

Nonruminant Nutrition: Enzymes and processing

113 Comparative efficacy of xylanases on energy and nutrient digestibility in growing pigs fed corn- or wheat-based diets. Elijah Kiarie^{*1,2}, Luis F. Romero¹, Susan Arent³, Rikke Lorentsen³, and Hans H. Stein⁴, ¹DuPont Industrial Biosciences-Danisco Animal Nutrition, Marlborough, Wiltshire, UK, ²Department of Animal Science, University of Manitoba, Winnipeg, MB, Canada, ³DuPont Nutrition Biosciences—Enzyme Research & Development, Brabrand, Arhus, Denmark, ⁴Department of Animal Sciences, University of Illinois, Urbana, IL.

Microbial xylanases differ with respect to source, substrate specificities, and biochemical characteristics, but these differences are rarely considered in their evaluation for animal feed applications. Therefore, an experiment was conducted to determine effects of 5 xylanases on apparent ileal (AID) and apparent total-tract digestibility (ATTD) of energy and nutrients in growing pigs fed diets based on corn plus 40% corn distillers dried grains with solubles (DDGS) or wheat plus 25% wheat co-products. The 5 xylanases (XA, XB, XC, XD and XE) were mono-component preparations of endo-1,4- β -xylanase produced by different fungal organisms except XC, which was of bacterial origin. Xylanases were fed at 75 mg of xylanase protein/kg of feed. All diets also contained microbial phytase (500 units/kg). All xylanases and phytase were provided by Danisco Animal Nutrition, Marlborough, Wiltshire, UK. Twelve ileal cannulated barrows (29.3 kg BW) were allotted to two 6 \times 6 Latin squares with 6 corn-based and 6 wheat-based diets in each square. Corn and wheat diets had similar levels of insoluble (11.6 vs. 11.0%) non-starch polysaccharides (NSP), but corn diets contained less soluble NSP (1.3 vs. 1.9%) and starch (31.1 vs. 39.0%) than wheat diets. Corn diets containing XD or XE had greater ($P < 0.05$) AID of GE (68.5%) than the control diet (64.6%) or diets containing XB (64.3%) or XC (64.3%), whereas in wheat diets, the diet containing XB had lower ($P < 0.05$) AID of GE (67.9%) compared with diets containing XA, XC, and XD that all had an AID of 72.8% (interaction, $P < 0.05$). Wheat based diets had greater ($P < 0.05$) AID of GE and nutrients compared with corn diets. There was no main effect of diet and no interactions between xylanase and diet for ATTD of GE, but diets containing XE or XD had greater ($P < 0.05$) ATTD of GE compared with the control diets and diets containing XC, whereas results for diets containing XA and XB were intermediate. These data indicate that not all xylanase sources are similar in efficacy at the pig gut level, which may be a result of the unique characteristics of each xylanase.

Key Words: digestibility, xylanase, pig

114 Effects of supplemental xylanase on digesta viscosity, gut health, and growth performance of nursery pigs. Hongyu Chen^{*1}, Rafael Cabrera², and Sung Woo Kim¹, ¹North Carolina State University, Raleigh, NC, ²Huvepharma Inc., Peachtree City, GA.

A total of 40 pigs (10.7 \pm 1.2 kg initial BW at 6 wk of age) were used in a 21 d trial to evaluate the effects of supplemental xylanase (Huvepharma Inc., Peachtree City, GA) in nursery diets on digesta viscosity, gut health, and growth performance. Pigs were individually housed and randomly allotted to 4 dietary treatments in a 2 \times 2 factorial arrangement (n = 10 per treatment, 0 or 1,500 EPU/kg xylanase and 0 or 30% DDGS as 2 factors). Body weight and feed intake were recorded weekly. Plasma samples were collected on d 19 to measure tumor necrosis factor- α (TNF- α) and malondialdehyde (MDA). On d 21, all pigs were euthanized to collect tissues from duodenum, jejunum, and colon for morphology

and to measure TNF- α , and MDA concentrations. Distal jejunal digesta were collected to measure viscosity. During the entire period, supplementation of xylanase increased ($P < 0.05$) ADG (616 to 660 g/d) of nursery pigs whereas DDGS (0 or 30%) did not affect ADG (628 vs. 648 g/d, respectively). There was no interaction between the 2 factors indicating that the effect of xylanase on ADG was independent to the use of DDGS in the nursery feed. On wk 3, ADFI was increased ($P < 0.05$) when fed DDGS (1,141 to 1,267 g/d) and there was an interaction ($P < 0.05$) between 2 factors indicating that xylanase decreased ADFI when DDGS was used in the feed. Use of DDGS increased ($P < 0.05$) viscosity (1.86 to 2.38 cP), whereas supplemental xylanase reduced ($P < 0.05$) viscosity (2.27 to 1.96 cP) of jejunal digesta. Plasma TNF- α was decreased ($P < 0.05$, 108.45 to 69.87 ng/mL) by supplemental xylanase. Use of DDGS reduced ($P < 0.05$) villus height: crypt depth ratio (1.46 to 1.27) in duodenum. Supplemental xylanase increased ($P < 0.05$) the crypt depth (360 to 404 μ m) in duodenum. Collectively, this study indicates that supplemental xylanase (1,500 EPU/kg) improved growth performance and inflammatory status of nursery pigs by reducing digesta viscosity and plasma TNF- α regardless of the use of DDGS in nursery diets.

Key Words: digesta viscosity, pig, xylanase

115 Effects of supplemental xylanase on growth, gut health, and ileal nutrient digestibility in nursery pigs fed corn-soybean meal-based diets with two dietary energy levels. I. Park^{*1}, H. Chen¹, J. Tyus², J. J. Wang², and S. W. Kim¹, ¹North Carolina State University, Raleigh, NC, ²BioResource International Inc., Durham, NC.

This study was conducted to determine the effects of supplemental xylanase (Xylamax, BioResource International, Inc., Durham, NC) on growth performance, gut health, and ileal nutrient digestibility in nursery pigs fed corn-soybean meal based diets with 2 dietary energy levels. Pigs (60 barrows and 60 gilts weaned at 21 d of age) had a 4-d adaptation period after weaning. On 25 d of age (7.77 \pm 0.63 kg BW), pigs were allotted to 4 treatments (2 \times 2 factorials arrangement: 3,427 or 3,323 kcal ME/kg of feed and 0 or 1,400 U of enzyme/kg feed) with 10 pens (5 barrow and 5 gilt pens, and 3 pigs per pen) per treatment in a randomized complete block design, and the feeding period lasted for 3 wks. Growth performance was measured weekly. Titanium dioxide (0.3%) was added to diets from d17 to 21 as an indigestible marker. Blood samples were taken on d 20 to measure tumor necrosis factor- α (TNF- α) and malondialdehyde (MDA). On d 21, 24 pigs (1 from each pen and 6 pens per treatment) were euthanized to obtain the duodenal and jejunal mucosa to measure TNF- α and MDA. Jejunal and ileal digesta were collected to measure viscosity and ileal nutrient digestibility. Data were analyzed using the Mixed procedure in SAS with pen as the experimental unit using treatments and sex as fixed effects and initial BW as a random effect. The G:F was improved ($P < 0.05$) by increasing dietary ME (0.774 to 0.800) and xylanase supplementation (0.775 to 0.799), respectively. Dietary energy levels and xylanase supplementation did not affect viscosity and ileal nutrient digestibility. High ME diet increased ($P < 0.05$) the concentrations of MDA in jejunal mucosa (0.74 to 1.25 nmol/mg protein) and plasma (16.89 to 23.79 μ M). Supplemental xylanase decreased ($P < 0.05$) MDA (1.02 to 0.88 nmol/mg protein) and TNF- α (3.03 to 2.50 pg/mg protein) concentrations in duodenal mucosa. Collectively, supplemental xylanase (1,400 U of enzyme/kg feed) in corn-soybean meal based pig diets enhances growth

performance and gut health of nursery pigs as indicated by increased feed efficiency and reduced MDA and TNF- α concentrations in duodenal mucosa, respectively.

Key Words: growth performance, gut health, xylanase

116 Porcine in vitro digestion and fermentation characteristics of wheat and wheat millrun without or with xylanase and β -glucanase blend. Tofuko A. Woyengo^{*1,2}, Elijah Kiarie^{3,4}, and Ruurd T. Zijlstra¹, ¹University of Alberta, Edmonton, AB, Canada, ²South Dakota State University, Brookings, SD, ³Danisco Animal Nutrition-DuPont Industrial Biosciences, Waukesha, WI, ⁴University of Manitoba, Winnipeg, MB, Canada.

A study was conducted to determine porcine in vitro digestion and fermentation characteristics of the wheat and wheat millrun without or with a with xylanase and β -glucanase blend (XB, Danisco UK Ltd., Marlborough, Wiltshire, UK) that supplied 4,880 units of xylanase and 608 units of β -glucanase per kilogram of treated feedstuff in a completely randomized design. Samples were hydrolyzed in 2 steps using pepsin and pancreatin. Subsequently, residues were incubated in a buffer solution with minerals and fresh pig feces as inoculum. Gas production was measured for 72 h, and modeled to estimate kinetics of gas production. Concentration of VFA per unit weight of residue incubated or feedstuff was measured in fermented solutions. In vitro digestibility of DM (IVDDM) for wheat (77.7%) was greater ($P < 0.05$) than that for wheat millrun (63.2%). Feedstuff and XB interacted ($P < 0.05$) on IVDDM such that XB supplementation increased ($P < 0.05$) IVDDM for wheat, but not for wheat millrun. Total gas production of residue incubated for wheat (176.6 mL/g DM) was greater ($P < 0.05$) than that for wheat millrun (117.4 mL/g DM). Also, total VFA production per unit weight of residue incubated for wheat (3.12 mmol/g DM) was greater ($P < 0.05$) than that for wheat millrun (2.16 mmol/g DM). However, XB did not affect total gas production and total VFA production per unit weight of residue incubated. Total VFA production per unit weight of feedstuff for wheat (0.79 mmol/g DM) was lower ($P < 0.05$) than that for wheat millrun (0.93 mmol/g DM). Feedstuff and XB tended to interact ($P = 0.096$) on total VFA production per unit weight of feedstuff such the XB decreased ($P < 0.05$) total VFA production per unit weight of feedstuff for wheat but not for wheat millrun. In conclusion, wheat was more digestible by porcine pepsin and pancreatin than wheat millrun, whereas wheat millrun was more fermentable than wheat. The XB supplementation increased the digestion of wheat, but had limited effect on the digestion and fermentation of wheat millrun.

Key Words: wheat and wheat millrun, in vitro fermentation, pig

117 Supplemental effects of β -mannanase on growth performance, ileal nutrient digestibility, and gut health of nursery pigs. Hongyu Chen*, Inkyung Park, Shihai Zhang, and Sung Woo Kim, North Carolina State University, Raleigh, NC.

A total of 84 pigs (17.6 ± 2.8 kg initial BW at 6 wk of age) were used in a 40-d trial to evaluate effects of dietary supplemental β -mannanase (400 U/kg feed, CTCBIO Inc., Seoul, Korea) on growth performance, ileal nutrient digestibility and gut health of nursery pigs. Pigs were allotted to 2 treatments (14 pens per treatment, 3 pigs per pen) based on a randomized complete block design with sex and initial BW as blocks. Experimental diets were corn (phase 3: 50%, phase 4: 57%), soybean meal (phase 3: 27%, phase 4: 20%), and 20% DDGS based with or without 400 U β -mannanase/kg feed. Growth performance (ADG, ADFI, and G:F) was recorded weekly. Plasma was collected on d 35 to

quantify tumor necrosis factor- α (TNF- α) and malonaldehyde (MDA). On d 35, 0.3% titanium oxide was added as an indigestible marker to the diets for an additional 4 d feeding. On d 40, 16 pigs (1 pig per pen, 8 pens per treatment) were euthanized to collect digesta from jejunum, ileum, and colon (to measure viscosity and pH value) and to collect tissues from duodenum, jejunum and ileum (for morphology, TNF- α , and MDA evaluation). Supplementation of β -mannanase reduced ($P < 0.05$) viscosity of jejunal digesta (2.52 to 1.97 cP, respectively). Supplementation of β -mannanase improved ($P < 0.05$) G:F during phase 3 (0.593 to 0.617) and overall period (0.572 to 0.589), pH of colon digesta (5.99 to 6.33), and ileal digestibility of NDF (31.3 to 41.1%) and ADF (26.8 to 38.7%). Supplementation of β -mannanase increased ($P < 0.05$) ileal villus height (377 to 432 μ m), decreased ($P < 0.05$) jejunal crypt depth (249 to 212 μ m), and improved ($P < 0.05$) villus height: crypt depth ratios in jejunum (1.58 to 2.10) and ileum (1.65 to 2.02). Supplementation of β -mannanase tended to reduce ($P = 0.078$) TNF- α concentration (7.94 to 6.46 pg/mg) in jejunal mucosa. Collectively, dietary β -mannanase (400 U/kg) could improve feed efficiency by decreasing digesta viscosity and increasing nutrient digestibility, and could also maintain gut health by improving gut morphology and reducing inflammatory response.

Key Words: digesta viscosity, nutrient digestibility, β -mannanase

118 Effect of superdosing two sources and two levels of phytases on pig performance when supplemented to commercial nursery diets. Chris Sparks^{*1}, Rafael A. Cabrera^{*1}, Gene Gourley², and Emily Weber², ¹Huvepharma US Inc., Peachtree City, GA, ²Gourley Research Group LLC, Webster City, IA.

The objective of this study was to determine the effect of superdosing 2 sources and levels of phytases on nursery pig performance in a commercial setting. Phase 1 (crumble/meal mix), phase 2 (common meal) and phase 3 diets were corn-SBM with 4, 10, and 20% DDGS respectively and contained 0.47, 0.40, and 0.35% av. P respectively. They were budgeted at 5.7 and 6.4 kg/pig for phase 1 and 2 and until they moved out of the nursery for phase 3. Six experimental diets were fed: Positive Control (PC), Negative Control (NC, PC minus 0.12% av. P), 500 and 1000 FTU/kg of Optiphos 2000 (Huvepharma USA, Inc.); and 500 and 1000 Quantum Blue 5G (AB Vista) were added to the NC. We had 10 pens per treatment and 21 pigs/pen. Pigs (Geneticpork Fertilis 25 female x PIC Line 359 Sire) were sourced out of a sow farm negative to PPRS, PED virus and *M. hyopneumoniae*. Pens were weighed at 7 d interval. Pens were the experimental units and we found no gender by treatment interactions therefore gender was removed from the model. The ANOVA was performed using SAS statistical software (SAS Institute, Cary, NC). From d 0 to 44 (Overall), all phytase treatments had higher ($P < 0.01$) final pig BW, increased ($P < 0.01$) ADG, and higher ($P < 0.01$) ADFI when compared with either PC or NC. Positive Control and NC treatments were not different for those traits. All phytase treatments had decreased ($P = 0.03$) FCR when compared with the PC but were not different than the NC. There were not significant differences in any performance traits between Optiphos and Quantum Blue. Increasing the levels of phytases from 500 FTU/kg of complete feed to 1000 FTU/kg of complete feed with either source did not result in improved performance. In this trial, 500 FTU/kg of complete feed performed as well as 1000 FTU/kg of complete feed of either Optiphos or Quantum Blue for commercially raised nursery pigs.

Key Words: nursery pig, superdosing, phytase level

119 Effects of superdosing of microbial phytase in diets for weanling pigs. T. D. Crenshaw*¹, O. Adeola², M. J. Azain³, S. K. Baidoo⁴, S. D. Carter⁵, G. M. Hill⁶, S. W. Kim⁷, P. S. Miller⁸, M. C. Shannon⁹, and H. H. Stein¹⁰, ¹University of Wisconsin, Madison, WI, ²Purdue University, Lafayette, IN, ³University of Georgia, Athens, GA, ⁴University of Minnesota, Minneapolis, MN, ⁵Oklahoma State University, Stillwater, OK, ⁶Michigan State University, East Lansing, MI, ⁷North Carolina State University, Raleigh, NC, ⁸University of Nebraska, Lincoln, NE, ⁹University of Missouri, Columbia, MO, ¹⁰University of Illinois, Urbana-Champaign, IL.

An experiment using 390 crossbred pigs (20 replications of 3 or 4 pigs/pen) was conducted at 10 research stations to assess the effects of superdosing phytase on nursery pig growth performance. Corn-soybean meal phase 2 nursery diets were fed for 21-d from 8.5 to 17.6 kg BW. A common premix was formulated using the NCCC42 formulations, and mixed at a central location. Diets were formulated to contain 1.35% standardized ileal digestible (SID) Lys. The positive control diet contained 0.8% Ca, 0.69% P and 0.40% standardized total-tract digestible (STTD) P. The negative control diet contained 0.50% Ca, 0.42% P and 0.18% STTD P. Dietary phytase (Ronozyme HiPhos) was added to the negative control diet premix to provide 0, 500, 1,500 or 3,000 phytase units (FTU)/kg complete diet. On d21, one pig per pen was killed and the 3rd and 4th metacarpals from the right front foot were analyzed for total bone ash. Data were analyzed using the Glimmix procedure of SAS. Pigs were randomly selected based on weight, age, sex, and ancestry. Station by treatment effects were observed for ADG in wk 2 and for the entire period, and for ADFI in wk 2, wk 3, and for the entire period. Body weight gain linearly increased as increased concentrations of phytase were added to the negative control diet (360, 440, 450, and 470 g/d; $P < 0.01$), but ADFI (640, 710, 700, 720 g/d) was not affected during the 21-d study. A linear increase ($P < 0.05$) in G:F was observed as phytase additions increased (0.56, 0.62, 0.64, 0.65 g/g for pigs fed diets containing 0, 500, 1,500, or 3,000 FTU of phytase). Percent bone ash also increased (linear, $P < 0.01$) as addition of phytase increased (44.6, 48.4, 49.2, and 50.6% for pigs fed diets containing 0, 500, 1,500 or 3,000 FTU of phytase, respectively). Percent bone ash was not different between pigs fed the positive control diet and the negative control diet containing 3,000 FTU/kg of phytase (51.1 vs. 50.5%, respectively). In this 21-d study, feeding phase 2 nursery diet containing up to 3,000 FTU/kg resulted in similar growth performance and bone ash percentage as pigs fed a positive control diet containing 0.8% Ca, 0.69% P and 0.40% STTD P.

Key Words: phosphorus, pig, phytase

120 Effect of water-to-feed ratio on the digestibility of diets fed to growing-finishing pigs. Cinta Sol*, Lorena Castillejos, Ramon Muns, and Josep Gasa, *Animal Nutrition and Welfare Service, Department of Animal and Food Sciences, Universitat Autònoma de Barcelona, Bellaterra, Spain.*

Dilution rates water to feed may affect the apparent total-tract digestibility (ATTD) of barley-wheat diets fed to growing-finishing pigs. The experiment lasted 52 d and it was divided in 2 studies of 26 d each. In the first study 16 female pigs (46.7 ± 1.98 kg of body weight, BW) were individually allotted and assigned to 1 of 4 treatments (n = 4). Treatments consisted in 4 water-to-feed ratios: in dry form (CON), with no added water, and ratios of 0.6:1, 2.1:1 and 2.7:1. In the second study the same animals (65.4 ± 3.14 Kg of BW) were again assigned to 4 new treatments: CON and 1.35:1, 2.7:1 and 3.5:1 ratios. Each pen was provided with a free-choice nipple drinker. Diet was fed close to “ad

libitum” trying to avoid refusals, a 0.3% of TiO₂ was added to the feed as an indigestible marker and fecal grab samples were collected from the rectum twice a day the 2 last days of each study. Data of ATTD of OM, GE and nutrients were analyzed by one-way ANOVA using the GLM procedure of SAS and differences among mean values were assessed by the Tukey *t*-test. In the first study, pigs fed diets with ratios 2.1:1 and 2.7:1 had higher organic matter digestibility (OMd) and gross energy digestibility (GEd) than CON ($P < 0.05$). Pigs fed diets with a ratio of dilution 2.7:1 also had higher ($P < 0.05$) intake of digestible organic matter (DOMi) and digestible energy (DEi) than pigs fed CON. In the second study, pigs fed water diluted diets (the 3 ratios) had better OMd and GEd than CON ($P < 0.05$) but no differences were found in DOMi. Compared with CON, the dilution of 3.5:1 also showed a higher ($P < 0.05$) digestibility coefficients for crude protein (CP), ether extract (EE) and crude fiber (CF) and the dilution 1.35:1 and 2.7:1 also for CF. Using a quadratic regressions approach, the maximum feed OM and GE digestibility coefficient was found with dilution rates of 1.83:1 and 2.70:1 for the first and second study, respectively. In conclusion, the water-to-feed ratio which optimized OM and GE digestibility varies depending on the age of the animals; being lower ratios better for young pigs and higher for finishing pigs. Despite the fact that dilution rates below 2.5–2.7:1 are not usually achieved in liquid feeding commercial farms.

Key Words: water-to-feed ratio, growing-finishing pig, nutrient digestibility

121 Effects of pelleting and extrusion on energy digestibility in pig diets containing different levels of fiber. Oscar J. Rojas*¹, Ester Vinyeta², and Hans H. Stein¹, ¹University of Illinois, Urbana, IL, ²Bühler AG, Uzwil, Switzerland.

An experiment was conducted to determine effects of pelleting, extrusion, and extrusion plus pelleting on energy and nutrient digestibility in diets containing low, medium, or high levels of fiber. Three diets were formulated: (1) a low fiber diet contained corn and soybean meal; (2) a medium fiber diet contained corn, soybean meal, and 25% distillers dried grains with solubles (DDGS); and (3) a high fiber diet contained corn, soybean meal, 25% DDGS, and 20% soybean hulls. Each diet was divided into 4 batches after mixing and the treatments included the following: (1) no further processing; (2) pelleted at 85°C; (3) extruded at 115°C using a single screw extruder; and (4) extruded at 115°C and then pelleted at 85°C. Thus, 12 different diets were produced. A total of 24 growing pigs (initial BW: 26.5 ± 1.5 kg) with a T-cannula fitted in the distal ileum were allotted to the diets in a split-plot design with 8 pigs allotted to the low fiber diets; 8 pigs were allotted to the medium fiber diets; and 8 pigs were allotted to the high fiber diets. Diets were fed to the pigs during 4 14-d periods. Within each type of diet, the 8 pigs were fed the diets produced using the 4 processing technologies. Thus, there were 8 replicate pigs per diet. Each of the 4 14-d periods consisted of 5 d for adaptation, 5 d of fecal collection, and ileal digesta were collected on d 13 and 14 of each period. Results indicated that pelleting, extrusion, or extrusion and pelleting improved ($P < 0.05$) the apparent ileal digestibility (AID) of starch and most indispensable AA. In most cases, there were no differences between the pelleted, the extruded, and the extruded plus pelleted diets. The apparent total-tract digestibility (ATTD) of energy and the ME of the diets were also improved ($P < 0.05$) by pelleting and by the combination of extrusion plus pelleting, and extrusion alone improved ATTD of energy and ME in the low fiber and the high fiber diets. Results of this experiment indicate that energy utilization may be improved by pelleting or extrusion or by the

combination of the 2 technologies, but the response to extrusion seems to be greater in diets that are relatively high in fiber.

Key Words: extrusion, fiber, pelleting

122 Mix time does not affect growth performance in finishing pigs fed meal and pelleted diets with high inclusion (32% DDGS and 32% wheat midds) of alternative ingredients. Megan E.

Morts*, Joe D. Hancock, C. Greg Aldrich, Charles R. Stark, Joel D. McAtee, and Kayla L. Kohake, *Kansas State University, Manhattan, KS.*

A total of 200 finishing pigs (average initial BW of 72 kg) were used in a 51-d growth assay to determine the effects of mix time in meal and pelleted diets with high inclusion of alternative ingredients (32% DDGS and 32% wheat middlings) on growth performance and carcass measurements. The pigs were sorted by gender and ancestry and assigned to pens (5 pigs/pen and 10 pens/treatment) in a completely randomized design. The diets (907 kg batches) were blended in a Hayes & Stolz twin-shaft double-ribbon mixer. All ingredients (corn, soybean meal, DDGS, wheat middlings, limestone, salt, vitamin mix, mineral mix, crystalline amino acids, and tylosin) were added to the stopped mixer. Mix times were 0 and 180 s before transfer to sack-off or being pelleted before transfer to sack-off. Treatments were arranged as a 2 × 2 factorial with main effects of diet form (meal vs. pellets) and mix time (0 vs. 180 s). Diets were formulated to at least 120, 120, and 110% of requirements for essential amino acids, vitamins, and minerals, respectively, as suggested in the NRC (2012) Nutrient Requirements of Swine. Feed and water were consumed on an ad libitum basis until the pigs were harvested (avg BW of 119 kg) at a commercial abattoir for collection of carcass data. There were no interactions among diet form and mix time ($P = 0.45$ or greater). Pelleting improved ($P < 0.01$) ADG and G:F, but did not affect ($P = 0.49$ or greater) hot carcass weight (HCW), last rib backfat thickness (BF), or dressing percentage (dress %). Mix time did not affect ($P = 0.17$ or greater) ADG, G:F, HCW, BF, or dress %. In conclusion, increasing mix time from 0 to 180 s in meal or pelleted diets with high inclusion of DDGS and wheat middlings did not improve growth performance or carcass characteristics.

Table 1 (Abstr. 122). Effects of diet form (meal vs. pellet) and mix time (0 vs. 180 s) on performance and carcass traits

Item	Mash		Pellet		SE	P-value		
	0 s	180 s	0 s	180 s		Form	Mix	Form x Mix
ADG, g	909	893	969	944	28	0.01	0.17	0.76
G:F, g/kg	294	298	312	319	5	0.01	0.31	0.78
HCW, kg	87.4	86.9	88.2	88.1	3.2	0.49	0.84	0.90
Dress %	73.3	72.9	72.8	73.1	0.5	0.71	0.98	0.45
BF, mm	23	22	23	22	2	0.76	0.54	0.66

Key Words: duration of mixing, DDGS, pigs

123 Effect of sieving methodology on determining particle size of ground corn, sorghum, and wheat by sieving. Julie R. Kalivoda*, Cassandra K. Jones, and Charles R. Stark, *Kansas State University, Manhattan, KS.*

Particle size determination by sieving is a standard method used to estimate the geometric mean (dgw) and geometric standard deviation (Sgw) of feedstuffs. However, the method allows for variation in time of sieving, sieve agitator setup, and the use of dispersing agent (fumed silica). The objectives of this experiment were to determine which method of particle size analysis best estimates the particle size of cereal grain and assess analytical variation within each method. Treatments were arranged in a 4 × 3 × 3 × 2 factorial design with 4 sieving methods: (1) 10 min with sieve agitators (10A), (2) 15 min with no sieve agitators (15N), (3) 15 min with sieve agitators (15A), or (4) 15 min with sieve agitators and a dispersing agent (15AS), 3 cereal grains (corn, wheat, or sorghum), 3 grinds (coarse, medium, or fine), and 2 mills (hammermill or roller mill). Mill parameters were adjusted to achieve 3 grinds with coarse being the largest and fine being the smallest. Samples were analyzed for particle size according to ASAE S319.3. Data were analyzed using GLIMMIX procedure of SAS with 4 replicates per treatment. Interactions were removed from the model if $P > 0.05$. The main effects of method, grain, grind size, and grind method all differed ($P < 0.01$) for both dgw and Sgw. All methods were significantly different from one another ($P < 0.05$; 587, 615, 576, and 541 for dgw and 2.23, 2.09, 2.27, and 2.63 for Sgw for 10A, 15N, 15A, and 15AS, respectively). All grains differed from one another, with corn having the smallest dgw and Sgw ($P < 0.05$; 537 and 2.28, 550 and 2.34, 652 and 2.31, respectively for corn, sorghum, and wheat dgw and Sgw). Hammermill ground grain had a smaller dgw and larger Sgw than roller mill ground grain ($P < 0.05$; 415 and 2.62 vs. 744 and 1.99, respectively). As expected, varying grind size resulted in different dgw ($P < 0.05$), but Sgw was also affected as the coarse and medium grinds had greater Sgw than the fine grind (2.36 and 2.35 vs. 2.23, respectively). In summary, the particle size analysis method of 15AS provided the lowest dgw and highest Sgw, suggesting that all particles had reached their appropriate spot within the sieve stack and thus was the most accurate of the tested methods.

Key Words: corn, grain, particle size analysis