380 Diet form and by-product level affect growth performance and carcass characteristics of grow-finish pigs. R. S. Fry,* W. Hu, S. B. Williams, N. D. Paton, and D. R. Cook, *Provimi North America, Akey Nutrition and Research Center.*

Two experiments were conducted to determine the effect of diet form and by-product (BP) level on growth performance and carcass characteristics of grow-finish pigs. In experiment 1, 384 pigs (22.2 ± 0.27 kg BW; 12 pigs/pen) were randomly assigned to one of the following treatments in a 2 × 2 arrangement: 1) low BP (LBP) meal [30% dried distiller grains with solubles (DDGS) and 15% wheat middlings (WM)] or 2) high BP (HBP) meal (50% DDGS and 15% WM) with diets fed either in meal or pellet form. In experiment 2, 1008 pigs (23.7 ± 0.27 kg BW; 21 pigs/pen) were randomly assigned to one of the following treatments in a 2 × 3 arrangement: 1) corn-soybean meal (CSBM), 2) LBP meal (25% DDGS and 7.5% WM), or 3) HBP meal (50% DDGS and 15% WM) with diets fed either in meal or pellet form. In both experiments, complete blocks of pigs were marketed when each block reached approximately 130 kg BW. In experiment 1, ADG was greater ($P < 0.01$) for pigs fed pelleted vs. meal diets. Increasing by-products in meal diets reduced ADFI, but not in pelleted diets ($P < 0.05$; diet form × BP level). Increasing by-products in meal diets improved G:F, but this did not occur when pelleted diets were fed ($P < 0.05$; diet form × BP level). In experiment 2, G:F was improved ($P < 0.01$) when diets were fed as a pellet vs. meal. Increasing by-product level decreased ($P < 0.01$) G:F. As BP level increased in meal diets ADG decreased, while increasing BP level in pelleted diets decreased ADG to a lesser extent ($P < 0.05$; diet form × BP level). As BP level increased, ADFI tended to decrease when meal diets were fed but not when pelleted diets were fed ($P < 0.10$; diet form × BP level). Increasing BP level decreased ($P < 0.05$) carcass yield and backfat. Pelleting tended ($P < 0.10$) to increase carcass yield. These data suggest that pelleting high by-product diets improves performance, and pelleting lessens the negative effects of by-product level on pig performance.

Key Words: pigs, by-products, pellet

381 Influence of ingredient complexity, feed form, and length of feeding of the phase I diets on nutrient digestibility and productive performance of Iberian pigs. J. D. Berrocoso, B. Saldaña, L. Cámara, M. P. Serrano, M. A. Ibáñez, and G. G. Mateos,* *Universidad Politécnica de Madrid, Madrid, Spain.*

In total, 216 Iberian piglets weaned at 28 d of age were used in a 35 d trial to evaluate the influence of ingredient complexity, feed form, and the length of feeding of the phase I diets on growth performance and total tract apparent digestibility (TTAD) of nutrients. There were 12 treatments with 2 type of diets that differed in CP content (20.5 vs. 18.5%) and in the percentage of inclusion of high quality ingredients (heat processed corn, protein concentrate, fish meal, and dried whey; HQ: high quality and LQ: low quality), 2 feed forms (mash vs. pellets), and 3 lengths of feeding the phase I diets (7, 14, and 21 d). From 7, 14 or 21 d to 35 d on trial, all pigs were fed a common phase II mash diet based on wheat and soybean meal. Cumulatively (0 to 35 d on trial), pigs fed the LQ phase I diets had higher ADFI ($P < 0.01$) and ADG ($P < 0.05$) than pigs fed the HQ diets. Pelleting improved ($P < 0.01$) G:F but not ADFI or ADG. Feeding the phase I diets for 21 d reduced ADFI and ADG but improved G:F as compared with 7 or 14 d feeding ($P < 0.01$). The incidence of diarrhea (DI) was higher in pigs fed the phase I diets for 21 or 14 d than in pigs fed these diets for 7 d ($P < 0.01$). Pigs fed pellets had higher ($P < 0.01$) DI than pigs fed mash. From 0 to 21 d of trial, pigs fed the HQ diets had lower ($P < 0.05$) ADFI than piglets fed the LQ diets and pelleting improved ($P < 0.01$) G:F. Increasing the length of feeding of the phase I diets improved G:F ($P < 0.01$). Also, DI was higher ($P < 0.01$) in pigs fed pellets than pigs fed mash and higher in pigs fed the phase I diets for 21 or 14 d than in pigs fed these diets for 7 d ($P < 0.01$). TTAD of nutrients was higher for pigs fed pellets ($P < 0.01$) or the HQ phase I diets ($P < 0.05$) than in pigs fed mash or the LQ phase I diets. From 21 to 35 d on trial, pigs previously fed the LQ diet had higher ($P < 0.01$) ADG and ADFI than pigs fed the HQ diet. Based on these results the use of LQ feeds in pellet form for only 7 d after weaning is recommended in Iberian pigs.

Key Words: diet complexity and feed form, growth performance, total-tract apparent digestibility

382 Hepatic gene expression analysis of nursery pigs fed simple and complex starter diets. M. Rudar,* L. D. Skinner, and C. F. M. de Lange, *University of Guelph, Guelph, ON, Canada.*

Reduced use of complex animal proteins in pig diets can reduce both feed costs and growth performance during the starter phase. The long-term consequences of this practice are unclear, as it may induce compensatory growth and alter disease resistance during the grower-finisher phase. The objective of this study was to explore potential indicators of health status, immune function, and nutrient partitioning that predict the effect of diet stressors on subsequent growth performance. Starter pigs were fed either simple (plant protein, non-medicated, n = 12 pens) or complex (milk and plasma proteins, medicated, n = 12 pens) diets formulated to be otherwise equivalent for 6 weeks. Liver tissue was collected from 4 pigs per treatment at 2 weeks post-weaning when the growth rate of pigs fed simple diets was reduced (397 vs 459 g/d, $P < 0.05$). Total RNA was isolated from liver and aminoallyl-modified cRNA was hybridized to Agilent Porcine Gene Expression Microarray in a reference design. The gene expression data were normalized, filtered, and analyzed using a simple linear (ANOVA) model. A total of 182 genes were detected to be differently expressed between the diets ($P < 0.10$, Benjamini-Hochberg false discovery rate adjustment). Pigs fed simple diets had increased hepatic gene expression of urea cycle enzymes (arginase-1, $P < 0.06$; and carbamoyl phosphate synthase-1, $P < 0.06$) and antioxidant enzymes (glutathione peroxidase-1, $P < 0.06$; and glutathione peroxidase-3, $P < 0.06$). Pigs fed complex diets had increased hepatic expression of genes involved in endogenous antigen processing and presentation (swine leukocyte antigen [SLA]-2, $P < 0.10$; SLA-8, $P < 0.08$; antigen peptide transporter-1, $P < 0.06$; and antigen peptide transporter-2, $P < 0.07$), and in exogenous antigen processing and presentation (SLA-DMA, $P < 0.08$; SLA-DMB, $P < 0.06$; SLA-DQA, $P < 0.06$; SLA-DQB1, $P < 0.03$; SLA-DRA, $P < 0.08$; SLA-DRB1, $P < 0.06$; CD74 invariant chain, $P < 0.09$; and cathepsin S, $P < 0.06$). These results indicate increased disease resistance of starter pigs fed complex diets in the nursery that may persist as they grow.

Key Words: immunity, microarray, pigs

383 Development and evaluation of a model estimating nitrogen partitioning in lactating sows. A. V. Hansen[1], A. B. Strathe[1], P. K. Theil[2], and E. Kebreab*[1], *[1]Department of Animal Science, University of California, Davis, [2]Department of Animal Science, Faculty of Science and Technology, Aarhus University, Tjele, Denmark.*

The impact of nitrogen excretion from swine operations on the environment is of growing concern. There are very few models that predict nutrient excretion from sows, therefore, our objective was to develop and evaluate a whole animal model that predicts the nitrogen partitioning by lactating sows and nutrient excretion. A factorial approach was taken to estimate requirements for maintenance, milk production and body deposition. It was assumed that the priority for nutrient partitioning was in the order of maintenance, milk production and body deposition with body tissue losses constrained within biological limits. The model inputs were dietary composition, potential litter size (LS), litter gain (LG), and BW of the sow. Nitrogen input (NI) was predicted and the other outputs from the model were nitrogen excretion in milk (NL), urine (NU) and feces (NF). The model also predicts the loss of body fat (dL) and protein (dP) during lactation. The model was evaluated using existing nitrogen balance data from the literature. The information on potential LS, LG, sow BW, dietary composition and feed intake from the literature was used as input to the model and the predicted values for the nitrogen balance was compared with the values given in the publications. The root mean squared prediction error (RMSPE) and concordance correlation coefficients (CCC) were used in the evaluation. The mean values for observed and predicted NI, NU, NF, and NL were 95.4, 34.6, 10.9, and 65.6 g/d and 94.8, 38.5, 10.9, and 64.5 g/d, respectively. The RMSPE for NI, NU, NF, and NL were 9.9, 9.8, 1.4 and 5.6 g/d, respectively. The CCC for NI, NU, NF, and NL were 0.97, 0.93, 0.95 and 0.80, respectively. The prediction of dL and dP was evaluated using publications with relevant information. The RMSPE was 5.2 and 1.9 kg for dL and dP, respectively. The CCC was 0.74 and 0.70 for dL and dP, respectively. In conclusion, the evaluation shows that the model can predict nitrogen partitioning, dL and dP in lactating sows, and it is a potential tool for assessing intervention methods such as dietary manipulation on nutrient loading in the environment.

Key Words: nitrogen, lactation, sow

384 Dynamics of nitrogen retention in entire male pigs immunized with Improvest. L. Huber,* D. Wey, and C. de Lange, *University of Guelph, Guelph, ON, Canada.*

Immunization against gonadotropin-releasing hormone (GnRH) reduces the occurrence of boar taint compounds in male pigs, and is likely to alter growth performance and whole body protein deposition (Pd). The latter is an important determinant of dietary amino acid requirements. Thirty-six male PIC pigs were used to determine the effects of immunization against GnRH with Improvest (Pfizer Animal Health) on plasma levels of androstenone and skatole and Pd (N-retention × 6.25). Four treatments were used: [1] conventional, early castrates (EC), [2] entire males (EM), [3] entire male pigs immunized with Improvest (IM), and [4] entire male pigs surgically castrated at 25–40 kg body weight (late castrates; LC). Improvest was injected at 30 kg and 70 kg BW. Within each of 9 litters, 4 males were randomly assigned to one treatment. Pigs were fed corn and soybean meal based diets that were not limiting in essential nutrients for high Pd. Five consecutive N-balances were conducted on days: −9 to −4, 1 to 7, 9 to 16, 20 to 26 and 30 to 36, relative to the second injection at d 0; blood was sampled on days: −4, −1, 2, 5, 8, 11, 14, 19, 28 and 37. Plasma androstenone became not different from zero in IM ($P > 0.10$) and equal to EC and LC ($P > 0.10$) by d 8. Treatment had no effect on plasma skatole levels (overall mean: 0.32 ± 0.10 ng/g; $P > 0.10$). There was an interactive effect of treatment and time on Pd ($P < 0.001$). Across periods, Pd for EC and LC were similar (204.4 vs 207.5 g/d, $P > 0.10$), and lower than EM (244.8 g/d, $P < 0.001$). Pd in EM and IM was similar up to d 7 (239.5 vs 242.1 g/d, $P > 0.10$), tended to be higher for EM than IM during d 9 to 16 (239.7 vs 216.7 g/d, $P = 0.07$) and was higher for EM than IM after d 20 (252.7 vs 202.6 g/d, $P < 0.05$). Between d 9 and 36 IM Pd was similar to EC and LC ($P > 0.10$). Immunization with IMPROVEST was effective at reducing plasma androstenone. Between d 7 and 16 after the second injection, Pd in IM changed gradually from EM levels to EC and LC levels, which should be considered when developing feeding programs for IM.

Key Words: entire males, Improvest, nitrogen retention

385 Effects of dietary protein and lipid levels on growth and stress tolerance of juvenile tilapia (*Oreochromis niloticus*). C. G. Hooley*[1], F. T. Barrows[3], J. A. Paterson[1], and W. M. Sealey[2], *[1]Montana State University, Bozeman, [2]United States Fish and Wildlife Service, Bozeman, MT, [3]US Department of Agriculture, Agriculture Research Service, Bozeman, MT.*

The objectives of this study were to determine optimal dietary protein and lipid levels in diets on rate and efficiency of growth and stress response of juvenile tilapia cultured in a high-intensity recirculating-water system. A 3 × 3 factorial arrangement of diets formulated to contain 3 levels of dietary protein (28, 32 and 36%) and 3 levels of dietary lipid (3, 6, and 9%) was employed. Juvenile tilapia (34.5 ± 0.4g) were randomly assigned to each of the tanks (30 fish/tank), with 3 replicate tanks for each treatment except for the 3% lipid level (2 replicates). Fish were fed 3 times per d to apparent satiation, 6 d per wk for 12wks. Fish were weighed every 3 wks and feed efficiency (G:F) was calculated. All data were subjected to a 2-way ANOVA to determine the effects of dietary protein and lipid and their interactions on fish growth, performance and body composition and blood chemistry following a simulated hauling trial. There was no protein by lipid interactions for either rate or efficiency of gain. Fish fed 36% CP had higher ($P < 0.05$) weight gains and lower ($P < 0.05$) G:F when compared with either 28% or 32% CP diets. Fish fed 3% crude lipid had higher ($P < 0.05$) G:F (1.56) when compared with diets containing 6% and 9% crude lipid (1.41 and 1.40 respectively). Tissue composition was significantly ($P < 0.05$) affected by diet, but fish fed 36% CP retained more ($P < 0.05$) whole body protein but less whole body lipid than fish fed diets with 32% or 28% CP. Feeding fish diets with 9% lipid increased ($P < 0.05$) whole body lipid concentrations as well as whole body gross energy. Following the completion of the growth trial, tilapia were subjected to a 24-h simulated live haul. Glucose, lactate, and cortisol measurements were determined at 0, 24, and 72 h. There were significant effects ($P < 0.01$) of protein level on initial blood lactate. Fish fed 32% CP had higher lactate levels than fish fed 36% CP. After 24 h fish fed 36% CP had higher lactate levels than fish fed 32% CP suggesting that fish fed higher protein levels were more stressed during the live haul. An interaction was measured for cortisol at 24 h ($P < 0.05$), with fish fed 28% CP and 6% crude lipid having higher levels than other dietary treatment. Diets containing, 36% protein and 3% lipid supported faster growth compared with diets with higher levels of protein and lipid.

Key Words: tilapia, protein by energy, stress

386 Comparison of the in vitro fermentation activity of fecal inocula from piglets and dogs. S. Brambillasca,* C. Deluca, A. Britos, and C. Cajarville, *Departamento de Nutrición Animal, Facultad de Veterinaria, Universidad de la República, Montevideo, Uruguay.*

It is expected that gut microbiota from dogs and piglets are different in terms of number and species. This would be reflected in differences in the fermentative activity. So, the aim of this study was to compare the microbiota potential of dogs and piglets to ferment different feedstuffs. Nine substrates (0.5 g of either ryegrass, citrus pulp, apple pomace, piglet and dog food, soy hulls, corn, barley and inulin) were incubated in vitro with 10 mL of diluted feces (1:5 w/v with 9 g/L NaCl solution) from 3 piglets and 3 adult dogs fed a soybean-corn based diet and a commercial dog food respectively (3 flask/inoculum, plus 3 blanks, n = 60). Gas volume was recorded at 2, 4, 6, 8, 10, 12, 18, 24, 48 and 67 h after inoculation. Asymptotic gas production (a, mL/g OM), rate of gas production (K_d, h^{-1}) and lag time (L, h) were determined. Data were analyzed by PROC MIXED considering the substrate and inoculum effects and its interaction. If interaction substrate*inoculum was significant simple main effect of inoculum was analyzed by the SLICE option. Interactions between inoculum and substrate were observed for a ($P < 0.001$), kd ($P = 0.011$) and L ($P = 0.002$). Inoculum from piglets produced more gas for all substrates incubated, except for corn, where gas production was similar among inoculum sources. Despite the fermentation rate was similar between inoculum sources, inulin fermentation rate was higher for piglets than for dogs (0.155 vs 0.099, $P < 0.001$). Lag times recorded were lower for ryegrass, citrus pulp, apple pomace, soy hulls and inulin when inoculum from dogs was used. In conclusion, inocula behaved different and it seems that piglets presented a microbiota more active to ferment substrates than that from dogs.

Key Words: hindgut fermentation, canine, swine

387 Prediction of voluntary feed intake in weaner pigs using physicochemical properties of bulky diets. S. P. Ndou,* M. Chimonyo, and R. M. Gous, *Animal and Poultry Science, University of KwaZulu-Natal, Scottsville, Pietermaritzburg, South Africa.*

Prediction of voluntary feed intake of growing pigs is crucial in the management and welfare of growing pigs; it facilitates the accurate formulation of feeds. The objective of the study was to predict maximum feed intake in weaner pigs using the physicochemical properties of bulky feeds. A total of 124 six-week-old pigs weighing 18.1 (SD 1.37) kg BW were given, ad libitum, diets containing 0, 80, 160, 240, 320 and 400 g/kg of either lucerne hay, maize cob, maize stover, saw dust, sunflower husks or grass hay. The basal feed contained 13.7 MJ digestible energy and 180 g of CP/kg DM. Each of the 31 diets was given to each of the 4 pigs, in individual cages, for 4 weeks. Properties of bulkiness measured were water holding capacity (WHC; g water/ g DM), bulk density (g DM/mL), neutral detergent fiber (NDF) and acid detergent fiber (ADF). Average daily feed intake was expressed per unit BW to determine scaled feed intake (SFI; g/kg/day) for each pig. Stepwise regression was used to identify significant physicochemical properties that affect SFI. Response surface regression was used to determine the relationship between SFI and each of the physicochemical properties of the bulky feeds. Water holding capacity, bulk density, NDF and ADF affected ($R^2 = 0.65$; $P < 0.01$) SFI. The SFI was quadratically related to WHC using the function SFI = 19.1 (±3.49) + 10.0 (±1.61) WHC - 1.1 (±0.17)WHC^2 ($P < 0.01$). The SFI was also related ($P < 0.01$) to NDF and ADF by quadratic functions SFI = 24.3 (±3.55) + 0.1(±0.23)NDF - 0.0001 (±0.000036)NDF^2 and SFI = 30.2 (±1.95) + 0.1 (±0.02)ADF - 0.0003(±0.000061)ADF^2, respectively. Using differentiation, the gut capacity was attained when WHC = 4.76 g water/g DM, NDF = 367.12 g/kg DM and ADF = 138.50 g/kg DM, respectively. In conclusion, WHC, NDF and ADF contents are appropriate measures of bulkiness responsible for constraining intake of bulky feeds.

Key Words: bulky feeds, gut capacity, water holding capacity