

Swine Species

M489 Long-term effects of dietary calcium montmorillonite on swine productivity in a conventional farm in Japan. Fang Chi*¹, Munetaka Oi², Tomohiro Furuichi², San Ching¹, and LeAnn Johnston¹, ¹Amlan International, Chicago, IL, ²Toyoura Veterinary Clinic, Kanagawa, Japan.

Dietary clay (Calibrin-Z; CZ), has been shown to enhance weaning pig performance due to its barrier function in the intestine. An 18-month trial was conducted to investigate the long-term feeding effects of CZ in swine. Sixteen crossbred sows (3.2 parities) were randomly assigned to 2 TRT. The sows were fed an antibiotic free diet with 0 (CON) or 0.1% CZ during the trial. The farrowings were between Nov 2012 and Mar 2013, and from Apr to Aug 2013. Litter size and weaning weights were recorded (sow was the experimental unit). Weaned pigs from approximately 1/2 of the litters (362 pigs) were divided into 2 TRT in a split-plot arrangement based on sow TRT, and fed diets with 0 or 0.1% CZ until slaughtered (litter was the experimental unit). Pigs were weighed and blood samples collected at weaning, d-60, 90, 140, and end of trial. Feeds were formulated to meet Japanese feeding standards for swine. Total born from the 2 farrowings was not different ($P > 0.05$) averaging 12.7 for the sows fed the CON vs. 14.4 piglets for the sows fed 0.1% CZ. However, total pigs born in the second litter was numerically higher (12.5 vs. 15.8; $P > 0.05$) when CZ was fed. This improvement in the size of the second litter suggests that feeding 0.1% CZ for a longer period may have positive effects on sow reproductive performance. The combined data of 2 cycles of G-F pig performance, showed pigs fed 0.1% CZ diets needed 4.9 fewer days to reach market weight (166.8 vs. 161.9 d; $P < 0.01$) although ADG was not improved (840 vs. 864 g; $P > 0.05$). Total feed consumption was lower in pigs fed the CZ diets (308.6 vs. 287.4 kg; $P < 0.01$), and therefore, an improvement of FCR (2.92 vs. 2.75; $P < 0.05$) was obtained when pigs consumed diets containing 0.1% CZ. There were no differences ($P > 0.05$) in the serum biochemical markers concentrations, such as total protein, albumin, GOT, GTP, γ GTP and IgG etc. In conclusion, pigs fed commercial diets containing 0.1% Calibrin-Z under normal conditions in Japan may increase numbers of total born and born-alive, and improve FCR in growing-finishing phases.

Key Words: sow litter size, growing-finishing, calcium montmorillonite

M490 Effect of dietary micronutrient on the transcriptome of boar semen. Dianelys Gonzalez-Pena*, Robmay Garcia, and Robert V. Knox, and Sandra L. Rodriguez-Zas, *University of Illinois at Urbana-Champaign, Urbana, IL.*

Micronutrients are important co-factors or substrates to enzymes that protect and repair DNA against damage or methylation. Micronutrient deficiency could induce genomic instability and changes in DNA leading to cell apoptosis and degenerative diseases. The objective of this study was to compare the sperm transcriptome of boars receiving a diet supplemented with high amounts of methylating micronutrients (methionine, choline, betaine, vitamin B6, folate, and vitamin B12) relative to boars with non-supplemented diet. Semen mRNA from 4 boars was profiled and single-end reads were mapped to the *Sus scrofa* reference genome (UCSC susScr3) using Tophat v2.0.12. In total, 477 transcripts from 446 genes were tested and 73 transcripts from 72 genes were differentially expressed between the supplemented and non-supplemented boars using Cufflink v2.2.1 (P -value < 0.05). Among the differentially expressed transcripts, 89% of those from boars with the supplemented

diet were overexpressed relative to those from non-supplemented boars. The porcine seminal protein II (PSP-II) was under-expressed; meanwhile, the AWN protein (AWN) was overexpressed in boars with the supplemented diet relative to non-supplemented. PSP-II encodes a protein with paradoxical functions: in vitro PSP-II enhances viability, motility and mitochondrial activity of highly-extended boar spermatozoa; in vivo PSP-II triggers the recruitment of polymorphonuclear leukocytes and T cells in the uterus of the sow after mating. AWN encodes a sperm surface-associated protein that participates in sperm adhesion to the egg. Functional analysis of the differentially expressed genes using DAVID identified one category cluster (enrichment score > 6) related to cellular metabolism and biosynthetic process, structural constituents of ribosomes and structural molecular activity. The limited differentially expressed transcripts and the solely functional category enrichment suggest that methylating micronutrients in high quantities had no impact on the transcriptome of sperm cells.

Key Words: micronutrient, transcriptome, semen

M491 Effects of supplementing high-fiber diets with a multi-carbohydrase enzyme on net portal flux of essential amino acids and urea-nitrogen in growing pigs. Atta K. Agyekum*¹, Elijah Kiarie^{2,1}, and Charles M. Nyachoti¹, ¹Department of Animal Science, University of Manitoba, Winnipeg, MB, Canada, ²DuPont Industrial Biosciences, Marlborough, Wiltshire, UK.

The present study investigated the effects of adding a multicarbohydrase enzyme (MC; 4000 units/g xylanase, 1000 units/g α -amylase, 500 units/g protease, 150 units/g β -glucanase) to a high-fiber diet on net portal fluxes of essential AA (EAA) and urea-N in growing pigs. Five female pigs (22.8 \pm 1.6 kg BW), with permanent catheters in the portal vein, ileal vein and carotid artery, were fed 3 isocaloric/nitrogenous diets at 4% of their BW once daily at 0900 h for 7 d in a replicated 3 \times 3 Latin square design. The diets contained corn and soybean meal with 0% (CTRL) or 30% distillers dried grains with solubles (DDGS; HF) produced from a 1:1 mixture of wheat and corn. The third diet was supplemented with MC in addition to the 30% DDGS (HF+MC). On d 7, para-amino hippuric acid was infused into the ileal vein (to measure flow rate) and blood was sampled from the portal vein and carotid artery for 7 h after feeding to assay EAA and urea-N. Portal absorption of nutrients was derived by multiplying the porto-arterial plasma concentration differences by portal vein plasma flow. Diet had no effect ($P > 0.10$) on postprandial portal vein plasma flow rate and net urea-N flux, but portal urea-N was lower ($P < 0.05$) during the first h and tended to be lower ($P = 0.07$) over the 7 h in pigs fed CTRL. Postprandial portal Arg, Ile, Leu, Trp, and Val were lower ($P < 0.05$) in HF-fed pigs from 30 to 240 min than CTRL-fed pigs and MC supplementation tended ($P < 0.10$) to or improved ($P < 0.05$) portal fluxes of those AA. Further, pigs fed CTRL had higher ($P < 0.05$) net portal fluxes of the above-mentioned AA from 30 to 120 min postprandial. Also, CTRL-fed pigs had higher ($P < 0.05$) net portal fluxes of most EAA and pigs fed HF+MC had higher ($P < 0.05$) Lys and similar Met and Phe ($P > 0.10$) net portal fluxes compared with CTRL-fed pigs. The results showed that supplementing the HF diet with MC improved net portal appearance and fluxes of some EAA in growing pigs.

Key Words: fibrous diet, multicarbohydrase, net portal flux

M492 Lifetime reproductive performance of South African Mukota sows following bio-stimulation protocols. Dennis O. Ume-siobi* and Matthew C. Achilonu, *Central University of Technology, Free State, Bloemfontein, South Africa.*

Bio-stimulation is the stimulus evoked by the presence of a male which induces sexual and oestrus expressions in females through genital stimulation, pheromones, and or other external cues. The aim of this study was to comparatively evaluate the effects of 2 bio-stimulation methods on lifetime reproductive performance of sows, arranged in a 2x3 factorial experiment. Thirty sows were assigned per group to each of 2 bio-stimulation protocols, twice daily (08:30 to 09:00 and 16:00 to 16:30) per 30 min duration in a 4-week observation per parity over 3 parities. The bio-stimulation protocols involved (1) fence-line boar exposure (FBE): in which sows were exposed to fence-line boars during oestrus detection and (2) physical boar exposure (PBE): in which sows received physical contact with the boar during oestrus detection. Following the bio-stimulation applications to each sow treatment group, oestrus was synchronised in sows by a single subcutaneous injection of P.G. 600 (400 IU PMSG with 200 IU HCG/5 mL dose/animal; Intervet Inc., Millsboro, DE). After the onset of oestrus, sows on each treatment were artificially inseminated using semen from the same boars and collections. All experimental females received inseminations of 3.5×10^9 sperm/80 mL at 24 h after onset of oestrus. Physical boar exposure before oestrus induction (PG600) evoked the highest ($P \leq 0.01$) reproductive performance in sows in parity 3 compared with those in parity 2 and 1, respectively. Sows that received physical boar exposure in parity 3 produced a higher ($P \leq 0.05$) oestrus expressions (98 ± 23.1 vs. $77.5 \pm 25.5\%$), Non-return rate (92.1 ± 6.3 vs. $74.4 \pm 3.5\%$), farrowing rate (88.2 ± 16.5 vs. $63.8 \pm 7.1\%$), litter size (12 ± 0.02 vs. 8 ± 0.05) and live piglets (10 ± 0.05 vs. 6.5 ± 0.02), respectively compared with those from sows that received fence-line boar exposure in parity 3. Results suggest that direct exposure of boars to sows before artificial insemination following oestrus induction progressively enhances the lifetime reproductive performance in South African Mukota sows.

Key Words: boar effect, reproductive longevity, Mukota pigs

M493 Improved piglets performance with protected sodium heptanoate. M. Puyalto*¹, P. Honrubia¹, M. I. Gracia², and J. J. Mallo¹, ¹Norel S.A., Spain, ²IMASDE Agroalimentaria S.L., Spain.

The objective of the present study was to evaluate the effect in piglets productive parameters of sodium heptanoate protected with hydrogenated palm fatty acids distillate sodium salt (HEPT^oON) in a control diet without any additive. Thirty-two 21-d-old piglets (6.5 ± 0.5 Kg) were randomly divided in 2 groups: control (C) and 70% Na-heptanoate protected (HEPT^oON) 3 kg/t (21–35 d) and 1 kg/t (36–49 d). Every treatment was replicated 4 times and each replicate consisted of 4 piglets in the first 2 weeks and 3 piglets in the second 2 weeks of the trial. Mash feeds and water were offered ad libitum. BW, ADG, ADFI and FCR were recorded for every period. At the end of each period (35 d and 49 d), one piglet per replicate was euthanized and samples from the ileum and cecum were taken to analyze gut microflora. Data were analyzed as a completely randomized design by GLM of SPSS v. 19.0. Piglets receiving sodium heptanoate protected with hydrogenated PFAD sodium salt (HEPT^oON) tended to have higher final body weight (15.997 kg vs 14.201 kg; $P = 0.0686$). The use of HEPT^oON resulted in a tendency to improve FCR ($P = 0.0660$). Also the ADG was numerically improved in this group ($P = 0.0686$). No significant differences were observed in count of *Lactobacillus* and *E. coli*. We can conclude that the use of sodium heptanoate protected with hydrogenated PFAD sodium salt may

be able to improve productive parameters in piglets compared with the control treatment. Further research is needed.

Key Words: protected sodium heptanoate, piglets

M494 Effects of dietary supplementation organic medicinal charcoal (Olga Black) on aflatoxin adsorption capacity, digestibility, population of *Lactobacillus* and *E. coli* in feces, and the fecal odor emission by In vitro and In vivo. Kwang-Sik Kim*¹, Jin-Ho Cho², Ki Hyun Kim¹, and Young Hwa Kim¹, ¹National institute of animal science, Cheonan, Chungnam, Korea, ²Chungbuk National University, Cheongju, Chungbuk, Korea.

This study was performed to evaluate effects of dietary supplementation organic medicinal charcoal (OMC: Olga Black) on aflatoxin adsorption capacity, digestibility, population of *Lactobacillus* and *E. coli* of feces and the fecal odor emission by in vitro and in vivo in finishing pig diet. Exp 1. the aflatoxin adsorption capacity of OMC, pyrolygneous charcoal (PC), and coconut tree charcoal (CC) was measured using the ELISA test kit. The aflatoxin absorption capacity was 100, 10 and 20% in OMC, PL and CC, respectively ($P < 0.05$). The effects of OMC on digestibility of dry- and organic matter were evaluated by in vitro prediction methods (Boisen, 1991). Treatments of in vitro and in vivo included: 1) CON (basal diet contaminated with 1,543ppb of deoxynivalenol and 596ppb of zearalenone); 2) OMC (basal diet + 0.25% Olga Black); 3) PC (basal diet + 0.50% Pyrolygneous Charcoal); 4) CC (basal diet + 0.50% Coconut tree Charcoal). The digestibility of OMC on dry matter was significantly higher than CON, PC, and CC ($P < 0.05$). The digestibility of OMC on organic matter was significantly higher than CON ($P < 0.05$). Exp 2. a 10-d trial with 20 [(Yorkshire \times Landrace) \times Duroc] finishing pigs (BW = 81 ± 3.3 kg) was conducted to investigate the population of *Lactobacillus* and *E. coli* in feces, and the fecal odor (NH_3 , H_2S , total mercaptans, and acetic acid) in vivo. The fecal NH_3 and H_2S emissions of OMC were significantly lower than CON, PC, and CC ($P < 0.05$). Several *Lactobacillus* in feces of OMC and CC were significantly higher than CON and PC ($P < 0.05$). Several fecal *E. coli* of OMC and CC were lower than CON and PC ($P < 0.05$). It was thought that organic medicinal charcoal is useful as a feed additive in pig diets because it improves the digestibility of feed and the fecal odor, and has positive effect on the population of microorganism in feces.

Key Words: swine, organic medicinal charcoal, fecal

M495 Effect of a functional feed additive on the stress nervous modulation response—Application on both the feeding behavior and performance of lactating sows and their litters. Mónika Korondi¹, Bertrand Medina*², and Tamás Tóth^{1,3}, ¹Adexgo Ltd., Balatonfüred, Hungary, ²Laboratoires Phodé, Terssac, France, ³Department of Animal Nutrition, University of West Hungary, Mosonmagyaróvár, Hungary.

Recently, the effects of a 1-week administration of cyclic terpene (d-limonene) on neurotransmitters as well as its expected anti-stress effect were evaluated on mice. Considering this, the preliminary aims of Laboratoires Phodé were to investigate the effect of specific and purified fractions of natural plant extracts (*Citrus* sp.) characterized by a high level of d-limonene (135000 ppm) on the feeding behavior (total feed intake through the lactation phase) and performance of lactating sows and their litters (piglet weaning weight). The trial was performed on sows (n = 98, Topigs genetic stock, ALW = 262 ± 26.6 kg) over 3 repetitions from farrowing (d0) to inseminating period (d36). Control (CTL) and Treated (VéO) groups of sows were completed by setting

lactation pairs under the same housing (individual farrowing pens) and feeding conditions (lactating feed: 17.1% CP, 5.57 Mcal/kg ME with a twice-a-day dispensing). The administration of the functional feed additive (VéOPremium, Laboratoire PHODÉ, France – 250 g/MT) was started with a 4-d pre-feeding period before the sows were moved to the farrowing barn (d-4). Data were analyzed under non-parametric tests (Kolmogorov-Smirnov test, Levene-test, independent-samples *t*-test) using SPSS 13.0 for Windows. There were no significant differences ($P > 0.05$) between groups regarding the body weight loss of lactating sows. The average lactating FI was significantly higher (+ 4.7%, $P \leq 0.05$) in the VéO group compared with the CTL one (157 ± 6.3 vs 150 ± 8.3 kg, respectively). Regarding the average number of weaned piglet/litter of sow, no significant difference was observed between groups (12.25 vs 12.3 piglets/litter, for both VéO and CTL groups, respectively). The average live-weight (ALW) of piglets at weaning showed significantly heavier value (+6.5%, $P \leq 0.05$) in the VéO group (ALW = 7.37 ± 0.72 kg) although the piglets were weaned after 26.1 d on average, while the average number of days from birth to weaning was 26.6 in the control group (ALW = 6.92 ± 0.77 kg). These results suggest that the administration of these specific and purified fractions of natural plant extracts are able to support higher sow feed intake and piglet weaning weight ($P \leq 0.05$) through lactation phase.

Key Words: botanical extract, lactating sow, stress

M496 Improved piglets performance with sodium heptanoate.

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The objective of the present study was to evaluate the effect in piglets productive parameters of sodium heptanoate in a control diet without any additive. Forty-eight 21-d-old piglets (6.5 ± 0.5 kg) were randomly divided in 2 groups: control (C) and 98% Na-heptanoate (NaC7) 3 kg/t. Every treatment was replicated 6 times and each replicate consisted of 4 piglets. Mash feeds and water were offered ad libitum. BW, ADG, ADFI and FCR were recorded for every period. At the end of each period (35 d and 49 d), one piglet per replicate was euthanized and samples from the ileum and cecum were taken to analyze gut microflora. Besides, samples of duodenum, jejunum and ileum epitheliums were obtained to determine their development status. Data were analyzed as a completely randomized design by GLM of SPSS v. 19.0. Piglets receiving sodium heptanoate had higher final body weight without significative differences (16 Kg vs 16.2 Kg; $P = 0.7583$). However the use of NaC7 resulted in an improvement ($P = 0.0431$) in the FCR (1.416 vs 1.324) when compared with the control treatment. No significant differences were observed in count of *Lactobacillus* and *E. coli*. Neither were there significant differences in villi height; however, there was a tendency to show deeper crypts in duodenum ($P = 0.1058$) in the animals that received the sodium heptanoate ($441.1 \mu\text{m}$ vs $374.3 \mu\text{m}$). We can conclude that the use of sodium heptanoate is able to improve productive parameters in piglets compared with the control treatment.

Key Words: sodium heptanoate, piglet

M497 Feeder space may affect pig performance in the early growing-finishing period.

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The number pigs fed per feeder space decrease along the whole growing period. However moving pigs from the weaning to the growing-

finishing facilities is a challenging period and feeder space may affect performance, growth and homogeneity of pigs. The aim of the present work was to study the effect feeder type in terms of feeder space (2 or 5) at the start of the growing period. At weaning a total of 264 28-d-old piglets [Pt \times (LD \times LW)] were distributed into 24 pens (11 piglets/pen) according to sex and initial body weight (BW) for the transition period (T; 28 to 64d). During T period, a commercial INOX lidded hopper was used (3 feeder spaces of 17cm/pen). When pigs moved to the growing facilities, the 24 pens were maintained and split into 2 groups of 12 according sex, BW and feeder type. Two different commercial concrete hoppers differing in feeder space were used (2 feeder space of 23cm or 5 feeder space of 18cm/pen) Pigs were feed the same diets during T and growing (G) period. Feed was offered ad libitum in mash form. Therefore, 2 experimental treatments were performed at the start of the growing period (64 to 92d) according to feeder space and sexes taking into account the same conditions from 28 to 64d. Individual BW was recorded at 28, 64 and 92d of age and average daily gain (ADG) and coefficient of variation (CV) of the pen were calculated. Behavioral measures and lesion scoring were also monitored on d 74 of age. No sex effect was observed for the T and G ($P > 0.10$). Higher BW (33.1 vs 32.5kg; $P = 0.061$) and ADG (583 vs 562g/d; $P = 0.062$) were observed for the animals raised in the 5 feeder space hoppers compared with the 2 feeder spaces. Moreover, the CV of the animals at the end of T was reduced (12%) along G with a 5 feeder spaces while increased (1.2%) with 2 feed spaces. Finally, no differences were observed in terms of aggressions and lesions due to feeder space during G period. It is concluded that feeder space may affect growth performance and body weigh homogeneity in growing pigs.

Key Words: feeder space, performance, pig homogeneity

M498 The effect of immunocastration on growth performances and carcass quality of heavy males and gilts.

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A trial was carried out with 48 Duroc \times (Landrace \times Large White) pigs intended for dry-cured ham; 24 males and 24 gilts of 46.3 and 42.9 kg BW, respectively. For that end, surgically castrated males are used to avoid sexual odour and minimum levels of fat thickness, measured at Gluteus medius muscle (GM; >16 mm), are required to improve the ripening process and ham quality. Currently, the main problems are the future prohibition in EU of this type of castration and the lack of fat in gilts. The effect of immunization against GnRH on growth performances and carcass quality was evaluated. There were 4 experimental treatments; surgically castrated males (CM), immunocastrated males (IM), entire gilts (EG) and immunocastrated gilts (IG). The CM had been castrated at 5 d of age. Immunization was carried out in both sexes with 2 injections of Improvac (Zoetis) with an interval of 4 weeks (1st: 44.6 kg BW, 2nd: 70.6 kg BW, as average). The replicate was a pen with 3 pigs ($n = 4$) for performance traits and the animal ($n = 12$) for carcass traits. A commercial diet, based on barley, wheat, and vegetable meals and containing 13.74 MJ DE/kg, 14.1% CP, and 0.75% Lys, was provided ad libitum through the trial. Pigs were slaughtered at 127 kg BW. Data were analyzed by ANOVA and the statistical model included the sex as main effect. Duncan test was used to compare pairs of means. From 1st to 2nd injection, the EG grew faster than IG with CM and IM being intermediate ($P < 0.001$) but this effect disappeared after. At the end of the trial, the CM had higher feed:gain ratio than the other treatments ($P < 0.05$). No effect of immunocastration was observed on carcass

yield but the IG had wider fat depth at GM and lower lean yield than EG with CM and IM being intermediate ($P < 0.05$). Intramuscular fat content was not affected by sex. It is concluded that the immunization against GnRF might be a good strategy to improve some traits desirable in pigs intended for dry-cured ham because, in gilts, it increased fat depth and, in males, it reduced feed:gain ratio in comparison with those surgically castrated.

Key Words: pig immunocastration, growth performance, carcass quality

M499 Is the lactation period the main variable responsible for reducing the efficiency of the swine production? Sergi López-Vergé, David Solà-Oriol, Laia Blavi*, and Josep Gasa, *Animal Nutrition and Welfare Service, Department of Animal and Food Sciences, Universitat Autònoma de Barcelona, Bellaterra, Spain.*

Pig body weight (BW) homogeneity across the entire production cycle plays an important role in the swine industry because it directly affects efficiency and farm occupation time, mainly in regards to the growing-finishing facilities. The aim of this study was to know if the BW variability is equally distributed along the pig productive life or is primarily important at one particular stage. A total of 433 crossbred piglets [Pietrain \times (Landrace \times Large White)] from 40 litters were used. All diets were offered ad libitum. During the nursery period, piglets were fed a diet formulated to contain 11.0 MJ/kg NE, 20.2% CP and 1.37 Lys. Thereafter, the animals were moved to a growing-finishing facility. Pigs were fed the same commercial growing and finishing diets (10.0 MJ/kg NE, 16.0% CP, 0.95 Lys). All animals were individually weighed from birth until slaughter at d 2 (CF; cross fostering), d 28 (weaning), d 42 (14 d post-weaning), d 63 (35 d post-weaning) and every 3 weeks until pigs were slaughtered. The relationship between BW at one stage and the next succeeding one along the whole cycle was analyzed by using the CORR procedure of SAS. Moreover, the variability at all periods was calculated taking into account the coefficient of variation (CV, %) by using the MEANS procedure of SAS. A strong relationship was observed between 2 consecutive steps along the whole production cycle (Pearson Correlation Coefficient (r) ranging from 0.85 to 0.96 ($P < 0.001$) until the first group of pigs were slaughtered), except for the lactation period (from birth to weaning, $r = 0.46$, $P > 0.001$). At the same time, the CV was higher at the first stages (22.17% until 35 d post-weaning) and then decreased until slaughter (8.42%). Results showed that the events occurred in the first stages of pig life, but especially during the lactation period (in terms of variability), have a huge effect along the subsequent performance of pigs, suggesting a more accurate management for the smallest piglets just after birth.

Key Words: correlation, piglet, variability.

M500 Evaluation of the efficacy of sodium heptanoate or butyrate in front of an enterotoxigenic *Escherichia coli* (ETEC) K88 oral challenge in piglets. P. López-Colom¹, L. Castillejos¹, M. Puyalto², J. J. Mallo^{*2}, and S. M. Martín-Orúe¹, *Animal Nutrition and Welfare Service, Departament de Ciència Animal i dels Aliments, Universitat Autònoma de Barcelona, Bellaterra, Barcelona, Spain, ²Norel S.A., Madrid, Madrid, Spain.*

This study evaluated the efficacy of sodium heptanoate (HEPT'ON) or sodium butyrate (GUSTOR BP70; Norel S.A.) against ETEC K88 in weanlings. A total of 72 3-week-old piglets were divided into 24 pens and 3 experimental groups: Plain diet (CTR); supplemented with GUSTOR BP70 (BUT); or supplemented with HEPT'ON (HPT), both

at 3 kg/t and containing 70% of acid salt protected with vegetable fat. Intake and weight were monitored along 15 d. After one week, animals were orally inoculated with ETEC K88 (1×10^9 cfu) and fecal consistency and rectal temperature evaluated afterward. On d 4 and 8 post inoculation (PI) one animal per pen was euthanized to evaluate inflammatory response (TNF α and Pig-MAP) and counts of enterobacteria and *E. coli* in ileal-colonic contents and ileal mucosa scrapes. No significant differences were seen in performance although numerical values were higher for the experimental diets (217, 264 and 243 g ADFI and 117, 123 and 124 g ADG for CTR, BUT and HPT). No significant differences were found in fecal consistency, rectal temperature and inflammatory markers. Regarding microbiological changes, no significant differences were observed between treatments in the colon. Nonetheless, in ileum digesta, there were numerical differences ($P = 0.126$) with higher number of enterobacteria in both acids treatments at d 4 PI, that was correlated to an increase in the number of enterobacteria and *E. coli* recovered from the ileal scrapes (4.30, 5.88 and 5.46 log cfu *E. coli* for CTR, BUT and HPT, $P = 0.003$). This increase, however, was not found at d 8 PI when even a decrease in the numerical values of *E. coli* in ileal digesta was seen for BUT treatment (6.58, 6.01 and 6.93 log cfu for CTR, BUT and HPT, $P = 0.036$) that also showed a tendency to improve the colonic consistency ($P = 0.099$). These results suggest the potential of BUT to improve the recovery of the animals after an ETEC challenge. More studies under field conditions with a higher number of animals would be needed to confirm the numerical differences found in performance.

Key Words: *Escherichia coli* K88, sodium heptanoate, sodium butyrate

M501 The use of multiple imputation for the accurate measurements of individual feed intake by electronic feeders. Shihui Jiao^{*1}, Christian Maltecca¹, Yijian Huang², and Kent A. Gray², *¹North Carolina State University, Raleigh, NC, ²Smithfield Premium Genetics, Rose Hill, NC.*

Obtaining accurate individual feed intake records is a key first step in achieving genetic progress toward a more efficient pig for nutrient utilization. Feed intake records collected by electronic feeding systems contain errors (extreme values or outliers), which are due to feeder malfunction or animal movements. In this study, we introduce a new feed intake data editing strategy to replace errors and missing observations occurring in feed intake data, based on multiple imputation methods. Compared with the well-established linear mixed model (LMM) approach, multiple imputation either by using conditional distribution (MI) or by chained equation (MICE) results in increased accuracy of data adjustment in simulated phenotypes with artificially introduced errors. Feeder visit records in the simulated data sets were sampled from a data set including individual pig feed intake visits collected by Smithfield Premium Genetics from year 2004 to 2013. Three scenarios were considered in the analysis with 5%, 10% and 20% error visits simulated. Each scenario was replicated 5 times. Accuracy of the error-adjustments was measured as correlation between the true error-free daily feed intake (DFI) or average daily feed intake (ADFI), and the adjusted ones. Multiple imputation methods outperformed the linear mixed model approach in all scenarios with average accuracies of 96.71%, 93.45% and 90.24% obtained with MI and 96.84%, 94.42% and 90.13% obtained with MICE, compared with 91.0%, 82.63% and 68.69% using LMM for DFI with simulated error rate 5%, 10% and 20%, respectively. Similar results were obtained for ADFI. In conclusion, multiple imputation was introduced in this study as a more accurate

and flexible error-adjustment method for feed intake data collected by electronic feeders.

Key Words: feed intake, electronic feeder, multiple imputation

M502 Effect of using nonconventional legumes (narbon vetch, black chickpea, and winter pea) as protein sources in piglet diets.

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A trial was carried out to study the effect of the partial substitution of soybean meal (SBM) by alternative protein sources: black chickpea (*Cicer arietinum*; BC), narbon vetch (*Vicia narbonensis*; NV), and winter pea (*Pisum sativum*; WP) on growth performance of piglets during starter period. The anti-nutritional factors are the main handicap of including in a diet a high proportion of legumes with no previous treatment. The protease inhibitors (PI) (trypsin inhibitor; TI and chymotrypsin; CI) interfere in the absorption of proteins affecting feed intake and feed efficiency in young pigs. A total of 192 animals (96 barrows and 96 gilts), from PIC L-65 sires x Topigs 20 dams, of 11.6 ± 0.56 kg BW and 42 ± 2 d of age were used in the experiment. Piglets were allocated according to sex and initial BW. Four diets were provided: 1) control with 21% SBM, 2) 24% BC + 14.4% SBM, 3) 20% BC + 5% NV + 13.2% SBM and 4) 24% WP + 5% NV + 11.4% SBM. Diets had a similar nutritional profile (10.24 MJ NE/kg, 18% CP, and 1.25% Lys). Trial lasted 20 d (23.35 ± 1.42 kg BW as average). Data were analyzed as a random factorial design 2 (sexes) × 4 (diets) by GLM of SAS. Each experimental treatment was replicated 4 times considering the box, with 6 piglets, as the replicate. The PI content in the experimental diets was 1.03, 2.41, 1.57, and 1.13 units TI/mg feedstuff, and 1.85, 2.66, 2.24, and 2.60 units CI/mg feedstuff for diet 1, 2, 3, and 4, respectively. No significant difference was detected for any variable studied between barrows and gilts. The average daily gain was not affected by diet ($P = 0.42$) but piglets fed diets 1, 2 and 3 ate more feed than those fed diet 4 (898, 951, 876 vs 836 ± 25.7 g/d, respectively; $P < 0.001$). Diet 4 provided better feed to gain ratio than diets 1 and 2, with diet 3 in an intermediate position (1.54, 1.58, 1.51, and 1.44 ± 0.034 g/g, for diets 1, 2, 3, and 4, respectively; $P < 0.005$). Although more studies are necessary, we can conclude that black chickpea, narbon vetch, and winter pea can substitute partial soybean meal in piglet diets during the starter phase.

Key Words: nonconventional legume, piglet, productive performance

M503 Effects of breed, sex, and birth weight on growth and carcass composition traits in pigs. L. L. Lo^{*1}, C. C. Tsai¹, and R. S. Lin², ¹Chinese Culture University, Taipei, Taiwan, Republic of China, ²National I-Lan University, I-Lan, Taiwan, Republic of China.

Effects of breed, sex, and birth weight on growth and carcass composition traits were investigated using purebred Duroc, Landrace, and Yorkshire, respectively. Twenty-three sets of three littermates, consisting of a boar, gilt, and barrow for each of 3 breeds was used. All pigs were classified into 3 groups based on their birth weights (BWT): small (mean = 1.15 kg), medium (mean = 1.50 kg), and big (mean = 1.75 kg). Gilts and barrows from each littermate were slaughtered at 103.40 kg (SD = 13.98 kg) of body weight. A mixed model that included fixed effects of

breed, sex, birth group, interaction of breed and sex, and random effect of animal was used. Breed significantly affected growth traits. Landrace pigs had the highest ($P < 0.05$) overall average daily gain than in other 2 breeds. The overall average daily gain was 608.93 ± 7.87 g, 649.00 ± 7.82 g, and 603.38 ± 8.61 g for Duroc, Landrace, and Yorkshire, respectively. Heavier pigs at birth showed significant advantage ($P < 0.05$) on overall average daily gain (small = 595.99 ± 12.00 g, medium = 615.64 ± 6.17 g, large = 649.68 ± 7.65 g). Carcasses from Landrace pigs had thinner average backfat and tenth rib backfat thickness than those from Duroc breeds. Duroc pigs however had heavier ($P < 0.05$) ham weight than that of Landrace pigs indicated the carcass characteristics of Duroc breed. Most carcass composition traits did not show the sex effect except for fat percentage and weight of tenderloin ($P < 0.05$). Pigs with heavier birth weight had larger ($P < 0.05$) Boston butt. In conclusion, the results suggest that breed, sex, and birth weight are important sources of variation for growth and carcass composition traits of pigs.

Key Words: birth weight, carcass, pig

M504 Reducing malodorous compounds on swine in vitro fermentation using probiotics. Yeon Jae Choi, Lovelia L. Mamuad, Seung Hyun Kim, and Sang Suk Lee^{*}, Suncheon National University, Suncheon, Jeonnam, South Korea.

Bacteria play a significant role in odor production. Thereby, we evaluated different bacteria for their ability to reduce malodorous compounds in swine using in vitro fermentation. Fresh cultures of *Lactobacillus plantarum* KACC 91016 (T1), *L. brevis* ATCC 14869(t) (T2), *Bacillus subtilis* KACC 10112 (T3), *Saccharomyces cerevisiae* KACC 30068 were used in this study. One hundred milliliters of anaerobic salt medium containing 10% fresh swine feces was transferred to serum bottles containing 1g DM of 50:50 soluble starch to casein ratio and inoculated with or without (control) 1mL of different microbial cultures and incubated for 24h. Highest ($P < 0.05$) total gas production was observed in T1 and lowest in control. Opposite was observed in hydrogen sulfide (H₂S) concentration, wherein lowest ($P < 0.05$) H₂S was observed in T1 and highest in control with 17.80% and 22.20%, respectively. Also, lower percent methanethiol, dimethyl sulfide and trimethylamine were observed in treated compared with control. Highest ($P < 0.05$) concentration of total fatty acids, propionate, and butyrate were also observed in T1 and the highest ($P < 0.05$) acetate was observed in T3. Among the bacteria used, addition of *L. plantarum* is the most effective for reducing malodorous compounds

Key Words: in vitro, malodorous compounds in swine, probiotic

M505 Relationship between birth weight and subsequent piglet performance: A meta-analytic study. Eloiza Lanferdini¹, Ines Andretta², Leonardo da Silva Fonseca¹, Rennan Herculano Rufino Moreira¹, Vinicius de Souza Cantarelli¹, Rony Antônio Ferreira¹, Alysson Saraiva³, Cesar Augusto Pospissil Garbossa¹, and Márvio Lobão Teixeira de Abreu^{*2}, ¹Universidade Federal de Lavras, Lavras, Minas Gerais, Brazil, ²Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil, ³Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil.

The aim of this study was to evaluate the effect of birth weight of piglets on subsequent performance through a meta-analysis. The database totaled 2,691 piglets (15 articles published between 2002 and 2014). Average birth weights were 1.785, 1.511 and 1.129 kg for heavy, medium and light piglets, respectively. The selected database publications contained results of experiments with at least 2 weight groups of piglets

at birth and performance results. The meta-analysis was based on 3 sequential analysis: graphic, correlation and variance-covariance. The birth weight of piglets was positively correlated with body weight in the subsequent phases and with weight gain during the lactation period. On the other hand, the age at slaughter to reach 110 kg correlation with birth weight of piglets was negative. The birth weight of piglets affected ($P < 0.05$) body weight and weight gain in the subsequent phases. Heavy piglets at birth showed an increase ($P < 0.05$) of 6.6 kg in the slaughter weight, at 150 d of age, compared with light piglets. Piglets with medium weight at birth reached similar weight at slaughter ($P > 0.05$) compared with heavy piglets and showed a difference ($P < 0.05$) of 5.2 kg compared with light piglets. The different birth weight of piglets had no influence ($P > 0.05$) on feed intake in the subsequent phases of growth. Feed efficiency improved ($P < 0.05$) in medium and heavy piglets at birth in the growing and finishing phases. The slaughter age to reach 110 kg of live weight decreased ($P < 0.05$) in the piglets born with medium and heavy weight, respectively, compared with piglets with low birth weight. Heavy piglets at birth (1.785 kg) performed better by increasing weight gain, and consequently greater final body weight and fewer days (10–12 d) to reach slaughter weight compared with light piglets (1.129 kg). Above 1.50 kg at birth the pig performance until slaughter is not influenced by birth weight.

Key Words: animal growth, meta-analysis, pig production

M506 Meat quality of finishing pigs from sows supplemented with arginine during gestation. Leonardo da Silva Fonseca¹, Eloiza Lanferdini¹, Rennan Herculano Rufino Moreira¹, Rhuane Fillipe Chaves¹, Peter Bitencourt Faria¹, Marianne Kutschenko², Eduardo Terra Nogueira², Alysson Saraiva³, Cesar Augusto Pospissil Garbossa¹, and Márvio Lobão Teixeira de Abreu^{*1}, ¹Universidade Federal de Lavras, Lavras, Minas Gerais, Brazil, ²Ajinomoto Animal Nutrition, Limeira, São Paulo, Brazil, ³Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil.

The aim of this study was to evaluate carcass traits and meat quality of finishing pigs from sows supplemented with arginine during gestation. Piglets of 48 sows from parities 2 to 6 fed gestation diets with or without 1.0% L-arginine (Ajinomoto) supplementation from 30 to 60 d of gestation and from 80 d of gestation until farrow were used. Twenty 4 pigs (6 males and 6 females per treatment), selected by average weight (96.17 kg \pm 3.74 for the pigs from control sows and 103.67 kg \pm 4.05 for the pigs from arginine fed sows) were slaughtered at 150 d of age. *Longissimus dorsi* temperature and pH at the 12th rib were measured 45 min and 24 h after slaughter on the left half of the carcass. Loin eye area and the fat area were evaluated by drawing the outline of the muscle and the fat at the tenth rib on a paper and then scanning and measuring the area through ImageJ IJ 1.46r. *Longissimus dorsi* samples were collected and cooled to perform the color ratings. Saturation indices (C^*) and hue angle (h^*) were determined. Pigs from sows fed arginine during pregnancy were 7.80% heavier ($P < 0.05$) at 140 d of age. The drip loss was negatively affected ($P < 0.05$) by arginine supplementation which was 3.40% higher compared with the control group. This feature may negatively influence the product choice by the consumer as it is one of PSE meat characteristics. The loin depth of the control group was 13.70% lower ($P < 0.05$), however the loin eye area and the loin fat area were not affected ($P > 0.05$). L^* , a^* , b^* , C^* , and h^* values as well as shear force and cooking loss were not affected ($P > 0.05$) by arginine. Dietary supplementation of gestating sows with arginine increase pig weight and loin depth at slaughter; however, drip loss is also increased.

Key Words: amino acid, carcass, nutrition

M507 Growth curve analysis of placental and fetal growth influenced by adjacent fetal sex status under crowded uterine conditions in pigs. Brad A. Freking* and Clay A. Lents, USDA, ARS, US Meat Animal Research Center, Clay Center, NE.

Intrauterine position and sex of adjacent fetuses in litter bearing species have been implicated in physiological and behavioral differences in males and females. Our objective was to establish growth curves for fetal and placental weight gain as influenced by sex status of flanking fetuses under crowded uterine conditions. Gilts were subjected to unilateral-hysterectomy-ovariectomy surgery at 160 d of age and mated at approximately 280 d of age. Gilts were assigned to be harvested at d 45, 65, 85, or 105 of gestation. A total of 297 pregnancies were evaluated in 4 contemporary groups. Position in the uterus relative to the cervix, fetal weight, and placental weight were recorded at harvest. Data were coded to test when each fetus was adjacent to 0, 1, or 2 opposite sex fetuses after removal of the first and last fetuses in each litter to remove bias of ends not being flanked on both sides. After this editing a total of 343, 651, and 303 fetuses were included in the analyses for 0, 1, or 2 opposite sex flanking fetuses, respectively. Nonlinear analyses fitted a logistic function ($Wt = Ae^{kt}$) to the fetal and placental weight data to establish unique growth curves for each flanking sex status code. Two parameters were estimated representing the initial weight at day zero (A) and a slope parameter (k) with respect to time of gestation (t). Gauss-Newton method was used in the NLIN procedure to generate solutions. A 4 df F-test was calculated to compare the ability of code-specific functions to account for more variation than the pooled function. The null hypothesis of a single pooled function to describe fetal weight was rejected ($F = 2.49$; $P < 0.05$) but not for placental weight ($F = 0.80$; $P > 0.1$). Code specific growth curves indicated placental weight separated only in the latter stage (d 105) of gestation whereas fetal weights separated as early as d 65 of gestation. Fetal growth development in pigs is influenced by sex status of adjacent fetuses, with increased growth by those surrounded by the same sex, and could be a potential source of variation in behavioral and reproductive differences later in life.

Key Words: pig, fetal growth, survival

M508 Effect of mineral sources on reproductive performance in sows. Tsung-cheng Tsai*¹, Gary A. Apgar², Mark J. Estienne³, Mark Wilson⁴, and Charles V. Maxwell¹, ¹University of Arkansas, Fayetteville, AR, ²Southern Illinois University, Carbondale, IL, ³Virginia Tech, Blacksburg, VA., ⁴Zinpro Inc., Eden Prairie, MN.

Sows ($n = 245$ from 3 stations) were blocked by parity [Pty 1: parity 1; Pty 2: parity 2 and 3; Pty 3: parity ≥ 4] and initial BW, and then randomly assigned to corn-SBM diets supplemented with either inorganic [IM: 120 ppm Zn (ZnO), 30 ppm Cu (CuSO₄), and 50 ppm Mn (MnSO₄)] or the same total level of minerals with AA complex of Zn, Cu and Mn (OM) replacing 50% of the IM in iso-mineral based diets which also provided 120, 165, 0.3, 0.3 ppm of inorganic Ca, Fe, I, and Se, respectively. Gestation (3391 kcal/kg of ME; 0.65% SID lysine) and lactation (3348 kcal/kg; 1.00% SID lysine) diets were formulated to meet 1998 NRC nutrient recommendations. Sow individual BW (at breeding, 110 d, 48 h postpartum, and weaning) and Intake (gestation: breeding to 110 d; lactation: postpartum to weaning) were collected to calculate ADG, ADFI and G:F ratio. During gestation, IM fed sows gained less weight (60.4 vs. 64.6 kg, $P = 0.054$), consumed less feed (263.5 vs. 264.8 kg, $P = 0.047$), and had lower G:F ratio (0.27 vs. 0.29, $P = 0.044$) than OM fed sows. In lactation, sows fed IM had higher ADFI in wk 2 (5.85 vs. 5.19 kg/d, $P = 0.021$), and weaned more light BW piglets per litter (<3.63 kg; 6.55 vs. 3.23%, $P = 0.047$) than those fed OM, whereas number born alive (11.4 vs. 10.9, $P = 0.238$), number weaned (10.2 vs. 9.8, $P =$

0.184), piglets pre-weaning ADG (0.27 vs. 0.27 kg/d, $P = 0.767$), and the percentage of pre-weaning mortality (13.1 vs. 12.9%, $P = 0.923$) were similar for IM and OM fed sows, respectively. Of all parities, the Pty 1 and 2 sows gained more BW in gestation (66.1 and 67.5 vs. 53.9 kg, $P < 0.001$) than Pty 3. In addition, the Pty 1 sows had lower overall lactation intake (99.0 vs. 124.7 and 126.2 kg, $P < 0.001$) when compared with Pty 2 and 3 sows. Sows of Pty 2 delivered 8.9% heavier average BW piglets [1.67 vs. 1.50 (Pty 1) and 1.52 (Pty 3) kg, $P < 0.001$], and had 11.5% higher piglet ADG [0.29 vs. 0.26 (Pty 1 and 3) kg/d, $P < 0.001$]. Results of current study demonstrate that supplemental organic minerals improved gestation weight gain, G:F ratio, and produced more full value weaned pigs.

Key Words: organic and inorganic minerals, sow, reproductive performance

M509 Transcriptome profile of boar spermatozoa as revealed by RNA-sequencing. Jean M. Feugang^{*1}, Shengfa S. Liao¹, William S. Sanders^{2,3}, Jingqiao Lu⁴, Mark A. Crenshaw¹, Scott T. Willard^{1,5}, and Peter L. Ryan^{1,6}, ¹Department of Animal and Dairy Sciences, Mississippi State University, Mississippi State, MS, ²Department of Computer Science & Engineering, Mississippi State University, Mississippi State, MS, ³Institute for Genomics, Biocomputing, and Biotechnology, Mississippi State University, Mississippi State, MS, ⁴School of Medicine, Emory University, GA, ⁵Biochemistry, Molecular Biology, Entomology and Plant Pathology, Mississippi State University, Mississippi State, MS, ⁶Pathobiology and Population Medicine, Mississippi State University, Mississippi State, MS.

High-throughput RNA sequencing (RNA-Seq) overcomes the limitations of the current hybridization-based techniques to detect the actual pool of RNA transcripts in spermatozoa. The application of this technology in livestock can speed the discovery of potential predictors of male fertility. As a first step to identify novel gene products of fertility importance in pigs, we conducted a RNA-sequence analysis of boar spermatozoa. Fresh semen of 8 fertile boars (3 ejaculates/boar) were purchased from a commercial stud and pure motile spermatozoa were obtained through a discontinuous percoll gradient. Total sperm RNA were extracted using commercial kits with an in-column DNase digestion. The purity and integrity of RNA samples were checked and those with high quality parameters were used for deep-RNA sequencing to produce millions of short cDNA reads using Illumina RNA-Seq technology. Resulting reads were aligned to the pig reference genome to produce a genome-scale transcription map that consisted of both the transcript structure and the expression level of each gene (fragments per kilobase of exon per million fragments mapped). Total of 18,357 sequence tags were successfully mapped to all pig chromosomes and mitochondrial genome. Five chromosomes (2, 1, 6, 7, and 13) comprised the highest density of mapped transcripts (42%), while the bottom lowest density (8%) was found in chromosomes 10, 18, 16, 11, and Y. The Y chromosome and mitochondrial genome contained only 0.07% and 0.08% of total mapped sequence tags. Structural annotation revealed a diverse population of sperm transcripts comprising both coding and non-coding RNAs. Approximately 12,355 of sequence tags were annotated with ENSEMBL and rRNAs (e.g., 5s and 7sk), snRNA (e.g., U1 and U6), miRNAs (e.g., mir127 and mir935), and mitochondrial RNA (e.g., ND6 and CO1) constituted the most abundant sequence tags. We further confirmed the presence of selected genes (e.g., AQP11 and AQN-1) through RT-PCR. The findings revealed a large pool of coding and non-coding RNA in mature boar spermatozoa. The full investigation of this RNA

population will allow for the identification of those having critical roles during fertilization and early embryogenesis.

Key Words: gamete, reproduction, swine

M510 Effects of chicken egg anti-F4 antibodies supplementation on performance and diarrhea incidences in enterotoxigenic *Escherichia coli* K88⁺ challenged piglets. Kolawole R. Aluko^{*1}, Deepak Ettungalpadi Velayudhan¹, Lin Fang², and Charles M. Nyachoti¹, ¹University of Manitoba, Winnipeg, MB, Canada, ²Zyme Fast System Inc., Winnipeg, MB, Canada.

This study was conducted to evaluate the effects of feeding diets supplemented with spay-dried whole egg containing anti-F4 antibodies (SDWE) against recombinantly produced F4 antigens to piglets challenged with enterotoxigenic *Escherichia coli* K88 (ETEC). Twenty-seven individually housed piglets [(Yorkshire × Landrace) × Duroc, 7.27 ± 0.47 kg initial BW] weaned at 21 ± 1 d were randomly allotted to 3 dietary treatments (n = 9) consisting of a wheat-soybean meal basal diet containing either 0 (control egg powder; CEP), 0.1% (SDWE1) or 0.4% (SDWE2) SDWE for a 14-d study. After a 7-d adaptation period, all pigs were weighed, blood samples collected and then orally challenged with 6 mL (2 × 10⁹ cfu/mL) of freshly grown ETEC inoculum on d 8. Pigs had ad libitum access to feed and water throughout the study. Blood was sampled at 24 h and 48 h post-challenge to determine plasma urea nitrogen (PUN) content and diarrhea incidences and fecal consistency scores were recorded from d 9 to d 12. On d 14, all pigs were weighed and then killed to obtain intestinal tissue samples for villus height and crypt depth measurements. During the pre-challenge period, pigs fed the SDWE2 diet had higher ($P < 0.05$) ADG and G:F compared with CEP but there were no differences among treatments in any of the performance response criteria during the post-challenge period. Incidences of diarrhea were similar among treatments although piglets fed SDWE-containing diets recovered from diarrhea within 48 h (with fecal consistency score of 0.0) of ETEC compared with CEP pigs. Also, fecal shedding of ETEC, PUN content and intestinal histomorphology were similar among treatments. The results show that SDWE at 0.4% supported greater piglet performance before challenge although there was no benefit of SDWE supplementation at either 0.1% or 0.4% evident during the post-challenge period.

Key Words: ETEC K88⁺, chicken egg anti-F4 antibodies, recombinant F4 antigens

M511 Combined effects of chitosan and probiotic supplementation on performance and diarrhea incidences in enterotoxigenic *Escherichia coli* K88⁺ challenged piglets. Kolawole R. Aluko^{*1}, Deepak Ettungalpadi Velayudhan¹, Aike Li², Yulong Yin³, and Charles M. Nyachoti¹, ¹University of Manitoba, Winnipeg, MB, Canada, ²Academy of State Administration of Grain, Beijing, China, ³Institute of Subtropical Agriculture, Chinese Academic of Sciences, Changsha, China.

The aim of this study was to investigate the combined effects of chitosan oligosaccharide (COS) and a microencapsulated *Enterococcus faecalis* probiotic (PRO) on growth performance and diarrhea incidences in enterotoxigenic *Escherichia coli* K88 (ETEC) challenged piglets in a 14-d study. Thirty piglets [(Yorkshire × Landrace) × Duroc], 7.19 ± 0.52 kg initial BW weaned at 21 ± 1 d were allotted to 5 treatment groups (n = 6) consisting of a corn-soybean meal diet with no additive (negative control, NC), the NC + 0.25% chlortetracycline (positive control, PC), NC + 400 mg/kg COS (COS), NC + 100 mg/kg PRO (PRO) and NC +

a combination of COS and PRO (CPRO). The basal diet was formulated to meet the NRC (2012) nutrient specifications for 5 to 10 kg BW pigs. Pigs were individually housed in cages, acclimated to treatments for a 7-d period and had ad libitum access to feed and water throughout the study. On d 8, pigs were weighed, blood samples were collected and then orally challenged with 6 mL (1×10^{11} cfu/mL) of freshly grown ETEC inoculum. Post-challenge, blood was sampled at 24 h and 48 h to determine plasma urea nitrogen (PUN) and diarrhea incidences and fecal consistency scores were recorded from d 9 to d 12. On d 14, all pigs were weighed and then killed to obtain intestinal tissue samples for histomorphometric measurements. Growth performance responses were similar among treatments during the pre- and post- challenge periods. There were no significant differences in PUN content, incidences of diarrhea and fecal consistency scores among treatment. The intestinal histomorphology results did not differ significantly among treatments except for PC with increased ($P = 0.0003$) villus-crypt ratio compared with the NC. Therefore, under the conditions of the present study, supplementing pig starter diet with 400 mg/kg COS or 100 mg/kg PRO or their combination had no effect against ETEC-induced diarrhea and did not improve growth performance in ETEC challenged piglets compared with control group.

Key Words: ETEC K88⁺, chitosan oligosaccharide, *Enterococcus faecalis* probiotic

M512 Yeast cell wall supplementation in the diet of weaned piglets and its effect on performance and diarrhea incidence.

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The objective of this study was to evaluate effects of yeast cell wall (YCW) supplementation in weaned piglet's diet on performance and diarrhea incidence. Trial 1 was conducted on a swine farm which recently recovered from hog cholera disease, and 120 piglets, 28-d old (avg. 8.37 kg) were distributed in a randomized complete block design (RCBD), with 2 treatments (0 and 2 kg/MT of YCW from *Saccharomyces cerevisiae*), being 8 reps for control group and 7 for YCW group, of 8 piglets in each. The 2nd trial was conducted on a swine farm where the low disease profile was relatively stable for the past 2 years, and 100 piglets, 28-d old (avg. 7.53 kg) were distributed in RCBD, with 2 treatments (same as 1st trial) each having 5 reps with 10 piglets in each. The periods were 20 and 21d, respectively, for 1st and 2nd trials, divided into booster (28–30d) and pre-starter diets (31–47d 1st trial, and 31–48d 2nd trial). The parameters measured in both trials were: body weight (BW, kg), body weight gain (BWG, kg), average daily feed intake (ADFI, kg), feed:gain (F:G) and mortality (M, %). Diarrhea incidence (DI) was observed in 1st trial, and given a corresponding score from zero to 3 in order of increasing severity. The data were analyzed using the GLM (SAS), and means were compared by Kruskal-Wallis test for non-parabolic data. The YCW supplementation in the diet of weaned piglets resulted in no differences ($P > 0.05$) in performance parameters analyzed for both trials. However, the groups supplemented with YCW, numerically had improved BWG (+6.3; +6.4%) and F:G (+7%; 13.2%), respectively, for both trials. There were no differences ($P > 0.05$) between treatments for DI score. For control group, 90.36% of the population has 0 score at the beginning, which suggests a normal type of feces, and at the final week of the experiment, it minimally increased to 93.05%. For YCW group, there was an increase in the number of animals having a 0 score, from 82.58% to 93.79%, at the last week of the experiment. Supplementation of YCW at 2 kg/MT to diets

of weaned piglets had numerical, but no significant, positive benefits when considering BWG, F:G, and DI, compared with control treatment.

Key Words: body weight, *Saccharomyces cerevisiae*

M513 Yeast cell wall supplementation in the diet of weaned piglets and its effect on gut health.

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The objective of this small-scale study was to evaluate effects of yeast cell wall (YCW) supplementation in weaned piglet's diet on gut health and integrity. The trial was conducted with 12 piglets, 28-d old (8.5 ± 1.5 kg), distributed in a complete randomized design, with 2 treatments (0 and 2kg/MT of YCW from *Saccharomyces cerevisiae*), 6 reps, 1 piglet in each. On d 1 of trial, *E. coli* was inoculated at 9.8×10^8 cfu/mL per pig. The experimental period was 14 d, where on d 1, 1 animal of control group (CG) was killed for baseline values; on d 7, 3 piglets from each treatment were killed; and on d 14, the remaining piglets were killed. Intestinal samples were collected from jejunum on d 1, 7, and 14 and measured under the light microscope for villus height (VH, μm), villus width (VW, μm), mucosal thickness (MT, μm), crypt depth (CD, μm) and villous surface area (VSA, μm^2). Also scanning electron microscopy (SEM) was performed. The jejunal samples were also used to determine *E. coli* (JEC) and total coliform counts (JCC). On d 4, 7, 11, and 14 of the trial, fecal samples of all pigs were also collected for *E. coli* (FEC) and total coliform count (FCC). The data were analyzed using the GLM (SAS), and means were compared by *t*-test ($P = 0.05$). Overall (d 7 and 14), the YCW-treated piglets differed ($P < 0.05$) from baseline piglet for VH, VW and CD. The CG had better results ($P < 0.05$) for VH, VW, CD and VSA at 7th d post-infection. However, at 14 d post-infection, YCW supplementation had improved ($P < 0.05$) VH, CD and VSA. Although there were no statistical differences ($P > 0.05$) between treatments for MT at d 14, it was numerically improved (+16.2 μm) for piglets supplemented with YCW. For SEM, YCW group appeared to have less erosion in villi apices and better microvilli surface, when compared with CG at d 7 and 14. The JEC, JCC, FEC and FCC average of YCW group and CG showed a significant increase ($P < 0.05$) among the days post-infection, compared with the baseline values; however, the averages of YCW group were significantly lower ($P < 0.05$) than the CG. These results demonstrated that YCW supplementation at 2 kg/MT to weaned piglets decreased jejunal and fecal *E. coli* counts and improved intestinal integrity.

Key Words: *Saccharomyces cerevisiae*

M514 Effect of chronic heat stress on mRNA expression of heat shock protein 70, uncoupling protein 3, and cytochrome p450 in pigs.

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Exposure of pigs to sudden increases in ambient temperature (AT), causing heat stress (HS) provokes cellular and molecular changes to cope with HS and maintain homeostasis. Abundance of mRNA coding for heat shock protein 70 kDa (HSP70) involved in the folding of proteins during heat stress, uncoupling protein 3 (UCP3) involved in heat generating in mitochondria, and cytochrome p450 (Cp450) involved in redox equilibrium, is affected in animals under acute HS. But it is

not clear whether those alterations are maintained in pigs with chronic exposure to HS. An experiment was conducted with 18 pigs (30–35 kg BW) to analyze the effect of chronic HS on mRNA expression of HSP70, UCP3, and Cp450. There were 3 treatments: 1) pigs housed inside an AT controlled room ($24 \pm 2^\circ\text{C}$) and fed ad libitum (TNL), 2) as in 1 but feed restricted (TNR), 3) pigs housed under natural HS conditions (27.1 to 39.6°C , average 33.3°C). Feed intake in HS pigs was restricted to 95% of ad libitum intake, and that of TNR pigs was similar to HS pigs. Body temperature (BT) was recorded every 15 min with a device implanted under the skin of 4 pigs per treatment. At the end of the 21-d study, all pigs were killed and samples of liver, and longissimus (LM) and semitendinosus (SM) muscles were collected to analyze the mRNA expression of HSP70, UCP3 and Cp450. The BT of TNL, TNR, and HS pigs was 38.4, 37.7 and 39.0°C , respectively. It was higher in HS pigs compared with TNL and TNR ($P < 0.05$). Expression values ($\times 10^{-4}$) for HSP70 in TNL, TNR, and HS pigs were liver, 2.03, 4.08, 7.66; LM, 2.47, 5.2, 4.69; SM, 2.10, 2.31, 2.23, respectively; for UCP3 were LD, 4.58, 4.92, 3.57; SM, 3.46, 2.42, 6.04. Expression values ($\times 10^{-3}$) for Cp450 in liver were 3.59, 1.77, 1.68. Chronic HS did not affect the expression of HSP, UCP3 or Cp450 in pigs. Although BT of pigs exposed to chronic HS remains higher than in TN pigs, the lack of effect on gene expression may suggest that pigs became acclimated at or before 21 d of natural exposure to HS.

Key Words: pig, heat stress, gene expression

M515 Influence of CLA supplementation on body composition of finished pigs. Kyle J. Stutts*, Ginger G. Vann, Mark J. Anderson, Jessica L. Leatherwood, Marcy M. Beverly, and Stanley F. Kelley, Sam Houston State University, Huntsville, TX.

Twenty-four pigs (Large White \times Landrace; 128.2 to 134.1 kg) of similar breeding were utilized in a randomized complete block design to evaluate the effects of dietary supplementation of conjugated linoleic acid on body composition of mature, finished pigs. Pigs were blocked by BW and sex and were randomly assigned and evenly distributed between a treatment ($n = 12$; TRT) or control group ($n = 12$; CON) for an 84-d feeding trial. Diets were formulated to be isocaloric and isonitrogenous and consisted of a CON diet of a commercially available concentrate (Producers Cooperative, Bryan, TX) with an additional 2% of the total diet of soybean oil, or the TRT diet that consisted of the same pelleted concentrate with an additional 2% of the total diet of oil containing CLA. The CLA source (BASF Corp., Florham Park, NJ) being utilized contained 55% CLA (mixture of *cis*-9, *trans*-11; *trans*-10, *cis*-12; and *trans*-9, *trans*-11 isomers) yielding a CLA supplementation of 1.1% of the total diet. Oil was top-dressed and mixed into feed immediately before feeding. Pigs were fed at 12-h intervals at 3.5% BW per day in concentrate. Body weight was obtained every 7 d with the intake of concentrate adjusted accordingly. Fat thickness (cm) was measured at 14-d intervals via ultrasonography at the 10th and last ribs. Longissimus muscle area (LMA) was collected via ultrasonography at d 0 and 84. Data were analyzed using the mixed procedure of SAS. Overall effects were analyzed using repeated measures and data from individual days were analyzed using fat thickness from d 0 as a covariate. CLA supplementation had no effect on body composition. Overall, there was no difference between treatments in BW ($P = 0.98$), 10th rib fat thickness ($P = 0.07$), last rib fat thickness ($P = 0.17$), or LMA ($P = 0.96$). Additionally, there were no treatment \times time interactions for the variables measured. These data indicate that CLA supplemented at 1.1% of the diet when mature pigs are fed at 3.5% BW has no effect on body composition or BW.

Further studies are needed to fully elucidate dietary CLA supplementation to alter body composition when fed to mature pigs.

Key Words: CLA, swine, fat thickness

M516 Effect of acute water and feed deprivation at weaning and subsequent heat stress on serum stress markers and ileal mucosa gene expression in nursery pigs. Nathan L. Horn*¹, Guy Miller², Frank Ruch³, Carrie R. Little³, Kolapo M. Ajuwon¹, and Olayiwola Adeola¹, ¹Purdue University, West Lafayette, IN, ²Biomatric, Princeton, MN, ³JBS United, Sheridan, IN.

The current experiment was conducted to investigate the effect of a feed and water deprivation event at weaning and subsequent heat stress event on serum stress markers and expression of selected genes in the ileum. Mixed-sex pigs were allotted on the basis of IBW ($6.97 \text{ kg} \pm 0.89$) in a RCBD with treatments in a split-plot arrangement and consisting of the whole-plot factor of with or without a 24-h feed + water deprivation event at weaning (deprivation event) and the sub-plot factor of with or without a cyclic 3-d heat stress event starting 27 d post-weaning. On 1, 27, and 30 d post-weaning one pig from each pen was selected for blood and ileal mucosa collection to determine serum cortisol, corticotrophin releasing factor (CRF), and endotoxins; and mucosal gene expression measurement of tumor necrosis factor α (TNF- α), interleukin 6 (IL-6), interleukin 8 (IL-8), glucose transporter 2 (GLUT2), claudin 1 (CL-1), occludin (OC), and zonula occludens 2 (ZO-2) by RT-PCR. There was an increase ($P < 0.05$) in serum CRF and endotoxins and a tendency for an increase ($P = 0.09$) in serum cortisol due to the deprivation event 1 d post-weaning. Furthermore, serum endotoxins and CRF tended to increase ($P < 0.10$) due to the deprivation event on 27 and 30 d post-weaning, respectively. Gene expression of GLUT 2 tended to decrease ($P = 0.07$), CL-1 tended to increase ($P = 0.10$), and OC decreased ($P = 0.05$) due to the deprivation event 1 d post-weaning. Expression of IL-8 and OC genes decreased ($P < 0.05$) due to the deprivation event 27 d post-weaning and OC and ZO-2 gene expression tended to decrease ($P = 0.07$) due to the heat stress event 30 d post-weaning. Results from the current experiment show that a post-weaning feed and water deprivation event impacts serum stress markers and mucosal gene expression throughout the nursery period and a subsequent heat stress event affects tight junction gene expression although an interaction of deprivation event by heat stress was not observed.

Key Words: feed and water deprivation, heat stress, nursery pig

M517 The growth of Tamworth \times Berkshire pigs farrowed outdoors and reared in a hoop structure. H.-S. Park¹, N. Whitley², and S.-H. Oh*¹, ¹Department of Animal Sciences, North Carolina A&T State University, Greensboro, NC, ²Cooperative Extension Program, North Carolina A&T State University, Greensboro, NC.

The objective was to investigate the growth of Tamworth- or Berkshire-sired pigs from Berkshire sows at the North Carolina Agricultural and Technical State University Farm. The location features a humid subtropical climate with subtropical summer temperatures and mild winters and an average annual precipitation of approximately 110 cm. Forty-four purebred Berkshire females were used to produce crossbred and purebred Berkshire pigs. Females were given altrenogest (Matrix) for estrus synchronization for 14 consecutive days at 7 ml for gilts and 9 ml for sows. Thirty-three females were detected in heat and artificially inseminated, which resulted in 10 farrowed sows. Each sow farrowed in a 15-m² paddock in June 2014. Total number born were 67 in Tamworth \times Berkshire (TB) and 51 in Berkshire \times Berkshire (BB), respectively.

Number born alive were 53 in TB, and 35 in BB. Pigs were weaned at 4 weeks of age. Body weights from 43 weaned Tamworth × Berkshire (TB) crossbred pigs were recorded from 6 sows, and weights from 28 weaned Berkshire × Berkshire (BB) purebreds were recorded from 4 sows as a control group. Birth weights (BW) were recorded at 3 d of age, and then body weights were recorded every 4 weeks from their birthdate to 20 weeks of age; weaning weight (WW), 8 weeks of age (W8), 12 weeks of age (W12), 16 weeks of age (W16), and 20 weeks of age (W20). Data were analyzed with repeated measures ANOVA using SAS PROC GLM. Least squares means of weights in TB were 1.90 ± 0.06kg (BW), 8.11 ± 0.29kg (WW), 19.11 ± 0.58kg (W8), 34.80 ± 1.10kg (W12), 54.49 ± 1.51kg (W16), and 79.16 ± 1.96kg (W20), respectively. Least squares means of weights in BB were 1.80 ± 0.08kg (BW), 7.78 ± 0.36kg (WW), 16.99 ± 0.74kg (W8), 31.58 ± 1.39kg (W12), 52.04 ± 1.91kg (W16), and 79.78 ± 2.48kg (W20), respectively. Body weights were significantly greater for TB compared with BB only for W8 and W12 ($P < 0.05$). More research is needed regarding breed types used in alternative production systems.

Key Words: Tamworth, Berkshire, growth

M518 Effect of postcervical artificial insemination with semen supplemented with oxytocin in sows in warm weather. Juan M. Romo, Javier A. Romo, Ruben Barajas, Hector R. Guemez, and Juan M. Uriarte*, *Universidad Autónoma de Sinaloa, Culiacan, Sinaloa, Mexico.*

To determine the effect of applying semen doses spiked with oxytocin by post-cervical insemination, on the reproductive performance of sows

serviced during the months of June to October (max. registered ambient temperature of 46°C and 28 min) in northwest Mexico, 223 multi parturient sows were inseminated. Sows were assigned randomly to be serviced twice with semen from same boar(s) in 1 of 2 treatments: (1) serviced with a reduced dosage equivalent to $1.5 \times 10,000,000,000$ viable spermatozoa cell diluted in 40 mL of semen dose (CONT, n = 111) and (2) similar to CONT plus addition of 4 IU oxytocin to semen at service time (OXY, n = 112). Sows were serviced from June to October, using an intrauterine semen delivery device. Total number born and total number born alive were counted at farrowing. Results were compared using X^2 analyses. Treatment had no effect on litter size with 11.0 vs. 10.8 ($P = 0.577$), or on number born alive with 9.8 vs. 9.6 for CONT and OXY, respectively. OXY enhances ($P = 0.03$) 9.6% the farrowing rate, with means values of 84.68 vs. 93.75 for CONT and OXY, respectively. These results suggest that the addition of oxytocin to semen at serviced time improves farrowing of multi parturient sows serviced during summer-autumn in northwest Mexico, without effects on other reproductive performance variables.

Key Words: sow, postcervical insemination