during large intestinal fermentation in monogastric animals. Digestible DM variability after hydrolysis with pepsin and pancreatin has been published for cereal grains and oilseed meals but not for high-fiber feed ingredients. Therefore, the objective of this experiment was to measure IVDMD of multiple sources of distillers dried grains with solubles (DDGS, $n = 16$), soybean hulls (SBH, $n = 16$), and wheat straw (WS, $n = 16$) using a modified pepsin and pancreatin hydrolysis procedure. Gastric hydrolysis was set for 2 h at pH 2.0 in a pepsin solution (400 mg/mL). Small intestinal hydrolysis was set for 4 h at pH 6.8 in a pancreatin solution (400 mg/mL). After hydrolysis, residues were filtered into nylon bags (pore size 50 μm) and sequentially washed twice with 95% ethanol and 99.5% acetone. The IVDMD was calculated as disappearance of DM from initial sample weight. All samples of each source were analyzed in 6 batches, and the mean, SD, and CV were calculated among replicates within each ingredient source. Repeatability of measurements was considered acceptable when CV was < 3% for DDGS and < 4% for SBH and WS. Data were analyzed using the GLM procedure of SAS with sample source as a fixed effect. The IVDMD in DDGS (55.6%) was greater ($P < 0.01$) than SBH (20.0%) and WS (14.6%), and IVDMD in SBH was also greater ($P < 0.01$) than WS. There were also differences in IVDMD among sources of each ingredient. The IVDMD varied among DDGS sources ($P < 0.01$) from 45.6 to 61.9%, among SBH sources ($P < 0.01$) from 17.2 to 23.2%, and among WS sources ($P < 0.01$) from 11.6 to 18.2%. In conclusion, the extent and variability of IVDMD among DDGS sources is greater than for SBH and WS, and differences in IVDMD observed among sources of each ingredient were large enough to impact the concentration of digestible energy and nutrients in the small intestine of monogastric animals. Further fermentation of hydrolyzed residues will allow us to measure the concentration of fermentable nutrients.

Key Words: high-fiber ingredients, in vitro dry matter digestibility, monogastrics

NONRUMINANT NUTRITION: MINERALS AND VITAMINS

183 **Effect of zinc amino acid complex and ractopamine on skeletal muscle gene and protein expression.** Z. J. Rambo[1,2,*], M. Ferreira[3,4], B. T. Richert[2], J. Waddell[2], M. E. Wilson[1], J. L. Torrison[1], *[1]Zinpro Corporation, Eden Prairie, MN, [2]Purdue University, West Lafayette, IN, [3]Department of Veterinary Medicine, Federal University of Larvas, Larvas, Brazil, [4]CAPES Foundation, Brasilia, Brazil.*

A study was conducted to evaluate the effect of 50 ppm supplemental Zn amino acid complex (Availa Zinc®, AZ) and ractopamine (RAC) on the growth performance, carcass composition, blood metabolites, and muscle gene and protein expression in finishing gilts. Twenty-four crossbred gilts were individually housed, blocked by ancestry and BW (108.5 ± 1.7 kg) into 6 blocks, and assigned to 1 of 4 dietary treatments: A) Control (50 ppm Zn from ZnO), B) A + RAC, C) A + 50 ppm AZ, and D) B + 50 ppm AZ. The Control diet was formulated to 1.10% TID Lys. RAC was fed at 5 ppm from d 0 to 7 and 10 ppm from d 7 to 14. Individual BW and feed disappearance were evaluated on d 0, 7, and 14. Longissimus dorsi (LD) and semimembranosis (SMB) muscle samples were collected immediately after exsanguination for analysis of myosin heavy chain (*MyHC*) gene expression and phosphorylation (p-) state of AKT, S-6, and 4E-BP1 proteins. Expression of *MyHC I, IIa, IIx,* and *IIb* were quantified using real-time PCR; p-AKT, p-S6, and p-4E-BP1 were determined using Western blot technique. Growth and carcass data were analyzed using the GLM procedure of SAS, and data for protein and gene expression were analyzed using the mixed procedure. RAC increased ($P < 0.01$) d 0–14 ADG (25.7%), G:F (20.5%), and LEA (10%) and tended ($P < 0.08$) to increase primal ham weight. RAC decreased expression of *MyHC IIa* in the LD ($P < 0.01$) and SMB ($P < 0.03$) and increased ($P < 0.05$) expression of *MyHC IIb* in the LD. Feeding AZ alone tended to decrease expression of *IIx* in the LD; however, *IIx* expression tended to increase ($P < 0.07$) when AZ was fed with RAC. Both RAC and AZ increased ($P < 0.05$) p-AKT in the LD. Feeding RAC or AZ, but not RAC + AZ, tended to increase p-4E-BP1 ($P < 0.07$) in the LD. Feeding RAC + AZ tended ($P < 0.06$) to increase p-4E-BP1 in the SMB. These data indicate that RAC-induced hypertrophy may be regulated partially by AKT in swine. Feeding AZ appears to have influenced the phosphorylation state of proteins regulated by mTOR, though this did not result in a biologically measurable growth effect in this short-term study.

Key Words: protein synthesis, ractopamine, zinc

184 **Effects of added Zn in diets with ractopamine HCl on growth performance, carcass characteristics, Zn concentrations in plasma, loin, and liver, and ileal mucosal inflammation mRNA expression of finishing pigs.** C. B. Paulk[1,*], M. D. Tokach[1], J. L. Nelssen[1], J. M. Gonzalez[1], J. M. DeRouchey[1], R. D. Goodband[1], S. S. Dritz[1], G. M. Hill[2], K. D. Haydon[3], *[1]Kansas State University, Manhattan, [2]Michigan State University, East Lansing, [3]Elanco Animal Health, Greenfield, IN.*

A total of 320 pigs (PIC 327 × 1050; 98 kg BW) were used in a 35-d study to determine the effects of added Zn on growth performance, carcass characteristics, plasma and tissue Zn concentrations, and ileal mucosal mRNA expression of finishing pigs fed ractopamine HCl (RAC; Elanco Animal Health, Greenfield, IN). Pens were randomly allotted to diets with 2 pigs per pen and

Table 184.

Item	Control	RAC	ZnO, ppm Zn			Availa-Zn, ppm Zn			SEM
			75	150	225	75	150	225	
ADG, kg	1.04	1.15	1.16	1.17	1.17	1.15	1.14	1.12	0.03
G:F	0.311	0.365	0.373	0.371	0.369	0.373	0.365	0.367	0.014
HCW, kg	99.0	101.7	102.5	101.7	102.8	101.9	101.7	101.0	1.3

20 pens per treatment. Treatments included a corn-soybean meal diet (0.66% SID Lys), a diet (0.92% SID Lys) with 10 ppm RAC, or the RAC diet plus 75, 150, and 225 ppm added Zn from ZnO or Availa-Zn (Zinpro, Eden Prairie, MN). All diets contained 55 ppm Zn from $ZnSO_4$. Mucosal swabs were collected (16 pigs/treatment) to determine mRNA expression of inflammatory cytokines. Pigs fed the RAC diet had increased ($P < 0.05$) ADG, G:F, HCW, loin depth, percentage lean, and liver weights compared with pigs fed the control diet. No Zn level or source effects or level × source interactions were observed for growth performance. However, pigs fed RAC diets with added Zn from ZnO had numerically heavier ($P = 0.09$) liver weights than pigs fed added Zn from Availa-Zn. A Zn level × source interaction (quadratic, $P = 0.02$) was observed in liver Zn concentrations, resulting from liver Zn concentrations plateauing at 150 ppm of added Zn from ZnO, but a linear increase when adding Zn from Availa-Zn. There was no difference in Zn concentrations in the loin. The only difference for plasma Zn was that pigs fed RAC diets with added Zn had increased (linear, $P < 0.02$) plasma Zn levels on d 18 and 32. The expression of *IL-1β* was increased ($P = 0.01$) in mucosa of pigs fed the RAC diet compared to those fed the control diet. Expression of *IL-1β* decreased (linear; $P = 0.03$) in the mucosa of pigs fed increasing levels of added Zn. There were no differences in *IL-8* or *TNF*-α relative expression. In conclusion, additional Zn increased plasma Zn and reduced *IL-1β* but did not improve growth performance of pigs fed diets containing RAC.

Key Words: finishing pigs, ractopamine HCl, zinc

185 **The effects of copper source (tribasic copper chloride or copper sulfate) on growth performance, carcass characteristics, and pen cleanliness in finishing pigs.** K. F. Coble[1,*], S. S. Dritz[1], M. D. Tokach[1], J. M. DeRouchey[1], J. L. Usry[2], R. D. Goodband[1], *[1]Kansas State University, Manhattan, [2]Micronutrients, Social Circle, GA.*

A total of 1143 pigs (initial BW 25.1 kg) were used in a 111-d study to determine the effects of tribasic copper chloride (TBCC, IntelliBond C; Micronutrients, Indianapolis, IN) or copper sulfate ($CuSO_4$) on growth performance, carcass characteristics, and pen cleanliness. Pens of pigs were allotted to 1 of 6 dietary treatments, balanced on average pen weight in a completely randomized design with 25 to 28 pigs per pen and 7 replications per treatment. Treatments included a corn-soybean meal positive control diet, a high by-product diet with 30% dried distillers grain with solubles (DDGS) and 15% bakery meal (negative control), or the negative control diet with 75 or 150 ppm added Cu from $CuSO_4$ or TBCC. All diets were formulated at 0.05% below the SID Lys requirement. Pigs fed the negative control diet had decreased ($P < 0.01$) G:F and tended to have increased ($P < 0.08$) ADFI compared to those fed the positive control. No Cu source × level interactions were observed. Pigs fed increasing $CuSO_4$ had increased (linear; $P < 0.05$) ADFI and final BW with a tendency (linear; $P < 0.10$) for increased ADG and lower G:F. Pigs fed increasing TBCC had increased (linear; $P < 0.01$) ADG, ADFI, final BW, and HCW. Wash time (s/pen) increased ($P < 0.01$) by 64% for negative control pens compared to positive control pens; however, wash time was not influenced by Cu. In summary, increasing dietary $CuSO_4$ or TBCC in high by-product diets increased growth and feed intake, resulting in increased final BW for pigs fed both copper sources and HCW for pigs fed TBCC without influencing pen wash time.

Key Words: copper, finishing pig, wash time

Table 185. Effects of CuSO4 and TBCC on growth, carcass characteristics, and wash time

Item	Positive Control	Negative Control	$CuSO_4$		TBCC		Probability, $P <$ [1]		
			75	150	75	150	Pos. vs. Neg.	$CuSO_4$ linear	TBCC[2] linear
d 111 BW, kg	124.5	124.2	127.6	127.5	128.4	130.0	0.87	0.05	0.01
ADG, kg	0.90	0.91	0.94	0.93	0.94	0.95	0.76	0.08	0.01
ADFI, kg	2.28	2.34	2.44	2.44	2.46	2.45	0.08	0.02	0.01
G:F	0.40	0.39	0.39	0.38	0.38	0.39	0.01	0.10	0.99
HCW, kg	92.5	91.8	93.3	93.1	93.6	95.3	0.59	0.29	0.01
Wash time, s/pen	268	417	413	383	373	389	0.01	0.27	0.36

[1]SEM was 2.04, 0.011, 0.043, 0.004, 1.19, and 21.5 for d 111 BW, ADG, ADFI, G:F, HCW, and wash time, respectively.
[2]Quadratic response ($P < 0.05$) for ADFI.