

## Swine Species

**T410 Effects of Actigen on peripheral blood immune cells in pigs experimentally infected with porcine reproductive and respiratory syndrome virus (PRRSV).** T. M. Che\*<sup>1</sup>, M. Song<sup>1</sup>, R. W. Johnson<sup>1</sup>, K. W. Kelley<sup>1</sup>, W. G. Van Alstine<sup>2</sup>, K. A. Dawson<sup>3</sup>, and J. E. Pettigrew<sup>1</sup>, <sup>1</sup>*Department of Animal Sciences, University of Illinois, Urbana*, <sup>2</sup>*Animal Disease and Diagnostic Laboratory, Purdue University, West Lafayette, IN*, <sup>3</sup>*Research, Alltech Biotechnology Center, Nicholasville, KY*.

This study evaluated effects of Actigen (ACT, a mannan preparation, Alltech, Inc.) on peripheral blood immune cells in pigs infected with PRRSV. Pigs (n = 64, 21 d old), free of PRRSV, were divided into uniform blocks on the basis of initial BW within sex. They were randomly assigned from within blocks to 1 of 4 treatments in a 2 × 2 factorial arrangement [2 types of diet: control (0%) and ACT addition (0.04%); 2 levels of PRRSV: with and without]. Sex and ancestry were equalized across treatments. Pigs were penned individually and considered experimental units. After 2 wk of an 8-wk period of feeding the treatments, pigs were intranasally inoculated with PRRSV or a sterile culture medium (Sham) at 5 wk of age. Subsets of blood leukocytes (n = 8/treatment) were measured by flow cytometry at d 0, 3, 7 post-inoculation (PI), and subsequently weekly until d 42 PI. Data were analyzed as repeated measures over time using the MIXED procedure of SAS. The numbers of leukocyte subsets in the infected pigs markedly decreased at d 3 to 7 PI, increased at d 14 to 28 PI and started declining by d 35 PI. Overall, PRRSV infection increased the numbers of total leukocytes ( $P < 0.03$ ), neutrophils ( $P < 0.001$ ), natural killer cells ( $P = 0.051$ ) and several T cell subsets ( $P < 0.01$ ) as compared with Sham. There were significant effects of day ( $P < 0.001$ ) and day × PRRSV interaction ( $P < 0.05$ ) on subsets of leukocytes during the course of study. Dietary ACT increased ( $P < 0.05$ ) the numbers of total leukocytes ( $16.5$  vs.  $15.2 \times 10^6/\text{mL}$ ), B cells ( $1.7$  vs.  $1.4 \times 10^6/\text{mL}$ ), cytotoxic T cells ( $2.0$  vs.  $1.7 \times 10^6/\text{mL}$ ) and  $\gamma\delta$  T cells as compared with the control. The diet × PRRSV interaction did not affect the numbers of total leukocytes or any subsets of immune cells. Briefly, feeding ACT to pigs results in increased peripheral blood leukocytes, B cells, and T cell subsets which may be beneficial, especially in bacterial co-infections. In addition, changes in subpopulations of immune cells over the experimental period would be a useful index of on-going processes of PRRSV infection and for designing future treatment approaches.

**Key words:** Actigen, pigs, PRRSV

**T411 Effects of dietary multi-carbohydrases on growth performance, nutrient digestibility and blood characteristics in finishing pigs.** J. P. Wang\*, X. Y. Guo, and I. H. Kim, *Dankook University, Cheonan, Choongnam, South Korea*.

The objective of this research was to evaluate the effect of multi-carbohydrases on growth performance, nutrient digestibility and blood characteristics in finishing pigs. A total of 100 crossbred barrows (initial body weight =  $56.2 \pm 1.3$  kg) were randomly allotted to 1 of 5 treatments by their BW and litters (5 replicate pens per treatment, 4 pigs per pen). Treatments included: 1) CON (barley-soybean basal diet), 2) MIX (CON + 0.05% Mixture( $\alpha$ -galactosidase:  $\beta$ -mannanase = w1:w1), 3) MAN (CON +  $\beta$ -mannanase 0.05%), 4) GB1 (CON + 0.05% enzyme complex) and 5) GB2 (CON + 0.1% enzyme complex). The enzyme complex contained protease 2,601 U/g, amylase 7,716 U/g, cellulase 5,204 U/g, xylanase 799 U/g and  $\alpha$ -galactosidase 176 U/g. During the 5 week trial, pigs fed MIX, GB1 and GB2 diets had

higher ADG than that of CON treatment group ( $P < 0.05$ ). There were no differences in ADFI and G:F among the treatments. Apparent total tract nutrient digestibility (ATTD) of DM and energy were increased by the MIX, GB1, and GB2 treatments as compared with the CON and MAN treatment ( $P < 0.05$ ). Nitrogen digestibility in GB2 treatment was greater than that of the CON and MAN treatment group ( $P < 0.05$ ). No differences in blood glucose, red blood cells (RBC), white blood cells (WBC), lymphocyte percentage and Immunoglobulin-G (IgG) concentration were observed among the treatments. After the feeding period, meat samples from pigs which reached marketing BW were collected from the slaughter house. No numerical differences were observed in backfat thickness, meat color, pH value and water holding capacity (WHC) among 4 treatments. In conclusion, the addition of  $\alpha$ -galactosidase, along with  $\beta$ -mannanase or multi-carbohydrases can improve ADG and nutrient digestibility more than single enzyme supplementation in barley soybean based diet of finishing pigs.

**Key words:**  $\alpha$ -galactosidase,  $\beta$ -mannanase, finishing pigs

**T412 Effects of a natural feed additive in comparison to an antibiotic treated group to prevent gram-negative associated diseases in pigs.** S. Schaumberger\*<sup>1</sup>, S. Masching<sup>2</sup>, A. Ganner<sup>1</sup>, and G. Schatzmayr<sup>1</sup>, <sup>1</sup>*Biomim Research Center, Tulln, Austria*, <sup>2</sup>*Biomim Holding, Herzogenburg, Austria*.

Aim of this study was to prove the positive effect of a feed additive containing a yeast-derivate, a clay mineral and a plant extract on health status (diarrhea incidence) and performance of weaning piglets compared with a positive antibiotic treated group. 90 weaning piglets were chosen from 15 litters and randomly assigned to 3 groups (A, B, C) with 3 replications each. Group A was fed the standard diet without additive; Group B was fed the control diet and additionally received 100 mg Colistin/liter drinking water for the first 21 d of the trial; Group C was supplied with 0.2% of the feed additive over the whole trial period. Incidences of diarrhea were recorded daily. Weight of each single animal was recorded at the beginning, at d 14, 21, 42 and 56. The amount of feed distributed, feeding frequency and mixing ratio were recorded automatically per pen and day. All data generated out of the trial was subjected to statistical analysis by means of PASW 18.0 (formerly SPSS Statistics). On d 56 weight of piglets of group C was improved with a statistical difference of  $P = 0.019$  compared with the control group. Daily weight gain (DWG) (d 1 to 56) showed significant differences ( $p = 0.007$ ) between groups A and B and A and C. For feed conversion rate (FCR) and feed intake no statistical differences could be observed, but for group C FCR (1.77) was lower compared to groups A (1.83) and B (1.88). On day 7 single incidences of diarrhea occurred in some pens and lasted for 13 days in varying intensities: group A showed diarrhea for 8 days, group B for 7 days and group C only for 4 days. Conclusion of our study was that a feed additive consisting of specific clays capable of binding endotoxin, yeast derivatives binding gram negative bacteria as well as acting anti-inflammatory and plant extracts with pro-inflammatory properties have a synergistic effect in vivo since in our study performance was enhanced and diarrhea incidence reduced.

**Key words:** piglet, feed additive, performance

**T413 Effects of feeding Actigen on ex vivo immune responses of porcine leukocytes.** T. M. Che\*<sup>1</sup>, R. W. Johnson<sup>1</sup>, K. W. Kelley<sup>1</sup>,

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An experiment was conducted to evaluate whether feeding Actigen (ACT) to nursery pigs subsequently alters cytokine secretion, gene expression of cell receptors and phagocytic activity of leukocytes. Weaned pigs were blocked on the basis of initial BW within sex. Pigs ( $n = 6/\text{treatment}$ ) were fed the control or 0.04% ACT diet for 2 wk and then euthanized for sample collection. Bronchoalveolar lavage cells (BALC) and peripheral blood mononuclear cells (PBMC) were stimulated in vitro with medium as a control, lipopolysaccharide (LPS; 1  $\mu\text{g}/\text{mL}$ ), or polyinosinic:polycytidylic acid (Poly I:C; 50  $\mu\text{g}/\text{mL}$ ) and incubated 24 h. Supernatants were collected for measurements of tumor necrosis factor (TNF)- $\alpha$ , IL-1 $\beta$ , interferon (IFN)- $\gamma$  and IL-10. Gene expression of mannose receptor (MR), toll-like receptor (TLR) 3 and TLR4 in BALC only was measured using qRT-PCR. Phagocytic activity of BALC and whole blood polymorphonuclear cells (PMNC) were determined by flow cytometry. Data were analyzed as a randomized complete block design using the MIXED procedure of SAS. Dietary ACT increased TNF- $\alpha$  secretion by BALC, in response to in vitro microbial stimulations, as compared with the control (17.4 vs. 12.1 ng/mL;  $P < 0.05$ ). Microbial stimulators increased BALC-produced TNF- $\alpha$  and IL-1 $\beta$  as compared with the control ( $P < 0.001$ ). There was a diet x stimulator interaction for IL-1 $\beta$  ( $P < 0.03$ ), as feeding ACT increased IL-1 $\beta$  production by BALC stimulated by Poly I:C (2.7 vs. 1.5 ng/mL;  $P < 0.04$ ), but not in those cells stimulated by LPS. Cytokines produced by PBMC were not different among the treatments. There was a diet x stimulator interaction ( $P < 0.05$ ) for expression of both MR and TLR4 genes, similar in pattern to the production of IL-1 $\beta$ . The expression of TLR3 gene was not detectable at 24-h postincubation. Dietary ACT enhanced the percentage of phagocytic PMNC as compared with the control (86 vs. 77%;  $P < 0.01$ ). Briefly, these results suggest that ACT appears to have a greater immunomodulatory effect in response to a viral model than in response to a bacterial model. It may bring benefits by enhancing the proportion of phagocytic PMNC.

**Key words:** Actigen, immune response, pigs

**T414 Effects of multiple sources and levels of dietary fiber on apparent total tract dry matter digestibility, growth performance, and concentration of fermentation indices in pigs.** A. Woldeghbriel, S. Smith\*, T. Barrios, and B. Bishop, *North Carolina Agriculture and Technical State University, Greensboro*.

Two experiments were conducted to investigate the effects of sources and levels of dietary fiber (DF) on apparent total tract digestibility (ATTD), growth performance, and concentration of fermentation indices in pigs. In Exp. 1, 16 barrows averaging 16 kg were randomly assigned to 1 of 4 diets after metabolic crate assignments with individual pig serving as the experimental unit. The pigs had free access to water, but feed allowance was limited to 10% of average body weight, fed twice d-1. The study period was split into 10d of adjustment, and 5d of urine and feces collection. In Exp.2, pigs ( $n = 96$ ; 16.4 kg) were randomly assigned to 16 pens (6/pen; 2 pen/diet) and fed their respective diets for 70 d. Diets used include: corn-soybean based control (C), and 3 antibiotic-free diets (D1, D2, and D3) each containing 5% sugar beet pulp plus, a 1:2, 1:1, and 2:1 oats to barley ratio as sources of DF, respectively. The diets were isonitrogenous (18% CP) and isocaloric (3.415 Mcal DE/kg) supplemented with vitamins and minerals to meet nutrient requirements. Average daily feed intake and body weight gain

of pigs that were fed D2 and D3 were higher ( $P < 0.05$ ) than the C or the D1 feed pigs. Pigs that were fed diets containing higher proportions of oats were more efficient than the remaining groups. Fermentation indices, pH and VFA concentrations in particular were lower ( $P < 0.05$ ) in pigs fed the C diet, and particularly in the distal colon. In general, pigs that were fed antibiotic-free, high-fiber diets performed better than pigs fed the control diet. This study demonstrates the potential benefits of adding different sources and levels of DF to the antibiotic-free diets of growing pigs. However, further work needs to be done to better understand the mode of action of DF from multiple sources and levels of fiber in the diet.

**Key words:** dietary fiber, growing pigs, antibiotic-free

**T415 Addition of bee pollen to the sow feed and effects on body weight of piglets.** C. H. Casillas-Gómez\*, I. J. Ruiz-García, and J. R. Orozco-Hernández, *Departamento de Ciencias Biológicas, Centro Universitario de Los Altos, Universidad de Guadalajara, Tzapatlan de Morelos, Jalisco, Mexico*.

The first days of the piglets life is spent depending on the quality of the mother's milk to obtain nutrients and growth promoters as well as the immunity system. Multiparous (Pietrain  $\times$  York + Landrace) sows lodged under commercial conditions were used to assess 3 levels of bee pollen (0, 31, 62, or 93 g/d) in the diet and the impact on the piglet performance before weaning. Piglet cumulative weight gain averaged 4.490 kg, and was affected by the addition of pollen to the sow's diet ( $P < 0.05$ ; 5.116, 4.598, 3.504, and 4.109 kg for 0, 31, 62 and 93 g of pollen/day, respectively). Therefore, the addition of pollen to the sow's diet had a negative effect ( $P < 0.05$ ) on the daily gain of weight (243, 219, 167, 196 g, for 0, 31, 62 and 93 g of pollen/day, respectively). Mortality was quite similar among treatments ( $P > 0.05$ ). Based on the results it could be concluded that with the addition of bee pollen to the sow's diet had an adverse effect on the piglets before weaning.

**Key words:** bee pollen, sow, piglet

**T416 Effects of thermal stress on liver xenobiotic metabolism gene expression in swine.** J. A. Madden\*, S. C. Pearce, N. K. Gabler, L. H. Baumgard, and A. F. Keating, *Department of Animal Science, Iowa State University, Ames*.

Thermal stress compromises intestinal integrity in growing pigs, resulting in increased circulating endotoxin concentrations and reduced pig performance. Thus, the study objective was to examine the effect of thermal stress on hepatic detoxification metabolism gene expression in growing *Sus scrofa*. Crossbred gilts ( $n = 48$ ;  $35 \pm 4$  kg BW) were housed in constant climate controlled rooms in individual pens and exposed to 1) thermal neutral (TN) conditions (20°C; 35–50% humidity) with ad libitum feed intake ( $n = 18$ ), 2) HS conditions (35°C; 20–35% humidity) with ad libitum feed intake ( $n = 24$ ) or 3) pair-fed (PF in TN conditions [PFTN],  $n = 6$ : to eliminate confounding effects of dissimilar feed intake [FI]). Animals were sacrificed at 1 or 7d of environmental exposure. RNA was isolated from the hepatic caudate lobe and RT-PCR used to quantify hepatic xenobiotic metabolism gene expression. Genes investigated were: 1) acyloxyacyl hydrolase (AoaH) – required for LPS deacylation, 2) aromatic hydrocarbon receptor (Ahr) and 3) NF-E2-related factor 2 (Nrf2) – transcription factors that regulate metabolism gene expression, 4) cytochrome P450 isoform 1A1 (Cyp1a1) – member of the cytochrome P450 family of enzymes with a wide substrate range and 5) glutathione S-transferase isoform mu (Gstm) – an enzyme that catalyzes xenobiotic glutathione conjuga-

tion. Compared with the TN pigs, there was no effect of HS on liver AoaH, Nr1h2 or Gstm mRNA abundance. In contrast, relative to TN, HS decreased liver Ahr ( $P = 0.05$ ) and Cyp1a1 ( $P = 0.12$ ) mRNA expression on d7. There was also a decrease in both hepatic Ahr and Cyp1a1 mRNA expression over time in HS animals compared with the TN and PFTN pigs ( $P < 0.10$ ). In conclusion, these data suggest that despite thermal stress-induced increased endotoxin concentrations, hepatic detoxification enzyme mRNAs are not upregulated. In fact, both Ahr and Cyp1a1 hepatic expression are decreased and this may indicate liver dysfunction and inadequate detoxification capability

**Key words:** heat stress, toxicology, liver

**T417 Effect of sex and housing density on growth performance, carcass quality, and fatty acid profile of pigs slaughtered at 110 kg BW.** J. I. Morales<sup>1</sup>, M. P. Serrano<sup>1</sup>, L. Cámara<sup>1</sup>, J. D. Berrocoso<sup>1</sup>, C. J. López-Bote<sup>2</sup>, J. P. López<sup>3</sup>, and G. G. Mateos<sup>\*1</sup>, <sup>1</sup>Universidad Politécnica de Madrid, Madrid, Spain, <sup>2</sup>Universidad Complutense de Madrid, Madrid, Spain, <sup>3</sup>Copiso S.A., Soria, Spain.

In total, 228 crossbred pigs (61 d of age) were used to study the effects of gender and housing density on growth performance, carcass quality, and fatty acid (FA) profile of the internal fat of m. gluteus medius (GM) in 110 kg BW pigs. There were 2 genders (gilts and barrows) and 2 rearing densities (0.84 and 0.76 m<sup>2</sup>/pig) forming a 2 × 2 factorial. Each treatment was replicated 6 times (a pen with 10 or 9 pigs depending on treatment). For the entire experimental period, barrows had poorer (2.63 vs. 2.51;  $P \leq 0.01$ ) F:G ratio than gilts. An interaction between sex and density were observed for ADFI and F:G ratio; both variables were improved in gilts as the space allowance decreased whereas the opposite effect was observed for barrows ( $P \leq 0.05$  for the interaction). No differences among treatments were found for carcass yield and pH<sub>24</sub> h postmortem. Furthermore, density did not affect any of the carcass quality traits studied. Trimmed ham (13.3 vs. 13.0%) and loin (5.96 vs. 5.67%) yield were higher ( $P \leq 0.001$ ) for gilts than for barrows. Treatment did not affect palmitic acid, stearic acid, or polyunsaturated FA concentration in GM fat. However, oleic acid content was higher (43.8 vs. 42.6%;  $P \leq 0.05$ ) for pigs reared at the higher density and linoleic (10.0 vs. 9.3%) and oleic (43.9 vs. 42.4%) acid content were higher ( $P \leq 0.01$ ) for gilts than for barrows. In conclusion, fat from GM from pigs reared at 0.76 m<sup>2</sup>/pig had more monounsaturated FA content than fat from pigs reared at 0.84 m<sup>2</sup>/pig. Also, fat from gilts had more monounsaturated FA content than fat from barrows. We concluded, that under the conditions of the present experiment, a density of 0.84 m<sup>2</sup>/pig for gilts and of 0.76 m<sup>2</sup>/pig for barrows is recommended. Sex and space allocation affected the FA profile of pigs slaughtered at 110 kg BW.

**Key words:** carcass quality and fatty acid profile, housing density, pig performance

**T418 Productive performance and carcass quality of gilts and surgically and immune-castrated male pigs from crossbreds of Duroc and Pietrain sire lines.** J. I. Morales<sup>1</sup>, M. P. Serrano<sup>1</sup>, L. Cámara<sup>1</sup>, J. D. Berrocoso<sup>1</sup>, J. P. López<sup>2</sup>, and G. G. Mateos<sup>\*1</sup>, <sup>1</sup>Universidad Politécnica de Madrid, Madrid, Spain, <sup>2</sup>Copiso S.A., Soria, Spain.

The influence of gender [intact females (IF), surgically castrated males (CM), and immune-castrated males (IMC)] and terminal sire line [Duroc (DU) and Pietrain (PI)] on growth performance and carcass

quality was studied in pigs from 23.5 to 134 kg BW. The female line used was Large White × Landrace in all cases. Each treatment (3 × 2) was replicated 5 times (a pen with 10 pigs). The CM were castrated at 4 d of age and the IMC pigs were immunized against GnRF at 87 and 137 d of age (34 d before slaughter). Backfat thickness at P<sub>2</sub> and intramuscular fat (ITMF) at Longissimus dorsi were recorded. The IMC and CM had higher (1.08 vs. 1.08 vs. 1.02 kg/d;  $P \leq 0.001$ ) ADG than IF. Furthermore, CM ate more feed (2.59 vs. 2.36 vs. 2.35 kg/d;  $P \leq 0.001$ ) than IMC and IF. Consequently, IMC had better (2.17 vs. 2.40 vs. 2.31;  $P \leq 0.001$ ) F:G ratio than CM, with IF being intermediate. Carcass yield was lower for IMC than for IF and CM (76.4 vs. 78.9 and 78.3%;  $P \leq 0.001$ ). Trimmed ham and loin yields were higher ( $P \leq 0.001$ ) for IF than for IMC and CM. The CM had more (28.6 vs. 26.7 vs. 26.1 mm;  $P \leq 0.001$ ) BF than IF and IMC, and ITMF was lower (3.5 vs. 3.9 vs. 3.7%;  $P \leq 0.05$ ) for IF than for CM, with IMC being intermediate. No differences were found between sire lines for carcass yield but crossbreds from PI had more ( $P \leq 0.001$ ) trimmed ham and loin yields than crossbreds from DU. The ITMF was higher ( $P \leq 0.001$ ) for DU crossbreds than for PI crossbreds. We conclude that IMC were more efficient but had lower carcass yield than CM and IF. Furthermore, IF have better carcass quality than IMC and CM and ITMF content is similar from IMC and CM. Crossbreds from PI sires have better carcass quality but poorer BW gain and meat quality traits than crossbreds from DU sires. Therefore, IMC and crossbreds from DU are preferred for the production of heavy pigs destined to the dry-cured industry.

**Key words:** productive performance and carcass quality, immune-castration, sire lines

**T419 Fatty acid composition of piglet tissues changes during suckling time.** M. Sini, A. Nudda, G. Pulina, S. P. G. Rassu, and G. Battacone\*, Dipartimento di Scienze Zootecniche, Università Degli Studi di Sassari, Sassari, Italy.

Aim of this work was to determinate the fatty acid (FA) evolution in different tissue of piglets during the suckling time. Litters of 3 sows similar for age, parity and breed (L × LW), and inseminated with the same Landrace boar semen, were used. Starting a week after parturition one piglet from each litter was stunned, exsanguinated, and eviscerated each week. Brain, liver, and skeletal muscle samples were removed from 4 piglets per sow. Fatty acid (FA) composition of total lipid extract from each tissue was determined by gas chromatography. Concentration of each FA was expressed as percentage of total FA. Data were analyzed with ANOVA to detect difference in FA composition between tissue during the suckling period. The mean of saturated fatty acid (SFA) increased during the suckling time, mainly due to the increase of C16:0 which represent about 50% of the total SFA. The mean values of unsaturated (UFA) and monounsaturated (MUFA) fatty acid and the PUFA-n3 decreased during the suckling time. FA composition differed significantly within tissues during the suckling time. In brain, the SFA decreased during suckling period, whereas SFA increased in liver and muscle. Conversely, UFA and MUFA increased in brain and decreased in liver and muscle. This leads to a significant decrease in relationships MUFA/SFA and SFA/UFA. These results confirm that the FA composition of the fat differed within the suckling time and suggest that the FA source in the diet must be adequate to support the growing piglets requirements.

**Key words:** fatty acid, piglet, tissues