

## Swine Species

**117 Dietary protease increases amino acid digestibility of various proteinaceous feedstuffs in growing pigs.** J. Escobar\*, J. Lunnemann, J. Xue, K. Eckert, N. Odetallah, and M. Vazquez-Añón, *Novus International Inc., St. Charles, MO.*

Supplementing diets with an exogenous protease to increase amino acid (AA) digestibility may be used to reduce feed cost, decrease protein fermentation in the hindgut, or both. The objective of this study was to quantify apparent ileal AA digestibility (AID) in soybean meal (SBM), corn-derived distillers dried grain with solubles (DDGS), meat and bone meal (MBM), and poultry byproduct (PBP) without or with exogenous protease (Cibenza DP100 at 500 ppm, PROT). Eight growing barrows (initial BW: 56.1 ± 0.6 kg) were individually housed and surgically fitted with a simple T-cannula in the distal ileum. The test order of feedstuffs was randomized and they were the only source of AA in each diet, which included 0.4% of TiO<sub>2</sub> as an indigestible marker. For each feedstuff, pigs were randomly allotted to a 2-period crossover design to give n = 8 per diet. Each independent feedstuff trial consisted of 5 d of diet adaptation and 2 d of ileal digesta collection. Results indicate that supplementation with PROT increased AID of Arg, Cys, His, Ile, Leu, Lys, Met, Thr, Phe, and Val in PBP ( $P < 0.04$ ) and SBM ( $P < 0.006$ ). In DDGS, PROT increased ( $P < 0.05$ ) AID of Cys, Leu, Met, Thr, Phe, and Val, as well as, Lys ( $P = 0.06$ ) and Ile ( $P = 0.08$ ). In MBM, PROT increased AID of Met ( $P = 0.04$ ), Lys ( $P = 0.06$ ), Leu and Thr ( $P = 0.07$ ), and Arg ( $P = 0.08$ ). Results from a meta-analysis of the 4 independent trials indicate that PROT supplementation increased ( $P < 0.05$ ) AID of Ala, Arg, Cys, Glu, Ile, Leu, Lys, Met, Ser, Thr, Phe, and Val, as well as Asp ( $P = 0.08$ ) and Gly ( $P = 0.10$ ). The increase in percent AID points was 6.2 for Lys, 5.8 for Met, and 7.6 for Thr. Collectively from these results, it can be concluded that PROT is an effective protease that increases in vivo AA digestibility of animal- and plant-derived proteinaceous feedstuffs.

**Key Words:** enzyme, amino acid digestibility, swine

**118 Protease and carbohydrase supplementation increased carcass weight and profit of finishing pigs.** J. Escobar\*, Y. Ma, N. Odetallah, and M. Vazquez-Añón, *Novus International Inc., St. Charles, MO.*

Inclusion of alternative ingredients and byproducts is a viable strategy to reduce the cost of diets. However, the combination of lower digestible ingredients and their higher content of anti-nutritional factors (e.g., fiber) compared with a corn-soy diet may contribute to reduce growth performance, carcass weight, and profit. The objective of this study was to evaluate the effect of enzyme supplementation of corn (TYP) and wheat (ALT) based diets with dietary protease and carbohydrases (Cibenza DP100 and Cibenza CSM, respectively, NZ) on growth performance, carcass weight, and profit. All diets contained 30% corn-derived DDGS and were formulated to contain equal content of ME and standardized ileal digestible amino acids. Barrows (TR-4 × C-22, PIC, Hendersonville, TN; 144 in total) were housed 2/pen and had free access to feed and water at all times. After a 7-d acclimation period, pigs were weighed (84.8 ± 2.9 kg BW) and randomly assigned to a 2 × 2 factorial arrangement of treatments in a complete randomized block design with n = 18 per treatment. Pigs were fed in 2 phases for 21 and 20 d each, and then transported to a commercial harvesting facility. Data were analyzed using the mixed procedure (SAS Institute, Cary, NC). Diet type or NZ inclusion had no effect ( $P = 0.15$  to 0.71) on dressing percent, lean content percent, jowl iodine value, or last rib loin and

backfat depths. No diet\*NZ interactions were found ( $P = 0.11$  to 0.92) for growth performance or carcass traits. A diet\*NZ interaction ( $P = 0.006$ ) was found for fecal DM content. Thus, NZ increased fecal DM in TYP but had no effect on ALT diets. Inclusion of NZ increased final body weight (+1.7%,  $P = 0.001$ ), ADG (+6.3%,  $P < 0.001$ ), ADFI (+1.9%,  $P = 0.05$ ), GF (+2.7%,  $P = 0.03$ ), hot carcass weight (HCW, +1.8%,  $P = 0.009$ ), HCW-ADG (+5.6%,  $P = 0.002$ ), HCW-GF (+4.3%,  $P = 0.006$ ), carcass income (+5.6%,  $P = 0.002$ ), and income-over-feed (+19%,  $P = 0.03$ ) compared with CON. In conclusion, dietary enzyme supplementation can be a viable solution to increase growth performance, carcass weight, and profitability of swine enterprises.

**Key Words:** enzyme, growth performance, swine

**119 Causes of in-transit losses of pigs.** K. Zurbrigg\*<sup>1</sup> and A. van Dreumel<sup>2</sup>, <sup>1</sup>Ontario Ministry of Agriculture, Food and Rural Affairs, Elora, ON, Canada, <sup>2</sup>Animal Health Laboratory, University of Guelph, Guelph, ON, Canada.

The cause of death for hogs that die in transit to a packing plant is an economic and welfare concern to producers, transporters, abattoirs and consumers. The increase in shipping mortalities observed during the summer months in Canada and the United States is commonly attributed to heat exhaustion or heat stress. However few studies have identified the specific cause of death for these hogs. The objective of this study is to determine if there are underlying physiologic risk factors that predispose a market hog to death during transport to slaughter. Post-mortems on 62 hogs that died in transit were completed at the abattoir or at the Animal Health Laboratory, University of Guelph. Fifty hearts were collected from hogs that did not die in transit. Each heart was examined blindly by one veterinary pathologist (TVD) grossly and histologically. Heart weights for hogs that died in transit were compared with the controls. Heart failure was the cause of death for 68% (42/62) of the hogs that died during transport. Heart lesions were chronic in nature. In 21% of the hogs, the only findings on gross post-mortem examination were pulmonary congestion and edema of the lungs. In 11% of the hogs, lesions unrelated to heart failure were identified (e.g., respiratory or gastrointestinal disease, fractures). No lesions were found on the gross examination of the control hearts. Average total heart weight for hearts with lesions (451.50 g ± 63.33) was greater than hearts without lesions (380.75 g ± 40.27) ( $P = 0.0001$ ). Final analysis of histologic results is pending. Compared with most other mammals, a pig's heart is small in relation to its body size (Friendship and Henry. 1998. Cardiovascular system, hematology and clinical chemistry. Pages 3–5 in Diseases of Swine. 7th ed.). As a result, hearts with compromised function have little reserve capacity to respond to challenges. The compensatory hypertrophy of defective hearts resulted in greater heart weights. In this study the majority of hogs that died in transit had a pre-existing cardiac abnormality resulting in hogs that were unable to survive standard transport practices.

**Key Words:** transportation, swine, death

**120 Effect of pig insemination technique and semen preparation on profitability.** D. Gonzalez-Pena\*, N. V. L. Serão, J. Pettigrew, R. Knox, and S. L. Rodriguez-Zas, *University of Illinois at Urbana-Champaign, Urbana.*

Intrauterine (IUI) and deep intrauterine (DUI) artificial insemination (AI) require lower boar semen counts compared with conventional (CON) AI. Fresh (FRE) or frozen (FRO) semen preparation and AI technique affect boar utilization efficiency and selection pressure, genetic dissemination, and biosecurity. The combined effect of 3 AI techniques and 2 semen preparations on the net profit of a pig crossbreeding system was evaluated. A 3-tier system was simulated starting with the cross of nucleus breeds A and B (500 sows/breed) that generated 200,000 AB sows at the multiplier level. The AB sows were mated to breed C terminal boars (from 500 nucleus sows) at the commercial level resulting in 4,500,000 weaned pigs/year. The combinations of preparation and techniques were represented by distinct boar:sow ratios in the AB x C cross. To understand the effects of technique and preparation, the ZPAN simulation assumed 2.1 semen doses/estrus, 2.25 farrowings/year, 50 collection/boar/year, 3 sperm counts (CON =  $3 \times 10^9$ , IUI =  $1 \times 10^9$  and DUI =  $15 \times 10^7$ ). Sow stayability ranged from 1 year (nucleus) to 3 years (commercial) and involuntary culling was 32%. A range of farrowing rates (75–85%) and number of piglets alive/litter (9–12) was tested. A significant ( $P < 0.0001$ ) improvement in the average net profit was observed in FRO (and FRE) from CON to IUI by 12.6% (4.0%) and to DUI by 17.8% (6%). There was a significant ( $P < 0.0001$ ) reduction on the average cost in FRO (and FRE) from CON to IUI by 6.6% (3.3%) and to DUI by 9.4% (4.5%). Lower total costs in IUI and DUI were driven by lower fixed costs (60%) across preparations. The variable cost of boar maintenance decreased from CON to IUI and DUI by 66% and 95%, respectively across preparations. The variable cost of sow increased for FRE (and FRO) from CON to IUI by 8.56% (4%) and to DUI by 15% (7%). Synergistic effects of AI technique and semen preparation on the net profit of pig crossbreeding systems ( $-0.94$  \$/sow for CON,  $0.24$  \$/sow for IUI,  $0.70$  \$/sow for DUI,  $0.95$  \$/sow for FRE, and  $-0.95$  \$/sow for FRO) were demonstrated.

**Key Words:** intrauterine insemination, deep uterine insemination, fresh semen

**121 Use of exogenous hormones on estrus synchronization and the reproductive life of female pigs.** L. J. Parazzi<sup>\*1</sup>, T. A. Del Santo<sup>1</sup>, A. Arruda<sup>2</sup>, S. M. M. K. Martins<sup>1</sup>, A. F. C. Andrade<sup>1</sup>, and A. S. Moretti<sup>1</sup>, <sup>1</sup>University of São Paulo (FMVZ-VNP), Pirassununga, São Paulo, Brasil, <sup>2</sup>University of Guelph, Guelph, Ontario, Canada.

Estrus induction and synchronization in gilts using exogenous hormones can bring advantages to the productive life of the female. The objective of this study was to evaluate the use of exogenous gonadotropins before puberty and its effects on the reproductive life of the female until the seventh parity. Ninety-six hybrid gilts from a commercial herd were enrolled in this study. The mean age, weight and backfat thickness were  $152.42 \pm 4.46$  d,  $99.83 \pm 8.12$  kg and  $11.90 \pm 3.06$  mm, respectively. The experimental design was a randomized trial with 2 treatments: use of an intramuscular injection of 600 IU of eCG (Novormon, Sintex S.A., Argentina) followed by an intramuscular injection of 2.5 mg of porcine LH (Lutropin Vetrepharm Canada Inc., Canada) 72 h later (Treatment H) and male stimuli only (Treatment M). Diet composition met NRC (1998) recommendations and was based on corn and soybean meal. Estrus was recorded for both groups until first artificial insemination. Data were collected through a computer program in place in the herd (Pig CHAMP software). A higher percentage of synchronization of estrus was observed on group H compared with group M ( $P > 0.05$ ). There was no effect of treatment on litter size, number of piglets born alive, number of stillbirths or number of mummified fetuses ( $P > 0.05$ ). There was a tendency effect for treatment H to farrowing interval ( $P = 0.069$ ), with a lower value observed for this group. In conclusion, the

use of exogenous hormones in gilts does not affect the productivity of the female regarding litter size; however it might bring advantages regarding number of non-productive days and facilitate female introduction in the sow herd.

**Key Words:** exogenous gonadotropin, longevity, productivity

**122 Gestational heat stress alters postnatal thermoregulation.** J. S. Johnson<sup>\*1</sup>, M. V. Sanz-Fernandez<sup>1</sup>, S. K. Stoakes<sup>1</sup>, M. Abuajamieh<sup>1</sup>, J. W. Ross<sup>1</sup>, M. C. Lucy<sup>2</sup>, T. J. Safranski<sup>2</sup>, R. P. Rhoads<sup>3</sup>, and L. H. Baumgard<sup>1</sup>, <sup>1</sup>Department of Animal Science, Iowa State University, Ames, <sup>2</sup>Division of Animal Sciences, University of Missouri, Columbia, <sup>3</sup>Department of Animal and Poultry Sciences, Virginia Polytechnic Institute and State University, Blacksburg.

Gestational heat stress (GHS) is a teratogen that negatively affects development in a variety of species, but how it alters postnatal thermoregulation is not well-understood. Study objectives were to characterize postnatal thermoregulation indices in pigs from differing in-utero thermal environments. First-parity gilts ( $n = 13$ ) were exposed to 1 of 4 ambient temperature treatments [HS (cyclic 28 to 34°C) or TN (18 to 22°C)], applied for the entire gestation (HSHS; TNTN), the first half (HSTN), or second half (TNHS) of gestation. Of the resultant offspring, 24 barrows ( $30 \pm 3$  kg BW;  $n = 6$  HSHS,  $n = 6$  TNTN,  $n = 6$  TNHS,  $n = 6$  HSTN) were housed at the ISU Zumwalt Climactic Chambers in TN ( $21.7 \pm 0.7^\circ\text{C}$ ) conditions and then exposed to 2 separate but identical HS periods (HS1 = 6 d; HS2 = 6 d; cycling 28 to 36°C). Core body temperature ( $T_{\text{core}}$ ) was assessed hourly using ThermoChron iButtons (Dallas Semiconductor), surgically implanted in the intraperitoneal cavity. Respiration rate (RR) was measured daily (0800, 1300, 1600, 2000 h). In TN conditions, all GHS pigs had elevated ( $P < 0.01$ ;  $0.35^\circ\text{C}$ )  $T_{\text{core}}$  compared with TNTN pigs. Regardless of gestational treatment, both RR and  $T_{\text{core}}$  increased from TN to HS periods ( $P < 0.01$ ; 61 bpm and  $0.70^\circ\text{C}$ , respectively). During HS1, HSHS and HSTN pigs had increased  $T_{\text{core}}$  ( $P < 0.01$ ;  $0.30$  and  $0.39^\circ\text{C}$ , respectively) compared with TNTN pigs, and tended to have increased  $T_{\text{core}}$  compared with TNTN during HS2 ( $P < 0.08$ ;  $0.25^\circ\text{C}$ ). No gestational area under the  $T_{\text{core}}$  response curve differences were detected in either HS period ( $P > 0.80$ ). No gestational differences were detected for either ADG or feed intake. In summary, pigs originating from in-utero heat stress (especially the first half of gestation) had increased  $T_{\text{core}}$  compared with controls, and this magnitude of differential was maintained in both TN and HS conditions. This suggests that in-utero HS increases ( $0.33^\circ\text{C}$ ) the thermoregulatory set-point, but how this influences whole body bioenergetics remains unknown.

**Key Words:** gestational heat stress, pig, thermal imprinting

**123 Comparison of cathelicidin expression, cytokine and gut microbes between Jinhua and Landrace pigs experimentally challenged with *Escherichia coli* K88.** Y. Gao<sup>\*1,2</sup>, X. Huang<sup>1,2</sup>, H. Yi<sup>1,2</sup>, Y. Rong<sup>1,2</sup>, and Y. Wang<sup>1,2</sup>, <sup>1</sup>Institute of Feed Science/College of Animal Science, Zhejiang University, <sup>2</sup>Key laboratory of Animal Nutrition and Feed Science, Ministry of Agriculture, Hangzhou, China.

This study was conducted to determine the possible role(s) of cathelicidins in the porcine immune system by comparing the cathelicidin expression, cytokine, gut microbes between Chinese Jinhua pigs and European Landrace experimentally challenged with *Escherichia coli* K88. The *E. coli* challenge resulted in decreased growth rate and increased diarrhea rate in both breeds. Average daily gain (ADG) of Jinhua and Landrace pigs decreased by 25% and 28.6%, respectively. The ADG of Jinhua

pigs was significantly higher ( $P < 0.05$ ) compared with Landrace pigs post-challenge. However challenged Jinhua pigs showed relatively lower rates of diarrhea compared with those in Landrace. Pigs challenged with *E. coli* showed different levels of expression for PR-39 and protegrin-1 between the 2 breeds examined. Jinhua pigs had a higher level of PR-39 in the bone marrow and spleen post-challenge compared with Landrace ( $P < 0.05$ ). Additionally, pro-inflammatory cytokines were induced, while anti-inflammatory cytokines (IL-4 and IL-10) were attenuated in all challenged pigs. Jinhua pigs had significantly higher IFN- $\gamma$ , IL-6 and IL-10 levels, but lower TNF- $\alpha$  and IL-4 levels compared with Landrace post-challenge. Moreover, *E. coli* challenge significantly increased the colonic quantity of *E. coli* in both breeds, and challenged Landrace had higher quantity of colonic *E. coli* compared with Jinhua pigs ( $P < 0.05$ ). Our findings revealed that porcine cathelicidin expression could be upregulated by *E. coli* challenge, indicating that endogenous cathelicidin expression may relate to disease resistance in pigs. Jinhua pigs exhibited higher level of cathelicidins and were associated with higher growth rate, lower diarrhea rate and colonic *E. coli* number post-challenge compared with Landrace, which were probably due to Jinhua pigs had higher disease resistance and were less susceptible to *E. coli* challenge. These results, in concert with the antibacterial properties of cathelicidins, suggest that they may play a crucial role in porcine immune responses to bacterial infection.

**Key Words:** cathelicidin, *Escherichia coli* K88, Jinhua pigs

**124 Whole-genome association analysis for feed efficiency traits in Duroc pigs.** S. Jiao\*<sup>1</sup>, J. Cassady<sup>1</sup>, C. Maltecca<sup>1</sup>, K. Gray<sup>2</sup>, and J. Holl<sup>2</sup>, <sup>1</sup>North Carolina State University, Raleigh, <sup>2</sup>Smithfield Premium Genetics, Roanoke Rapids, NC.

Improvement of feed utilization is expected to significantly increase efficiency of production given that feed costs represent the largest variable cost in pork production. The objective of this study was to identify genomic regions associated with variation in feed efficiency and its component traits in a Duroc terminal sire population. Traits analyzed were ADFI (Average daily feed intake), ADG (Average daily gain), FCR (Feed conversion ratio) and RFI (Residual feed intake). Individual feed intake and serial pig body weights were recorded using the FIRE system on 1047 individuals. Feed intake data were edited by linear mixed model to adjust errors of individual visits to the feeders. Subsequent measures were estimated from both linear and robust regression. Genotyping was performed using Illumina PorcineSNP60K Bead Chip. After quality control 40,008 SNPs remained for analysis. Missing SNP genotypes were imputed for all available boars ( $n = 1022$ ) with pedigree information. Single trait association analyses were performed using a Bayes-B model. The proportion of phenotypic variance explained by markers was 0.268 for ADFI, 0.175 for ADG, 0.187 for FCR and 0.076 for RFI. Significant regions were identified by using 3 different significance tests; posterior windows variance, Bayes factor and bootstrapping. Significance was declared for regions where tests significance overlapped. Regions associated with ADFI were mapped to chromosome 1 and 10. Similarly, regions associated with ADG mapped to chromosome 1, 4, 11, and 14. A significant region was found for FCR on chromosome 4 while no QTL were identified for RFI. In conclusion, we have identified several genomic regions associated with traits affecting nutrient utilization that could be considered for future genomic prediction to improve feed utilization.

**Key Words:** genomics, Duroc, feed efficiency