

difference observed in MOT due to LINE ($P > 0.05$). As the sample sizes are quite small (line D is represented by one sire), additional data are needed to confirm these results. These preliminary data indicate that variability seen in semen characteristics may be explained by pedigree when sire, age, season of collection, and level of inbreeding are accounted for.

Number of sires	2	3	5	1
Mean F	22.5	10.0	18.2	15.2
Mean AGE	12.0	17.0	12.6	28.0
Mean VOL	89.2 ^A	69.6 ^B	56.6 ^{B,C}	39.0 ^C
Mean CON	113.3 ^{B,C}	171.8 ^A	128.2 ^{A,B}	67.8 ^C

Mean values shown with uncommon superscripts within a row differ ($P < 0.05$).

Key Words: Horse, Semen, Inbreeding

Nonruminant Nutrition: Additives and Supplements

M85 A strawberry flavor in drinking water and feed improves water intake and growth of pigs at weaning. E. Roura^{*1}, D. Solà-Oriol², and D. Torrallardona², ¹LUCTA SA, Barcelona, Spain, ²IRTA, Centre Mas Bové, Reus, Spain.

A two-phase trial was conducted to study the effects of a strawberry flavor (flavor) and a high intensity sweetener (HIS) in drinking water and feed on the performance of weanling pigs. Eighty 21 day-old Landrace piglets (6.6 ± 1.40 kg) were distributed in 24 pens with three or four pigs, each provided with an independent water container. In phase I, all pigs were offered the same unflavored diet for a period of 14 days but four treatments were administered in the water: either with no additions (C), or with flavor (A), with HIS (S) or both flavor and HIS (AS). In phase II (day 14 to 27), the animals in each treatment were divided into two groups receiving unflavored water but offered either flavored or unflavored feed. At the end of phase I, average water intake was 618, 681, 642 and 645 g/p/d, and weight gain was 168, 199, 189 and 180 g/p/d for groups C, A, S and AS, respectively. Thus, group A compared to C showed 10% ($P > 0.1$) and 18% ($P < 0.1$) higher water intake and weight gain, respectively. In addition, feed to gain ratio during the same period was better ($P < 0.05$) for A (1.37) than that for C (1.63) and intermediates for S (1.45) and AS (1.50). No differences in feed intake were observed. Statistics of phase II suffered from a low number of replicates. Nevertheless, it seems relevant ($P < 0.01$) that the group receiving flavor+HIS through water in phase I followed by flavor+HIS through feed in Phase II increased body weight gain by 18% over those receiving flavored water in Phase I and unflavored feed in Phase II. Thus, in phase II, the withdrawal of flavor in water together with not adding flavor in feed resulted in the lowest performance. Overall, these results suggest that water intake after weaning is encouraged with the use of flavor, and that this has beneficial effects on piglet performance. After the withdrawal of flavor in water, improving piglet performance might be linked to flavoring also the feed. The interaction between flavoring drinking water and flavoring feeds at weaning merits further studies.

Key Words: Water Intake, Piglet Weaning, Flavor

M86 Effect of oregano, cinnamon and chili pepper herbal extracts as growth promoters on growth performance of young pigs. G. Velazquez¹, A. G. Borbolla^{*1}, G. Mariscal-Landin², T. Reis de Souza³, and A. Pinelli⁴, ¹Universidad Nacional Autonoma de Mexico, Mexico City, Mexico, ²INIFAP CENID Fisiología, Ajuchitlan, Queretaro, Mexico, ³Universidad Autonoma de Queretaro, Queretaro, Queretaro, Mexico, ⁴Centro de Investigación en Alimentación y Desarrollo A.C., Mexico City, Mexico.

The aim of this work was to evaluate the effect of oregano, cinnamon and chili pepper herbal extracts (HE) as growth promoters on live weight (LW), daily weight gain (DWG), daily feed intake (DFI) and feed conversion (FC) of pigs weaned at 19 days of age during 35 days (weaned stage) after weaning (divided into two feeding phases). Eighty-four pigs were randomly assigned to four treatments (tx): negative control (NC), diet with no growth promoter added; positive control (PC), diet with carbadox as growth promoter; negative control + 150 ppm of HE (NC150), diet NC with the addition of 150 ppm of HE; and

negative control + 300 ppm of HE (NC300), diet with the addition of 300 ppm of HE. The pigs were distributed into 24 pens (three or four pigs/pen and six pens/tx). A randomized complete block design with covariable (initial weight) was used for the data analysis. The blocking factor was the week of weaning. The experimental unit was the pen for DFI and FC; and the pig for LW and DWG. Phase I lasted 14 days after weaning and Phase II for 21 days. The PC had higher LW ($P < 0.001$) compared with NC150, NC300 and NC (14.5 vs. 13.0, 12.5 and 11.9 kg, respectively). On week two of phase II, NC150, NC300 and PC showed higher DWG ($P < 0.05$) compared with NC (516.2, 477.9 and 525 vs. 398.8 g, respectively). The DFI for PC in both phases were higher ($P < 0.05$) compared with the rest of experimental groups. FC was lower ($P < 0.005$) for the NC300 and PC groups compared with NC and NC150 (2.0, 1.7 vs. 2.4 and 2.5, respectively) during phase I. In phase II, FC was lower ($P < 0.005$) in NC150, NC300 and PC compared with NC (1.3, 1.3, 1.4 vs. 1.6, respectively). The use of herbal extracts in young weaned pigs statistically imitates some of the parameters achieved when the antibiotic-origin growth promoter, carbadox, is used in the fed.

Key Words: Herbal Extracts, Growth Performance, Weaned Pigs

M87 Intestinal morphology of weaned pigs fed diets containing herbal extracts as growth promoters. G. Velazquez¹, A. G. Borbolla^{*1}, G. Mariscal-Landin², T. Reis de Souza³, and A. Pinelli⁴, ¹Universidad Nacional Autonoma de Mexico, Mexico City, Mexico, ²INIFAP CENID Fisiología, Ajuchitlan, Queretaro, Mexico, ³Universidad Autonoma de Queretaro, Queretaro, Queretaro, Mexico, ⁴Centro de Investigación en Alimentación y Desarrollo A.C., Mexico City, Mexico.

The aim of this work was to evaluate the effect of herbal extracts (HE) used as growth promoters on villous height (VH) and crypt depth in the duodenum (D), jejunum (J) and ileum (I) of fifty-two weaned (22 d) pigs. At day of weaning (d 0), four pigs (d 0 pigs) were randomly chosen and slaughtered to obtain basal levels of VH and CD from D, J and I. The remaining pigs were randomly assigned to four treatments: negative control (NC), diet without any growth promoter; positive control (PC), diet with carbadox as growth promoter; negative control + 150 ppm of HE (NC150), NC diet with the addition of 150 ppm of HE; and negative control + 300 ppm of HE (NC300), diet with the addition of 300 ppm of HE. Pigs were allocated in 16 pens (four pens/treatment). A split plot experimental design was used for data analysis. At days 7, 14 and 21 postweaning, four pigs from each treatment were randomly killed to obtain intestinal samples. The experimental unit was the pig, and the analysis unit was the villous. Fourteen days after weaning, VH in D, J, and I of all pigs regardless of treatment decreased 60% ($P < 0.01$) when compared with the VH at d 0. At day 21, however, DVH ($P < 0.05$), JVH ($P < 0.07$) and IVH ($P < 0.09$) were highest for NC150. CD increased ($P < 0.005$) in all treatment groups regardless of treatment when compared to CD of pigs at d 0. CD in D and I were equal ($P > 0.05$) for all treatments at d 7 and d 14. JCD was the lowest ($P < 0.05$) in PC, NC150 and NC300. At d 21, DCD was similar ($P > 0.05$) among treatment groups. JCD was lowest ($P < 0.01$) in NC300 pigs when compared with CD of the PC pigs (95 vs. 130 μ). In I, NC150, NC300 and PC had the lower ($P <$

0.001) CD when compared with NC (100, 100 and 101 vs. 140 μ). HE can produce a faster recovery of the VH when supply in the diet of weaned pigs. Whether it will increase performance remains to be evaluated.

Key Words: Intestinal Morphology, Weaned Pigs, Herbal Extracts

M88 Effect of essential oils (Fresta F Conc[®]) supplementation on growth performance, immune response and fecal noxious gas of weaned pigs. J. H. Cho^{*1}, Y. J. Chen¹, B. J. Min¹, K. S. Son¹, H. J. Kim¹, O. S. Kwon¹, S. J. Kim², and I. H. Kim¹, ¹Dankook University, Cheonan, Korea, ²Yuhan Co., Korea.

Ninety six crossed pigs [(Duroc \times Yorkshire) \times Landrace] were used to determine the effects of essential oils (Fresta F Conc[®]) supplementation on growth performance, immune response and fecal noxious gas of weaned pigs. Treatments were: 1) CON (basal diet without antibiotics), 2) T1 [basal diet + 0.1% of CSP(CTC + Sulfathiazole + Penicillin)], 3) T2 (basal diet + 0.03% of Essential oils), and 4) T3 [basal diet + 0.1% of CSP (CTC + Sulfathiazole + Penicillin) + 0.02% of Essential oils]. For d 0 to 14, ADFI was increased in pigs fed T3 diet ($P < 0.05$). For d 14 to 28, pigs fed T3 diet had significantly increased ADG and ADFI compared to pigs fed CON diet ($P < 0.05$). For d 28 to 49, ADG in pigs fed T3 diet were higher than that of pigs fed CON diet ($P < 0.05$). For the entire experimental period, ADG and ADFI in pigs fed T3 diet were the highest compared to pigs fed CON and T1 diets ($P < 0.05$). Serum IgG concentration of T3 treatment was greater than that of others ($P < 0.05$). For d 0 to 14, volatile fatty acid (VFA) productions in pigs fed T2 diet were lower than those of pigs fed CON and T1 diets ($P < 0.05$). For d 14 to 28, propionic and butyric acid productions of T2 treatment were the lowest among the treatments ($P < 0.05$). For d 28 to 49, Pigs fed T2 diet were the lowest in propionic acid and butyric acid ($P < 0.05$). Overall, $\text{NH}_3\text{-N}$ in pigs fed diets added essential oils was lower than pigs fed others ($P < 0.05$). For d 14 to 28, digestibility of dry matter in pigs fed T1, T2 and T3 diets was higher than that of pigs fed CON diet ($P < 0.05$) and T3 treatment was the highest on digestibility of nitrogen ($P < 0.05$). For d 28 to 49, digestibility of nitrogen in pigs fed T3 diet was the highest among others ($P < 0.05$). In conclusion, the results suggest that the dietary essential oils and antibiotics improve growth performance, IgG level and nitrogen digestibility and reduce noxious gas production in weaned pigs.

Key Words: Essential Oils, Weaned Pigs, Growth Performance

M89 The effect of dietary garlic and rosemary on grower-finisher pig performance and sensory characteristics of pork. S. Cullen, F. Monahan, and J. O'Doherty*, University College Dublin, Ireland.

The objective of this study was to investigate the effects of inclusion of rosemary (*Rosmarinus officinalis*) and garlic (*Allium sativum*) in pig diets on apparent nutrient digestibility, pig performance, carcass characteristics and sensory characteristics of the pork. Seventy individually fed grower finisher pigs (42 to 93 kg) were offered the following diets ad-libitum: (1) control diet (wheat, pollard and soya bean meal based), (2) control diet supplemented with rosemary at 1 g/kg (low rosemary; LR), (3) control diet supplemented with rosemary at 10 g/kg (high rosemary; HR), (4) control diet supplemented with garlic at 1 g/kg (low garlic; LG), and (5) control diet supplemented with garlic at 10 g/kg (high garlic; HG). The pigs offered the garlic diets (LG and HG) had a significantly lower feed intake ($P < 0.01$) and lower digestible energy intake ($P < 0.05$) compared to the pigs offered the control and rosemary (LR and HR) diets during the grower-finisher period. The pigs offered the garlic (LG and HG) diets had a significantly better food conversion ratio (FCR) ($P < 0.05$) than the pigs offered the control and rosemary (LR and HR) diets during the grower-finisher period. The pigs offered the high inclusion of garlic (HG) had a lower dry matter digestibility ($P < 0.05$) and organic matter digestibility ($P < 0.05$) than pigs fed the low garlic (LG) diet. The inclusion of high level of rosemary (HR) in the diet resulted in a lower gross energy digestibility and digestible energy content ($P < 0.05$) compared to the low rosemary (LR) inclusion. Sensory panellists found a significant difference ($P < 0.001$) in the sensory properties of cooked muscle from the control and HG treatments. In conclusion, the

addition of garlic to the diets of grower-finisher pigs reduced feed intake and improved FCR while the addition of rosemary had no beneficial effects on growth performance and carcass characteristics.

Key Words: Pigs, Garlic, Rosemary

M90 Effect of a commercial essential oil on growth performance, intestinal microfloral colony and digestive enzyme activities in broiler chickens. I. S. Jang^{*}, Y. H. Ko, H. Y. Yang, S. Y. Kang, J. K. Jin, S. S. Jun, and C. Y. Lee, Jinju National University, Jinju, Korea.

The present study was designed to define whether a blend of commercial essential oils (EO) extracted from herbs could affect growth performance, antimicrobial activity and the functional activity of the gut in growing broiler chickens. A total of one hundred twenty 3-d-old male broiler chickens were fed a basal diet (CON), basal diet supplemented with 10 ppm antibiotics (ANTI), 25 ppm EO (EO I) or 50 ppm EO (EO II) until 35 days of age. As a result, there were no differences in BW, weight gain and FCR among the five groups of birds fed the corresponding diets throughout the entire experiment (3-35 days). The weights of internal organs including the liver, pancreas, intestine and mucosal tissues were not affected by the dietary treatments. The colony-forming units (CFU) of *E. coli* in the lower ileal-cecum of the birds fed the diet supplemented with EO was similar to that of birds fed the diet fortified with antibiotics without affecting the number of lactobacilli CFU. The activities of pancreatic trypsin and amylase, and intestinal maltase were significantly enhanced ($P < 0.05$) in the birds fed EO II diet compared with those fed CON or ANTI diets. It is concluded that dietary supplementation of a commercial EO causes a significant decrease in *E. coli* population and increase in digestive enzyme activities, suggesting that EO can be used as alternatives to antibiotics in broiler chickens.

Key Words: Essential Oils, Broiler, Digestive Functions

M91 Effect of dietary herb products (Animunin Powder[®]) on egg characteristic, blood components and nutrient digestibility in laying hens. K. S. Son^{*}, O. S. Kwon, B. J. Min, J. H. Cho, Y. J. Chen, H. S. Kim, and I. H. Kim, Dankook University, Cheonan, Korea.

This study was conducted to investigate the effects of dietary Animunin Powder[®] on the egg quality characteristics, blood components and nutrient digestibility in laying hens. A total of two hundred seventy laying hens were randomly allocated into three treatments with fifteen replications for eight weeks. Dietary treatments included: 1) CON (Control), 2) AM1 (Control + 0.1% Animunin Powder[®]) and 3) AM2 (Control + 0.2% Animunin Powder[®]). During the period of 0-4 weeks, the birds fed the AM1 diet had an improved egg production rate compared to the birds fed the CON ($P < 0.05$). During the period of 4-8 weeks, the birds fed AM1 diet showed a statistically improved egg production rate compared to the control treatment ($P < 0.05$). No significant differences were found in the egg weight ($P > 0.05$). During the period of 4-8 weeks, the hens fed the AM2 diet had improved egg yolk color compared to the hens fed CON and AM1 diets ($P < 0.05$). For the period of 0-4 weeks, haugh unit of the AM2 treatment showed significantly improved results compared to the control treatment ($P < 0.05$). Average egg shell breaking showed no significant differences through the experiment period, but in the period of 4-8 weeks the AM2 treatment tended to be improved compared to the CON and AM1 treatments ($P > 0.05$). There was no significant difference in egg shell thickness ($P > 0.05$). In the serum cholesterol, the AM1 and AM2 treatments were significantly lower than the control treatment ($P < 0.05$). The concentrations of RBC and WBC in the AM treatments tended to increase but there were no significant differences ($P > 0.05$). For the differences of lymphocytes between the end and initiation of the experiment, the hens fed the AM1 treatment were significantly different compared to the hens fed the CON and AM2 treatments ($P < 0.05$). During the period of the experiment, the hens fed the AM2 diet were tended to show higher DM digestibility than the hens fed the CON and AM1 diet, but it was not statistically different ($P > 0.05$). In conclusion, dietary Animunin Powder[®] could improve egg production rate, egg yolk color and haugh unit.

Key Words: Herb Products, Egg Quality, Blood Components

M92 Dietary nucleotides supplementation alleviates villus atrophy and improves immune response of early weaned piglets. D. Martínez-Puig^{*1}, E. Borda¹, E. G. Manzanilla², C. Chetrit¹, and J. F. Pérez², ¹BIOIBERICA S.A., Palafolls, Barcelona, Spain, ²University Autònoma Barcelona, Barcelona, Spain.

Transition from sow's milk to a solid food in the early weaned pigs is associated with a variable period of anorexia and the withdrawal of some micronutrients contained in milk. Dietary nucleotides are known to have an important role in cell division, cell growth and modulation of the immune system. As a first step, we studied the nucleotide composition in the milk from five 21-day lactating sows. The nucleotide content of the five milk samples analyzed was $102.8 \pm 9.16 \mu\text{mol}/100 \text{ mL}$. Pyrimidines, in the form of 5'UMP and 5CDP, represented 85% of the total free nucleotides. A product based on this composition (Nucleoforce[®]) was administered to 36 early weaned piglets (21 d) dosed at 0, 1,000 and 2,000 ppm. On day 7 after weaning six animals per group were euthanized, and samples of jejunal mucosa were processed for histological measurements. Another group of six unweaned piglets were euthanized on day 27 of lactation as a positive control for histological measurements. No differences were found among treatments on average daily feed intake. Villus height was higher in the nursing pigs (448 μm) than in the control group (275 μm). The Nucleoforce[®] supplemented groups showed intermediate ($P < 0.001$) villous heights, 351 and 378 μm with the doses of 1,000 and 2,000 ppm, respectively. Similar results were observed in the measurement of the total surface area of the villi ($P < 0.001$) but no changes on crypt depth were observed between weaned and unweaned piglets or with the nucleotide supplementation. The absolute number of intraepithelial lymphocytes per villus increased ($P < 0.001$) with the dose of 1,000 ppm (12.7) and 2,000 ppm (14.9) compared with the control diet (10.2), showing a close relationship with the height of the villi. The overall results suggest that dietary supplementation of Nucleoforce[®] appears to alleviate postweaning villus atrophy.

Key Words: Nucleotides, Piglet, Villus Atrophy

M93 Effect of blended organic acids on growth performance and intestinal microflora of post weaning piglets. V. Bontempo^{*}, R. Maiorano, A. Agazzi, B. Tonini, and G. Savoini, *Dept Veterinary Sciences and Technology for Food Safety, Milan, Italy.*

Organic acids have been investigated for many years as a potential alternative to prophylactic use of feed antibiotics in order to reduce post weaning lag and improve the performance of nursery pigs. However, their effects have been often found to be variable and more studies are necessary to evaluate the possible mechanism of action. The aim of this study was to determine the effect of dietary supplementation of blended organic acids on growth performance and intestinal equilibrium of post weaning piglets. One-hundred and sixty weaning piglets averaging 28 d of age and $8.9 \pm 1.4 \text{ kg}$ initial BW were fed one of two dietary treatments for 49 d after weaning: 1) Control diet (C), and 2) Control diet + organic acids blend (OA). Organic acids blend (Ascor chimici, Italy) consisted of fumaric acid, lactic acid, citric acid and malic acid and were included at 0.2% to starter diet. Diets contained no added antibiotic. Piglets were weighted at 0, 14, 28 and 49 d. On the same time faecal samples were collected from eight piglets per group and analysed for pH and microbial population. Feed consumed was recorded for each group for the whole nursery period. No significant differences were observed within the groups both in live weight and ADG considering the overall period. However, from 14 d to 28 d and from 28 d to 49 d, piglets fed the organic acids tended to grow faster (280 vs. 240 g/d and 510 vs. 480 g/d, respectively; $P \leq 0.07$) than control. No differences were observed for feed conversion between dietary treatments for any of the periods studied. Faecal pH was not influenced by treatment while fecal Lactobacillus populations tended to be increased by OA addition (16×10^8 vs. 9×10^8 ; $P \leq 0.08$). No differences were observed in the E. Coli populations. These results suggest that blended acidifiers may improve growth of piglets during starter period.

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Key Words: Piglets, Nursery, Organic Acids

M94 Large bowel fermentation of resistant starch and conventional fiber supplements in the growing boar. T. C. Rideout^{*1}, Q. Liu², and M. Z. Fan¹, ¹University of Guelph, Guelph, Ontario, Canada, ²Agriculture and Agri-Food Canada, Guelph, Ontario, Canada.

We investigated the production of short-chain fatty acids (SCFA) and amino acid metabolites in the large intestine of pigs in response to the consumption of three varieties of resistant starch (RS) in comparison to conventional fiber supplements. Forty-two grower boars (initial BW, 30 kg) were fed an atherogenic basal (control) diet or the basal diet supplemented with 10% of resistant starch (Novelose[®] 330; Novelose[®] 240; and Avebe potato starch), guar gum (GG), or cellulose (Cell) for a period of 36 d according to a completely randomized block design. Consumption of GG enhanced the cecal production of isobutyric, butyric, isovaleric, and hexanoic acid and resulted in a higher ($P < 0.05$) total cecal SCFA concentration ($104.24 \pm 9.73 \text{ mg/g DM}$) in comparison to the control ($64.11 \pm 7.36 \text{ mg/g DM}$) and the Novelose 240 group ($56.29 \pm 9.73 \text{ mg/g DM}$). Pigs consuming Novelose 330 had a higher ($P < 0.05$) cecal concentration of butyric acid in comparison to the control group (11.89 ± 0.99 vs. $4.98 \pm 0.84 \text{ mg/g DM}$). Cecal indole production was lower ($P < 0.05$) in pigs consuming Novelose 330 ($0.04 \pm 0.02 \text{ mg/g DM}$), Novelose 240 ($0.04 \pm 0.02 \text{ mg/g DM}$), and Avebe potato starch ($0.02 \pm 0.02 \text{ mg/g DM}$) in comparison to the control group ($0.12 \pm 0.01 \text{ mg/g DM}$). Consumption of the dietary fiber supplements did not ($P > 0.05$) affect SCFA or amino acid metabolite concentrations in the colon. In conclusion, the source and physiochemical properties associated with unique dietary fiber preparations differentially affect microbial fermentative activities in the cecum of pigs.

Key Words: Resistant Starch, Short-Chain Fatty Acids, Growing Boars

M95 Effect of gluconic acid on swine in vitro caecal fermentation. A. Piva^{*}, E. Grilli, G. Biagi, and G. Casadei, *University of Bologna, Bologna, Italy.*

Gluconic acid (GA) derives from the incomplete oxidation of glucose by some *Gluconobacter* strains. When fed to monogastric animals, GA is poorly absorbed in the small intestine and can reach the lower gut where it is fermented to butyric acid. This study investigated the effect of GA on in vitro growth response and proteolytic state of swine caecal microflora. A diet for pigs (CP, 15.8%; DE, 15.0 MJ/kg) was predigested in vitro to simulate ileal digestion and later used as the substrate in the in vitro fermentation. Caecal content was collected from six pigs, diluted with buffer and used as inoculum. The inoculum was flushed with CO₂ and dispensed into five glass syringes and five vessels per treatment, containing predigested diet. Syringes and vessels were incubated at 39°C for 24 h. There were 6 treatments: control diet, or control diet with GA added at 2,000, 4,000, 6,000, 8,000, and 10,000 ppm. Gas production was measured recording the cumulative volume of gas produced every 30 min. Samples of fermentation fluid were collected from each vessel at time 0, 4, 8 and 24 h for ammonia and at time 24 h for short-chain fatty acids (SCFA) determination. During the 24 h caecal *in vitro* fermentation, total gas production and maximum rate of gas production were increased by all GA concentrations in a dose-dependent manner ($P < 0.001$). Ammonia in fermentation liquor was reduced by GA at 2,000 (26%; $P < 0.01$) and 4,000 ppm (17%; $P < 0.05$) after 4 h and at all concentrations ($P < 0.001$) after 8 h and 24 h, with the only exception of GA at 2,000 ppm. After 24 h of fermentation, total SCFA, acetic acid, butyric acid, acetic to propionic acid ratio, and acetic + butyric to propionic acid ratio were linearly increased in all GA treatments ($P < 0.001$). This study showed that GA can positively influence the activity of the swine caecal microflora controlling the proteolysis during the 24 h of fermentation moreover implementing the production of butyric acid which maintains the mucosal health status.

Key Words: Gluconic Acid, Microflora, Pig

M96 The effects of feeding trans-10, cis-12 and cis-9, trans-11 conjugated linoleic acid on broiler breeder growth. E. J. Clarke^{*1}, A. L. Lock², P. Garland³, D. E. Bauman², and G. E. Mann¹, ¹University of Nottingham, Sutton Bonington, Loughborough, UK, ²Cornell University, Ithaca, NY, ³BOCM Pauls, Tucks Mill, Burston, Diss, UK.

Trans-10, cis-12 conjugated linoleic acid (CLA) has been shown to reduce body fat accretion in several species. In this study, we fed CLA to female broiler breeders and assessed the effects on growth rate, body fat and liver fatty acid composition. Thirty-two female Ross 308 parent stock 1-d old chickens were individually caged and fed either a standard control diet incorporating 3.5% soybean oil (n = 16) or a diet incorporating 3.5% CLA (Luta CLA-60; 30% c9, t11 CLA and 30% t10, c12 CLA; n = 16). Birds were reared under a modified version of the Ross parent stock management regime to maintain a growth rate in excess of the standard recommended regime. Experimental diets were fed from d 0 to d 49 during which time birds were weighed at weekly intervals and feed intake recorded so that feed conversion efficiency (FCE) could be calculated. At 49 d of age eight Control and eight CLA birds were slaughtered and body fat and liver fatty acid composition determined. The remaining eight Control and eight CLA birds were housed on a single floor pen and placed on a standard rearing diet with feed intake of 10-15% above the standard controlled intake regime until slaughter at 133 d of age. During CLA feeding (0 to 49 d) there was no difference in growth rate or FCE between the two groups. At d 49 there was no difference in total body fat (CLA, 9.4 ± 0.3%; Control, 9.6 ± 0.4%). However, there were significant treatment effects on liver fatty acid composition with elevations (P < 0.001) in 16:0 and 18:0 as well as c9 t11 CLA and t10 c12 CLA and reductions (P < 0.001) in 18:2 n-6, 20:2 n-6, 20:3 n-6, 20:4 n-6, 22:5 n-3 and 22:6 n-3 in the birds fed CLA. At d 133, after birds had all been fed the same diet, those previously fed CLA were significantly smaller than birds fed the Control diet (CLA, 2.63 ± 0.05 kg; Control, 2.83 ± 0.07 kg; P < 0.05). However, there was no difference in body fat (CLA, 6.9 ± 0.5%; Control, 6.2 ± 0.4%) or liver fatty acid composition. The results suggest that feeding of CLA during early life can affect subsequent growth through a mechanism that may not involve differences in body fat.

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Key Words: Conjugated Linoleic Acid, Chickens, Growth

M97 The effect of omega-3 fatty acids on sow and litter performance. S. A. Meers^{*}, C. R. Dove, and M. J. Azain, *University of Georgia, Athens.*

The objective of this study was to determine the effects of feeding a diet containing n-3 fatty acids during late gestation and/or lactation on sow reproductive performance. The study was designed as a 2 x 2 factorial arrangement with main effects of feeding n-3 fatty acids in the Gestation diet (G) and/or Lactation diet (L). Diets were corn-SBM based diets such that the G diet was calculated to contain approximately 3,290 kcal ME, 13% CP and, 0.78% lysine, while the L diet was calculated to contain 3,242 kcal ME, 17.5% CP and, 1.15% lysine. Omega-3 fatty acids, supplemented in the form of a protected n-3 product (Fertiliun[®], United Feeds, Sheridan, IN), added to the G or L diet resulted in a shift of the n-6/n-3 ratio from approximately 20 in the Control to 13 in the Omega-3 G diets and 13 to 10, respectively, in the L diets. Sows (n = 44) were allocated by parity to either the Control or Omega-3 diet at approximately d 60 of gestation. Sows were moved to the farrowing barn on d 110 and switched to the L diet, with half of the sows in each dietary treatment maintained on the same treatment and half switched to the other diet (Control or Omega-3). Litters were weaned at an average of 21 d and sows were maintained on their respective experimental diet through re-breeding. Nursery performance of the progeny was monitored to 35 d post weaning. Gestation diet had no effect on sow performance through gestation. However, there was a main effect of G diet on feed intake during the lactation period. During lactation, sows fed the Control diet during gestation had greater consumption (7.2 kg/d) than those fed Omega-3 diet (6.4 kg/d, P < 0.02). Pigs from sows fed Omega-3 L diet, challenged with LPS at d 14, showed a trend for attenuated temperature change and body weight loss. Additionally, those sows fed Control diet during gestation weaned heavier litters (63.7 kg) than sows fed Omega-3 diet (54.24 kg, P <

0.05). While there is need for continued work in this area, it is apparent that feeding a diet containing Omega-3 fatty acids during late gestation had an effect on sow feed intake, and thus litter performance during lactation.

Key Words: Sow, Performance, n-3 Polyunsaturated Fatty Acid

M98 Blood analytes and performance of lactating sows fed diets added with NaHCO₃. J. Cruz¹, A. G. Borbolla^{*1}, J. Bouda¹, and G. Mariscal², ¹Universidad Nacional Autonoma de Mexico, Mexico City, Mexico, ²INIFAP CENID Fisiología, Ajuchitlan, Queretaro, Mexico.

Thirty-six primiparous sows were used to determine the effect of NaHCO₃ on productive performance and blood analytes during 21 days of lactation. The sows were randomly distributed in three treatments (n = 12): the control diet (C); the control diet containing 0.5% of NaHCO₃ (0.5%); and the control diet with 1% of NaHCO₃ (1%). At farrowing and lactation, the body weight (BW), backfat thickness at 10th and 13th rib, and the size (LS) and weight of litter were recorded. On 3rd, 12th, and 21st days of lactation, the concentrations of glucose, urea, total proteins, albumin, free fatty acids, electrolytes (Na⁺, K⁺, Cl⁻) and creatine kinase in blood serum were determined. The values of pH, blood pCO₂, HCO₃⁻ and base excess were determined in heparinized blood between the 10th and 12th days of lactation. The results were analyzed using the multivariate analysis of variance for the repeated measures and a randomized complete model to determine the effect of experimental diets on blood analytes, acid-base status, and productive performance. The BW of sows and the LS were used as covariables. The use of NaHCO₃ in the diet increased (P < 0.001) the daily feed intake (DFI) (5.21, 5.02, and 4.28 kg for treatments 0.5%, 1% and C, respectively) without affecting other variables of the productive performance. Blood pH was also increased (P < 0.02) in sows with the addition of 1% NaHCO₃ in diet compared with the C (7.41 vs. 7.36). The addition of NaHCO₃ tended (P < 0.08) to decrease the blood pCO₂, but the values of base excess and HCO₃⁻ were not affected. The biochemical analytes of serum did not show changes of tissue mobilization; however, the free fatty acids indicated a higher (P < 0.01) mobilization of lipids in the C diet compared with the other experimental diets (0.617, 0.074, and 0.127 mmol/L for groups C, 0.5% and 1%, respectively). The addition of NaHCO₃ in sow diets is an alternative for the DFI stimulation in primiparous sows, and it may have a possible role in decreasing fat tissue mobilization.

Key Words: Lactating Sows, NaHCO₃, Feed Intake

M99 Effects of supplemental inulin on utilization of iron in corn-soy diet by young pigs for hemoglobin synthesis. K. Yasuda^{*1}, K. R. Roneker¹, D. D. Miller¹, R. M. Welch², and X. G. Lei¹, ¹Cornell University, Ithaca, NY, ²USDA/ARS US Plant Soil & Nutrition Laboratory, Ithaca, NY.

Inulin is a blend of fructan chains found in nature as plant storage carbohydrates and may exert nutritional and health-promoting effects in the large intestines. The objective of this study was to determine if supplemental inulin improved bioavailability of iron from a corn-soy based diet to young pigs. A total of 14 weanling pigs (7.63 kg BW) were divided into two groups and fed the corn-soy based diet (without inorganic iron added, total iron = 61 mg/kg) or the diet supplemented with 4% inulin (Raftline HP, Orafiti, Tienen, Belgium) for 6 weeks. Weight gain, blood hemoglobin concentration, and hematocrit of individual pigs were measured weekly. Daily feed intake of individual pigs was also recorded. Compared with those fed the basal diet, pigs fed the inulin-supplemented diet had 17% higher (11.6 vs. 13.6 g/dL, P < 0.01) final blood hemoglobin concentration and 17% greater (18.9 vs. 22.2%, P < 0.03) overall hemoglobin repletion efficiency. Growth performance and hematocrit were similar between the two treatment groups. In conclusion, supplemental 4% inulin in the corn-soy diet improved dietary iron utilization by young pigs.

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Key Words: Inulin, Iron, Pigs

M100 Efficacy of pantothenic acid as a modifier of body composition in a porcine model of obesity development. C. A. Baldwin* and T. S. Stahly, *Iowa State University, Ames.*

Pantothenic acid (PA) in amounts above that needed to maximize body growth has been determined at our station to effectively reduce fat tissue accretion in growing pigs. In the current study, the efficacy of PA to minimize fatty tissue accretion in a porcine model of obesity development was determined. Heavy weight pigs (154 kg BW, 27% body fat) were allotted to one of four dietary regimens (17 individually penned barrows/treatment) consisting of a basal diet (8 ppm PA) supplemented with 0, 80, 800, 8,000 ppm added PA. The basal diet consisted of a dietary nutrient mix representative of the American diet (34% of calories from fat), and was provided at daily caloric intakes equivalent to 1.8 times each animal's maintenance needs for 144 days. A state of obesity development occurred over the duration of the study. Specifically, pigs accrued 73

kg of body weight, of which 48% was fat tissue (determined by DEXA analysis). BW gains and BW gain/feed ratios were not altered by PA additions. Fat tissue content of BW gain responded quadratically to increasing PA additions. Specifically, fat tissue content was reduced by 3.2 percentage units by a ten fold addition of PA (80 ppm) but was increased by 2.2 and 1.4 percentage units by 100- and 1,000-fold additions (800 and 8,000 ppm) of PA, respectively. The 80 ppm addition is equivalent in dosage (mg PA ingested/kcal of dietary energy expended) to that observed to reduce body fat accretion in growing pigs fed a high starch diet ad libitum. Hepatic ACO, ACC, and FAS mRNA expression (six pigs/treatment) did not differ between the 0 and 8,000 ppm supplemented PA diets. Based on these data, PA is not an efficient modifier of body composition in a porcine model of obesity development induced by a high fat dietary regimen.

Key Words: Pantothenic Acid, Pigs, Obesity

Nonruminant Nutrition: Mannan-Oligosaccharides, Yeast Culture, and Probiotics

M101 Effects of feeding galactomannan oligosaccharides on growth performance, immune response and intestinal microflora in newly-weaned pigs. Z. P. Hou¹, Y. L. Yin^{*1,2}, E. A. Jeaurond², H. Namkung², and C. F. M. de Lange², ¹*The Chinese Academy of Sciences, Changsha, China,* ²*University of Guelph, Guelph, Ontario, Canada.*

One hundred and twenty newly-weaned piglets (15-19 days old; four pigs per pen; six pens per treatment) were used to investigate the effect of feeding galactomannan oligosaccharides (GMOS; from sesbania gum, containing 20% galactose and 15% mannose) on growth performance, immune response and intestinal microflora. Five dietary treatments were: basal diet (control), medicated diet (control + 110 ppm lincomycin), and three dietary inclusion levels of GMOS (control + 0.1%, 0.2%, or 0.3%). The inclusion of lincomycin in the diet did not influence any of the response criteria ($P > 0.10$), except for intestinal microflora. During week 1 post-weaning, ADG (80 vs. 45 g/d on control vs. 0.3% GMOS; SE, 29) and ADFI (141 vs. 110 g/d on control vs. 0.3% GMOS; SE, 28) decreased linearly ($P < 0.05$) with increasing dietary GMOS level. After week 1 and over the 4-week experimental period, ADG (290 vs. 286 g/d on control vs. 0.3% GMOS; SE, 43) and ADFI (448 vs. 412 g/d on control vs. 0.3% GMOS; SE, 47) did not differ between treatments ($P > 0.10$). On day 4 post-weaning, blood serum levels of IgA (70 vs. 87 mg/dL on control vs. 0.3% GMOS; SE, 5.6), IgG (285 vs. 401 mg/dL on control vs. 0.3% GMOS; SE, 12.5), and IgM (155 vs. 273 mg/dL on control vs. 0.3% GMOS; SE, 13.6) increased linearly ($P < 0.01$) with dietary GMOS level. On day 14 post-weaning, serum Ig levels were not influenced by feeding GMOS ($P > 0.10$). Based on PCR-DGGE analysis, diversity of microflora in ileal digesta was increased by feeding GMOS and reduced by feeding lincomycin as compared to the control. These results indicate that dietary GMOS increases humoral immunity and microbial diversity in the ileum of newly-weaned pigs but reduces feed intake and growth performance during the first week post-weaning.

Key Words: Piglet, Galactomannan Oligosaccharides, Immune Response

M102 Effect of adding a mannanoligosaccharide product on performance of nursery pigs fed diets with or without antibiotics. H. Yang^{*1}, J. Less², T. Shipp³, T. Radke¹, M. Cecava¹, and D. Holzgraefe¹, ¹*ADM Alliance Nutrition, Quincy, IL,* ²*ADM Specialty Feed Ingredients, Decatur, IL,* ³*ADM Animal Health and Nutrition, Quincy, IL.*

The objective of this study was to evaluate the effect of a mannanoligosaccharide (MOS) product (CitriStim™) on performance of nursery pigs fed diets with or without antibiotics (AB). Weanling pigs ($n = 144$; 4.56 kg BW) were blocked by initial weight and assigned to one of four dietary treatments (trt), with six pens per trt and six pigs per pen. The trts were a 2 x 2 factorial arrangement, with two levels of MOS (0 vs. 0.2% CitriStim™) and two levels of AB (0 vs. 55

ppm Carbadox). ADG, ADFI and G/F were measured throughout four phases ending at d 7, 14, 28, and 41. Feeds were pelleted in the first two phases and meal thereafter. No interactions (Int) of ADG and ADFI were observed between MOS and AB ($P > 0.05$), indicating they could have an additive effect. MOS improved ADG ($P < 0.05$) and ADFI ($P < 0.05$) from d 0 to 14 and numerically improved ADG and ADFI from d 0 to 41. Although AB did not affect performance from d 0 to 14 ($P > 0.10$), it improved overall ADG ($P < 0.10$) and ADFI ($P < 0.05$). AB did not have a significant effect on G/F from d 0 to 14 and d 0 to 41 ($P > 0.55$). However, MOS tended to improve G/F from d 0 to 14 and d 0 to 41 ($P < 0.11$). MOS dramatically improved G/F in medicated diets but had minimal effects on G/F in non-medicated diets, resulting in an interaction for overall G/F ($P < 0.10$). In summary, MOS and AB improved ADG and ADFI and an interaction of G/F might exist between MOS and AB.

MOS AB						P Value		
		-	+	-	+	SE	MOS	AB
End Weight, kg	21.80	22.01	22.36	23.49	0.51	0.213	0.067	0.390
ADG, g (d 0 to 14)	233	260	233	278	14	0.020	0.519	0.507
ADG, g (d 0 to 41)	419	426	435	462	13	0.201	0.060	0.434
ADFI, g (d 0 to 14)	278	309	289	307	11	0.044	0.735	0.557
ADFI, g (d 0 to 14)	278	309	289	307	11	0.044	0.735	0.557
ADFI, g (d 0 to 14)	278	309	289	307	11	0.044	0.735	0.557
ADFI, g (d 0 to 14)	278	309	289	307	11	0.044	0.735	0.557

Key Words: Pigs, Mannanoligosaccharide, Antibiotics

M103 Effect of dietary mannan-oligosaccharides and(or) organic zinc on growth performance and prevalence of post-weaning diarrhoea in piglets. M. Castillo^{*1}, G. Ferrini¹, E. G. Manzanilla¹, J. Roquet², J. A. Taylor-Pickard³, J. F. Pérez¹, and S. M. Martín-Orúe¹, ¹*Departament de Ciència Animal i dels Aliments, Universitat Autònoma de Barcelona, Bellaterra, Barcelona, Spain,* ²*Probasa, Barcelona, Spain,* ³*Alltech Biotechnology Centre, Summerhill, Sarney, Ireland.*

The efficacy of Mannan-oligosaccharide (MOS) and organic zinc (Zn) to enhance performance and prevent diarrhoea in early-weaned pigs was evaluated. A total of 128 piglets, weaned at 20 ± 2 days were housed in 32 pens following a complete randomized design. Animals received four dietary treatments: a control diet (CT) to which 0.2% of a commercial source of MOS (Bio-Mos[®] Alltech Inc, USA; BM), 0.08% organic Zn (Bioplex-Zn™ Alltech Inc, USA; BP) or both additives (BMP) were added. The experiment lasted for 5 weeks including a pre-starter period of two weeks and a starter period of three weeks.