Nonruminant Nutrition: Energy and Dietary Fat

842 Determining the energy digestibility of mold-damaged corn selected for low mycotoxin content in finishing pigs. C. M. Pilcher*, A. Greco, C. R. Hurburgh, G. P. Munkvold, C. K. Jones, and J. F. Patience, *Iowa State University, Ames.*

There is very limited information on the impact of mold damage on the digestibility of nutrients in corn. The objective of this study was to determine the DE content of mold damaged corn samples selected for low mycotoxin content. Corn samples with visible mold damage were collected from 14 Midwestern sites and corn samples with no visible mold damage were selected from 4 Midwestern sites. All samples were screened for mycotoxin content and only samples with low mycotoxin content (i.e., < 1.0 ppm deoxynivalenol; < 20 ppb aflatoxin; < 10 ppm fumonisin; < 3 ppm zearalenone) were selected for use in the trial. A single control sample was created by blending 3 samples with no visible mold damage, and 7 mold damaged samples were selected. Corn samples were inspected by an official US grain inspection agency. Mold damaged samples varied in test weight (58 to 72 kg/hL; mean = 67 ± 5.2 kg/hL), total damaged kernels (9.4 to 65.8%; mean = 33.8 ± 21.70%) and moisture (13.9 to 16.5; mean = 14.9 ± 0.84%). Experimental diets were comprised of 96.9% corn from the control or one of the 7 mold damaged sources supplemented with vitamins and minerals. Barrows (initial BW = 99.0 ± 4.98 kg, n = 16) were allotted to an 8 × 3 Youden square design with the 8 diets and 3 replicate periods. Periods included 6 d of adaptation to treatment diets followed by a 2 d fecal collection period. Pigs received a fully balanced finishing diet for 4 d between replicates. Gross energy of diets and feces was determined by bomb calorimetry. There was a considerable range among the mold damaged corn samples for DM digestibility (85.2 to 87.3%; $P < 0.01$), energy digestibility (83.2 to 85.7%; $P < 0.01$) and DE (3,436 to 3,611 kcal/kg DM; $P < 0.0001$). DM digestibility (86.8 vs. 89.2%; $P < 0.01$), energy digestibility (85.0 vs. 87.8%; $P < 0.01$), and DE (3,558 vs. 3,714 kcal/kg DM; $P < 0.001$) were lower for mold damaged corn compared with the control corn. The current practice of blending mold damaged corn with good quality corn presents risks of lowering nutrient availability.

Key words: corn, mold, swine

843 Effects of dietary energy density on performance and lean deposition of growing-finishing pigs raised in a commercial environment. L. C. Chu*, C. J. Cai, G. J. Zhang, S. Y. Qiao, and D. F. Li, *China Agricultural University, Beijing, China.*

Three experiments were conducted to determine the effects of digestible energy (DE) density on performance and lean deposition in growing-finishing pigs (Yorkshire × Landrace × Duroc) during 3 separate phases when housed in a commercial environment. A completely randomized block design within sex was used involving 480 pigs (20.8 to 55.9 kg) in Exp. 1, 420 pigs in Exp. 2 (57.0 to 76.6 kg) and 240 pigs (78.6 to 105.8 kg) in Exp. 3. Pigs were allotted to one of 5 treatments containing 13.62, 13.87, 14.12, 14.37 and 14.62 MJ DE/kg. Pig body weight and feed consumption were determined every 2 weeks and carcass composition was evaluated at the start and end of the experiments to evaluate lean deposition. ANOVA, linear and quadratic contrasts and the broken-line regression model was used to analyze the experimental data. In Exp. 1, energy density had no significant effect ($P > 0.05$) on weight gain or feed efficiency. Meanwhile, carcass fat-free lean gain decreased (linear, $P = 0.02$; quadratic, $P = 0.02$) and fat-free lean index decreased quadratically (quadratic, $P = 0.05$) with increasing dietary energy density. The optimum level of dietary DE to maximize lean deposition was 13.81 MJ DE/kg. In Exp. 2, both weight gain ($P = 0.01$) and feed efficiency ($P = 0.06$) increased linearly with increasing DE density, while carcass fat-free lean gain ($P = 0.05$) and fat-free lean index decreased significantly ($P < 0.01$). The optimum level of dietary DE to maximize lean deposition was 13.76 MJ DE/kg. In Exp. 3, weight gain ($P = 0.09$) and feed efficiency ($P = 0.05$) also showed an increasing trend. The decreasing trend of carcass fat-free lean gain ($P = 0.05$) and fat-free lean index ($P < 0.01$) suggest the optimum level of dietary DE to maximize lean deposition was 13.82 MJ DE/kg. The results of the present study demonstrate that pigs reared in a commercial environment require different dietary energy levels for lean deposition compared with performance. Therefore, diets may be formulated with different energy levels depending on the overall goal of a swine producer.

Key words: digestible energy, growing-finishing pigs, lean deposition

844 Effect of feeding soy and sunflower based reconstituted fat or monoestearate as fat sources in piglet diets. J. J. Mallo[1], J. Alcañiz*[1], M. I. Gracia[2], and C. Millán[2], *[1]Norel, S.A., Madrid, Spain, [2]Imasde Agroalimentaria, S.L., Madrid, Spain.*

A total of 216 weaned piglets (Large White x Landrace*Large White) were allocated at random to 4 experimental treatments (T1: basal diet, 4% soy oil; T2: 4% Soy+Sunflower oil fatty acids esterified with glycerol (reconstituted fat, RE); T3: 4% Soy+Sunflower oil monoestearate (ME); and T4: 2% soy oil + 2% ME), including 6 replicates of 9 piglets per treatment (half male and half female). Mash feeds and water were offered ad libitum with no added growth promoter or veterinary antibiotics. A common prestarter diet was offered from weaning at 26 d during a week. Experimental treatments were applied in the starter diets from 33 to 63 d of age. After consuming the experimental diets for 9 d, fecal samples were taken to calculate nutrient digestibility. Observations included body weight (BW), growth (ADG), feed intake (ADFI), feed conversion ratio (FCR) and apparent fecal digestibility of dry matter, organic matter, ether extract and gross energy of the diets. Data were analyzed as a completely randomized design by GLM of SAS. No significant differences were observed between fat sources in any of the performance parameters studied (374, 368, 375, 357 g/d and 1.28, 1.34, 1.32, 1.35 g feed/g gain for growth and feed conversion at 33–63 d of age, for T1 to T4, respectively; $P > 0.10$). Significant differences were observed in digestibility between the 4 treatments. Apparent fecal digestibility of dry matter was improved with RE, ME and the combination when compared with the basal diet (68.8^{b}, 75.0^{a}, 78.1^{a}, 76.6^{a} %, $P = 0.0288$, for T1-T4, respectively). Apparent fecal digestibility of gross energy (DCGE) and organic matter (DCOM) were improved when ME or the combination were used, presenting RE intermediate results (DCGE: 68.7^{b}, 73.5^{ab}, 77.8^{a}, 76.3^{a} %, $P = 0.0334$; and DCOM: 73.8^{b}, 78.2^{ab}, 81.5^{a}, 80.9^{a} %, $P = 0.0246$, for T1-T4, respectively). It is concluded that soy and sunflower oil reconstituted fat or monoestearate improve digestibility of piglet diets and can be used as an alternative to soya oil for weaned piglets.

Key words: monoestearate, vegetable reconstituted fat, piglets

845 Impact of fat source on nutrient digestibility and performance in nursery pigs. S. M. Mendoza* and E. van Heugten, *North Carolina State University, Raleigh.*

This study was designed to evaluate the impact of fat saturation (iodine value, IV) and FFA concentration of fat on nursery pig performance and digestibility of fat and gross energy. Pigs (n = 189; BW = 9.32 ± 0.11 kg) were weaned at 21 d and fed a common diet for 14 d. Pigs were housed 3 pigs per pen using a total of 63 pens and assigned within weight blocks to one of 7 dietary treatments. Diets were corn-soybean meal based (3.76% SID lysine/Mcal ME) and consisted of a negative control diet without added fat and a basal diet with 6% added fat from a combination of 4 fat sources to create 6 diets with 2 levels of FFA (0.4 or 54.0%) and 3 degrees of fat saturation (IV = 77, 100, or 123) in a 2 × 3 factorial arrangement. Fat sources were: soybean oil (SO, 0.3% FFA, IV = 129.4), soybean-refined cottonseed acid oil (SAO, 70.5% FFA, IV = 112.9), choice white grease (CWG, 0.6% FFA, IV = 74.8), and choice white acid grease (CWAG, 56.0% FFA, IV = 79.0). Fat sources were included in diets at the following proportions: diet 1, 100% CWG; diet 2, 95% CWAG and 5% CWG; diet 3, 50% SO and50% CWG; diet 4, 38% SAO, 12% SO, 48% CWAG, and 2% CWG; diet 5, 100% SO; and diet 6, 76% SOA and 24% SO. Fat supplementation decreased ADFI (812 vs. 873 g/d; $P = 0.02$) and improved G:F (715 vs. 646 g/kg; $P < 0.001$) compared with the negative control diet. Diets with high FFA tended ($P = 0.08$) to improve BW (21.69 vs. 21.13 kg) and ADG (592 vs. 566 g/d). Apparent digestibility of fat was higher in fat supplemented diets than control diets (63.3 vs. 28.1%, $P < 0.001$). Fat digestibility was higher in diets with low FFA (65.6% vs. 60.9%, $P < 0.001$) and decreased linearly with increasing IV (72.6, 65.5, and 58.9%) when FFA concentration was low, but was unaffected by IV when FFA concentration was high (60.6, 61.3, and 60.9%). Digestibility of GE was higher in diets with low FFA (83.1% vs. 80.9%; $P < 0.001$). In conclusion, G:F was improved when fat was supplemented to pigs. Digestibility of fat and GE was reduced for fats high in FFA. However, nursery pig performance tended to be improved with high FFA, indicating that SAO and CWAG could be economic alternatives to more expensive fats.

Key words: pigs, fat, digestibility

846 Effect of altering the dietary omega-6 to omega-3 fatty acid profile of sow diets on the immune responses of their offspring when challenged with *E. coli* lipopolysaccharide. L. Eastwood*[1,2], A. D. Beaulieu[1,2], and P. Leterme[3], *[1]Prairie Swine Centre Inc, Saskatoon, SK, Canada, [2]Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada, [3]Cargill - R & D Centre Europe, Havenstraat, Vilvoorde, Belgium.*

The objective of this experiment was to determine the effects of altering the omega-6 (n6) to omega-3 (n3) fatty acid (FA) ratio in sow diets on the immune responses of their offspring. Sows consumed one of 5 treatment diets for 2 reproductive cycles. Treatments were a control (tallow based) or plant based diets with n6:n3 ratios of 10:1, 5:1, 1:1, or a fish based 5:1 ratio. Piglets weaned from the 2nd cycle (d28 of lactation) were used in the immune challenge study. On d 6 post-weaning, weanling pigs (n = 100), 20 from each diet group, were randomized to a challenge control group (saline) or to an *E. coli* lipopolysaccharide (15 µg/kg BW; LPS) injected group (n = 10/challenge/diet). Rectal temperatures were recorded at 0, 1, 2, 3, 4, 5, 6, 12 and 24 h post injection and blood samples were collected at 0, 2, 6 and 12 h post injection for cytokine analysis (IL-1β, IL-6, IL-8, TNFα). Treatments were arranged as a 5 × 2 factorial (diet x immune challenge) and analyzed with time of sampling as a repeated measure. The sow′s milk had n6:n3 ratios of 7.5:1, 4.5:1, 1.5:1 and 3:1 for the 10:1, 5:1, 1:1 and 5:1 fish diets respectively. For all parameters except IL-6, an effect of challenge, time and the challenge by time interaction were observed ($P < 0.05$), indicating the LPS elicited an immune response. Piglets from the 1:1 dietary treatment group had the highest body temperature ($P = 0.0004$). The diet by immune challenge interaction tended to be different for body temperature ($P = 0.12$) and IL-8 ($P = 0.18$). Piglets from the 1:1 and 5:1 fish groups had a greater IL-8 response to the immune challenge relative to piglets from the other diets. A greater febrile response to the LPS challenge was seen in piglets originating from sows consuming the 1:1 diet. Weanling pigs produced from sows consuming different n6:n3 FA ratios respond differently to a LPS induced immune response. This implies that the fatty acid profile of a sow′s diet may affect the response of her offspring to immune challenges that occur regularly at the time of weaning.

Key words: cytokine, omega-3, swine

847 Impact of dietary fat on milk composition, milk output and apparent digestibility is fat source dependent in lactating sows. D. S. Rosero*[1], E. van Heughten[1], J. Odle[1], V. Fellner[1], and R. D. Boyd[2], *[1]Department of Animal Sciences, North Carolina State University, Raleigh, [2]Hanor Company Inc., Franklin, KY.*

This study investigated the impact of 2 sources of supplemental fat on milk composition and apparent digestibility of fat during lactation. In Exp. 1, milk samples were collected from 30 sows (PIC Camborough) during d 4, 11 and 18 of lactation. Sows were assigned to a control diet without added fat and 2 diets supplemented with 6% fat consisting of either animal-vegetable blend (AV; 14.5% FFA, IV = 89) or choice white grease (CWG; 3.7% FFA, IV = 62). In Exp. 2, fecal samples were collected from 56 sows to calculate fat digestibility using TiO2 as a marker. Sows were assigned to a 2 × 3 factorial arrangement and a control diet without fat. Factors included: 1) fat sources (AV and CWG); and 2) fat level (2, 4 and 6%). For the 2 studies, sows were balanced for parity 1, and 3 to 5 (P3+). Diets were corn-soybean meal based with 8% DDGS and 6% wheat middlings, and contained 3.56 g standardized ileal digestible Lys/Mcal ME. Piglet growth rate in Exp. 1 was improved by CWG ($P < 0.05$; 197.7 g/d) but not with AV (169.9) compared with the control (169.2). Calculated milk production (2.5 x ADG + 80 x initial BW + 7) was greater for CWG ($P < 0.01$; 646 $g \bullet pig^{-1} \bullet d^{-1}$) than AV and the control diet (564 and 569, respectively). CWG, but not AV increased ($P < 0.05$; 7.35%) fat content in the milk (6.30, 6.70, for control and AV, respectively). Milk protein decreased ($P < 0.001$; 5.2, 4.6 and 4.7% for d 4, 11 and 18, respectively), lactose increased ($P < 0.001$; 5.2, 5.7 and 5.7) and Ca increased ($P = 0.003$; 0.16, 0.17 and 0.18) during lactation. Linoleic (C18:2) and linolenic acid (C18:3) were higher ($P < 0.001$) in milk fat from sows fed AV (23.2 and 1.4%, respectively) than CWG (18.9 and 1.0) and control (17.4 and 0.7). Milk fat IV was higher ($P < 0.001$) for AV (75.9) than CWG (72.5) and control (68.4). Apparent digestibility of fat increased with each increment (Linear, $P < 0.001$), but CWG was more digestible than A-V (Fat x Level, $P < 0.05$). In conclusion, digestibility of fat was improved with increasing levels of fat and was higher for CWG than AV, affecting positively composition and production of milk, consequently improving piglet growth rate.

Key words: sow, fat, milk