Guangzhou, China) replacing equal amounts of soybean meal. Nucleotides were composed of CMP (19.9%), UMP (23.3%), GMP (23.3%), and AMP (33.2%), which were originated from yeast cells. Pigs were fed for 21 d based on 2 phases (Phase 1: 11 d and Phase 2: 10 d) following NRC (2012). Feed intake and BW were recorded weekly. Titanium oxide (0.4%) was added to all diets as an indigestible marker from d 17. Plasma samples were collected on d 18 to measure tumor necrosis factor-α (TNF-α), IL-6, and malondialdehyde (MDA). Pigs were euthanized on d 21 to collect tissues to evaluate TNF-α, IL-6, MDA, morphology, and crypt cell proliferation rate in the jejunum. Ileal digesta were collected to measure ileal nutrient digestibility. Data were analyzed using contrasts in the MIXED procedure of SAS. Nucleotide supplementation increased ($P < 0.05$) ADFI (218 vs. 260 g) in phase 1. Nucleotide supplementation at 0.005 and 0.015% increased ($P < 0.05$) ADG (190 vs. 236 g) in phase 1, whereas increased ($P < 0.05$) ADFI (335 vs. 401 g) and tended to increase ($P = 0.082$) ADG (280 vs. 323 g) in overall period. Increasing nucleotide supplementation increased (quadratic, $P < 0.05$) villus height-crypt ratio from 2.0 to 2.2 (at 0.025%) and decreased (linear, $P < 0.05$) crypt cell proliferation rate (20.0 to 17.1%) in the jejunum. Increasing nucleotide supplementation tended to reduced (quadratic, $P = 0.074$) plasma MDA from 17.9 to 12.9 μM (at 0.023%). Increasing nucleotide supplementation tended to increase ($P = 0.072$) ileal digestibility of energy (70.9 vs. 75.3%). Nucleotide supplementation at 0.005 and 0.015% increased ($P < 0.05$) ileal digestibility of energy (70.9 to 76.1%) and ether extract (73.5 to 78.3%). In conclusion, nucleotide supplementation especially at 0.005 and 0.025% could enhance gut structure increasing nutrient digestibility, feed intake, and growth of newly weaned pigs.

Key Words: Gut health, Nucleotides, Pigs

NONRUMINANT NUTRITION V: FIBER/ ENZYMES

294 Diet nutrient digestibility and growth performance of weaned pigs fed hulled or hull-less barley differing in fermentable starch or fiber to replace wheat. L. F. Wang[1], H. Zhang[1], E. Beltranena[1,2], R. T. Zijlstra*[,1], [1]*University of Alberta, Edmonton, AB, Canada,* [2]*Alberta Agriculture and Forestry, Edmonton, AB, Canada*

Starch and fiber composition of whole grains may differ and thereby change site of digestion of energy-yielding nutrients from the small to large intestine. We selected 5 grains differing in fermentable carbohydrates: low-fermentable wheat (LFW); low-fermentable hulled barley (LFB); and 3 hull-less barley of moderate-fermentable (MFB), high-fermentable and high-amylose (HFA), or high-fermentable and high-β-glucan (HFB) to study apparent total tract digestibility (ATTD) of GE and CP, and DE and predicted NE value of diets. In total, 240 pigs were weaned at d 20 and fed diets containing 63.0–70.6% of the 5 grains from 1 wk post-weaning (initial BW 7.3 kg). Diets were formulated to provide 2.3 and 2.2 Mcal NE/kg, and 5.52 and 5.10 g standardized ileal digestible (SID) Lys/Mcal NE for Phase 1 (d 1–14) and Phase 2 (d 15–35), respectively. The ATTD of GE was greatest ($P < 0.05$) for LFW and MFB diets (87%), intermediate for HFB and HFA diets (85%), and lowest ($P < 0.05$) for LFB diet (84%) in Phase 1, with similar ranking in Phase 2 and for diet DE value. The ATTD of CP during Phase 1 was greater ($P < 0.05$) for LFW diet than the 4 barley diets (85 vs. 79%), and during Phase 2 was greatest ($P < 0.05$) for LFW diet (82%), intermediate for HFA and LFB diets (77%), and lowest ($P < 0.05$) for MFB and HFB diets (75%). Diet predicted NE value during Phase 1 was greater ($P < 0.05$) for MFB diet than the other 4 diets (2.39 vs. 2.28-2.33 Mcal/kg), and during Phase 2 was greater ($P < 0.05$) for MFB (2.23 Mcal/kg) than LFB and HFB diets, and lowest for HFA diet (2.20 Mcal/kg). Overall (d 1–35), the ADFI was greatest ($P < 0.05$) for LFB, LFW, and MFB diets (829-860 g), followed by HFB diet (789 g), and lowest for HFA diet (770 g). The ADG (514-557 g), but not G:F (0.64-0.67), tended to differ ($P < 0.10$) among the 5 diets. In conclusion, increased fermentable carbohydrates (starch or β-glucan) or non-fermentable fiber in cereal grains reduced ATTD of energy and protein in young pigs. While increased non-fermentable fiber did not reduce growth performance, increased fermentable carbohydrates reduced ADFI. Fermentable carbohydrates should be titrated carefully in diets for young pigs to ensure that their increased inclusion does not reduce dietary energy and protein intake and thus maintains growth performance.

Key Words: Starch, Fiber, Pig

295 Regression Analysis to Predict the Impact of Dietary Neutral Detergent Fiber on Carcass Yield. J. A. Soto*[,1], M. D. Tokach[1], S. S. Dritz[1], M. A. D. Goncalves[2], J. C. Woodworth[1], J. M. DeRouchey[1], B. D. Goodband[1], [1]*Kansas State University, Manhattan, KS,* [2]*Genus PIC, Hendersonville, TN*

Research has shown that carcass yield is reduced when feeding DDGS or other ingredients with high neutral detergent fiber (NDF). Considering the financial implications of changing carcass yield, the objective of this project was to develop a regression equation to estimate carcass yield from dietary NDF withdrawal strategies. Data from 8 trials (43 observations) originated from 5 journal articles, 2 theses and 1 technical memo were used to develop the regression equation. All trials applied treatments to mixed-sex pens. Treatment diets of each trial were reformulated to obtain nutrient content using the NRC ingredient library. Composition of experimental diets was used to calculate NE (kcal/kg), CP (%), crude fiber (CF [%]), NDF (%), and ADF (%) in the last two dietary phases. The PROC GLIMMIX procedure of SAS (SAS Institute, Inc., Cary, NC) was used to develop regression equations. The model was determined using a step-wise selection procedure starting with manual forward selection through individual predictor variables, with a statistical significance at $P < 0.05$ used to determine inclusion of terms in the final model. The regression analysis showed that number of days in the withdrawal period (WP; $P = 0.011$), NDF level in the dietary phase prior to the final phase (NDF1; $P = 0.001$), NDF level in the last dietary phase before marketing (NDF2; $P < 0.001$), and the interaction between NDF2 and WP (NDF2 × WP; $P = 0.010$) were the most important variables in the dataset to predict carcass yield. The resulting regression equation was carcass yield % = 0.03492 × WP (d) – 0.05092 × NDF1 (%) – 0.06897 × NDF2 (%) – 0.00289 (NDF2 (%) × WP (d)) + 76.0769. As expected, high levels of NDF had a negative impact on carcass yield. Increasing the length of the withdrawal period improved carcass yield; however, the effect of withdrawal period was dependent on the level of NDF2, as indicated by the interaction term. Carcass yield reduction from feeding high-fiber ingredients results from an increase in the weight of intestinal contents, and the increase in gut fill is a result of the type of fiber in the ingredients. Neutral detergent fiber has been shown to result in digestive contents to swell in the by absorbing water thus increasing the fecal volume in the large intestine. In conclusion, the equations herein provide an estimation of the impact of dietary NDF on carcass yield.

Key Words: carcass yield, mixed models, neutral detergent fiber

296 Effects of Inclusion Rate of High Fiber Dietary Ingredients on Concentration of Digestible and Metabolizable Energy in Mixed Diets Fed to Growing Pigs. D. M. D. L. Navarro*[,1], E. M. A. M. Bruininx[2], L. de Jong[2], H. H. Stein[1], *[1]University of Illinois at Urbana-Champaign, Urbana, IL, [2]Agrifirm Innovation Center, Royal Dutch Agrifirm, Apeldoorn, Netherlands*

An experiment was conducted to test the hypothesis that an increased inclusion rate of fiber decreases the contribution of DE and ME from hindgut fermentation. Twenty ileal-cannulated pigs (BW: 30.64 ± 2.09 kg) were allotted to a replicated 10 × 4 incomplete Latin Square design with 10 diets and 4 26-d periods. A basal diet based on corn and soybean meal (SBM) and a corn-SBM diet with 30% corn starch were formulated. Six additional diets were formulated by replacing 15 or 30% corn starch by 15 or 30% corn germ meal (CGM), sugar beet pulp (SBP), or wheat middlings (WM), and 2 diets were formulated by including 15 or 30% canola meal (CM) in a diet containing corn, SBM, and 30% corn starch. Effects of adding 15 or 30% of each fiber source to the corn starch diet were analyzed using orthogonal polynomial contrasts. Two-independent-sample t-tests were used to compare inclusion rates within each ingredient. Results indicated that concentration of ME (kcal/kg) linearly decreased ($P < 0.001$) from 3,420 kcal/kg in the corn starch diet to 3,348 and 3,305, 3,290 and 3,221, 3,316 and 3,125 and 3,310 and 3,213 kcal/kg as 15 or 30% CM, CGM, SBP, or WM was added to the diet. However, inclusion rate did not affect DE and ME of the ingredients (Table 1). This indicates that DE and ME in ingredients were independent of inclusion rates and utilization of energy from test ingredients was equally efficient in diets with 30% inclusion compared with diets with 15% inclusion. In conclusion, fiber had a negative effect on DE and ME in the diet, but inclusion rate does not affect calculated values for DE and ME in feed ingredients with relatively high concentration of fiber indicating that the microbial capacity for fermentation of fiber in pigs is not overwhelmed by inclusion of 30% high-fiber ingredients in the diets.

Key Words: Energy, Inclusion rate, Pigs

Table 1. Concentration of DE and ME in canola meal, corn germ meal, sugar beet pulp, and wheat middlings

Item, kcal/kg DM		Inclusion rate			
		15%	30%	SEM	*P*-value
Digestible Energy	Canola meal	3,257	3,517	198	0.218
	Corn germ meal	3,254	3,314	165	0.722
	Sugar beet pulp	3,027	2,839	197	0.357
	Wheat middlings	3,181	3,319	198	0.495
Metabolizable Energy	Canola meal	3,235	3,377	167	0.410
	Corn germ meal	3,024	3,290	182	0.165
	Sugar beet pulp	3,032	2,729	190	0.136
	Wheat middlings	3,197	3,244	198	0.817