

**M75 Comparison of beef tallow versus poultry fat in the finishing diets of steers on muscle and subcutaneous fatty acid profiles.** S. Hutchison<sup>\*1</sup>, E. B. Kegley<sup>1</sup>, J. K. Apple<sup>1</sup>, T. J. Wistuba<sup>2</sup>, and D. C. Rule<sup>3</sup>, <sup>1</sup>University of Arkansas, Fayetteville, <sup>2</sup>Morehead State University, Morehead, KY, <sup>3</sup>University of Wyoming, Laramie.

Poultry fat has become a more economical source of energy than by-products currently used. Therefore, this study was conducted to determine the effects of dietary fat source (poultry fat or beef tallow) in finishing diets for cattle on the fatty acid composition of beef. Sixty Angus crossbred steers (410.8 kg initial BW) were stratified by source, blocked by weight, and assigned within block to 15 pens (4 steers/pen). Pens were then assigned randomly within blocks to one of three dietary treatments consisting of: 1) a corn-soybean meal control diet devoid of supplemental fat (Ctrl); 2) the control diet formulated with 4% tallow (TAL); or 3) the control diet formulated with 4% poultry fat (PF). Cattle were fed for 112-d and harvested at a commercial beef packing plant. Wholesale ribs were collected during carcass fabrication (357.7, 357.3, and 369.5 kg for carcasses of Ctrl, TAL, and PF-fed cattle, respectively), and samples of subcutaneous fat and LM were analyzed for fatty acid composition (reported as mg/g wet tissue). In the LM, total saturated fats (14:0, 15:0, 16:0, and 18:0) were similar ( $P > 0.10$ ) among diets. Furthermore, total monounsaturated fatty acids (MUFA) were not ( $P > 0.10$ ) affected by finishing diets. The LM from the steers fed PF had increased ( $P < 0.05$ ) 18:2 and total PUFA than the LM of the steers fed Ctrl or TAL-diets. Conversely, the LM of TAL-steers had lower ( $P < 0.05$ ) concentrations of 20:3 than Ctrl or PF-fed steers. The only changes detected in subcutaneous fat were steers that consumed the Ctrl-diet had the highest ( $P < 0.05$ ), and PF-fed steers had the lowest ( $P < 0.05$ ), 17:0 concentrations. Furthermore, subcutaneous fat from TAL-fed steers had lower ( $P < 0.05$ ) conjugated linoleic acid concentrations than fat from controls and PF steers; however, diet did not ( $P > 0.10$ ) affect total saturated, MUFA, PUFA, omega-6, or trans fatty acids. Feeding finishing steers diets formulated with poultry fat did not negatively impact the fatty acid composition of subcutaneous fat or the LM, and may serve as an alternative to beef tallow as a source of energy for cattle finishing diets.

**Key Words:** Beef Tallow, Poultry Fat, Fatty Acids

**M76 Comparison of beef tallow versus poultry fat in the finishing diets of steers on beef quality during retail display.** S. Hutchison<sup>\*1</sup>, J. K. Apple<sup>1</sup>, E. B. Kegley<sup>1</sup>, and T. J. Wistuba<sup>2</sup>, <sup>1</sup>University of Arkansas, Fayetteville, <sup>2</sup>Morehead State University, Morehead, KY.

The current study was conducted to determine the effects of dietary fat source (poultry fat or beef tallow) in finishing diets of cattle on beef quality traits during 7 d of simulated retail display. Sixty Angus crossbred steers (410.8 kg initial BW) were stratified by fat source, blocked by weight, and assigned to 15 pens (4 steers/pen). Pens were then assigned randomly within blocks to one of three dietary treatments consisting of: 1) a corn-soybean meal control diet devoid of supplemental fat (Ctrl); 2) the control diet formulated with 4% tallow (TAL); or 3) the control diet formulated with 4% poultry fat (PF). Cattle were fed for 112-d and harvested at a commercial beef packing plant. Wholesale, bone-in ribs were collected during carcass fabrication, and 2.54-cm thick, boneless LM steaks were cut, weighed, placed on foam trays with an absorbent pad, and overwrapped with PVC film for display (deluxe warm white

## Nonruminant Nutrition: Weanling Pig - Vitamin & Mineral

**M78 Is vitamin B6 a modulator of the effect of supplementary tryptophan on tryptophan metabolism and growth responses in weanling pigs?** J. J. Matte<sup>\*1</sup>, N. LeFloc'h<sup>2</sup>, C. Relandeu<sup>3</sup>, L. Le Bellego<sup>3</sup>, A. Giguère<sup>1</sup>, and M. Lessard<sup>1</sup>, <sup>1</sup>Agriculture and Agri-Food Canada, Lennoxville, Qc, Canada, <sup>2</sup>Institut National de la Recherche Agronomique, St-Gilles, France, <sup>3</sup>Ajinomoto Eurolysine S.A.S., Paris, France.

The present experiment aimed to determine if tryptophan (Trp) metabolism and the eventual growth response to dietary supplement of Trp is modulated by the dietary supply of pyridoxine (B6). Early-weaned piglets ( $n = 544$ ) (BW:  $5.96 \pm 0.14$  kg) were grouped in 32 pens ( $n = 32$ ) of 17 animals and distributed by initial weight ranges in four

light; 1600 lx) in chest-type display cases ( $3^{\circ}\text{C}$ ). On d 0, 1, 3, 5, and 7 of display, a three-person panel scored steak discoloration (1 = total discoloration to 7 = no discoloration), and instrumental color ( $L^*$ ,  $a^*$ , and  $b^*$  values) was measured and used to calculate hue angle, chroma, and delta E (measure of total color change from d-0) values. Thiobarbituric acid reactive substances (TBARS) of steaks were measured on d 0 and 7 of display. Beef became lighter (higher  $L^*$  value;  $P < 0.01$ ), and less red (lower  $a^*$  value;  $P < 0.001$ ) and yellow (lower  $b^*$  value;  $P < 0.001$ ) during the 7 d of retail display. The LM from Ctrl-steers tended to be lighter (higher  $L^*$  value;  $P < 0.10$ ); however, there were no ( $P > 0.10$ ) diet effects on  $a^*$ ,  $b^*$ , hue angle, chroma, delta E, or discoloration scores. Even though TBARS concentrations were numerically higher in the LM of steers consuming diets formulated with fat (0.54, 0.53, and 0.34 mg/kg for PF, TAL, and Ctrl, respectively), diet had no ( $P > 0.10$ ) appreciable effect on the development of oxidative rancidity. Results indicated that replacing beef tallow with a more economical energy source, poultry fat, in cattle finishing diets had no detrimental effects on beef quality during retail display.

**Key Words:** Dietary Fat, Beef Quality, Retail Display

**M77 Glycolytic intermediates in muscle and adipose tissue of cattle fed different sources and amount of energy.** R. D. Rhoades<sup>\*</sup>, J. T. Vasconcelos, D. K. Lunt, J. E. Sawyer, K. Y. Chung, and S. B. Smith, Department of Animal Science, Texas A&M University, College Station.

Seven Angus and eight Wagyu steers (BW = 208 and 172 kg) were used to evaluate energy source effects on glycolytic intermediates within muscle and adipose tissue. Steers were blocked by breed and fed a corn-based diet for 244 d (total energy: 3207 Mcal/kg) or a hay diet for 362 d (total energy: 6293 Mcal/kg). Corn-based diet was fed for 1.3 kg/d gain. Hay-fed steers were fed to the same carcass endpoint. Carcass adjusted fat thickness (AFT), marbling score, postmortem plasma, muscle, subcutaneous, and intramuscular adipose tissues were collected. Data were analyzed as a complete block design. Plasma glucose ( $\mu\text{mol/ml}$ ) was numerically greater ( $P=0.06$ ) in corn-fed ( $3.77 \pm 0.06$ ) vs. hay-fed ( $2.88 \pm 0.05$ ) steers. Glucose ( $\mu\text{mol/g}$ ) in muscle was greater ( $P=0.04$ ) in hay-fed steers ( $4.68 \pm 0.07$  vs.  $3.07 \pm 0.08$ ). Muscle glucose-6-phosphate (G6P), and fructose-6-phosphate (F6P;  $\mu\text{mol/g}$ ) were similar ( $P=0.10$ ) among treatments. Glucose ( $P=0.13$ ), G6P ( $P=0.34$ ), and F6P ( $P=0.22$ ) concentrations in subcutaneous adipose were also similar. Glucose and F6P concentrations in intramuscular adipose were 2-fold and 10-fold higher, respectively, than observed in subcutaneous depots, but were similar ( $P>0.6$ ) for corn-fed and hay-fed steers. G6P was numerically greater in hay-fed ( $0.186 \pm 0.008$ ) vs. corn-fed steers ( $0.084 \pm 0.009$ ;  $P=0.08$ ). Steers were fed to a common AFT (0.47 cm). Mean marbling score in corn-fed steers ( $710 \pm 78$ ) was numerically greater than in hay-fed steers ( $564 \pm 72$ ) although statistical separation was not achieved ( $P=0.4$ ). Plasma glucose indicates greater glucose pool size in corn-fed steers; greater concentrations of glucose and intermediaries in muscle of hay-fed steers may reflect decreased pathway flux. Correlations between marbling score and intramuscular adipose glucose concentration were -0.6 ( $P=0.18$ ) for corn-fed steers and 0.7 ( $P=0.04$ ) for hay-fed steers, supporting the concept that corn-based diets promoted provision and utilization of glucose for accretion of intramuscular fat relative to hay-based diets. Manipulation of glucose disposal rate in finishing steers may improve carcass quality grade.

**Key Words:** Glucose, Marbling, Energy

factorial treatments ( $n = 8$  pens in each): two dietary additions of B6 [0 (B6-) vs. 5 ppm (B6+)] and two dietary additions of synthetic Trp [0 (Trp-) vs. 0.05 % (Trp+) for a Trp/Lys ratio of 0.174 vs. 0.204, respectively]. Growth performance was recorded every week from 2 to 9 wk of age. Blood samples were taken from 64 piglets, two from each pen, before initiation of treatments and at 4, 6 and 8 wk of age. No treatment effect ( $P > 0.19$ ) was observed on overall ADFI ( $679 \pm 7$  g), ADG ( $454 \pm 4$  g), or feed conversion ( $1.50 \pm 0.01$ ), although the B6+Trp+ piglets had the highest ADG and feed conversion during the last week of experiment (B6 x Trp x Age linear,  $P < 0.02$ ). Pyridoxal in red blood cells was 19% lower in B6- ( $2.8 \pm 0.1 \mu\text{M}$ ) than in B6+ piglets ( $3.3 \pm 0.1 \mu\text{M}$ ; B6 x Age quadratic,  $P < 0.01$ ). Initial values

(33.1 ± 1.5 μM) of plasma Trp declined ( $P < 0.01$ ) with age but the effect tended to be more pronounced (B6 x Age linear,  $P < 0.08$ ) in B6 than in B6+ piglets; values at 8 wk of age were 22.6 ± 1.7 vs 26.7 ± 1.4 μM, respectively. Initial values (1.48 ± 0.09 μM) of plasma kynurenin, an intermediate metabolite of Trp oxidation, decreased with age but were higher, at 4 and 6 wk of age, in Trp+ than in Trp- piglets (Trp x Age quadratic,  $P < 0.01$ ); this effect faded (1.21 ± 0.07 μM) at 8 wk of age. It seems that, although stimulated by dietary Trp at 4 and 6 wk of age, Trp oxidation would not be altered at 8 wk of age in spite of the B6 x Trp effect. This apparent sparing effect of B6 on Trp status could originate from the small intestine microflora since bacterial synthesis of Trp is B6-dependent. Those late (8 wk of age) metabolic and growth performance effects merit further investigation especially for their eventual carry over impact shortly after the nursery period.

**Key Words:** Tryptophan, Pyridoxine, Piglets

**M79 Vitamin C and β-carotene in weanling pig diets.** D. M. Fernandez<sup>\*1</sup> and J. A. Cuaron<sup>2</sup>, <sup>1</sup>Universidad Nacional Autonoma de Mexico Mexico City, <sup>2</sup>Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias Queretaro, MX.

Two experiments were conducted to evaluate productive performance of lightweight pigs at weaning in response to vitamin C and β-carotene supplementation at 150 and 350 mg/kg of diet, respectively, on both a commercial farm (Trial 1) and an experimental farm (Trial 2). Supplementary energy source used in each experiment was oxidized canola oil in Trial 1 and oxidized tallow in Trial 2. In Trial 1, piglets were weaned at 22.08 ± 1.66 days of age and 5.47 ± 1.18 kg. In Trial 2 animals were weaned at 21.5 ± 0.85 days of age, weighing 5.79 ± 1.12 kg. Vitamins were added from a corrected standard commercial premix. Both trials were conducted as a randomized complete block design in a factorial arrangement (2 vitamin C 2 β-carotene levels) and the treatments were: 1) Vitamin C, 0 and β-carotene, 0 mg/kg of diet (T1); 2) Vitamin C, 150 and β-carotene, 0 mg/kg (T2); 3) Vitamin C, 0 and β-carotene, 350 mg/kg of diet (T3); 4) Vitamin C, 150 and β-carotene 350 mg/kg (T4). In Trial 1, there were no differences ( $P > .13$ ) in ADFI, ADG and feed efficiency (FE). In Trial 2, after 20-d, a Vitamin C by β-carotene interaction in ADFI was observed ( $P < .03$ ). ADFI was greater for T1 and T4 compared to T2 and T3 (.292 and .287 vs .251 and .259). The ADG and FE were not affected. It is concluded that antioxidant capacity of the diet provided by standard levels of Vitamin E, Se and chemical antioxidants (BHT) is sufficient to overcome oxidative stress imposed on lightweight pigs at weaning.

**Key Words:** Weanling Pigs, Vitamin C, Beta-Carotene

**M80 Ontogeny of mitochondrial carnitine palmitoyltransferase I in porcine liver and skeletal muscle.** P. Lyvers Pepper<sup>\*1</sup>, X. Lin<sup>1</sup>, L. Averette Gatlin<sup>1</sup>, J. Woodworth<sup>2</sup>, and J. Odle<sup>1</sup>, <sup>1</sup>North Carolina State University, Raleigh, <sup>2</sup>Lonza, Inc., Fairlawn, NJ.

Molecular evaluation of carnitine status can be made by comparing tissue carnitine concentrations with the carnitine-K<sub>M</sub> of carnitine palmitoyltransferase I (CPT I). Therefore, a study was conducted to assess hepatic and muscle mitochondrial CPT I kinetics in pigs during different stages of development. Mitochondria were isolated from liver and semitendinosus muscle from suckling, 24-h-old and fed 5-wk-old (2 wk post-weaning) pigs. Activity of CPT I was determined via radioenzymatic analysis, and the V<sub>max</sub> and apparent K<sub>M</sub> for carnitine were estimated. Activity (V<sub>max</sub>) in skeletal muscle increased between 24 h and 5 wk of age, signifying developmental induction, but no change in V<sub>max</sub> was detected in hepatic tissue. Despite increased CPT I activity of skeletal muscle, differences in the K<sub>M</sub> for carnitine were not detected for either tissue examined. The ontogenic induction of skeletal muscle CPT I may be necessitated by contracting muscle preferentially oxidizing fatty acids as their primary fuel.

Carnitine palmitoyltransferase I kinetic constants (V<sub>max</sub> and apparent K<sub>M</sub>) measured in mitochondria from hepatic and muscle tissue of pigs<sup>1</sup>

	AGE	
	24 h (n = 5)	5 wk (n = 4)
V <sub>max</sub> , μmol/(hg mitochondrial protein)		
Liver	25.1 ± 4.4	30.3 ± 4.9
Skeletal Muscle <sup>a</sup>	25.8 ± 4.0	44.9 ± 4.5
K <sub>M</sub> for carnitine, μmol/L		
Liver	254 ± 36	301 ± 40
Skeletal Muscle	350 ± 80	495 ± 90

<sup>1</sup>Values are means ± SE; <sup>a</sup>Age effect,  $P < 0.05$ .

**Key Words:** Carnitine Palmitoyltransferase, Ontogeny, Pigs

**M81 Determination of true digestible calcium and phosphorus requirements in weaned pigs.** M. Fan<sup>\*1</sup>, Y. Shen<sup>1</sup>, T. Archbold<sup>1</sup>, A. Holt<sup>1</sup>, and Y. Yin<sup>2</sup>, <sup>1</sup>University of Guelph, Guelph, Ontario, Canada, <sup>2</sup>The Chinese Academy of Sciences, China.

This study was conducted to determine true digestible calcium (Ca) and phosphorus (P) requirements in weaned pigs. Thirty-six Yorkshire pigs (18 barrows and 18 gilts), initial and final BW of 10 and 18 kg, were fed six experimental diets for six periods according to a completely randomized block design. The six diets were corn and soybean meal-based, and formulated to contain six levels of total Ca at 0.49, 0.58, 0.67, 0.74, 0.83, and 0.92%, and total P at 0.42, 0.50, 0.58, 0.64, 0.72, and 0.80%, respectively, through supplementing limestone and dicalcium phosphate. Diet 1 was the control diet and contained 0.49% total Ca and 0.42% total P corresponding to 0.40% true digestible Ca and 0.21% true digestible P without supplemental P but with limestone supplementation. Each experimental period lasted 25 d with 20-d adaptation and 4-d collection of total urine excretion and fecal samples. BW gain and feed intake were recorded. Graded levels of Ca and P did not affect ( $P > 0.05$ ) feed intake, weight gain, and feed conversion. Supplementation of P did not improve ( $P > 0.05$ ) P retention, whereas Ca supplementation increased ( $P < 0.05$ ) Ca retention. Diet 1, with total Ca and P contents below the NRC (1998) recommendations, was associated with the minimal levels of total manure Ca and P excretion. In conclusion, the current NRC (1998) recommendations of Ca and P requirements for weaned pigs are likely overestimated, therefore resulting in excessive manure Ca and P excretion.

**Key Words:** Calcium and Phosphorus, Requirements, Weaned Pigs

**M82 Diet buffer capacity and mineral sources alter growth and Salmonella prevalence in nursery pigs.** P. Bahson, M. E. Glenn, and T. D. Crenshaw<sup>\*</sup>, University of Wisconsin, Madison.

Diet buffer capacity and organic acids are potential substitutes for sub-therapeutic antibiotics in nursery pigs. Coliforms and clostridia, but not lactobacillus, were reduced in ingesta from nursery pigs fed diets with low buffering capacity (LB) vs. high buffering capacity (HB), organic acids, or antibiotics. The LB diets involved shifts in sources and levels of minerals, but LB and HB diets were based on plant protein (Pln) ingredients. Whether shifts in microflora were related to minerals or Pln ingredients was not distinguished. This trial involved pigs fed complex diets (Cmx) which included whey, lactose, porcine plasma protein and blood cells, or Pln diets used earlier. Diets included: 1) Cmx + carbadox, 2) Cmx + citric acid, 3) Cmx + HB, 4) Cmx + LB, 5) Pln + HB, 6) Pln + LB. No antibiotics were added to diets 2-6. In LB diets sources (tricalcium phosphate and calcium sulfate) and levels (0.80 % Ca and 0.80 % P, diets 1, 3, and 5; 0.55 % Ca and 0.65 % P, diets 2, 4, and 6) were altered. Ninety-six pigs (PIC Cambrough X Line 19) were weaned (3 wk) and randomly allotted to diets for 31 d (P1, 14 d; P2, 17 d). In P1, pigs fed Cmx + carbadox and Cmx + LB gained faster ( $P < 0.01$ ) than those fed other diets over both P1 and P2. Pigs fed Pln diets gained less ( $P < 0.01$ ) than pigs fed Cmx diets during P1, but not P2, or the entire 31 d. On d 0, 41% of pigs were Salmonella positive. Pigs fed the Cmx + LB diet had the highest prevalence on d 7, but prevalence was also higher on d 0 ( $P < 0.01$ ). Salmonella prevalence apparently did not compromise growth. Feeding LB diets improved growth to levels equal to pigs fed carbadox.

Trait	Period	Cmx		Pln				SEM
		+ Carbadox	+ Citric acid	+ HB	+ LB	+ HB	+ LB	
Gain, kg/d								
	0-14 <sup>abc</sup>	0.098	0.073	0.062	0.117	0.048	0.016	0.011
	14-31 <sup>ab</sup>	0.443	0.394	0.353	0.426	0.402	0.384	0.023
	0-31 <sup>ab</sup>	0.288	0.249	0.222	0.287	0.242	0.218	0.017
Salmonella prevalence,								
	0 <sup>b</sup>	38	31	31	69	25	50	12
	4	44	50	56	63	50	69	14
	7 <sup>b</sup>	25	44	31	75	50	31	12
	31	19	31	19	31	25	0	11

<sup>a</sup>Difference + Carbadox vs. others ( $P < 0.05$ );

<sup>b</sup>Cmx + HB vs. Cmx + LB differs ( $P < 0.05$ );

<sup>c</sup>Cmx + HB, + LB differs from Pln + HB, + LB ( $P < 0.05$ ).

**Key Words:** Antibiotics, Minerals, Salmonella

**M83 Effect of supplementing zinc oxide and biotin with or without carbadox on nursery pig growth performance.** H.D. Wilt\* and M.S. Carlson, *University of Missouri, Columbia*.

A 28-d nursery experiment was conducted to evaluate the effects of supplementing zinc oxide (ZnO) and biotin with or without a feed-grade antibiotic (carbadox) on nursery pig performance, as well as plasma and fecal Zn concentrations. One hundred ninety-two crossbred pigs (5.94 ± 0.03 kg; 20 d of age) were weaned and allotted to one of eight treatments based on weight, sex, and ancestry in a randomized complete block design (3 pigs/pen and 8 reps). Phase 1 (d 1 to 14) and Phase 2 (d 15 to 28) nursery diets were fed in meal form. Fecal samples were collected weekly and pigs were bled on d 1, 14, and 28 to measure Zn concentrations. Phase 1 and Phase 2 diets utilized 8 dietary treatments in a 2 × 2 × 2 factorial design: (1) Basal diet contained 135 ppm Zn as ZnSO<sub>4</sub> and no supplemental d-biotin, (2) Basal + 25 g/T carbadox, (3) Basal + 3,000 ppm Zn as ZnO, (4) Basal + 3,000 ppm Zn as ZnO + 25 g/T carbadox, (5) Basal + 440 ppb biotin, (6) Basal + 440 ppb biotin + 25 g/T carbadox, (7) Basal + 3,000 ppm Zn as ZnO + 440 ppb biotin, and (8) Basal + 3,000 ppm Zn as ZnO + 440 ppb biotin + 25 g/T carbadox. Dietary treatments had no effect ( $P > 0.05$ ) on growth performance during wk 1 or Phase 2. During wk 2, Phase 1 and overall, pigs fed either 3,000 ppm Zn as ZnO or 440 ppb biotin independently or in combination with or without carbadox had greater ADG ( $P < 0.05$ ) than the pigs fed the basal diet. However, the greatest overall ADG ( $P < 0.05$ ) was observed in pigs fed 440 ppb biotin with or without ZnO and carbadox. During wk 3 and Phase 2, pigs fed 440 ppb biotin with or without ZnO and carbadox had greater ADFI ( $P < 0.05$ ) than the pigs fed the basal diet. Overall, Gain/Feed improved ( $P < 0.05$ ) when pigs fed either the 3,000 ppm Zn as ZnO or 440 ppb biotin independently or in combination with carbadox. Plasma and fecal Zn concentrations were higher ( $P < 0.05$ ) for pigs fed the 3,000 ppm Zn as ZnO compared to pigs fed the other dietary treatments. These results indicate that feeding nursery pigs either 440 ppb biotin or 3,000 ppm Zn as ZnO improve growth performance with or without carbadox.

**Key Words:** Biotin, Nursery pigs, Zinc

**M84 Impact of feeding herbal extracts and additional copper plus zinc on growth performance and immune function of newly weaned piglets.** H. Namkung\* and C. F. M. de Lange, *Department of Animal and Poultry Science, University of Guelph, Guelph, Ontario, Canada*.

The effect of feeding herbal extracts or additional copper plus zinc to newly weaned piglets on growth performance, gut morphology, and immune system stimulation were investigated. One hundred eighty piglets

(16-19 days of age) were randomly assigned to one of five treatments: non-medicated control (CO), medicated (44 ppm Lincomycin; CO+), herbal extract product (essential oils and spice extracts; Phodé, Albi, France) at diet levels of 0.3 and 0.15% (HEh) or 0.2 and 0.1% (HEl) for phase I and II, respectively, and 160 and 150 ppm of additional copper plus zinc (from copper sulfate and zinc oxide; Cu/Zn). Phase I diets (20.5% CP) were fed for the first three weeks post-weaning and Phase II diets (19.6% CP) thereafter. During phase II, weight gain was highest ( $P < 0.01$ ) for pigs on Cu/Zn, lowest ( $P < 0.01$ ) for CO and intermediate for the other treatments. Over the 7-wk period, there were no differences ( $P > 0.01$ ) in weight gain among pigs on HEh, HEl and CO+ (442, 418 and 431 g/d, respectively), while it was highest for Cu/Zn (481 g/d) and lowest for CO (351 g/d; SEM, 18). Gain:feed and fecal consistency scores were not different among treatments ( $P > 0.05$ ). There were no differences ( $P > 0.05$ ) in morphology of intestine of pigs among treatment, although full and empty weights of total gut, small intestine, and cecum were numerically lower in the pigs on HEh and Cu/Zn and the numbers of goblet cells tended to be increased in villi and decreased in crypt in intestines of pigs fed HEh and HEl. Counts of white blood cells and neutrophils were higher ( $P < 0.01$ ) in pigs on d 14 than on d 7 post-weaning. Lymphocyte count was lower ( $P < 0.05$ ) in pigs on HEl compared to other treatments. Plasma concentrations of IgG on d 14 tended to be lower ( $P < 0.10$ ) in pigs on HEl, HEh, Cu/Zn, CO+ than on CO. These results suggest that the herbal extract product could be used as an alternative to in-feed antibiotics.

**Key Words:** Piglets, Herbal Extract, Growth Promotion

**M85 The role of high dietary zinc oxide in cholecystokinin and insulin-like growth factor I secretion and growth in weaned pigs.** D. Li\* and J. Yin, *Ministry of Agriculture Feed Industry Center, China Agricultural University, Yuanminyuan, Beijing*.

In this study, the mechanism through which high levels of dietary zinc oxide (ZnO) stimulate pig growth was investigated. Thirty-six, 28-d old weaned male pigs (initial BW, 7.5 ± 0.5 kg) were randomly assigned to one of two treatments, with 6 pens per treatment and 3 pigs per pen for the 4-wk experiment. The pigs were fed a corn-soybean meal basal diet (20% CP) either supplemented or unsupplemented with 2,000 mg/kg zinc as ZnO. Blood samples (n = 10/treatment) were collected from anterior vena cava, and RNA samples (n = 6) were extracted from the duodenum and the liver. Real time fluorescence quantitative PCR was used to evaluate hormone gene expression of cholecystokinin (CCK), growth hormone receptor (GHR) mRNA, and insulin-like growth factor I (IGF-1) at the transcription level. The results indicated that ADG was improved by zinc supplementation from 0-2 wk ( $P < 0.02$ ) and 0-4 wk ( $P < 0.03$ ) with an improvement in feed conversion from 0-2 wk ( $P < 0.01$ ). Dietary supplementation of ZnO increased the levels of plasma CCK (5.11 vs 3.07 pmol/L,  $P < 0.01$ ) and serum IGF-1 (386.11 vs 227.42 ng/ml;  $P < 0.03$ ). No changes were detected in other gut-brain peptide concentrations including insulin, gastrin, somatostatin (SS) or growth hormone (GH). In the duodenum, the abundance of CCK mRNA and pregastrin mRNA were 2.54 times ( $P < 0.01$ ) and 1.97 times ( $P < 0.01$ ) greater in pigs receiving the diet containing ZnO. In the liver, levels of IGF-1 mRNA and GHR mRNA were increased [4.74 vs 0.23 ( $P < 0.001$ ) and 16.02 vs 6.28 ( $P < 0.02$ ), respectively] by ZnO supplementation. No differences in the level of duodenum IGF-1 mRNA were detected ( $P > 0.10$ ). In conclusion, results indicate that supplementation of pharmacological level of zinc oxide used in this study may enhance plasma CCK content at the level of mRNA transcription, and further upregulate the liver GHR mRNA and IGF-1 mRNA abundance and raise plasma IGF-1 levels. This may help explain the mechanism through which piglet growth is stimulated by zinc oxide.

**Key Words:** Pig, Zinc Oxide, Gene Expression