

in the elevated pen treatment compared to the floor-slotted pen treatment ($P < 0.01$, 696 vs. 643g in ADFI). However, no differences were found in ADG and G:F ratio among all treatments. At 3 weeks the elevated pen treatments showed a lower diarrhea occurrence score ($P < 0.05$, 3.2 vs. 3.7) compared to the floor-slotted pen treatment. The dietary antibiotics did not influence diarrhea score. Floor-slotted pen treatments at Wk 2 were significantly higher in serum IgG concentration ($P < 0.01$, 0.9 vs. 2.0mg/ml). These results demonstrated that elevated pens were better than floor-slotted pens for improving growth performance and immune responses in weanling pigs.

Key Words: pen type, weaning pig, growth performance

T183 Evaluation of antimicrobial activity of organic acids against *Salmonella typhimurium* isolated from swine. M. R. Messina^{*1}, E. Grilli¹, S. Albonetti², and A. Piva¹, ¹*DIMORFIPA, University of Bologna, Italy*, ²*DSPVPA, University of Bologna, Italy*.

Aim of the study was to investigate the antibacterial activity of organic acids against the serovar *typhimurium* of *Salmonella enterica* subsp *enterica* isolated from pig slurry. Organic acids (OA) tested were: citric, sorbic, malic, fumaric, benzoic, lactic, heptanoic and octanoic. A broth dilution assay was performed as follows: 96-wells microtiter plates were filled with 10^4 CFU of *Salmonella*/well and with each OA solutions at concentrations from 0.49 mM to 500 mM. The positive control wells were inoculated in the same way without the addition of any substance. Medium was buffered at pH 6.5 and plates were incubated at 37 °C. The turbidity of cultures after 24 hours was used as indicator of bacterial growth and evaluated by absorbance measurement at 630 nm. Optical density (OD) data were analyzed by ANOVA followed by a Dunnett post-test; Pearson correlation, and linear regression between the OD data and OA concentrations were also exploited. Compared to control, benzoic acid at 125 mM completely inhibited *Salmonella* growth ($P < 0.01$), while other acids were effective at much lower concentrations in reducing the OD of *Salmonella* by -85% heptanoic acid and by -83% octanoic acid at 1.82 mM, by -92% sorbic acid at 50 mM ($P < 0.01$); citric and malic acids reduced OD by -51% and -85% at 250 mM and 500 mM, respectively ($P < 0.01$). Fumaric and lactic acids did

not significantly inhibit *Salmonella*. Linear regression analysis showed an interesting dose-effect for citric, malic, heptanoic and octanoic acid ($R^2=0.99$; $R^2=0.98$; $R^2=0.94$; $R^2=0.91$, respectively, $P < 0.01$). The interaction and possible synergistic effect of these acids should be tested to improve their efficacy. Heptanoic, octanoic, sorbic, citric, malic, and benzoic acids showed strong antibacterial properties, and therefore could be regarded as useful instruments both as food preservatives as well as feed additives in animal nutrition against *Salmonella*.

Key Words: swine, *Salmonella*, organic acids

T184 Effect of Natuzyme supplementation on broiler performance in deficient standardized ileal threonine diets. S. Khalaji, M. Zaghari*, and M. Shivazad, *University of Tehran, Karaj, Iran*.

The objective of this study was to determine the effects of Natuzyme supplementation on broiler performance in a threonine deficient diet. Day-old male broiler chicks were randomly assigned to 20 battery cage pens in a completely randomized block design and grown to 6 wk of age. Birds were fed dietary treatments from 1 to 42 d of age. The 6 treatments were basal diets containing 0.56 and 0.46% standardized ileal threonine (SID Thr) in starter and grower periods, respectively. Treatments 2 to 6 were the basal diets supplemented with 0.1, 0.2, 0.3, 0.4 and 0.5 g/kg Natuzyme. Body weight and feed intake of birds were recorded at 28 and 42 d of age. In vivo lymphoproliferation of birds against Phytohemagglutinin-P (PHA-P) was measured at 36 d of age. Data was analyzed using the GLM procedure of SAS. Means were compared by Duncan's multiple range test. Supplementing diets with Natuzyme significantly ($P < 0.001$) improved feed conversion ratio (FCR) at 28 and 42 d of age. The effect of Natuzyme on body weight was significant ($P < 0.05$) at 28 d of age but it had no effect on body weight at 42 d of age. In vivo lymphoproliferation against the Phytohemagglutinin-P (PHA-P) at 36 d of age significantly ($P < 0.05$) increased with supplementation of Natuzyme. There were no significant differences in breast, thigh and abdominal fat at 42 d of age. These results showed that Natuzyme improved the efficiency of broilers fed a low threonine diet during the starter period.

Key Words: Natuzyme, threonine, broiler performance

Nonruminant Nutrition: Nutrients

T185 Effects of protein and sulfur AA concentration in diets fed to weanling pigs on growth performance and diarrhea incidence. T. C. S. Reis^{*1}, G. Mariscal-Landin², P. E. Urriola³, and H. H. Stein³, ¹*Universidad Autonoma de Queretaro, Queretaro, Mexico*, ²*INIFAB CENID Fisiologica, Queretaro, Mexico*, ³*University of Illinois, Urbana*.

A 3-wk experiment was conducted to measure the effect of dietary CP, Met, and Cys levels on pig growth performance, and incidence (ID) and severity of diarrhea (SD) during the post-weaning period. Sixty pigs were weaned at 23.9 ± 3.6 d of age (initial BW: 7.48 ± 0.50 kg) and allotted to 4 treatment groups based on sex, litter of origin, and BW. There were 3 pigs per pen and 5 pens per treatment. Four antibiotic-free diets were formulated. The HCP diet contained 23.58% CP, 0.34% Met, and 0.33% Cys. The LCP diet contained 17.64% CP, 0.25% Met, and 0.26% Cys. The HMet diet contained 16.95% CP, 0.32% Met, and 0.24% Cys. The HCys diet contained 17.68% CP, 0.26% Met, and 0.49% Cys. The ID was the number of days where diarrhea was observed within a pen. The SD was based on a daily visual fecal consistency score on a scale of 0 to 3. Results showed that for the entire 21-d period, no differences

in ADG or ADFI were observed among treatments. However, G:F were greater ($P < 0.01$) for pigs fed the HCP diet (0.656 kg/kg) than for pigs fed the LCP (0.501 kg/kg), the HMet diet (0.495 kg/kg), or the HCys diet (0.479 kg/kg). The ID in wk 1 was greater ($P < 0.01$) in pigs fed the HCP diet (4.6 d) than in pigs fed the other diets (2.0, 2.0 and 2.0 d, for LCP, HMet, and HCys diets, respectively). In week 2 and 3, no differences among diets were observed for ID. Pigs fed the HCys diet had lower ($P < 0.05$) ID (6.4 d) over the entire period than pigs fed the HCP diet (15.2d). The SD was greater ($P < 0.01$) in pigs fed the HCP diet during wk 1 than for pigs fed LCP, HMet, and HCys diets (0.94, vs. 0.34, 0.37, and 0.32, respectively). In wk 2, no differences in SD among treatments were observed, but pigs fed the HCys diet had the lowest ($P < 0.05$) SD in wk 3 (0.31) and over the entire period (0.33) compared with pigs fed the HCP, the LCP, and the HMet diets (1.17, 0.57, 0.66, and 1.04, 0.53, 0.55, respectively). In conclusion, pigs fed a HCP diet gained weight more efficiently, but had also greater incidence and severity of post-weaning diarrhea than pigs fed LCP, HMet, or HFCys diets. High levels of Cys in the diet reduce post-weaning ID and SD.

Key Words: pigs, diarrhea, dietary CP

T186 Effect of the degree and duration of early dietary amino acid restrictions on subsequent and overall pig performance and physical and sensory characteristics of pork. R. B. Kamalakar*, L. I. Chiba, K. C. Divakala, S. P. Rodning, E. G. Welles, W. G. Bergen, C. R. Kerth, D. L. Kuhlers, and N. K. Nadarajah, *Auburn University, Auburn, AL*.

The objective of this study was to investigate the effect of the degree and duration of early dietary AA restrictions on subsequent and overall pig performance and physical and sensory traits of pork. For the grower (G) and finisher-1 (F1) phases, 3 corn-soybean meal diets were formulated to contain 100, 80, or 60% of the 1998 NRC total Lys recommendations (100G, 80G, or 60G, and 100F1, 80F1, or 60F1, for the G and F1 phases, respectively). A common finisher-2 (F2) diet was used. Thirty gilts and 30 barrows (22.7 kg; 2 gilts or 2 barrows/pen) were randomly assigned to 5 diet combinations (100G-100F1, 80G-100F1, 80G-80F1, 60G-100F1, and 60G-60F1), and pigs were switched to F1 and F2 diets at 50.7 and 79.9 kg, respectively. The LM samples were collected at 110.7 kg. Pigs fed the 60G diet had lower ($P \leq 0.05$) ADG during the G phase and greater ($P \leq 0.05$) ultrasound backfat (UBF) at the end of the G phase than those fed the 100G diet. Although serum total protein (TP) and albumin concentrations in pigs fed the 60G-100F1 diets were lower ($P \leq 0.05$) than those fed the 100G-100F1 diets at the end of the G phase, TP and UBF at the end of the F1 phase and ADG during the F1 phase were similar between the 2 groups. Feeding the 80G diet resulted in decreased ADG during the G phase but no differences in ADG during the F1 and F2 phases and UBF between pigs fed the 80G and 100G diets. Overall, pigs fed the 80G-80F1 diets had similar ADG but less ($P \leq 0.05$) fat-free lean gain (LG) and TP and albumin throughout the study than those fed the 100G-100F1 diets. Pigs fed the 60G-60F1 diets had lower ($P \leq 0.05$) overall ADG and G:F and less ($P \leq 0.05$) LM area and LG but a higher ($P \leq 0.05$) marbling score than those fed the 100G-100F1 diets. In summary, pigs fed the 80G-80F1 diets may have exhibited compensatory growth in ADG but not in terms of LG. The ADG and carcass traits of pigs fed the 60G-60F1 diets were depressed, indicating that the restriction may have been too severe or too long or both. Early dietary AA restrictions had no clear effect on physical and sensory traits of pork.

Key Words: amino acid restrictions, pork, pig

T187 Apparent ileal digestibility of CP and amino acids in pigs fed sorghum-soybean meal diets supplemented with phytase. M. Cervantes*¹, E. Sánchez¹, A. Morales¹, A. Araiza¹, W. Sauer¹, M. Barrera¹, and J. Yáñez², ¹ICA, *Universidad Autónoma de Baja California, Mexicali, BC, México*, ²Universidad Autónoma de Tlaxcala, *Tlaxcala, México*.

An experiment was conducted to evaluate the effect of supplementing phytase to sorghum-based diets on the apparent ileal digestibility (AID) of CP and amino acids (AA). Twelve pigs (average initial BW 18.6 kg) fitted with a simple T-cannula at the distal ileum were fed six diets in a repeated 6×6 Latin square design. Diet 1 was the positive control (PC), sorghum-soybean meal diet, with supplemental inorganic P. Diet 2 was the negative control (NC), sorghum-soybean meal diet, with no supplemental inorganic P. Diets 3, 4, and 5 were the NC diets supplemented with phytase A at 250, 500, and 1000 units of phytase activity (FTU/kg diet), respectively. Diet 6 was the NC diet supplemented with 500 FTU of phytase B per kg. All diets were added with vitamins and trace minerals, as well as chromic oxide as a digestibility marker. Five contrasts were constructed as follows: C1, NC vs. PC diet; C2, NC vs. diets added with phytase A, C3, Linear effect; C4, Quadratic effect; C5, Phytase A vs. B, at 500 FTU/kg. The AID values (%) for CP and AA in

Diets 1 to 6 were: CP, 64.5, 69.8, 69.7, 68.3, 67.2, 69.2; Arg, 85.8, 86.2, 88.0, 86.5, 86.3, 86.6; His, 78.1, 79.5, 80.0, 78.7, 77.6, 78.0; Ile, 74.1, 76.9, 77.7, 76.4, 75.9, 78.0; Leu, 76.3, 78.4, 79.1, 77.9, 77.2, 79.5; Lys, 83.1, 85.0, 86.2, 85.1, 85.0, 86.1, Met, 75.6, 79.0, 79.4, 79.1, 78.0, 80.2; Phe, 76.7, 78.8, 80.0, 78.5, 78.1, 80.0, Thr, 69.0, 72.3, 74.1, 72.8, 70.9, 73.5; Val, 68.5, 70.3, 72.4, 71.1, 69.5, 71.9. The AID of CP in the PC was higher ($P < 0.01$) than in the NC, but there was no difference in the AID of AA. There was no effect of phytase supplementation, at any level, on the AID of CP and AA ($P > 0.10$). There was no difference between phytase A and B. These data indicate that phytase supplementation to sorghum-based diets had no effect on the digestibility of protein and amino acids in growing pigs. These also indicate that the supplementation of inorganic P reduces the AID of CP and some AA

Key Words: pigs, phytase, amino acids

T188 Effects of low-CP feeding on growth, nutrient utilization and manure odor in weanling pigs. M. Z. Fan*, T. Archbold, Z. R. Wang, and C. Yang, *University of Guelph, Guelph, Ontario, Canada*.

The objectives of this study were to examine effects of low-protein feeding on growth performance, efficiency of dietary N and P utilization, carcass fat content and fecal total volatile sulfides in weanling pigs fed corn and SBM-based diets. The study was conducted with 36 Yorkshire weanling barrows of average initial and final BW of 9.6 and 12.9 kg and the pigs were fed six diets according to a completely randomized block design. The six diets were corn and SBM-based, including diets 1-4 with graded declining levels of total CP (diet 1, control, 18.5; diet 2, 17.5; diet 3, 16.5; and diet 4, 15.5 CP%) plus diet 5 (15.1% CP+5% cellulose), and diet 6 (15.1% CP+extra crystalline L-Leu). Chromic oxide (0.30%) was included as a digestibility marker. Each experimental period consisted of 15 d with 10-d adaptation and 5-d collection of representative fecal and urinary samples. Reduction in CP content from 18.5 to 15.5% did not have effects ($P > 0.05$) on performance endpoints. A reduction in net energy content of the low-CP diet with 5% cellulose (diet 5) did not affect ($P > 0.05$) the growth performance endpoints. While 5% cellulose supplementation (diet 5) reduced total fecal sulfide excretion, it also decreased ($P < 0.05$) dry matter digestibility. Fortification of the low-CP diet with L-Leu (diet 6) did not affect ($P > 0.05$) the growth performance endpoints. The reduction of dietary CP content in 3% did not affect ($P > 0.05$) carcass fat content. Decreases in dietary CP levels had a linear positive effect ($P < 0.05$) on efficiency of apparent CP retention with optimal responses observed in diets 3 and 4. Both cellulose supplementation and L-Leu fortification reduced ($P < 0.05$) efficiency of apparent P retention. In summary, a reduction of dietary CP content at 3% of the NRC (1998) recommended level through use of crystalline limiting essential AA can significantly improve efficiency of N utilization and reduce manure N excretion by up to 20% of the conventional diet without negatively affecting performance, carcass fat content, as well as manure sulfide and P excretions in weanling pigs fed corn and SBM-based diets.

Key Words: dietary protein, nutrient utilization, weanling pigs

T189 Effects of NCG or Arginine on immune function of intestinal mucosa in weaning period of piglets. X. Wu, Y. Gao, Y. Yin*, X. Zhou, R. Huang, Z. Tang, M. Geng, and T. Li, *Laboratory of Animal Nutritional Physiology and Metabolic Process, Institute of Subtropical Agriculture, the Chinese Academy of Sciences, Changsha, China.*

The aim of this study was to assess the effects of N-Carbamylglutamate (NCG) and L-Arginine (Arg) on immune function of the intestinal mucosa in early-weaned piglets. Eighty-nine healthy Landrace×Yorkshire piglets weaned at 21 d (average pen weight 5.56±0.51 kg) were randomly divided into 3 treatments, supplying with one of the following diets for 7 days: a standard diet (SD), SD+NCG (0.08%), or SD+Arg (0.6%), respectively. Six piglets were selected from each treatment randomly for serum samples. Then the selected piglets were slaughtered for intestinal and mucosa samples. Results showed that Serum IgM concentration in the NCG group was lower than that of the Arg group (P<0.05). Both arginine and NCG increased IEL counts along the villous mucosal epithelium of the ileum significantly (P<0.05), compared with control piglets. However, IEL counts were similar between the three groups in the duodenum and jejunum. Western blotting further confirmed that CD4 expression was higher in the ileum mucosa (P<0.05), and had a high trend in jejunum (P>0.05) in the Arg and NCG group. Also, the results showed that NCG increased TNF- α in jejunum and ileum mucosa (P>0.05). The results indicated that dietary supplementation with 0.08% NCG or 0.6% Arg could improve immune function of intestinal mucosa in weaning period of piglets. *Supported by NSFC, CAS.*

Key Words: N-Carbamylglutamate, L-Arginine, intestinal mucosa

T190 Effect of varying levels of metabolizable energy and crude protein in phytase-supplemented diets on nitrogen retention and growth performance in young pigs. M. J. M. Almeida, E. T. Fialho*, J. A. F. Lima, P. B. Rodrigues, V. S. Cantarelli, and H. O. Silva, *University Federal of Lavras, Lavras-MG-BRAZIL-Financed By FAPEMIG.*

A study was conducted to evaluate the effects of different levels of metabolizable energy (ME) and crude protein (CP) in diets formulated according to the ideal protein concept and supplemented with phytase (Natuphos®) on growth performance in piglets. A total of 84 barrows and gilts with initial BW 15.3 ± 1.2kg were blocked by weight and sex and randomly allotted to one of seven treatments. There were two pigs (one barrow and one gilt) per pen and six pens per treatment. Pigs were fed corn and soybean meal based diets formulated according to ideal protein concept. The treatments were in a 3x2+1 factorial arrangement with three ME levels (3080, 3230 and 3380 kcal ME/kg) and two CP levels (14% and 16%); diets were supplemented with synthetic amino acids and phytase (750 U/Kg) and with calcium levels decreased by 25% and phosphorus decreased by 30%. The additional treatment was formulated on the basis of CP and no phytase to meet the nutrient requirements of piglets according to NRC (1998). Diets and water were available ad libitum for 25 d. Throughout the experiment, there were no energy or CP treatment effects (P > 0.05) on body weight as well as ADG, F:G, daily ME intake, or on weight of organs (heart, kidney, liver, muscle, and spleen) for the piglets. Feed intake was lower (P<0.05) and fat deposition rate in the carcass was higher (P<0.05) for the levels of 3380 kcal ME/kg. The control diet without phytase supplementation yielded a higher blood urea content and an increased (P<0.05) nitrogen, calcium and phosphorus excretion in pigs as compared to the phytase-supplemented diets with 14% CP. In conclusion, the levels of ME, CP and lower P and Ca content on diets can be reduced to 3080 Kcal/kg, 14%, 0.54% and 0.28%, respectively for piglets in diets based on ideal

protein concept with supplementation of phytase, since better growth performance and lower nitrogen, calcium and phosphorus excretion is shown in piglets from 15 to 30 kg.

Key Words: amino acids, enzyme, ideal protein

T191 The effects of reduction in protein and phosphorus in finishing broiler chicken diets supplemented with phytase. Y. L. Silva, P. B. Rodrigues, E. T. Fialho*, R. T. F. Freitas, and A. G. Bertechini, *University Federal of Lavras, Lavras, MG, Brazil.*

A study was conducted to evaluate the growth performance, carcass characteristics and nutrient levels in litter of broiler chickens from 22 to 42 days old fed low-Crude Protein (CP) and low available Phosphorus (AP) diets supplemented with synthetic amino acids (AA) and phytase. A total of 1200 male broiler chickens (Cobb, 21 days of age, initial weight of 646+ 8 g) were fed diets based on corn-soybean meal. Chicks were fed in a randomized block design with six replicates (20 birds per pen). Treatments were arranged as a 3 × 3 +1 factorial with main effects of CP (14, 16 and 18%) and levels of AP (0.20, 0.30, and 0.40%) and a control diet with nutritional requirements according to (NRC, 1994). In the diets with 0.20 and 0.30% AP, were added 500 FTU of phytase (Natuphos® 5000) and the Ca requirement level was lowered 20% when phytase was added. The broilers fed diets with 14% CP and 0.20% AP + phytase had lower weight gain (P<0.05) and better feed conversion (P<0.05) in relation to those fed the control diet. The performance of the broilers fed diets with 14% CP and 0.30% AP + phytase were similar (P>0.05) in relation to those fed the control diet. The P content in litter was lower for the broilers fed low-CP and low AP diets supplemented with synthetic amino acids and phytase. The Ca content in litter was lower for broilers fed diets with 16% CP at all levels of AP than those fed the control diet. There were no differences (P>0.05) among diets for N, Zn and Cu in the litter. No differences (P>0.05) in carcass yield were observed for broilers fed diets with low-CP and low AP supplemented with synthetic AA and phytase compared to those fed the control diet. In conclusion, dietary CP, AP and Ca can be reduced 27.8, 25.0 and 19.5%, respectively when synthetic amino acids and phytase are added to the diet while performance and carcass characteristics are maintained.

Key Words: additive, environmental, enzyme

T192 Intestinal absorption of vitamin B₁₂ in growing pigs. D. Prévérard^{2,1}, C. L. Girard¹, F. Guay², N. LeFloc'h³, and J. J. Matte^{*1}, ¹Dairy & Swine R & D Centre, Agriculture & Agri-Food Canada, STN-Lennoxville, Sherbrooke, QC, Canada, ²Laval University, Quebec City, QC, Canada, ³UMR 1079 SENAH, INRA, St-Gilles, France.

There are few data on the bioavailability of dietary vitamin B₁₂ for pigs. The aim of the present project was to estimate intestinal absorption of this vitamin using the measurement of portal flux after ingestion of dietary supplements. Eleven pigs (35.1 ± 4.0 kg BW), fed a B₁₂ free diet from weaning at 21 d of age, were surgically equipped at 75.4 ± 5.9 d of age with catheters in the portal vein and carotid artery; an ultrasonic flow probe was also installed around the portal vein. According to a cross-over design, pigs received 3 doses of dietary vitamin B₁₂: 0, 25 and 250 µg in 1.2 kg of a vitamin-free semi-purified diet (<1.4 µg of vitamin B₁₂). Blood samples were collected simultaneously from the 2 catheters before meal, every 45 min for the first 3 h post-feeding, and every hour for the following 21 h. Portal blood flow was recorded continuously for 24 h. The total amount of vitamin B₁₂ reaching the portal circulation during the 24 h post-feeding was the cumulation of portal net flux of vitamin B₁₂

at each sampling time multiplied by the time interval between samples. Portal concentrations of vitamin B₁₂ were stable at 130.1 ± 1.0 pg/mL during the whole post-meal period with 250 µg while post-meal values for 25 and 0 µg were 7.2 and 27.0% lower than pre-meal concentration (treatment × time, P<0.01). Changes in portal net flux during the 24 h post-meal showed that most of the absorption occurred between 5 and 14 h post-feeding with 25 and 250 µg of vitamin B₁₂ but another period of absorption was observed from 15 to 18 hours with 250 µg. The total amount of vitamin B₁₂ reaching the portal circulation during the 24 h post-feeding differed among treatments (P=0.02); the value was higher (P≤0.03) for 250 µg (6.0 ± 1.2 µg) than for 25 (2.1 ± 1.2 µg) and 0 µg, the latter was not different from zero (P=0.32). Therefore, although the absolute amount of vitamin B₁₂ reaching portal blood increased with the dose ingested, the proportion of oral intake followed an opposite trend, from 8.5 to 2.4% for 25 and 250 µg, respectively. The peculiar kinetic of vitamin B₁₂ absorption as compared to other nutrients deserves further investigations

Key Words: vitamin B₁₂, absorption, pig

T193 Multivariate nonlinear mixed effect models for protein and lipid deposition in growing pigs. A. B. Strathe*¹ and E. Kebreab², ¹University of Copenhagen, Copenhagen, Denmark, ²University of Manitoba, Winnipeg, Manitoba, Canada.

Dealing with animal to animal variation in utilization of dietary energy is a key determinant in predicting efficiency of whole pig production units. Recently, stochastic simulation models for pig growth have been constructed to address this issue. Parameterization of these models required determination of both mean values and the variation around the mean in key metabolic parameters. In this study a novel multivariate energy deposition model (protein (PD) and lipid deposition (LD) as dependent variables) was developed. It was assumed that PD was a quadratic function of the metabolic size of the pig. The parameters in the simple function could be expressed in terms of the inflexion point i.e. the maximum rate of PD (PD_{max}) and corresponding BW (BWPD_{max}) at that point. The LD was equated as the difference between ME intake and the sum of ME used for maintenance and ME for PD which was used with efficiency *k_f*. NLMIXED procedure in SAS was used for parameter estimation, where the general option in the model statement was implemented to specify a conditional multivariate normal distribution for the PD and LD data given the random effects. The approach was applied to energy balance data collected from 48 barrows, where each balance was determined 8 times for each pig. Variance components (σ_{PDmax}^2 and σ_{kf}^2) for the traits PD_{max} and *k_f* and their correlation (ρ) were estimated and are reported as standard deviations because their units match the parameter dimension. The values were 11.4 (g/d), 0.06 and -0.02 σ_{PDmax} σ_{kf} and ρ , respectively. The correlation was not significantly different from zero (P = 0.73). For purposes of stochastic simulation modeling, these traits may be assumed independent which simplifies construction and execution of the model.

Key Words: nonlinear mixed model, protein deposition, pigs

T194 Impacts of zinc and arginine in the piglets diets at weaning on inflammatory reaction and antioxidant potential. N. Bergeron*, A. Hudon-Thibault, M. Roy, and F. Guay, *Université Laval, Québec, QC, Canada.*

The objective of this experiment was to evaluate the effects of dietary zinc (ZN) and arginine (ARG) supplementation on oxidative and

inflammatory status of weaning piglets. Thirty-two weaned piglets were allotted in a completely randomized block design with dietary ZN (0 vs 2500 mg/kg) and ARG (0 vs 1%) supplementation as main factors. The 4 diets were the following: control (standard post-weaning diet), ZN2500, ARG1 and ZN2500ARG1. The piglets were assigned to 1 of the 4 diets, maintained individually in pen and fed 3 times per day for a period of 12 days. At the end of the feeding period, blood samples were taken before (T0) and 3 hours following (T1) an intraperitoneal injection of LPS (10 mg/kg BW) in order to assess the inflammatory reaction (Tumour Necrosis Factor (TNF), Prostaglandin E2 (PGE) and Nitric Oxide (NO)) and antioxidant response (Malondialdehyde (MDA), Ferric Reducing Ability of Plasma (FRAP) and Superoxide Dismutase (SOD)). The piglets fed ZN supplemented diets had lower MDA at T0 (P<0.001) but not at T1. At T1, FRAP increased in piglets fed ARG supplemented diets (P<0.05) especially if ZN was added (ZN*ARG, P<0.07). ZN supplementation reduced SOD activity at T1 (P<0.05), especially when the ARG was added (ZN*ARG, P<0.07). No difference was noted at T0 for FRAP and SOD activity. PGE tended to be increased in piglets fed ARG diets (P<0.07) at T1. The piglets fed ZN supplemented diets had higher TNF at T1. At T0, no difference was noted for PGE and TNF. For NO, no difference was noted at T0 and T1. However, ratio T1/T0 for NO tended to be increased in piglets fed ARG supplemented diets (P<0.06). In summary, the present results showed that ZN and ARG did not reduce inflammatory reaction in peripheral blood circulation at T0 and T1. In fact, ZN increased TNF and ARG increased NO and PGE at T1. However, ZN and ARG had a synergistic effect on improvement of antioxidant status in inflammatory conditions.

Key Words: antioxidant, inflammatory reaction, zinc arginine

T195 Meta-analytic study of phosphorus excretion in pigs. R. S. Dias*¹, J. Chen¹, J. Ellis¹, E. Kebreab², S. Lopes³, D. M. S. S. Vitti⁴, M. Fan¹, and J. France¹, ¹University of Guelph, Guelph, Ontario, Canada, ²University of Manitoba, Winnipeg, Manitoba, Canada, ³Universidad de Leon, Leon, Leon, Spain, ⁴Centro de Energia Nuclear na Agricultura, Piracicaba, Sao Paulo, Brazil.

Many studies have been carried out to better understand the factors affecting P excretion in pigs in an attempt to search for more efficient ways of minimizing its detrimental effects on the environment. The large amount of data available allows researchers to use meta-analysis as a tool to synthesize results from several studies. In the present work, initially 69 studies were assembled and used in a meta-analysis to generate different information related to phosphorus excretion in pigs. The database contained information on diet, feed intake, P intake, P excretion and weight of pig. First all data were assessed to determine which are the most important dietary features affecting P excretion in pigs. The meta-analysis was performed using 190 data points resulting in the following model: P feces (g/kg of BW^{0.75}.d) = 0.00002 phytase × phytate + 0.33 P – 0.05 Ca/P + 0.14, with all parameters significant. For a second analysis, a subset of the data (total 27 studies and 71 data points) containing only values of P excreted in feces of animals that were not fed phytase was selected and the following linear model was elicited: P feces (g/kg of BW^{0.75}.d) = 0.4 P intake + 0.07. Further, the model was validated using data from another 27 studies. The predicted values were strongly related to measured values as shown by MSPE (mean square prediction error) analysis. The bulk of MSPE was due to random variation in the data set. According to the linear model when P intake is zero endogenous P in feces is 70 mg/kg of BW^{0.75}.d, a value that agrees with the literature. The first model indicates that P, Ca/P and the interaction between phytate and phytase present in the diet affect

P excretion in feces of pigs. The linear model presented may be used to predict P excretion in pigs when P ingested is given and no phytase is added to diet.

Key Words: phosphorus excretion, pigs, meta-analysis

T196 Effects of dietary lactose levels during different starter phases on the performance of weanling pigs. J. S. Kim, Y. X. Yang, K. Yun, J. Y. Choi, P. L. Shinde, and B. J. Chae*, *College of Animal Life Sciences, Kangwon National University, Chuncheon, Republic of Korea.*

Two experiments were conducted to evaluate dietary lactose levels during different starter phases on growth performance, nutrient digestibility and fecal microbial populations. In Exp. 1, 192 weanling pigs (Landrace × Yorkshire; 21 ± 2 d of age; 6.94 ± 0.97 kg) were used and allotted by a 2 × 2 factorial arrangement to test the effects of dietary lactose levels and different starter feeding programs (FP). Phase I diets containing two levels of lactose (low, 15 and high, 25%) were prepared, then the same phase II and phase III diets were used containing 10% and 0% lactose, respectively. Phase I, II, III diets were provided for wk 1, wk 2 to 3, and wk 4 to 5 for FP 1 and for wk 1 to 2, wk 3, and wk 4 to 5 for FP 2, respectively. Pigs fed high lactose diets had improved ADG, ADFI and better nutrient digestibility at the end of wk 1 and 2 of the experiment. Also, increased fecal *Lactobacillus* spp. (d 7 and 14, $P < 0.05$) and reduced coliforms (d 7, $P = 0.049$) were noticed in pigs fed high lactose diets. Experiment 2, involved 192 weanling pigs (Landrace × Yorkshire; 28 ± 3 d of age; 9.57 ± 0.79 kg) in a 2 × 2 factorial design similar to Exp. 1 and the same phase I, II and III diets were used. For FP 1, phase I, II, III diets were provided for wk 1, wk 2, and wk 3 to 5 and for FP 2, phase I, II, III diets were provided for wk 1, wk 2 to 3, and wk 4 to 5, respectively. Improved ADG ($P = 0.001$), ADFI ($P = 0.003$), and nutrient digestibility ($P < 0.001$) at the end of 1 wk were noticed in pigs fed high lactose diets. In addition, pigs fed high lactose diets had higher fecal *Lactobacillus* spp. on d 7 ($P = 0.007$) and d 14 ($P = 0.054$) than pigs fed low lactose diets. In both the experiments, the FP had no effect on the performance, nutrient digestibility and fecal microflora except for increased fecal *Lactobacillus* spp. on d 14 ($P = 0.013$) in pigs of FP 2 in Exp. 1. These results demonstrated that improved performance could be obtained by including 25% lactose during the initial two weeks post-weaning in pigs weaned at 21 d of age and during the first week post-weaning in pigs weaned at 28 d of age, respectively.

Key Words: starter feeding program, lactose, weanling pigs

T197 Effect of lysine levels in gestating and lactating diets on reproductive performance of sows and their progeny. J. S. Chang^{*1}, H. F. Long², L. G. Piao², W. S. Ju², Y. D. Jang², and Y. Y. Kim², ¹*CJ Cheiljedang Corporation, Seoul, Korea*, ²*Seoul National University, Seoul, Korea.*

The objective of this experiment was to investigate the effect of dietary lysine levels in gestation and lactation diets on the reproductive performance of sows and their progeny. Two experiments were conducted using 4 different levels of lysine in each diet for the gestation and lactation periods, respectively. Exp. 1 was conducted during gestation and treatments were: 1) GA - diet contained 0.49% lysine, 2) GB - diet contained 0.62% lysine, 3) GC - diet contained 0.74% lysine, and 4) GD - diet contained 0.86% lysine. Exp. 2 was conducted during lactation and treatments were: 1) LA - diet contained 0.76% lysine, 2) LB - diet contained 0.90% lysine, 3) LC - diet contained 1.03% lysine, and 4)

LD - diet contained 1.16% lysine. All other nutrients met or exceeded NRC (1998) requirements. A total of 43 FI (Yorkshire × Landrace) sows, with initial body weight 210.9 ± 7.7kg, were allotted in 4 treatments with replicates by body weight, backfat thickness and parity in a completely randomized design. After Exp. 1, sows were reallocated to treatments for Exp. 2. In Exp. 1, no significant differences were observed in body weight and backfat thickness due to dietary lysine levels. At farrowing, no statistical difference was found in litter size among dietary treatments. For the first week of Exp. 2, the body weight of sows tended to decrease linearly with increasing dietary lysine levels ($P = 0.092$, 13.59, 12.18, 9.61 and 10.15 kg for LA, LB, LC and LD, respectively). For the third week of Exp. 2, ADFI of sows was decreased quadratically by increasing lysine levels ($P < 0.05$, 8.21, 7.36, 7.27 and 7.93 kg for LA, LB, LC and LD, respectively). However, there were no significant differences in litter weight and litter weight gain among all treatments during lactation. Consequently, these results demonstrated that dietary lysine levels in lactation influenced ADFI, body weight and backfat thickness of sows but gestating sows were not affected by different lysine levels.

Key Words: lysine level, sow, reproductive performance

T198 Effect of betaine partially replacing dietary methionine on nutrient digestibility and on serum metabolites and enzymes of broiler chickens. H. Sun¹, W. R. Yang¹, Y. Wang², Z. B. Yang^{*1}, S. Z. Jiang¹, and G. G. Zhang¹, ¹*Shandong Agricultural University, Tai-an, Shandong, P.R. China*, ²*Agriculture and Agri-Food Canada, Lethbridge Research Centre, P.O. Box 3000, Lethbridge, AB, Canada.*

Studies showed inconsistent animal production response to partial replacement of dietary methionine (Met) by betaine (BET). Effect of BET supplementation on nutrient digestibility and metabolism is rarely determined. A total of 900 day-old AA broiler chicks were fed three corn-soybean meal-based starters (d 1-21) and growers (d 22-42). Dietary treatments were: Diet 1, Met content at the recommended level (4.8 (starter) and 4.0 (grower) g/kg DM); Diet 2, Met level at 85% of the Diet 1 with BET supplementing at the rate of 400 (starter) or 300 (grower) mg/kg DM; Diet 3, Met level at 75% of the Diet 1 with BET supplementing at 600 (starter) or 500 (grower) mg/kg DM. The broilers were raised in nine pens (100 birds/pen, 3 pens/treatment) in a temperature controlled house with continuous lighting. Chicks were fed for *ad libitum* intake, had free access to water and weighed weekly. Nutrient digestibility was determined (6 birds per diet in individual metabolic cages) by excreta collection for three days at the end of the feeding experiment. Concentrations of metabolites and enzyme activity in the serum were measured on d 21 and 42. All broilers had similar ADG, ADFI or G:F in each period or during entire feeding experiment. Broilers consuming Diet 3 had higher ($P < 0.05$) apparent digestibility of CP and ether extract than broilers consuming Diets 1 and 2, whereas all broilers had a similar digestibility for DM or GE. Compared to Diet 1, broilers fed Diet 3 had lower ($P < 0.05$) concentrations of low density lipoprotein-cholesterol at d 21 and 42, uric acids and triglyceride, but higher ($P < 0.05$) high density lipoprotein-cholesterol at d 42 but not d 21. Broilers fed Diet 3 also had higher ($P < 0.05$) activity of serum alkaline phosphatase and lactate dehydrogenase, but lower ($P < 0.05$) activity of creatine kinase than that fed Diet 1, whereas activity of aspartate aminotransferase and alanine aminotransferase were similar among treatments. The results demonstrated that BET can replace up to 25% of total Met in the diet that was formulated to meet the requirement based on the Feeding Standard of China.

Key Words: broilers, betaine, digestibility

T199 Effects of decreased levels of crude protein in nursery diets on growth performance and diarrhea occurrence of pigs weaned at 21 days. C. J. Giroto Jr.*, F. F. Barbosa, P. F. Campos, P. C. Brustolini, and J. V. Moutinho, *Federal University of Viçosa, Viçosa, Minas Gerais, Brazil.*

A 21-d experiment with 126 pigs was conducted to evaluate growth performance and diarrhea occurrence of nursery pigs fed different levels of crude protein. Pigs (6.05 ± 0.35 kg of initial weight) were allotted in pens with three pigs each on day 21 after weaning, with six treatments, and seven blocks on a randomized blocks experimental design. The treatments were six corn-soybean meal based diets with decreased levels of crude protein (24%; 23%; 22%; 21%; 20%; and 19%). Increased levels of synthetic amino acid were added to the diets in order to keep the ratio between lysine and each one of the following amino acids constant (methionine + cystine, threonine, tryptophan, valine, and isoleucine). The performance results are presented in the Table 1. Decreasing levels of crude protein from 24% to 19% did not influence average daily feed intake (P>0.05), feed:gain (P>0.05) or carcass weight (P>0.05) but increased linearly (P<0.05) weight at 42 days of age of the pigs. Decreasing levels of crude protein also did not influence (P>0.05) the diarrhea occurrence. In summary, decreasing levels of crude protein in nursery diets from 24% to 19% did not affect ADFI, F:G, carcass weight, and diarrhea occurrence but improved weight at 42 days of pigs weaned at 21 days.

Table 1 – Performance of pigs weaned at 21 days of age fed decreased levels of crude protein.

Parameters	Treatments						Mean	CV%
	24	23	22	21	20	19		
Weight, lb (21d)	13.73	13.75	13.68	13.70	13.62	13.59	13.68	4.05
Weight, lb (42d) ¹	30.27	30.12	30.34	31.68	31.68	31.28	30.89	12.69
ADG (g/d)	375	354	358	386	385	361	370	13.56
ADFI (g/d)	450	490	460	480	510	510	483	12.43
F:G	1.23	1.40	1.24	1.26	1.31	1.39	1.31	10.85
Carcass weight, lb	20.67	20.33	20.89	21.33	22.25	21.48	21.15	21.08

¹ Linear effect (P<0.05)

Key Words: crude protein, diarrhea, weaning

T200 Effects of decreasing nutrient density of diet on Cu and nutrient absorption in ileal tissue of broilers. B. E. Aldridge* and J. S. Radcliffe, *Purdue University, West Lafayette, IN.*

Ileal tissue was harvested from 15 male broiler chickens and mounted in modified Ussing chambers to investigate the effect of a reduced plane of nutrition on active Cu absorption from a Cu proteinate and CuSO₄, as well as from Glucose, Phosphorus, Carbachol and Gly-Sar. Seven birds were fed a corn-SBM based, 20% CP diet, and 8 birds were fed a reduced nutrient density diet by diluting the 20% CP diet with 50% cellulose for three days prior to euthanasia. Ileal tissue was removed and used in duplicates on days 16-23 in modified Ussing Chambers. All tissue were challenged with Glucose, Phosphorus or Carbachol, but only one piece of tissue (plus duplicate) was challenged with either CuSO₄ or Cu proteinate or Gly-Sar (indicative of dipeptide uptake). Active uptake was based on the change in short circuit current resulting from the addition of 10 mM Glucose, Phosphorus, Carbachol and (2 mM)

Cu proteinate, CuSO₄ or 10 mM Gly-Sar to the brush border membrane buffer solution. Cu concentrations in the mucosal and serosal buffer were determined using ICP-MS. The 50% nutrient reduced diet not only increased (P<0.001) basal Isc (5.08 μA/cm² vs. 0.37 μA/cm²) compared to the control diet, but also increased (P<0.001) glucose, copper and gly-sar active transport compared to the control diet, which suggests up regulation of membrane transport proteins during times of low nutrient intake. Carbachol tended (P = 0.07) to increase chloride ion secretion for the 50% reduced nutrient diet compared to the control. Phosphorus active transport was not affected by dietary treatment (P = 0.59). Active copper transport for the 50% cellulose diet increased (P<0.04) for both copper sources (4.3 μA/cm² vs. 0.47 μA/cm²), but differences between sources were not observed. Copper concentration in the mucosal and serosal buffer did not differ between diets (P=0.15) or between CuSO₄ and Cu proteinate (mucosal side: P=0.1; serosal side: P=0.99). Overall, a reduced plane of nutrition in broilers increased active transport for a variety of core nutrients, presumably due to more active versus passive activated transport systems in the intestine.

Key Words: nutrient uptake, intestine, chicken

T201 The effect of period and duration of feeding restriction on nitrogen balance in pigs. M. Richer-Lancieult¹, M. Roy*¹, J. F. Bernier¹, R. Fillion³, M. Lessard², and F. Guay¹, ¹Universite Laval, Quebec, Quebec, Canada, ²Agriculture and Agrifood Canada, Sherbrooke, Quebec, Canada, ³CDPQ, Quebec, Quebec, Canada.

The objective of this experiment was to evaluate the effect of period and duration of qualitative feed restriction or compensatory feeding on N balance in pigs. For N balance trial, 24 castrated pigs (18 kg) were maintained in individual pens and fed ad libitum, except during collection period, according to four different feeding strategies. The first group of pigs (CON) fed with a conventional feeding sequence (starter (1.02% digestible Lys, 0.54% P, 0.76% Ca), grower (0.95% Lys, 0.47% P, 0.69% Ca), finisher1 (0.75% Lys, 0.43% P, 0.52% Ca) and finisher2 (0.63% Lys, 0.35% P, 0.49% Ca). The other feeding sequences were: RES0-21: finisher1, grower, finisher1 and finisher2; RES21-49: starter, finisher2, finisher1 and finisher2; RES0-49: finisher1, finisher2, finisher1 and finisher2; when the restriction was applied, Lys, P and total Ca were reduced by 30%. Pigs were placed in metabolic crates for a 7-d period during each of the starter (0-21d), grower (21-49d), finisher1 (49-70d) and finisher2 (70-slaughter) phases on days 14 (28 kg), 35 (48 kg), 63 (79 kg), 84 (100 kg), respectively, to determine N balance (N intake, retention, digestibility, utilization (retention/intake), fecal and urinary). Data was analyzed with SAS Mixed procedure and restricted groups were compared to CON. During starter phase (0 to 21d), RES0-21 and RES0-49 pigs had lower N intake (38, 37 vs 44 g/d) digestibility (81, 81, vs 84%) utilization (57, 57 vs 62%) and retention (22, 21 vs 27 g/d) than CON pigs. During grower phase, RES21-49 and RES0-49 pigs had lower N intake (43, 41 vs 59 g/d), urinary (12, 11 vs 19 g/d) and retention (25, 23 vs 32 g/d). During grower phase, corresponding to a compensatory feeding period for RES0-21 pigs, their N balance was not different from CON pigs. However, during finisher1 phase, RES0-21 had higher N retention (39 vs 29 g/d), digestibility (89 vs 86%, P<0.07) and utilization (61 vs 48%, P<0.09) than CON pigs. Finally, during finisher2 phase, N balance was not affected by previous feeding restriction. These results show that pigs subjected to early feeding restriction can improve N utilization and retention during compensatory phases.

Key Words: growing pigs, compensatory growth, N balance

T202 Effects of feeding sodium selenite vs. selenium yeast as the selenium source for sows during late gestation and lactation. T. E. Shipp*, D. W. Funderburke, and C. L. Funderburke, *Cape Fear Consulting, LLC, Warsaw, NC.*

Litter and sow performance were compared when sows were fed 0.3 ppm added Se as sodium selenite (Control, C) or Se yeast (SY, SelPlex, Alltech Inc.). Sows were balanced by parity group and season and allotted to one of the two treatments. SY treatment began 3 wk pre-farrowing and continued through lactation. Respectively, C and SY gestation and lactation diets were equal in nutrients, except for Se source. Each farrowing group had 20 to 24 sows; litters were weaned at 23 to 24 d. Lactation feed intake was measured on a subset of sows (C, n = 51; SY, n = 54). All other parameters were measured on the entire data set of C (n = 309) and SY (n = 310) sow observations. All data were analyzed by the GLM procedure of SAS with fixed effects of treatment, parity group (group 1 = parity 1; group 2 = parity 2; group 3 = parities 3 to 5; group 4 = parities 6 and above), and season (season 1 = Oct through Mar; season 2 = Apr through Sept). Experimental unit was individual sow observation. There were no differences by treatment for sow mortality, re-breeding rate, cull rate, average parity, or beginning or ending body condition score. There were also no differences by treatment for sow lactation feed intake as measured on the subset of sows. Pigs born alive, total pigs born, stillborns, mummies, pigs weaned, and individual and litter birth weight did not differ with treatment. SY sows produced heavier weaned litters (75.82 kg vs. 72.04 kg; $P < 0.007$) and heavier pigs at weaning (7.56 kg vs. 7.09 kg; $P < 0.001$) than C sows. Selenium yeast can replace added Se from sodium selenite for sows, with resulting improvements in weaning pig weights.

Key Words: litter performance, lactation, selenium yeast

T203 Efficacy of Cr (III) supplementation on growth, carcass composition, blood metabolites, and endocrine parameters in finishing pigs. M. Q. Wang*^{1,2}, Y. D. He^{1,2}, and Z. R. Xu^{1,2}, ¹*Animal Science College of Zhejiang University, Hangzhou, Zhejiang, P. R. China,* ²*The Key Laboratory of Molecular Animal Nutrition, Ministry of Education, Hangzhou, Zhejiang, P. R. China.*

The objective of this study was to evaluate the effects of trivalent chromium from different sources on growth, carcass composition, and serum parameters in finishing pigs. Ninety-six crossbred pigs with an initial average body weight 65.57 ± 1.05 kg were blocked by body weight and randomly assigned to four treatments with three replicates. Pigs were offered one of four diets including a control diet or the control diet supplemented with 200 $\mu\text{g}/\text{kg}$ chromium from either chromium chloride (CrCl₃), chromium picolinate (CrPic) or Chromium nanocomposite (CrNano) for 40 days. After completion of the feeding trial, eight pigs from each treatment were selected to collect blood samples, and slaughtered to measure carcass composition. The results showed that supplemental CrNano had no effects on average daily gain and feed conversion rate, while it increased carcass lean proportion and loin longissimus muscle area ($P < 0.05$), and decreased carcass fat proportion and 10th rib backfat depth ($P < 0.05$). CrPic supplementation also resulted in lower fat proportion and larger longissimus muscle area ($P < 0.05$). The addition of Cr from CrNano or CrPic decreased serum glucose ($P < 0.05$), increased concentrations of total protein and free fat acid in serum ($P < 0.05$). Serum urea nitrogen, triglyceride and cholesterol were decreased ($P < 0.05$), and serum high density lipoprotein and lipase activity were increased ($P < 0.05$) with the supplementation of CrNano. Serum insulin was decreased ($P < 0.05$) by supplemental Cr from CrNano or CrPic, and serum insulin like growth factor I was increased in the

CrNano treated group. These results suggest that chromium nanocomposite has higher efficacy on carcass composition in pigs compared to the traditional chromium sources.

Key Words: chromium, pigs, nanocomposite

T204 Biochemical profile of broiler chicken supplemented with organic selenium (SelPlex®) in total replacement of inorganic selenium (sodium selenite). F. M. Gonçalves, M. N. Corrêa*, M. A. Anciuti, F. Rutz, and F. A. B. Del Pino, *Federal University of Pelotas, Pelotas, RS, Brazil.*

The aim of this study was to evaluate the biochemical profile of broiler chickens supplemented with selenium yeast in total replacement of sodium selenite in the diets. A total of 704 day-old Cobb male chicks were used until 42 days of age. The experimental design was a completely randomized design with two treatments which consisted of two different sources of selenium in the diets (sodium selenite and selenium yeast), in a total of 16 replicates per treatment. The basal diet was prepared using corn and soybean meal in agreement with the nutritional values established by the breeder manual. Calcium (Ca), phosphorus (P), aspartate aminotransferase (AST), gamma glutamyl-transferase (GGT), albumin (Alb.), total proteins (TPs), cholesterol (Chol), uric acid (UA) and creatine kinase (CK) were evaluated by specific kits. The highest level of creatine kinase was observed at 35 days of age in the chicks supplemented with sodium selenite. Selenium yeast-fed birds showed higher level of total serum proteins in the same period. Se from sodium selenite can be replaced by Se from selenium yeast in broilers diets slightly altering blood biochemistry.

Table 1. Biochemical profile of broilers supplemented with two different sources of selenium in the diets

	28		35		42	
	SeO	Sel	SeO	Sel	SeO	Sel
Ca (mg/dL)	8.22	8.26	9.52	9.58	10.65	10.70
P (mg/dL)	6.60	6.78	6.75	6.21	5.58	5.62
AST (U/l)	92.55	96.72	76.69	80.60	73.84	95.03
GGT (U/l)	50.78	39.47	63.99	61.65	-	-
Alb (g/dL)	1.87	1.80	1.68	1.61	1.58	1.54
TPs (g/dL)	2.86	3.00	2.84a	2.64b	3.29	3.02
Chol (mg/dL)	136.18	148.68	132.46	140.37	106.97	111.77
UA (g/dL)	5.63	4.17	3.67	3.07	4.30	3.88
CK (U/l)	1335.26	1437.34	2207.26b	3349.50a	4081.23	4015.12

Key Words: selenium-yeast, bioavailability, metabolites

T205 Effects of level of soybean oil in diets on true and ileal digestibility and endogenous losses of amino acids in growing pigs. E. C. Almeida, E. T. Fialho*, V. S. Cantarelli, M. G. Zangeronimo, R. A. N. Pereira, and P. B. Rodrigues, *University Federal of Lavras, Lavras, MG, Brazil.*

A total of 16 barrows with an initial BW of 42.3 ± 2.3 kg were surgically equipped with a T-cannula in the distal ileum and used to evaluate the effect of different levels of soybean oil on endogenous amino acid losses, as well as the apparent and true ileal digestibility of amino acids in growing pigs. The pigs were randomly allotted to four dietary treatments for a 4-wk experiment. Dietary treatments were increased

levels of soybean oil (0.0, 1.5, 3.0, and 4.5%) added to corn and soybean meal based diets formulated to meet the requirements for apparent ileal digestible lysine (0.61%) for growing pigs according to NRC (1998). Chromic oxide (0.25%) was used as an indigestible marker. During wk 1, pigs were fed only a basal diet; during wk 2 to 4, treatment diets were provided, and ileal samples were collected on days 6 and 7 of each week. The digesta samples were pooled. There was no effect of the supplementation of soybean oil levels on the apparent ileal digestibility of Glu, Gly, Arg, Ala, Pro, Tyr, His and Lys. However, a linear increase in the true and apparent ileal digestibility of Thr and Ser was observed with increasing soybean oil concentrations. A quadratic effect of soybean oil concentration was observed for the true and apparent ileal digestibility of Val, Phe, total non-essential and total of essential amino acids. True ileal digestibility coefficients of Arg and Tyr, also responded quadratically to soybean oil supplementation. In conclusion, the present results indicate that diets with soybean oil supplementation at the 2.5 to 3.0% level improves ileal digestibility of most indispensable AA, and that this effect is not further enhanced by providing more than 3.0% of soybean oil to diets for growing pigs.

Key Words: energy, metabolism assay, cannulated pigs

T206 Antagonistic strains isolated from the porcine gastrointestinal tract. V. Klose*¹, K. Bayer¹, R. Bruckbeck¹, A. P. Loibner¹, and G. Schatzmayr², ¹BOKU-University, Vienna, A-3430 Tulln, Austria, ²BIOMIN Research Center, A-3430 Tulln, Austria.

The supplementation of feed with beneficial strains originating from the porcine gastrointestinal tract (GIT) appears to be a promising alternative to the use of antibiotics, in order to maintain the health of weaner piglets by suppressing pathogens in a competition-like manner. A successful alternative must protect piglets from a myriad of enteric pathogens. Therefore, the combination of multiple strains may offer a competitive advantage to single-strain probiotics. The present work was part of the selection process of probiotic strains for their combined use as feed additives in pig production. Eleven strains, phylogenetically affiliated to *Bacillus subtilis* (n = 1), *Lactobacillus salivarius* (n = 2), *L. reuteri* (n = 2), *L. amylovorus* (n = 2), *L. mucosae* (n = 2) and *B. thermophilum* (n = 2), were isolated from the porcine gastrointestinal tract and examined for their antagonistic effect against a broad panel of pathogens. Using an agar spot test, the most effective strains were shown to inhibit various pathogens such as enterotoxigenic and enterohemorrhagic *E. coli* serotypes O8 K88, O138, O139, O147, O157, O6, as well as *S. enterica* serovar Enteritidis, *Choleraesuis* and *Typhimurium* and/or *Clostridium perfringens* type A. Six strains were able to suppress the growth of *Brachyspira hyodysenteriae*, the main causing agent of Swine Dysentery. These results encouraged us to explore the potential of four porcine strains belonging to *E. faecium*, *L. salivarius*, *L. reuteri* and *B. thermophilum* for their combined use as feed additives. Their effect will be examined in future feeding trials.

Key Words: pig, enteric pathogens, antagonistic activity

T207 The effect of period and duration of feeding restriction on compensatory growth and global growth performances in pigs. M. Richer-Lancault*¹, J. F. Bernier¹, R. Fillion³, M. Lessard², and F. Guay¹, ¹Universite Laval, Quebec, Quebec, Canada, ²Agriculture and AgriFood Canada, Sherbrooke, Quebec, Canada, ³CDPQ, Quebec, Quebec, Canada.

The objective of this experiment was to evaluate the effect of period and duration of qualitative feed restriction on compensatory growth in pigs. For the growth trial, 96 castrated piglets (18.7 kg) were maintained two per pen and fed ad libitum according to four different feeding sequences. The first group of pigs (CON) fed with a conventional feeding sequence (starter (1.02% digestible Lys, 0.54% P, 0.76% Ca), grower (0.95% digestible Lys, 0.47% P, 0.69% Ca), finisher1 (0.75% digestible Lys, 0.43% P, 0.52% Ca) and finisher2 (0.63% digestible Lys, 0.35% P, 0.49% Ca)). The other feeding sequences were: RES0-21: finisher1, grower, finisher1 and finisher2; RES21-49: starter, finisher2, finisher1 and finisher2; RES0-49: finisher1, finisher2, finisher1 and finisher2; when the restriction was applied Lys, P and Ca were reduced by 30%. Pigs were weighed at the initiation of the experiment, at each diet change (21d, 49d and 70d) and the day before slaughter (120 kg). Feed disappearance was measured on each weigh day. All pigs had 10th rib backfat and muscle thickness taken by ultrasonic scan at d45, d66 and d87. Data was analyzed with Mixed procedure and restricted groups were compared to CON. In the starter phase, RES0-21 and RES0-49 has lower G/F and ADG than CON pigs (0.51, 0.47 vs 0.59 and 0.68, 0.63 vs 0.82 kg/d, P<0.05). In the grower phase, RES21-49 and RES0-49 had lower G/F and ADG than CON pigs (0.42, 0.41 vs 0.45 and 0.89, 0.91 vs 1.07 kg/d, P<0.05). In the grower phase, corresponding to a compensatory feeding period for RES0-21 pigs, their G/F was higher than CON (0.48 vs 0.44, P<0.05). In finisher1 and 2 phases (their compensatory growth period), RES21-49 and RES0-49 groups also had higher G/F than CON (0.43, 0.42 vs 0.38 and 0.36, 0.37 vs 0.32, P<0.05). Finally, overall G/F and ADG, as well as backfat thickness in restricted groups were not different from CON. Muscle depth was lower in RES0-49 than in CON, but only on d45 and d66 (Time x Diet, P<0.05). These results show that growing pigs subjected to an early feed restriction compensated completely and can maintain global growth performances.

Key Words: growing pig, compensatory growth, growing performances

T208 Citrulline as a parameter for villus atrophy in weaned piglets. L. der Kinderen*¹, H. Zwolschen², D. Bravo³, A. Mul¹, and E. Bruininx^{1,4}, ¹CCL Research, Veghel, the Netherlands, ²Cehave Landbouwbewang Voeders Nederland, Veghel, the Netherlands, ³Pancosma, Geneva, Switzerland, ⁴Animal Nutrition Group, Wageningen University, Wageningen, the Netherlands.

In order to test plasma citrulline concentration (PCC) as a longitudinal marker for small intestinal morphology, 2 groups of twelve 23-day-old crossbred piglets (initial BW 7.75 kg ± 1.28) were used during a 5 day experiment. Group 1 (control) consisted of unweaned piglets remaining with the sow during the total experimental period. Group 2 (weaned) consisted of weaned piglets at 23 days of age and housed individually. The weaned piglets were fasted for 72 hrs after weaning and were fed 0.5 of their NEm (≈ 500 kJ ME/kg^{0.75}/d) including Phaseolus Vulgaris lectins. Blood samples of all piglets in both groups were collected daily and analyzed on PCC. At day 5, piglets were euthanized via intracardial injection with sodiumpentobarbital and samples of intestinal tissues were taken at 0.5 m distal from the Treitz ligamentum. Daily PCC values were analysed using a split plot model using group treatment (Control vs. Weaned) as a whole plot factor and time as a split plot factor. Overall treatment effects were tested with differences between days within a group as the error term. Additionally, overall linear relationships between PCC and morphological parameters were assessed using regression analysis. Averaged over all sampling days, PCC for the control group was higher (P < 0.001) than for the weaned piglets (111 vs. 60 μmol/L).

Moreover, time related changes in PCC were affected by experimental treatments as well ($P < 0.001$). Overall linear regression analysis showed a significant relation ($P < 0.0001$) between citrulline plasma levels measured on day 4 and villus/crypt ratio and villus height ($\alpha = 0.027 \mu\text{mol/L}$, $\text{SE} = 0.003$ and $\alpha = 3.679 \mu\text{mol/L}$, $\text{SE} = 0.410$ respectively).

This study suggests that PCC can be used as a longitudinal marker for small intestinal morphology in weaned piglets. As such, PCC could be a useful parameter in monitoring the effects of different feeding strategies on small intestinal morphology in weaned piglets.

Key Words: citrulline, Intestinal marker, Intestinal morphology

Physiology and Endocrinology: Estrous Synchronization

T209 Effect of progesterone insert during presynchronization program on reproductive responses of dairy cows. R. G. S. Bruno^{*1}, A. C. Denicol¹, D. F. Resende¹, G. Lopes Jr.¹, L. G. D. Mendonça¹, F. A. Rivera¹, J. E. P. Santos², and R.C. Chebel¹, ¹University of California - Davis, Tulare, ²University of Florida, Gainesville.

Lactating Holstein cows from two commercial dairies, 552 (392 multiparous and 160 primiparous) were blocked by parity and body condition at 44 ± 3 d in milk (DIM) and randomly assigned to one of two presynchronization programs, a control (CON, $n=282$) or a controlled internal drug-releasing (CIDR, $n=272$) containing 1.38 g of progesterone were inserted at 44 ± 3 DIM and removed on day 51 ± 3 DIM, 11 d before the initiation of the timed AI protocol (GnRH, 7 d PGF_{2 α} , and 3 d GnRH + timed AI). All cows were time inseminated at 72 ± 3 DIM. Ovaries were scanned at 62 ± 3 and 69 ± 3 DIM in order to identify ovarian structures and blood was sampled at 62 ± 3 , 72 ± 3 , and 80 ± 3 DIM for progesterone analyses. Pregnancy was diagnosed at 38 and 66 d after timed AI by palpation per rectum. Data were analyzed by the LOGISTIC procedure of SAS. Pregnancy per AI (P/AI) at 38 and 66 d after insemination was not affected ($P=0.45$) by type of presynchronization program (35.9 vs 34.6% for CIDR and CON respectively). However cows in the CIDR group had increased ($P=0.04$) ovulation synchronization following the timed AI program than CON cows (84.8 vs 77.6%, respectively) and synchronized cows had greater ($P<0.001$) P/AI at 38 and 66 d after AI (40.3 vs. 13.2% at 38 d; 38.2 vs. 12.1% at 66 d). Presynchronization with CIDR did not affect ($P=0.72$) the number of CL at the time of the initiation of the timed AI protocol, but increased ($P=0.05$) the proportion of cows with multiple CL at the time of the PGF (62.7 vs. 55.5% for CIDR and CON respectively) and increased ($P<0.01$) ovulation to the first GnRH of the timed AI (79.7 vs 68.9% for CIDR and CON respectively). Presynchronization with CIDR increased the proportion of cows responding to the synchronization program but did not improve P/AI.

Key Words: dairy cows, presynchronization, progesterone

T210 Effect of duration of CIDR treatment on reproductive performance of dairy heifers using a timed-AI protocol. G. Lopes Jr.^{*1}, L. G. D. Mendonça¹, R. C. Chebel¹, J. C. Dalton², and A. Ahmadzadeh³, ¹Veterinary Medicine Cooperative Extension, University of California-Davis, Tulare, ²Caldwell Research and Extension Center, University of Idaho, Caldwell, ³University of Idaho, Moscow.

The objective of this experiment was to determine the effect of reducing the duration of CIDR insert exposure in a timed-AI (TAI) protocol (CIDR-PGF_{2 α} -GnRH and AI) on pregnancy per AI (P/AI) in dairy heifers. Holstein heifers ($n=415$) were assigned randomly to one of three treatments: 1) Control heifers (CONT, $n=141$) received two PGF_{2 α} (25mg) injections every 11 d until inseminated on detected estrus or 22 d after enrollment; 2) CIDR7 heifers ($n=135$) received a CIDR insert for 7 d; and 3) CIDR5 heifers ($n=139$) received a CIDR insert for 5 d. Heifers in CIDR7 and CIDR5 were given (i.m.) PGF_{2 α} upon CIDR removal fol-

lowed by GnRH (i.m., 100 μg) and concomitant with AI approximately 50 h after CIDR removal. All heifers were re-inseminated following 1st AI if detected in estrus. Pregnancy status was diagnosed 36 ± 1 d after AI. Data were analyzed by logistic regression, ANOVA, and Cox proportional hazard regression. Interval from enrollment to 1st AI tended to ($P=0.07$) and was ($P=0.02$) shorter for CIDR5 (7.0 ± 0.6) than CONT (8.6 ± 0.6) and CIDR7 (9.0 ± 0.6), respectively, but there was no difference between CONT and CIDR7. Treatment affected ($P < 0.01$) P/AI as CONT (60%) had greater ($P < 0.05$) P/AI compared with CIDR5 (45.3%) and CIDR7 (28.1%). Moreover, CIDR5 had greater ($P < 0.05$) P/AI than CIDR7. Heifers in CONT become pregnant faster ($P < 0.01$) than CIDR5 and CIDR7, and CIDR5 tended to ($P=0.06$) become pregnant faster than CIDR7. Interval from enrollment to pregnancy was ($P < 0.01$) shortest for CONT (CONT= 29.5 ± 2.9 , CIDR5= 43.4 ± 4.3 , and CIDR7= 49.3 ± 3.9 d). Proportion of heifers pregnant at the end of 180 d after enrollment tended to ($P=0.11$) and was ($P < 0.01$) greater for CONT (97.2%) than CIDR5 (92.8%) and CIDR7 (88.2%). Reducing the duration of CIDR treatment from 7 to 5 d in a CIDR-based TAI protocol increased P/AI; however, heifers inseminated on detected estrus following PGF_{2 α} synchronization had greater P/AI compared with either the CIDR5 or CIDR7 TAI protocols.

Key Words: synchronization, CIDR, dairy heifers

T211 Effect of reusing CIDRs on the pregnancy rate of beef cattle. W. A. Greene^{*} and M. L. Borger, *The Ohio State University, Wooster.*

The objective of this study was to determine the effect of reusing intra-vaginal progesterone inserts (CIDRs), as a part of a synchronization program, on pregnancy rates (PR) in beef cattle. One hundred and twenty-four animals were allotted to two similar groups, new CIDR (N) and used CIDR (U), based upon breed, age, postpartum interval, and postpartum cyclicity (as determined by estrus detection and ultrasonography). On d 0, all cattle received 100 μg GnRH i.m., N group cattle received a new CIDR, containing 1.38 g progesterone, and U group cattle received a CIDR previously used for 7d. Used CIDRs had been thoroughly rinsed with a mild disinfectant solution, air-dried, and stored in a dry, enclosed container after first use. Blood samples were collected for plasma progesterone (P4) analyses on d 2. On d 7, CIDRs were removed and animals received 25 mg PGF_{2 α} i.m. Each CIDR was evaluated for signs of vaginal infection and scored from 1 (clear) to 5 (heavy pus). Animals were observed for estrus 0700 and 1900 and were artificially inseminated (AI) 11 - 13 h after estrus was observed. If estrus was not observed, animals were timed AI and received 100 μg GnRH i.m. 70 - 72 h after PGF_{2 α} . Following the synchronization period, repeat breedings were done until d 75. Cattle were pregnancy diagnosed by ultrasonography on d 111. N and U groups had similar ($P > 0.05$) estrus detection rates [EDR] (57.8 and 53.3%). The N group had higher ($P < 0.05$) PR to synchronization (50.0 vs. 28.3%) and higher ($P = .09$) overall PR (93.8 vs. 83.3%) than the U group. The rates of high vaginal