examine the effect of oral rumen fluid supplements on calf performance and the incidence of diarrhea. The calves for this study were purchased at d 1 of age from commercial dairy farms and then transported to a calf research facility. Each calf was systematically allocated to a non-treated control group or a rumen fluid treatment group, in which 8 mL of rumen fluid was added to the milk of the afternoon feeding until d 28. Milk intake, starter intake, water intake, and fecal scores were determined daily for all experimental calves. The calves were weighed weekly and average daily gain was determined. Between d 3 and d 23, three weekly fecal samples were collected from each experimental calf. The occurrence of Cryptosporidium parvum was determined by a sucrose flotation and microscopic examination method, and fecal pH was measured. Control and rumen fluid treatment calves were not significantly different with respect to milk intake (p=0.82), feed intake (p=0.95), water intake (p=0.16), average daily gain (p=0.18), and days to weaning (p=0.96). Rumen fluid supplementation did not significantly affect the fluidity or form of calf fecal stools.

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Rumen fluid, Performance, Diarrhea

683 Effects of colostrum (C) and dexamethasone (DEXA) treatment on insulin (I)-dependent glucose (G) metabolism in neonatal calves. B. Scheuer1, L. Tappy2, J. W. Blum1, and H. M. Hammon*3,1, 1


The occurrence of Cryptosporidium parvum was determined by a sucrose flotation and microscopic examination method, and fecal pH was measured. Control and rumen fluid treatment calves were not significantly different with respect to milk intake (p=0.82), feed intake (p=0.95), water intake (p=0.16), average daily gain (p=0.18), and days to weaning (p=0.96). Rumen fluid supplementation did not significantly affect the fluidity or form of calf fecal stools.

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Feedings of C and glucocorticoid (DEXA) treatment affected G metabolism and I release in neonatal calves. We have tested whether at a high glucocorticoid status after birth and C feeding influence I-dependent G utilization. Neonatal calves were randomly separated into 4 groups of 7 calves, resp. Calves were fed C or a milk-based formula and in each feeding group, calves were either treated with DEXA (30 µg/kg BW per d) or 0.9% NaCl for the first 4 d of life. On d 5 euglycemic-hyperinsulinemic clamps were performed after an overnight period of 16 h without food. Blood samples were taken before and during the clamp for determination of plasma G and I. I [1mU/(kg BW×min)] was infused for 3 h and plasma G concentrations were kept at 5 mmol/L ±10%. Clamp studies were combined with [13C]-bicarbonate (2.82 mmol/kg BW×min) and [6,6-2H]-G (40 µg/kg BW×min) infusions for 5.5 h (i.e., from -150 min to 180 min, relative to the start of I infusion) to determine G flux (GFx), endogenous G production (eGP), and gluconeogenesis (GNG) before and at the end of the clamp. Data were analyzed by the Mixed Model with feeding, DEXA treatment and time as fixed effects. In the pre-clamp period plasma concentrations of G and I were higher in DEXA-treated than in non-treated calves. G infusion rates were lower (P < 0.05) in DEXA-treated than in non-treated calves during the whole clamp study. GFx increased (P < 0.05) during the clamp and was higher (P < 0.05) at the end of the clamp in non-treated than in DEXA-treated calves. GNG did not differ between groups, but eGP tended to be lower (P = 0.1) in DEXA-treated than in non-treated calves at the end of the clamp study. In conclusion, I alone increased G utilization, but GNG and eGP were not affected. The high glucocorticoid status impaired I-dependent G utilization, but did not influence GNG whereas the eGP seems to be reduced during I infusion.

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Key Words: Neonate, Glucose, Insulin


Twenty Angus x Gelbvieh rotationally crossed cows carrying female fetuses were blocked by BW and were fed in equal numbers to either meet NRC requirements to gain weight (average = + 4.25% of BW, Control, C) or fed below NRC (nutrient restricted, NR) to lose weight (average = - 6.8% of BW) from d 30 to d 125 of gestation. On d 125, five C and NR cows were necropsied, and the remaining 5 NR cows were reallimented to achieve similar BW to C cows when necropsied on d 250 of gestation. The LD muscle of fetuses at 12th rib was removed, fixed and embedded in paraffin for histochemical examination. At d 125 gestation, maternal nutrient restriction reduced the average number of myofibers in muscle bundles of fetal LD muscle; the average number of myofibers from C cows was 12.2 ± 0.34 while that of NR cows was 10.2 ± 0.53 (P<0.05). Comparing to the LD muscle of fetuses from C cows at d 250 gestation, maternal nutrient restriction significantly increased the volume of myofibers and reduced the number of myofibers per square area in the fetuses from NR cows; the ratio of the average cross-sectional area of fetal myofibers from C cows versus NR cows was 1 ± 0.07 to 1.29 ± 0.14 (P<0.05). The result showed that nutrient restriction during the early gestation (d 31 to d 125) significantly affected fetal muscle development by reducing the number of myofibers in each muscle bundle. This reduction in the number of muscle fibers due to maternal nutrient restriction at early gestation could not be recovered by realimentation during the late stage of gestation (d 125 to d 250), which resulted in a muscle with reduced numbers of myofibers of larger volume. The reduced number and increased volume of myofibers in fetal muscle due to maternal nutrient restriction during early stage of gestation is expected to impact the physiological function of skeletal muscle and affect meat quality of offspring, which needs further investigation.

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Key Words: Maternal Nutrient Restriction, Cow, Fetal Skeletal Muscle

Nonruminant Nutrition: Enzyme Supplementation


The objective of this study was to determine the functional site of a supplemental E. coli phytase and its impact on phosphorus contents of digesta in different segments of the gastrointestinal tract of pigs. A total of 18 weaning pigs (8.3 ± 0.9 kg BW) were allotted to three groups (n = 6) and were fed a low-P (0.4%) corn-soy basal diet (BD), BD + E. coli AppA2 phytase (500 U/kg), or BD + inorganic P (0.2%) for 4 wk. Individual growth performance and plasma inorganic P concentration were measured weekly. At the end of the study, all pigs were euthanized to collect digesta samples from stomach, duodenum, upper and lower jejunum, ileum, and colon. After freeze-drying, the samples were assayed for phytase activity and soluble P content. Pigs fed BD had lower (P < 0.05) daily weight gain, feed use efficiency, and plasma inorganic P concentrations than the other two groups. Phytase activities were similar in the digesta of stomach, duodenum, and upper jejunum, but diminished in the digesta of lower jejunum and ileum of pigs fed BD + phytase. While little phytase activity was detected in the digesta of all these segments from the other two groups, all groups had relatively high phytase activity in the colon digesta (128-267 U/kg). There was a gradual decrease in soluble P of digesta from the stomach to lower jejunum in pigs fed BD + phytase or inorganic P. Digesta soluble P in pigs fed BD was lower (P < 0.05) in stomach, but higher (P < 0.05) in upper jejunum.
868 Site of digestibility of protein and phosphorus by growing pigs fed diets without or with microbial phytase. L. L. Geraths*, M. G. Boersma, and H. H. Stein, South Dakota State University, Brookings.

An experiment was conducted to determine the site of digestibility of CP and P by growing pigs. Six growing barrows (initial BW: 39.5 kg ± 1.3 kg) were randomly allotted to one of two dietary treatments in a two-period switch-back design. Pigs on Treatment 1 were fed a corn-soybean meal based control diet (18% CP, 0.37% P) while pigs on Treatment 2 were fed the same diet supplemented with 500 FYT of microbial phytase (Rhizoprotex, DSM Nutritional Products, Inc.). No inorganic P was included in the diets. Each pig was equipped with two T-cannulas, one in the proximal duodenum and one in the distal ileum. Each feeding period lasted 14 d. Fecal samples were collected on d-10, ileal samples on d-11 and d-12, and duodenal samples on d-13 and d-14. The apparent duodenal (ADD), apparent ileal (AID), and apparent total tract (ATTD) digestibility coefficients of DM, CP, and P were calculated. The digestibility of CP and CP increased as feed moved down the GI-tract with the ATTD being higher (P ≤ 0.001) than the AID, which was higher (P ≤ 0.001) than the ADD. The ATTD, AID, and ADD for DM were 91.2, 76.8, and 0.4% vs. 90.9, 75.7, and 1.3% for the control and phytase diets, respectively. The corresponding numbers for the digestibility of CP were 90.2, 80.7, and 13.2% vs. 89.2, 80.1, and 1.3% for the control and phytase diets, respectively. Numbers for the digestibility of P were 90.2, 80.7, and 13.2% vs. 89.2, 80.1, and 1.3% for the control and phytase diets, respectively.

In conclusion, a higher FL has a positive impact on apparent ileal and fecal P digestibility in pigs fed corn-soybean meal diets containing microbial or plant phytase. Therefore, comparative studies on the efficacy of different phytases require a standardization in feed intake at a high level.

Key Words: Feeding Level, Phytase, Pigs

869 The evaluation of phosphorus feeding strategies in pigs from 12 kg to market. R. W. Fent*, G. L. Allee1, D. M. Webel2, J. D. Spencer2, and T. S. Torrance2, 1University of Missouri, Columbia, 2United Foods, Inc., Sheridan, IN.

An experiment using 528 barrows was conducted to evaluate diets targeted at reducing phosphorus (P) excretion from 12 kg BW to market. Pigs were allotted to one of eight dietary treatments in a wean-to-finish facility with six replicates per treatment (11 pigs/pen). Pigs were fed in four stages corresponding to 12-27 kg, 27-53 kg, 53-91 kg, and 91 kg BW during which dietary true digestible lysine levels were 1.30, 1.15, 0.80, and 0.65%, respectively. Treatment consisted of: 1) available phosphorus (aP) concentration at 125% of the 1998 NRC recommendation, 2) NRC dietary aP, 3) high aP early, NRC late as previously determined in our lab, 4) NRC aP to 91 kg, then no supplemental P to market, 5) high aP early, no supplemental P from 91 kg to market, 6) no supplemental P with phytase (OptiPhos™ added at 1,000 FTU/kg throughout, 7) high aP early, with 500 FTU/kg phytase replacing 0.12% aP and 8) phytase added at 1,000, 500, and 300 FTU/kg (replacing 0.20, 0.12, and 0.10% aP) from 12-53 kg, 53-91 kg, and 91 kg market, respectively. Metacarpal ash and breaking load were determined for one pig/pen at 53 and 91 kg BW and four pigs/pen at termination of the experiment. Removing supplemental P from the diet without phytase supplementation after 91 kg BW decreased (P < 0.05) ADG, ADFI, and gain/feed regardless of dietary P early in life. Gain/feed from 91 kg to market was greatest (P < 0.05) for those fed phytase-containing diets. Metacarpal ash and breaking load were reduced (P < 0.05) in pigs fed diets without inorganic P or phytase after 91 kg BW. The three phytase-containing treatments, whether replacing a portion or all of the inorganic P with phytase, resulted in similar (P > 0.05) growth during the final finishing stage and final bone measures with ADG similar to the 125% of NRC diet. These data suggest that removing supplemental P from the diet after 91 kg BW will affect growth performance and bone parameters regardless of prior P feeding. However, substituting some inorganic P with phytase throughout the growing-finishing period resulted in maintained weight gains and bone parameters and improved feed conversion.

Key Words: Phytase, Bone, Excretion
containing 4.8 and 3.9 g/kg Ca and P, respectively, the NC diet + 0.4, 0.8, and 1.2 g/kg i.P from MSP, and NC + 500, 750, and 1,000 FTU/kg ECP. Daily gain improved (linear, P < 0.05) with ECP addition, as did apparent digestibility of Ca and P (linear, P < 0.01). Supplementation with 500 FTU/kg was determined to be equivalent to approximately 533 mg i.P from MSP in grower pig diets. The results of these studies showed ECP to be efficacious in releasing phytate phosphorus, and addition of 500 FTU/kg to be equivalent to between 533 and 721 mg i.P from MSP.

Key Words: Broilers, E. coli Phytate, Pigs

690 Effect of xylanase and(or) phytase supplementation on amino acid digestibility of grower pigs fed wheat-based diets containing wheat millrun. T. Nortey*1,2, N. Trotter1, J. Patience1, P. Simmins3, and R. Zijlstra4, 1Prairie Swine Centre, Saskatoon, SK, Canada, 2University of Saskatchewan, Saskatoon, SK, Canada, 3Michigan State University, East Lansing, 4Danisco Animal Nutrition, Marlborough, UK, 5University of Alberta, Edmonton, AB, Canada.

Wheat by-products such as millrun might be more readily included in swine diets if nutrients bound by arabinoxylans and phytate were made more available, such as through the use of exogenous enzymes. Effects of millrun inclusion level (L1, 20%; L2, 40%), xylanase supplementation (0 or 4.375 U/kg feed), and (or) phytase supplementation (0 or 500 FTU/kg feed) on amino acid digestibility were investigated in a 2 x 2 x 2 factorial arrangement together with a wheat-based positive-control diet. Diets were formulated to contain 3.34 Mcal DE/kg and 2.8 g apparent digestible lysine/Mcal DE and included 0.4% chronic oxide. Eighteen cannulated pigs (36.2 ± 1.9 kg) were fed three diets at 3 x maintenance in consecutive periods, to provide six observations per diet. Ileal digesta and then fecal samples were collected for 2 d. Millrun inclusion linearly reduced apparent digestibility of Asp, His, Ile, Leu, Lys, Phe, Thr, Tyr, Val (P < 0.001) and Phe (P < 0.05). Within millrun diets, xylanase supplementation improved digestibility of His, Ile, Leu, Phe, Thr, Tyr and Val (P < 0.05, but not Arg (P > 0.05). For L2, xylanase improved lysyl digestibility by 5.1% from 78.6% to 82.6% (P < 0.05) and the latter value was not different from the positive-control diet (86.4%: P > 0.10). Phytase supplementation of L1 and L2 diets improved digestibility of Arg, His, Leu, Lys, Phe, Tyr and Val (P < 0.05). For Ile and Thr, digestibility was improved solely in L2 (P < 0.05). Generally, xylanase and phytase did not interact (P > 0.10). In summary, millrun inclusion caused a reduction in AA digestibility that could be partially overcome by xylanase and(or) phytase supplementation. In conclusion, the use of wheat millrun in swine diets can be enhanced by using supplemental xylanase and phytase, which might afford opportunities to reduce feed costs.

Key Words: Wheat Millrun, Xylanase, Pig

691 The effect of wheat variety and enzyme supplementation on pig performance. M. E. E. McCann*1,2, K. J. McCracken1, and P. H. Simmins3, 1Agricultural Research Institute of Northern Ireland, Hillsborough, Co. Down, Northern Ireland, 2Queen’s University of Belfast, Belfast, Northern Ireland, 3Danisco Animal Nutrition, Marlborough, Wiltshire, England.

Although wheat is a major component of many pig diets, it has been reported to be the most variable in terms of chemical composition and nutritive value. This variation arises from a number of factors, including variety. Wheat nutritive value can also be affected by non starch polysaccharide (NSP) content, the presence of the 1B/1R gene and endosperm hardness. The aim of this experiment was to examine the effect of wheat variety, enzyme supplementation, endosperm hardness and the 1B/1R gene on the production performance of growing pigs. Six wheat varieties were formulated into 12 diets, differing in wheat variety, with or without supplementation with exogenous enzyme (Porzyme 9100; inclusion rate, 1 g/kg) and offered to a total 120 individually housed crossbred (Large White x Landrace) pigs from 8-12 weeks of age. Liveweight gain (LWG, g/d), dry matter intake (DMI, g/d) and feed conversion ratio (FCR) were determined weekly. There were no significant effects on pig performance as a result of variety, enzyme addition, endosperm hardness or the presence of the 1B/1R gene. However, wide ranges in LWG, DMI and FCR were observed for pigs offered the 12 experimental diets (650-772 g/d, 1063-1171 g/d and 1.52-1.72, respectively) which may be important in a commercial situation. The lack of variety and 1B/1R gene effects can be attributed to the lack of difference in chemical composition. The results also indicated that, in contrast to previous research, hard wheat was not more efficiently utilised than soft wheat and that enzyme supplementation did not have any significant effect on pig performance.

Key Words: Wheat, Enzyme, Pigs

692 The effect of enzyme supplementation on energy and crude protein digestibility of wheat distiller’s dried grains with solubles in grower-finisher pigs. G. P. Widyaratne1,2 and R. T. Zijlstra1, 1Prairie Swine Centre Inc., Saskatoon, SK, Canada, 2University of Saskatchewan, Saskatoon, SK, Canada, 3University of Alberta, Edmonton, AB, Canada.

Wheat distiller’s dried grains with solubles (DDGS) have a lower energy digestibility than wheat, which is likely due to an increased arabinoxylan content as a result of starch removal during ethanol production. Yet, wheat DDGS had a DE content not different than wheat. The objective of the present study was to study the effect of enzyme supplementation on total-tract energy and crude protein (CP) digestibility of wheat DDGS. Wheat-based diets with or without 40% wheat DDGS were tested with or without supplemented xylanase (4,000 U/kg feed) in a 2 x 2 factorial arrangement using eight 30-kg barrows, according to a repeated Latin square design. Following a 6-day acclimation, feces samples were collected for 2 days. The energy digestibility was 5.7% higher for wheat than wheat DDGS (P < 0.05). However, xylanase supplementation did not improve energy digestibility in wheat or wheat DDGS (P > 0.10). The DE content was similar in wheat and wheat DDGS, and was not improved by xylanase supplementation (P > 0.10). In contrast to the previous study, total-tract CP digestibility did not differ between wheat and wheat DDGS (P > 0.10), and xylanase supplementation did not improve CP digestibility of wheat or wheat DDGS (P > 0.10). However, the digestible CP content was 15.6% higher for wheat DDGS than wheat (P < 0.05), indicating that feeding wheat DDGS causes a high N absorption into the body. In summary, wheat DDGS has a lower energy and similar CP digestibility as wheat, and xylanase supplementation did not improve energy or CP digestibility in either wheat or wheat DDGS (P > 0.10). In conclusion, in the specific batch of wheat DDGS used in the present study, arabinoxylans might not be the limitation for energy or CP digestibility or the selected level of xylanase was not proper to increase either energy or CP digestibility.

Key Words: Pig, Enzyme, Digestibility

693 The effect of cereal type and enzyme supplementation on nutrient digestibility, intestinal microflora, volatile fatty acid concentration and manure ammonia emissions from pigs. J. M. O’Connell, T. Sweeney, C. Byrne, J. J. Callan, and J. V. O’Doherty*, University College Dublin, Ireland.

A 2 x 2 factorial arrangement was used to investigate the interaction between cereal type (wheat vs. barley) and an exogenous enzyme supplement (with or without a glucanase/xylanase mix) on apparent nutrient digestibility, large intestinal microflora, volatile fatty acid concentration and in vitro manure ammonia emissions from pigs. Urine and faeces were collected over 7 days from 16 boars (four/treatment, 80.0 kg live weight) that were housed in metabolism crates. After collections, the pigs were slaughtered and the contents of the intestinal tracts were removed for analysis. There was an interaction (P < 0.05) between cereal type and enzyme inclusion in apparent nutrient digestibility, gut microflora, VFA production and in vitro ammonia emissions. The inclusion of enzyme to barley diets increased DMD, OMD and N digestibility compared to unsupplemented diets, however there was no effect of enzyme inclusion in wheat diets. Pigs offered unsupplemented barley-based diets had higher populations of bifidobacteria in the caecum and colon than enzyme supplemented barley diet; however, there was no effect of enzyme supplementation in wheat-based diets. Pigs offered barley based diets had a significantly reduced acetic acid: J. Anim. Sci. Vol. 83, Suppl. 1/J. Dairy Sci. Vol. 88, Suppl. 1
propionic acid ratio in the caecum (P < 0.001) and in the colon (P < 0.001) compared to wheat based diets. In the absence of an enzyme supplement, barley-based diets reduced the proportion of isovaleric acid (P < 0.05) and isobutyric acid (P < 0.05) in the caecum and colon and also reduced manure ammonia emissions during storage from 0 to 240 hours (P < 0.05) compared to the wheat diet, however there was no effect of cereal type in enzyme supplemented diets. In conclusion, the inclusion of an enzyme to barley-based diets increased nutrient digestibility but also increased ammonia emissions.

Key Words: Pigs, Cereal, Enzyme


An experiment was conducted to evaluate the influence of a multi-enzyme preparation (Rovabio™ Excel LC; ADISSEO, France; 17 enzymatic activities with main activities being Endo-1.4-β-Xylanase & Endo-1,3(4)-β-Glucanase) on the gut morphology of weaning piglets. At d 28 of age, 12 piglets (9.9 ± 0.7 kg) were divided into two groups consisting of six animals each and assigned to two different treatments: 1) a basal diet based on corn and soybean meal (ME, 13.9 MJ/kg; CP, 17.5%; Lys, 11.5 g/kg) and 2) an experimental diet consisting of the basal diet supplemented with Rovabio™ Excel at a level of 200 mL/t. The piglets were housed individually, fed ad libitum the diets for 3 weeks and were euthanized on d 23. Samples from duodenum, jejunum (proximal, mid, distal) and ileum were taken. Villi length and crypt depth were determined by means of confocal microscopy. Data was analyzed by ANOVA. The enzyme supplementation increased (P < 0.01) the crypt depth (+10.6%, +23%, +6.3%, +10.4%, and +8.5% for duodenum, distal-, mid-, proximal-jejunum and ileum, respectively), which indicates an enhanced secretion into the lumen, presumably related to changes of the osmolarity of digesta. The enzyme supplementation mediated the hydrolysis of NSP and therefore increased the appearance of mono- or short oligomeric sugars. This could probably be the main reason for the change in osmolarity. The villi length was increased (P < 0.01) in the duodenum (control: 380 ± 98 um; enzyme: 470 ± 105 um) as well as in tendency (P < 0.08) in the proximal jejunum (control: 353 ± 82 um; enzyme: 374 ± 53 um). This enlarged the mucosa surface and therefore improved its capacity to absorb nutrients. The effect of the enzyme supplementation on crypt depth as well as on villi length was evident mostly in the proximal parts of the gut, indicating a pronounced action of the enzyme preparation on NSP in the duodenum and proximal jejunum. In conclusion, the supplementation of feed with Rovabio™ Excel influences positively the gut morphology of weaning piglets.

Key Words: Villi Length, Enzyme, Piglet


The supplementation of feed for piglets and growing-finishers pigs with a multi-enzyme preparation (Rovabio™ Excel; ADISSEO, France; 17 enzymatic activities with main activities being Endo-1,4-β-Xylanase & Endo-1,3(4)-β-Glucanase) can decrease intestinal viscosity, and increased nutrient digestibilities and animal performance, regardless the dietary raw materials, have been observed. The aim of this in vitro study was to determine whether a supplementa-