminal ileum. Another four cannulated pigs were offered a similar amount of a 20% DM liquid diet based on enzymatically hydrolyzed casein and lactose to assess endogenous amino acid losses. All pigs were fed about 875 g of each diet per day in 10 hourly meals from 0700 to 1700. Following 2 d of adaptation, ileal digesta were collected from 0800 to 1800 for 2 d. Diets and digesta were analyzed for amino acids using appropriate hydrolysis and preoxidation procedures. Average nitrogen true digestibility was 88%, whereas amino acid true digestibilities ranged from 84% (cystine and threonine) to 100% (methionine, histidine, and glutamic acid); the average for all amino acids was 92±4%. Based on average values, true digestibility of essential amino acids was not different from that of nonessential amino acids ($P > 0.10$). In whole milk, amino acids found in abundance in whey proteins (i.e., cystine, glycine, and threonine) were less ($P < 0.05$) digestible than amino acids predominating in casein proteins (i.e., glutamic acid, proline, and methionine). When true ileal digestible amino acid concentrations in sow's milk were expressed as ratios to digestible lysine, it appeared that threonine, tryptophan, and arginine were lower than what might be considered optimal. In conclusion, amino acids in sow's milk were highly digestible, but most of the amino acids had true ileal digestibility values significantly less than 100%.

Key Words: Sow's milk, Amino acid digestibility, Suckling pigs

144 Relative bioefficacy of Biolys 60 compared to L-lysine-HCl in young pigs. M. R. Smiricky^{*1}, I. Mavromichalis², D. M. Albin¹, J. E. Wubben¹, M. Rademacher³, and V. M. Gabert¹, ¹University of Illinois, Urbana, IL, ²SCA Nutrition, Marion, IA, ³Degussa-Huls AG, Hanau-Wolfgang, Germany.

Lysine is accepted as the first limiting amino acid in swine diets. Lysine deficient diets are generally supplemented with lysine in the form of L-lysine-HCl. Recently, a new source of lysine has been developed by Degussa-Huls called Biolys 60. Biolys 60 is a L-lysine sulfate that contains byproducts from fermentation, with a minimum lysine content of 46%. A pig growth assay was utilized to determine lysine bioavailability from Biolys 60. One hundred PIC nursery pigs with an average initial BW of 9.47 ± 1.5 kg were randomly allotted to 5 dietary treatments of 20 pigs based upon weight and gender. A corn-peanut meal diet containing 0.62% lysine was supplemented with 2 levels (.1% and .2%) of lysine as L-lysine-HCl or Biolys 60. Pigs were withdrawn from study after 3 wk. Relative bioavailability value (RBV) of Biolys 60 was determined using multiple regression slope-ratio methodology, using gain and feed efficiency as the response criteria. At the tested levels, linear responses for gain and feed efficiency were obtained. When weight gain was regressed on supplemental lysine intake, the bioavailability of Biolys 60 was 99% ($P < 0.01$) of L-lysine-HCl. When feed efficiency was regressed on supplemental lysine intake, the bioavailability of Biolys 60 was 97% ($P < 0.01$) of L-lysine-HCl. The RBV of Biolys 60 was subjected to a t-test and was determined not to be different from L-lysine-HCl, which was considered to be 100% bioavailable. These results support the conclusion that the RBV of Biolys 60 is not different from L-lysine-HCl.

Key Words: Pigs, Lysine, Relative Bioavailability

145 The optimum isoleucine:lysine ratio to maximize growth performance of the early-weaned pig. B. W. James^{*}, R. D. Goodband, M. D. Tokach, J. L. Nelsens, J. M. DeRouchey, and J. C. Woodworth, *Kansas State University, Manhattan.*

A 14-d growth assay was conducted to determine the optimal apparent digestible isoleucine:lysine ratio to maximize growth performance of the early-weaned pig. A total of 360 pigs (initially 5.6 kg and approximately 18 d of age, PIC C22 × 327) were blocked by weight and allotted randomly to 12 dietary treatments. Each treatment had 6 replications and

5 pigs per pen. Corn, soybean meal, spray-dried animal plasma, blood cells, fish meal, and spray-dried whey were analyzed for amino acid profiles prior to diet formulation. The 12 treatments consisted of two basal diets containing 1.00 and 1.26% apparent digestible lysine with .45 and .57% apparent digestible isoleucine, respectively. Crystalline isoleucine was added to each of the basal diets to provide concentrations of 50, 55, 60, and 65% of lysine. Two positive control diets contained 1.10 and 1.39% apparent digestible lysine. An isoleucine \times lysine interaction ($P < 0.06$) was observed for ADFI. Pigs fed 1.00% apparent digestible lysine had the greatest ADFI at 55% isoleucine; however, those fed 1.26% had greatest ADFI at 50% isoleucine. The greatest increase in ADG, ADFI, and G:F (quadratic, $P < 0.01$) was observed as the ratio increased from 45 to 50% with further numeric improvements as the ratio increased from 50 to 55% at 1.00% apparent digestible lysine. Feeding 1.26% apparent digestible lysine improved ($P < 0.02$) ADG and G:F. The positive control fed 1.39% apparent digestible lysine had greater ($P < 0.02$) ADG and G:F when compared to pigs fed 1.26% apparent digestible lysine. A broken-line model predicted an isoleucine requirement of approximately 55% of lysine at 1.00% apparent digestible lysine and approximately 50% of lysine at 1.26% apparent digestible lysine to achieve optimum growth performance.

Key Words: Isoleucine, Lysine, Weanling pigs

146 The tryptophan requirement of Phase I, II, and III pigs. A. C. Guzik^{*1}, B. J. Kerr², L. L. Southern¹, and T. D. Bidner¹, ¹LSU Agricultural Center, Baton Rouge, LA, ²Nutri-Quest Inc., Chesterfield, MO.

Five Exp. were conducted to determine the digestible Trp (dTrp) requirement of nursery pigs. Treatments were replicated with four or five pens of five or six pigs each. Pigs were weaned at 21 (Exp. 1, 2 and 5) or 19 d (Exp. 3 and 4), and diets were fed for 8 (Exp. 1), 13 (Exp. 2 and 3), or 14 d (Exp. 4 and 5). Experiment 1 (160 pigs, initial and final BW of 8.4 and 11.4 kg) evaluated six protein sources relative to a positive control diet. The results indicated that the diet with Canadian field peas (CFP), with supplemental Trp, resulted in ADG, ADFI, and gain:feed (GF) equal to ($P > 0.10$) the positive control diet. In Exp. 2 (75 pigs, initial and final BW of 13.2 and 19.2 kg) pigs were fed: 1) Trp-deficient diet (0.13% dTrp) with CFP, 2) Diet 1 + Trp (0.23% dTrp), or 3) positive control diet (0.22% dTrp). Daily gain, ADFI and GF were decreased ($P < 0.01$) in pigs fed Diet 1 compared with pigs fed Diets 2 and 3, but ADG, ADFI, and GF were equal ($P > 0.10$) between pigs fed Diets 2 and 3. Experiments 3 (180 pigs, initial and final BW of 5.2 and 7.3 kg), 4 (120 pigs, initial and final BW of 6.3 and 10.2 kg), and 5 (144 pigs, initial and final BW of 10.3 and 15.7 kg) were conducted to estimate the dTrp requirement of Phase I, II, and III pigs, and the diets used CFP as a primary protein source. Response variables were ADG, ADFI, GF, and plasma urea N concentrations, and data were analyzed using the broken-line model. The levels of dTrp in the diets for Exp. 3 (Phase I) were 0.14, 0.17, 0.20, 0.23, 0.26, and 0.29%. The average dTrp requirement was estimated to be 0.21% (0.24% total Trp). The levels of dTrp in the diets for Exp. 4 (Phase II) were 0.13, 0.16, 0.19, 0.22, 0.25, and 0.28%. The average dTrp requirement was estimated to be 0.20% (0.23% total Trp). The levels of dTrp in the diets for Exp. 5 (Phase III) were 0.130, 0.155, 0.180, 0.205, 0.230, and 0.255%. The average dTrp requirement was estimated to be 0.18% (0.22% total Trp). These results indicate that the dTrp requirement is 0.21, 0.20, and 0.18% for Phase I, II, and III pigs, respectively.

Key Words: Pig, Tryptophan, Requirement

147 Responses of young pigs to amino acids as influenced by environmental temperature. N. S. Ferguson^{*}, University of Natal, South Africa.

A series of experiments were conducted to measure the effects of dietary lysine, threonine and tryptophan concentrations and environmental temperatures on the performance of pigs grown from 13 to 25 kg live weight. In the experiments involving lysine and threonine 96 Large White \times Landrace entire male pigs were used while 72 males were used in the tryptophan experiment. The experiments followed a factorial design with 4 replications per treatment. A summit-dilution technique was used to determine the six dietary treatments per amino acid, each contained the following proportion of requirements 1.10(AA1), 0.94(AA2), 0.77(AA3),

0.61(AA4), 0.45(AA5) and 0.45+synthetic amino acid (AA6), respectively. Four temperature treatments were used in the lysine and threonine experiments (18, 22, 26 and 30 °C) and three for tryptophan (20, 25 and 30 °C). To simplify comparisons between amino acid experiments the 18 and 22 °C treatments were combined and compared with the 20 °C. The response in ADFI to decreasing dietary amino acid concentrations were significantly ($P < 0.05$) modified by ambient temperature. ADFI increased with decreasing amino acid contents and in some cases reached a maximum before declining. The treatment in which the pigs attained maximum ADFI depended on the temperature. For lysine and threonine ADFI was highest on AA5 at 20 °C while for tryptophan it was AA4. At 25 °C maximum ADFI was attained by pigs on AA4 for lysine and tryptophan but on AA5 for threonine. At 30 °C it was AA4 for lysine and threonine but AA3 for tryptophan. The responses in ADG to lysine and tryptophan were independent of temperature whereas threonine responses were dependent on temperature. The highest ADGs were obtained on AA1 and AA2 for all amino acids. Similarly the responses in G:F to decreasing amino acid concentrations were independent of temperature. Maximum G:F was attained on AA1. These results suggest that pigs, given a diet limiting in an amino acid, will attempt to maintain the intake of the limiting amino acid, as the concentration decreases, by increasing food intake. This compensation is dependent on the environmental temperature. Irrespective of temperature ADG and G:F were maximized on diets that were close to or exceeded the requirement of the animal.

Key Words: Pig, Amino acids, Temperature

148 Amino acid digestibility of reduced concentrations of intact dietary protein fed to growing pigs. E. R. Otto^{*}, P. K. Ku, and N. L. Trottier, Michigan State University, East Lansing.

Reducing dietary crude protein (CP) can reduce N excretion and ammonia emission from swine manure (Otto, 2000), but protein digestibility may be affected. The objective of this study was to test whether reducing CP of corn-soybean meal based diets (CSBM) decreases apparent (AID) and standardized (SID) ileal amino acid digestibility when crystalline amino acids (CAA) are provided to meet digestible amino acid requirements. Six crossbred barrows (53.13 \pm 1.18 kg) were surgically fitted with a T-cannula at the terminal ileum and allocated to six diets in a Latin square design. Diets consisted of 15, 12, 9, and 6% CP CSBM, a 15% CP casein based, and a protein-free diet. The casein based and protein-free diets were used to determine basal endogenous AA losses (EAL). Amino acid AID and SID in the 9 and 6% diets were higher ($P < 0.01$) for all indispensable amino acids (IAA) compared to the 15 and 12% diets. Amino acid digestibility in CSBM alone (AIDI and SIDI) was estimated by removing CAA in the calculations of AID and SID. Histidine, Ile, Lys, Phe, and Val AIDI and SIDI, Leu AIDI, and Met SIDI were higher ($P < 0.01$) in the 9% compared to 15, 12, and 6% diets. Leucine SIDI was higher ($P < 0.01$) in the 9% than the 12 and 15% diets; however, no difference was found when comparing the 6 to the 9, 12 or 15% diets. The Met AIDI was higher ($P < 0.01$) in the 9% than the 6% diet. The AIDI of Met in the 12 and 15% were similar to the 6 and 9% diets. The Thr AIDI was higher ($P < 0.01$) in the 9, 12, and 15% than the 6% diet. The 9% diet AIDI of Thr was higher ($P < 0.01$) than the 15% diet. The Thr AIDI in the 12% was similar to the 9 and 15% diets. The Thr AIDI in the 9% was higher ($P < 0.01$) than the 12 and 15% diets. The SIDI of Thr in the 9% was higher ($P < 0.01$) than in the 12 and 15% diets. Threonine SIDI in the 6% was higher ($P < 0.01$) than the 15% diet. The Thr SIDI in the 6% was similar to the 9 and 12% diets. Results show that AID and SID are improved in the 6 and 9% diets; AIDI and SIDI were improved when intact CP concentration was reduced from 15 to 9%. These results indicate that reducing dietary CP concentration does not reduce AID and SID when CAA are included in the diets.

Key Words: Reduced protein, Crystalline amino acids, Digestibility

149 Amino acid fortified all-corn diets for late-finishing gilts. H. J. Liu, G. F. Yi^{*}, J.D. Spencer, J.W. Frank, and G.L. Allee, University of Missouri-Columbia.

Seventy-eight late-finishing gilts (LFG) (85.9 kg) were used to evaluate the effects of feeding synthetic amino acid (AA) fortified all-corn diets on growth performance, carcass characteristics, nitrogen (N) retention and N excretion. Six pigs were killed at the beginning of the experiment