

748 Effect of xylanase inclusion level on nutrient digestibility of diets containing different corn varieties and wheat middlings in finishing pigs. Young Hyun^{*1}, Mike Ellis¹, and Howard Simmins², ¹University of Illinois, Urbana, ²Finnfeeds International Ltd., UK.

The objective of this study was to determine the effect of dietary xylanase supplementation (Porzyme #, Finnfeeds International Ltd., UK) on nutrient digestibility in diets based on either waxy or normal corn and containing 20% wheat middlings, in finishing pigs. The study was conducted using a 4 x 4 Latin Square design having 2 x 2 factorial arrangement of treatments. The treatments were 1) type of corn (waxy vs normal) and 2) enzyme level (0.000 vs 0.125 %). Eight pigs fitted with a post-valve T-cecal cannula were used to measure the apparent ileal digestibility of nutrients. The average initial BW was 101.0 ± 7.25 kg and the average final BW was 118.8 ± 6.22 kg at the end of a four-week study period. The normal corn and waxy corn diets were formulated to the same content (3,241 vs 3,246 ME Kcal/kg; 18.3 vs 18.2 % CP and 0.66 vs. 0.66 % true ileal digestible lysine, respectively). Chromic oxide (0.5 % of the diet) was used as a marker for the determination of the ileal digestibilities. For the first period (week) of the study, pigs were fed 2.4 kg of feed per day in two equal meals at 8 am and 3 pm (1.2 kg per meal). Feed intake was increased by 200 g per day (100 g per meal) after each experimental period. Pigs had free access to water. In each period, the pigs were allowed to adapt to the diets for five days (days 1 to 5). Ileal digesta were collected on days 6 and 7, in two 12-hr periods from 0700 h to 1900 h. There were no interactions ($P > 0.05$) between corn type and enzyme level for nutrient digestibility. The waxy corn had higher ($P < 0.05$) ileal digestibility for dry matter and energy than the normal corn (65.5 vs 61.7 SE 0.99 % and 66.4 vs 62.6 SE 1.10 %, respectively). However, there was no difference ($P < 0.05$) in crude protein digestibility between the corn types. Dietary supplementation with the enzyme at 0.125 % of the diet when compared to the control treatment resulted in higher digestibility for dry matter (60.5 vs 66.7 SE 0.99 %, $P < 0.01$), protein (70.6 vs 74.0 SE 0.93 %, $P < 0.05$) and energy (61.5 vs 67.5 SE 1.10 %, $P < 0.01$). Xylanase supplementation improved ileal digestibility of nutrients in diets based on both normal and waxy corn and wheat middlings.

Key Words: Xylanase, Ileal digestibility, Finishing pigs

749 Effects of feed processing technologies and diet formulation strategies on growth performance and carcass characteristics in finishing pigs. D. J. Lee, J. D. Hancock, G. A. Kennedy^{*}, C. L. Jones, and C. W. Starkey, *Kansas State University, Manhattan.*

A total of 176 crossbred pigs (avg initial BW of 52 kg) were used to determine the effects of feed processing technologies and diet formulation strategies on growth performance and carcass characteristics in finishing pigs. The pigs were blocked by sex and weight and allotted to 16 pens with 11 pigs per pen. Corn (mean particle size of 900 microns)-soybean meal-based diets, formulated to 17% CP, 0.60% Ca, and 0.50% P for d 0 to 39 and 14% CP, 0.54% Ca, and 0.45% P for d 39 to 67, were used as the control. Low-excretion diets were formulated to 15% CP (with added lys, thr, met, and trp), 0.61% Ca, and 0.51% P for d 0 to 39 and 12% CP (with added lys, thr, met, and trp), 0.48% Ca, and 0.40% P for d 39 to 67. Also, these diets had 5% soybean oil, and for d 39 to 67, the vitamin and trace mineral premixes were omitted. To enhance nutrient digestion in these diets, the corn was ground to a mean particle size of 600 microns and the diets were steam conditioned (82°C), expander processed (cone pressure of 14.1 kg/cm²), and pelleted (diameter of 4.8 mm). Finally, phytase (500 FTU/kg) was sprayed onto the cooled pellets. The pigs were slaughtered at a commercial plant and the pars esophagea of the stomachs were collected and scored on a scale of 0 to 3 (0 = none, 1 = slight, 2 = moderate, and 3 = severe) for stomach ulceration. Rate and efficiency of gain were increased by 11 and 13% ($P < 0.001$) for pigs fed the low-excretion diets. Dressing percentage and FFLI were not affected ($P > 0.10$), but last rib backfat thickness was increased ($P < 0.04$) and ulcer scores were greatest ($P < 0.001$) for pigs fed the low-excretion diets. Our data suggest that growth performance was increased with low-excretion diets, but pigs fed these diets tended to be fatter and have greater scores for stomach ulcers.

Item	Control	Low excretion	SE
ADG, kg	0.82	0.92	0.01
Gain/feed	0.291	0.335	0.005
Dressing %	73.4	73.8	0.3
Backfat, mm	25	27	0.4
FFLI, %	51.6	51.1	0.2
Ulcer score	0.00	2.08	0.09

Key Words: Pig, Growth, Nutrient excretion

750 Improving ileal and total tract digestion of corn and soybean meal-based diets by growing pigs using feed enzymes, steeping, and particle size reduction. M. R. Smiricky^{*}, K. L. Saddoris, D. M. Albin, V. M. Gabert, and G. C. Fahey, Jr., *University of Illinois, Urbana.*

Limited research has been reported concerning the efficacy of fiber-degrading enzymes (FDE) in conjunction with feed steeping and /or phytase supplementation. These enzymes may assist in the digestion of the incompletely utilized fibrous fraction of corn and soybean meal. Twelve barrows were surgically fitted with a simple T-cannula at the distal ileum to evaluate the efficacy of the addition of the FDE, α -galactosidase (0.3%), cellulase (0.1%), hemicellulase (0.2%), pectinase/arabinase (0.1%), and xylanase (0.05%) with or without feed steeping, and with or without 0.5% phytase on large (731 micron) and small (555 micron) particle size diets. The barrows were separated into two 6 x 6 Latin squares. Square 1 utilized 731-micron particle size diets and square 2 utilized 555-micron particle size diets to test the efficacy of enzymes and steeping. The corn-soybean meal-based diets were formulated to contain 17% CP and chromic oxide for determination of nutrient digestibilities. Water for feed steeping was added in a 1.45:1 ratio on a weight basis. The pigs were fed 1.40, 1.52, 1.68, 1.84, 2.00, and 2.12 kg/d, respectively, for periods 1-6 in 2 equal feedings at 0800 and 2000 h. The experimental period lasted 7 d, with 5 d diet adaptation, fecal collection on d 6, and ileal digesta collection on d 7. Diets, feces, and digesta samples were analyzed for DM, OM, N, AA, and chromic oxide concentrations. Diets were analyzed for particle size. Lower particle size improved ($P < 0.05$) ileal digestibilities of OM, Asp, Pro, Ala, Leu, Tyr, and Phe. Lower particle size improved ($P < 0.05$) total tract digestibilities of N and all AA measured. Ileal and total tract digestibilities of DM, N, and AA were improved ($P < 0.05$) by FDE and phytase addition in combination or by feed steeping. In conclusion, decreasing particle size, the addition of phytase, as well as feed steeping improved digestibilities of most of the nutrients measured.

Key Words: Pigs, Digestibility, Enzymes

751 Use of toe ash regression analysis to compare bioefficacy of phytase enzymes. M Coelho^{*}, B Cousins, and W McKnight, *BASF Corporation.*

Two hundred fifty two day old broilers were utilized in a 3X3 factorial design (10 replications/treatment) to determine the bioefficacy of Natuphos[®] compared with peniophora lysii phytase using a monocalcium phosphate standard. A phosphorus deficient corn/soybean diet was used as the control. This phosphorus deficient diet was supplemented with monocalcium phosphate (0.2, 0.4 and 0.6 g P/kg) or phytase (100, 200 and 300 U/kg). Bioefficacy was compared based on toe ash regression analysis. Regression equations of phytase on toe ash were $y = 0.0122x + 19.7$, $R^2 = 0.9715$ and $y = 0.0066x + 19.7$, $R^2 = 0.4022$ for Natuphos and peniophora lysii phytase, respectively. Toe ash increased by 0.0122 and 0.0066 mg per phytase unit for Natuphos and peniophora lysii phytase, respectively. Natuphos phytase required fewer (p.05) phytase units than peniophora lysii to reach 26.88 mg toe ash (588 and 1087 U, respectively). The bioefficacy of Natuphos phytase and peniophora lysii based on toe ash regression analysis were 100% and 54%, respectively.

Key Words: Enzymes, Phytase, Bioefficacy

752 In vitro and in vivo hydrolysis of phytate in feed ingredients and complete feeds by phytase. J. S. Sands^{*1}, P. H. Simmins², and O. Adeola¹, ¹Purdue University, West Lafayette, IN USA, ²Finnfeeds International Ltd., Marlborough, UK.

The hydrolysis of phytate in a variety of feed ingredients and complete feed (CF) by phytase was investigated both *in vitro* and *in vivo*. For the *in vitro* release of P in feed ingredients and CF (73% corn, 23% soybean meal; 17% CP; 0.33% P - not supplemented with inorganic P), 6 replicates of each feed ingredient or CF were used with phytase stock solution added to give: 0, 125, 250, 500, 750, 1000, 2000, or 4000 units/kg sample. The response in P release to phytase concentration was curvilinear. Under conditions used in this study, maximal P release were 0.9, 1.8, and 1.12 mg P/g sample for corn, soybean meal and CF, respectively. For wheat, barley, canola, and sunflower meals, maximal P release were 2.97, 2.97, 3.27, and 3.17 mg P/g sample, respectively. For the *in vivo* study, 36 barrows with an average initial weight of 19 kg were assigned to six diets and housed in stainless-steel metabolism crates. The CF was supplemented with 0, 250, 500, 750, or 1000 phytase units/kg diet. Pigs were fed in two equal feedings daily in a study consisting of a 5-d adjustment period followed by a 5-d period of total but separate collection of feces and urine. Fecal phosphorus output was higher ($P < 0.05$) in pigs fed CF than in those fed the phytase-supplemented diets. This led to both lower ($P < 0.05$) daily absorbed P and percent P digestibility in CF than the phytase-supplemented diets. Phytase supplementation of corn-soybean meal diet significantly improved the digestibility of phytate. Nonlinear broken-line regression analysis revealed that the optimum level of phytase in the corn-soybean meal diet used in the current experiment was 298 units/kg for daily absorbed P and 326 units/kg for percent P digestibility. The digestibilities of nitrogen and energy were not affected by phytase supplementation. The results of these studies show that the phytase preparation is efficacious in hydrolyzing phytate.

Key Words: Pigs, Phytase, Phosphorus

753 Enhanced phosphorus digestion and reduced pollution potential by transgenic pigs with salivary phytase. Serguei Golovan, Roy Meidinger, Ayodele Ajakaiye, Michael Cottrill, Claire Plante, Ming Fan, Anthony Hayes, Roger Hacker, John Phillips, and Cecil Forsberg^{*}, University of Guelph, Guelph, Ontario, Canada.

To address the problem of manure-based environmental phosphorus pollution in the pork industry, we have developed phytase transgenic pigs. The transgene introduced into pigs by pronuclear microinjection is composed of the mouse parotid secretory protein promoter and the *Escherichia coli* *appA* phytase gene. The transgenic pigs secrete the enzyme phytase in their saliva that hydrolyzes dietary phytate releasing phosphorus which is readily absorbed in the small intestine. Without this enzyme, phytate phosphorus passes undigested into the manure. These pigs offer a unique biological approach to management of phosphorus nutrition and environmental pollution in the pork industry.

Key Words: Transgenic pigs, Phytase, Phosphorus digestibility

754 The effects of phytase on calcium, phosphorus, and dry matter digestibility in pigs fitted with steered ileocecal valve cannulas. J.P. Rice^{*}, J.S. Radcliffe, and R.S. Pleasant, Virginia Polytechnic Institute and State University.

Twelve crossbred barrows fitted with steered ileo-cecal valve cannulas were used in a replicated 6 x 6 Latin square design to investigate the effects of phytase on Ca, P and DM digestibilities. Each 2-wk period consisted of a 7-d adjustment, a 3-d total collection, a 12-h ileal digesta collection, a 3-d adjustment to the enzymatically hydrolyzed casein (EHC) diet and a second 12-h ileal digesta collection. The EHC diet was fed to supply readily available amino acids so that true amino acid digestibilities could be determined. All diets, except for the EHC diet, were corn-soybean meal based and contained 0.15% available P, 0.44% Ca, and 0.05% Cr₂O₃ as an indigestible marker. Water was supplied ad libitum and feed was supplied at a level of 9% of metabolic BW (BW^{0.75})/d. Pigs were weighed prior to the start of each period and feeding levels were adjusted. Diets 1, 2 and 3 contained 13.0, 12.0 and 11.0% CP, respectively. Diets 4, 5 and 6 were Diet 3 plus 250, 500 or 750 U of phytase per kilogram of diet, respectively. Digesta and fecal samples were pooled by pig for each collection day/period and analyzed for P, Ca, Cr and DM. As the level of dietary CP decreased, ADG ($P < 0.001$)

and feed efficiency ($P < 0.01$) decreased linearly. The addition of phytase to the low CP diet did not affect ($P < 0.10$) ADG or feed efficiency. The addition of phytase to the diet resulted in a linear increase ($P < 0.001$) in P apparent ileal digestibility (AID) and Ca apparent total tract digestibility (ATTD), a quadratic increase ($P < 0.01$) in P ATTD, and a tendency ($P < 0.10$) towards an increased Ca AID and DM ATTD. As the level of dietary CP was decreased a quadratic response ($P < 0.05$) was observed for P and DM AID and ATTD. Calcium AID and ATTD were unaffected by dietary CP level. Pigs fed the 12.0% CP diet had a higher P and DM AID and ATTD compared to pigs fed the 13.0 and 11.0% CP diets. Phytase addition to the diet improved P and Ca AID and ATTD and tended to improve DM ATTD.

Key Words: Pig, Phytase, Digestibility

755 Xylanase improves the ileal energy and nitrogen digestibility of high wheat finisher diets containing increasing levels of wheat shorts in swine. S. C. Wolford¹, P. H. Simmins², and T.A.T.G. van Kempen^{*1}, ¹North Carolina State University, ²Finnfeeds International.

Wheat and wheat byproducts contain non-starch polysaccharides, predominantly arabinoxylans, which negatively affect nutrient digestibility. In-feed xylanases reduce the anti-nutritional effects of the arabinoxylans on digestibility, although responses have been variable in pigs. The efficacy of three levels of xylanase (0, 4000, and 7000 IU/kg, Porzyme[®] 9300) in diets containing 77% wheat + 10% wheat shorts, 67% wheat + 20% wheat shorts, and 57% wheat + 30% wheat shorts was evaluated in an ileal digestibility experiment. Diets were evaluated in nine ileally cannulated grower pigs using a Youden square design with eight periods. Ileal digesta were collected over a 2-d period following a 5-d adaptation period. The model that best described the results used wheat shorts level as a discrete variable and enzyme level as a continuous variable. No significant interactions occurred between wheat shorts level and enzyme level. Increasing wheat shorts from 10 to 20% numerically reduced energy digestibility with $0.99 \pm 0.65\%$ ($P = 0.13$) without affecting nitrogen digestibility ($P = 0.48$), and when increased from 20 to 30%, energy digestibility was reduced with $3.23 \pm 0.65\%$ and nitrogen digestibility was decreased $1.29\% \pm 0.55$ ($P < 0.05$). Xylanase linearly increased nitrogen and energy digestibility of the diets within the range tested, with an increase in digestibility for energy of $0.37 \pm 0.09\%$ and for nitrogen of $0.22 \pm 0.08\%$ for each IU enzyme per g of feed ($P < 0.05$). Interestingly, xylanase decreased both the indigestible nitrogen and energy with approximately 1.2% for each IU enzyme per g of feed. Results from this experiment indicate that increasing wheat shorts inclusion from 20 to 30% has a negative effect on digestibility of energy and nitrogen. Xylanase improved the digestibility of both nitrogen and energy in a linear fashion. In conclusion, the in-feed xylanase improves the digestibility of both nitrogen and energy in high wheat swine diets containing between 10 to 30% inclusion of wheat shorts.

Key Words: Swine, Digestibility, Xylanase

756 Use of feed processing technologies and diet formulation strategies to maximize digestibility and minimize excretion of nutrients in finishing pigs. D. J. Lee^{*}, J. D. Hancock, J. M. DeRouchey, C. A. Maloney, and D. W. Dean, Kansas State University, Manhattan.

Six crossbred barrows (70 kg average BW) were used in a repeated 2 x 2 Latin square design to determine the effects of feed processing technologies and diet formulation strategies on nutrient utilization. A corn (ground to a mean particle size of 900 microns)-soybean meal-based diet, formulated to 16.5% CP, 0.55% Ca, and 0.50% P, was used as the control. A low-excretion diet was formulated to 13.4% CP (with added lys, thr, met, and trp), 0.45% Ca, and 0.40% P. Also, this diet had 5% soybean oil and the vitamin and trace mineral premixes were omitted. To enhance nutrient digestion in this diet, the corn was ground to a mean particle size of 600 microns and the diet was steam conditioned (82°C), expander processed (cone pressure of 14.1 kg/cm²), and pelleted (diameter of 4.8 mm). Finally, phytase (500 FTU/kg) was sprayed onto the cooled pellets. In this 14-d experiment, initial and final BW were not different for pigs fed the control vs the low-excretion diet ($P > 0.27$). Dry matter intake was similar for pigs fed the two diets ($P > 0.07$) but DM excretion was decreased by 35% for pigs fed the low-excretion diet ($P < 0.001$). Nitrogen intake and excretion were decreased ($P < 0.003$) by 22 and 39% and P intake and excretion by 27 and 51% ($P < 0.002$)

for pigs fed the low-excretion diet. Apparent ileal digestibilities of lysine and threonine were increased by 11 and 18% ($P < 0.02$) and DE and ME were increased by 11 and 12% ($P < 0.004$) for pigs fed the low-excretion vs the control diet. Our data indicate markedly desirable effects on digestibility and excretion of nutrients from currently available processing technologies and diet formulation strategies.

Item	Control	Low excretion	SE
DM intake, g/d	2,064	2,128	18
DM excreted, g/d	477	311	5
N intake, g/d	73.1	56.9	0.6
N excreted, g/d	43.1	26.2	1.8
P intake, g/d	12.4	9.1	0.1
P excreted, g/d	10.5	5.1	0.3
Ileal lys dig, %	79.0	88.3	1.7
Ileal thr dig, %	64.4	78.5	2.2
DE of the diet, kcal/kg	3,657	4,117	17
ME of the diet, kcal/kg	3,181	3,617	51

Key Words: Pig, Digestibility, Nutrient excretion

757 Dietary factors are additive in reducing in vitro ammonia emission from pig manure. G.C.M. Bakker^{*1} and M.C.J. Smits², ¹ID TNO Animal Nutrition, Lelystad, ²IMAG, Wageningen.

In the past the effects of dietary factors on ammonia emission from pig manure have been studied separately and not in combination. Therefore, in the present study it was hypothesized that the effects of the tested dietary factors on ammonia emission are additive. Of each of the four dietary factors three levels were studied: crude protein (142, 161 and 180 g/kg), calcium sulfate (0, 9 and 18 g/kg), dietary fiber (129, 189 and 245 g/kg) and fermentable fiber (62, 83 and 104 g/kg). The number of $3^4=81$ potential dietary combinations was reduced to 26 by using a fractional design for the study, the Box-Benhken design. This design allowed quantifying linear and quadratic main effects and two-way interactions, whereas from the more complex interactions only qualitative information could be obtained. The 26 diets contained similar amounts of ileal digestible amino acids, minerals and net energy. In total 39 individually housed pigs were used; two diets were tested more than once for determining standard deviation. All pigs were allowed a 3-week adaptation period and received similar amounts of water and energy. Their mean weight during the test period was 70 kg. In a 5-day period feces and urine were collected and mixed as slurry. A sample from this slurry was placed in an in vitro system to determine the cumulative ammonia emission for 7 days. Results on ammonia emission showed only linear main effects of the dietary factors; there was no evidence for quadratic or interaction effects. Of the four feed components, only dietary fiber had no effect on ammonia emission. The equation was: cumulative ammonia emission (g per 7 d) = $-5.67^{***}(0.678) + 0.058^{***}(0.0035) \times \text{protein content} - 0.052^{***}(0.0073) \times \text{calcium sulfate} - 0.011^{***}(0.0037) \times \text{fermentable fiber}$; R-square = 93.2; all feed factors in g/kg. We concluded that the effects of the dietary factors on ammonia emission are additive. However, these in vitro results need to be validated under pig house conditions, where excretion patterns, floor pollution and climate, especially air flow dynamics are included.

Key Words: Ammonia emission, Dietary factors, Pig manure

758 Effect of dietary crude protein level and fiber sources on nitrogen excretion patterns of grower pigs. S. Zervas^{1,2} and R.T. Zijlstra^{*1}, ¹Prairie Swine Centre Inc., ²University of Saskatchewan, Saskatoon, Canada.

Successful nitrogen (N) management is important for sustainable pork production. Effects of dietary CP (high, 18.5%; low, 15.6%) and fiber sources (control, soybean hulls (SH; 15%), and sugar beet pulp (SBP; 20%) on N-excretion patterns were studied in a 2x3 factorial arrangement. Diets were formulated to 3.3 Mcal DE/kg and 2.4 g dLys/Mcal, supplemented with Lys, Met, Trp, Thr, Ile, and Val to maintain a similar content of digestible AA. Pigs (30.5 \pm 3 kg; n = 30) were housed in confinement-type metabolism crates, with restricted access to feed (3 x maintenance DE) from d 1 to 18, and free access to feed from d 19 to 26. Feces and urine were collected from d 15 to 18 and d 23 to 26, and blood on d 25. With restricted access to feed, feces N (as % of N intake) was increased 3% for low vs high CP, and increased 5% for SH and 7%

for SBP compared to control ($P < 0.05$); urine N was reduced 5% for low vs high CP, and reduced 4% for SH and 8% for SBP compared to control ($P < 0.05$). Retention of N (in g/d) was reduced 12% for low vs high CP (17 vs 19 g/d; $P < 0.05$), and similar among fiber treatments ($P > 0.10$). With free access to feed, feces N (as % of N intake) was increased 3% for low vs high CP, and increased 6% for SH and 9% for SBP compared to control ($P < 0.05$); urine N was reduced 6% for low vs high CP, and reduced 8% for SH and 10% for SBP compared to control ($P < 0.05$). Retention of N (in g/d) was similar for CP levels (29 g/d; $P > 0.10$), and reduced for SH (27 g/d; $P < 0.05$) compared to control (31 g/d), and intermediate for SBP (29 g/d). Plasma urea was correlated to urine N ($R^2 = 0.69$; $P < 0.001$). Reduction of dietary CP reduced urine N, and fiber sources high in fermentable fiber shifted N excretion from urine N to feces N. Level of feed intake is an important consideration when effectiveness of a nutrient management strategy is studied. Diets with a low CP and containing synthetic AA should be studied using pigs with free access to feed to verify that nitrogen retention is maintained.

Key Words: Pig, Nitrogen excretion, Fiber

759 Efficacy of betaine as a carcass modifier in finishing pigs fed normal and low protein diets supplemented with amino acids. L. A. Pettey^{*}, G. L. Cromwell, M. D. Lindemann, J. H. Randolph, H. J. Monegue, K. M. Laurent, G. R. Parker, and R. D. Coffey, University of Kentucky, Lexington.

Three experiments were conducted to determine if betaine would overcome the reduced carcass leanness often associated with feeding low protein, AA supplemented diets to pigs. Exp. 1 and 2 involved 192 pigs (10 reps of five pigs/pen) from 53 to 113 kg BW. Diets 1 and 3 were fortified corn-soy with adequate CP (16% to 85 kg, then 14.5%) or low CP (12%, 10.5%) with added lys (0.30%), thr (0.08%), and trp (0.03%). Diets 2 and 4 were the same as 1 and 3 except betaine was included at 1.14 g/kg (0.125% Betafin[®] [Finnfeeds Intl., Ltd, Marlborough, U.K.]). Lys levels in all diets during the two phases were 0.80 and 0.70%. All pigs were scanned by real-time ultrasound at 110 kg. ADG, feed/gain (F/G), 10th rib backfat (BF), and estimated carcass lean for pigs fed diets 1-4 were: 916, 918, 857, 882 g; 3.48, 3.53, 3.66, 3.50; 23.2, 22.1, 23.7, 23.4 mm; 52.9, 53.6, 52.6, 52.9%. Low CP resulted in slower gains, more BF, and reduced carcass lean ($P < 0.05$). Betaine improved F/G in pigs fed low CP ($P < 0.05$) and improved leanness in pigs fed adequate CP ($P < 0.05$). In Exp. 3, 180 pigs (six reps of five pigs/pen; 37 to 117 kg) were fed diets with (1) adequate CP during three phases (17.5/15.5/13.5%), (3) reduced CP (16/14/12%) with added lysine (0.15%), or (5) low CP (14.5/12.5/10.5%) with lys (0.30%), thr (0.08%), and trp (0.03%). CP levels were changed at 56 and 84 kg BW. Three other diets (2, 4, and 6) were as 1, 3, and 5 but with betaine. Lys levels during the three phases were 0.90, 0.80, and 0.70%. All pigs were scanned at 114 kg. ADG, F/G, BF, and carcass lean for pigs fed diets 1-6 were: 943, 955, 948, 934, 950, 930 g; 2.86, 2.94, 2.94, 2.93, 2.96, 2.87; 20.9, 21.2, 21.1, 21.5, 22.4, 21.6 mm; 53.9, 53.6, 53.9, 53.4, 53.0, 53.7%. Performance was unaffected by diet. Carcasses tended to be fatter with less lean in pigs fed low CP, and this appeared (ns, $P = 0.10$) to be alleviated with betaine. In this study, the effects of betaine on performance and carcass leanness in pigs were inconsistent.

Key Words: Pigs, Betaine, Amino acids

760 Descriptive flavor analysis of bacon and pork loin from lean-genotype gilts fed conjugated linoleic acid. L. Averette Gatlin^{*}, D.K. Larick, M.T. See, and J. Odle, North Carolina State University Raleigh.

Conjugated linoleic acid (CLA) supplementation has previously been demonstrated to increase firmness of pork bellies. However, effects of CLA on flavor of pork have not been described. This study evaluated the combined effects of dietary CLA and supplemental fat (SF) on organoleptic characteristics of bacon and pork loin samples. Lean-genotype gilts (49.3 kg; n=48) were randomly assigned to a 2 x 3 factorial arrangement of supplemental fat level and linoleic acid supplementation for the final 47d of finishing. Supplemental fat treatments included 0%, 4% yellow grease (YG), and 4% tallow (T). Linoleic acid (LA) treatments included 1% corn oil (CO) or 1% CLA (CLA-60, Natural Lipids, Norway). Lysine:calorie ratio was constant in all diets. A trained six-member sensory panel developed a flavor profile on commercially cured bacon samples (12 descriptors) and center-cut boneless pork loin chops (19 descriptors) using a 14-point universal intensity scale. Samples were

vacuum packaged and stored at -7 °C, then thawed in a refrigerator 20 to 24 h and cooked immediately prior to analysis. Bacon samples from pigs fed 4% SF were considered to have a sweeter flavor (4.07 .07) than those fed 0% SF (3.89 .07; $P < .04$). The intensity of salty flavor was higher in bacon samples from pigs fed CO (6.18 .09) compared to those fed CLA (5.86 .10; $P < .02$). The intensity of salty aftertaste was greater when CO was combined with YG (5.21 .14; $P < .07$) or T (5.44 .14; $P < .01$) than CO alone (4.85 .14) but SF combined with CLA was not different from CLA alone (SF * LA; $P < .02$). Sour flavor intensity tended to be lower in loin samples from pigs fed CLA than from those fed CO (1.60 vs 1.73 .06; $P < .09$). Samples from animals fed 4% T tended to have slightly lower ($P < .09$) notes of astringent aftertaste (1.42 .08) compared to those fed 0% SF (1.62 .09) or 4% YG (1.66 .09). In summary, minimal differences in flavor descriptors determined by the sensory panel were detected. Panel results indicate consumer acceptance of bacon and pork products from pigs fed CLA will not differ from commodity pork products.

Key Words: Conjugated Linoleic Acid, Pork flavor, Bacon

761 Effect of dietary betaine supplementation on energy partitioning in pigs. J.W. Schrama¹, P.H. Simmins², and W.J.J. Gerrits^{*1}, ¹Wageningen Institute of Animal Science, Wageningen University, Wageningen, The Netherlands, ²Finnfeeds International Ltd, Malborough, UK.

The effect of dietary betaine supplementation on energy partitioning in pigs was studied. Six groups of 14 group-housed barrows were assigned

to one of two dietary treatments: control or betaine supplemented (1.25 g Betafin[®] per kg of feed). The experimental diets were maize and soy-bean meal-based. Diets were aimed to be limiting in energy content and sufficient in protein. The experiment consisted of a 3-wk adaptation and a 3-wk experimental period. Initial BW was 46 kg during the experimental period, when each group of pigs was housed in a climate respiration chamber. During the experimental period, pigs were offered changed diets, which were diluted with 10% oat hulls. Pigs were fed at 2.5 times the energy requirements for maintenance. During the experimental period, heat production, energy and nitrogen balances were measured weekly. The metabolizable energy intake was unaffected by dietary betaine supplementation ($P > 0.10$). Averaged over the experimental period, betaine supplementation reduced heat production ($5 \text{ kJ} \cdot \text{kg}^{-0.75} \cdot \text{d}^{-1}$, $P < 0.05$). Moreover, this difference between diets increased with time within the experimental period ($P < 0.05$). Averaged over the 3-wk period, energy retention was increased ($P < 0.10$) and energy requirements for maintenance were decreased ($P < 0.10$) in pigs fed the betaine supplemented diet. However, the effect of betaine on the energy requirements for maintenance changed with time ($P < 0.05$). Maintenance requirements were similar in Week 1 and were reduced by betaine supplementation by 5.5% during Week 3 (477 vs. 452 $\text{kJ} \cdot \text{kg}^{-0.75} \cdot \text{d}^{-1}$). The current results showed that betaine supplementation affected energy partitioning of growing pigs. This effect was not due to a methionine sparing effect of betaine, because diets were formulated to be sufficient in amino acid as well as choline.

Key Words: Pigs, Betaine, Energy metabolism

ASAS Swine Species

762 ECG-gated dynamic MR examination of pig heart. Robert Romvari¹, Imre Repa¹, Zsolt Petrasi¹, Gabor Bajzik¹, Bela Fenyves², and Peter Horn^{*1}, ¹Kaposvar University, Faculty of Animal Science, Diagnostic Institute, ²Szent Istvan University, Faculty of Veterinary Science, Department and Clinic of Surgery.

The selection of pigs for high lean meat production plays an important role in the disadvantageous changes of the circulatory system. In pork production cardiovascular disorders mean serious problems during fattening, namely 14 to 18 % of the total deaths have a circulatory background.

For in vivo examination of the porcine heart, dynamic MR imaging methodology was developed. Measurements were carried out on 15 meat type pigs (22 or 106 kg) using a Siemens Magnetom Vision Plus type equipment of 1.5 T magnetic-field strength.

Regarding the motion sensitiveness, inhalation anaesthesia was applied, then ECG-gating synchronised the data acquisition with the pulsation of the heart. At first quick images were made to locate the heart according to the co-ordinate system of the body. Following in the sagittal, coronal and transversal planes localisation images were taken to allocate the longitudinal axis of the heart. Finally, depending on the heart frequency and on the size of the heart, in each case 8 to 10 slices and in each slice 8 to 14 cine images were acquired prospectively according to one heart cycle.

The means of traits measured in ml at 22 and 106 kg liveweight, respectively were; left ventricular end-diastolic volume: 51.4 vs. 125.7, left ventricular end-systolic volume: 24.4 vs. 60.1, left ventricular stroke volume: 27.0 vs. 65.6, right ventricular end-diastolic volume: 55.7 vs. 118.4, right ventricular end-systolic volume: 28.6 vs. 52.5, right ventricular stroke volume: 27.1 vs. 65.9. The left ventricular ejection fraction: 52.5 vs. 52.2 and the right ventricular ejection fraction: 48.7 vs. 55.7 were given in percentage. The cardiac output values were 3.5 l (22 kg, 132 beat/min.), and 6.0 l (106 kg, 91 beat/min.), respectively. The contraction values were also determined by the septum (70%), and by the anterior (61%), posterior (41%) and lateral (54%) walls.

Based on the investigation, the preconditioning, the narcotic procedure, the specific details of ECG measuring (i.e. proper signal transmission) and the correct MR imaging were worked out. After our results we declare this methodology as a well applicable one in the quantitative measurement of the heart, where each investigation takes 30 to 40 minutes.

Key Words: pig, heart, magnetic resonance imaging

763 A comparison of methods of editing and adjusting feed intake data from electronic swine feeders. D.S. Casey^{*} and J.C.M. Dekkers, Iowa State University, Ames, Iowa.

Data from electronic swine feeders contain errors that must be identified, edited, and replaced. The objective of this study was to compare the accuracy of six methods of editing and replacing missing data to estimate daily (DFI) and average daily feed intake (ADFI) in short and long test periods. Data from FIRETM feeders on 591 pigs from the National Pork Producers Council's Maternal Line Genetic Evaluation Program were used. Errors in each visit were identified using 16 criteria. To create an error-free data set as a basis for comparison, data from 124 pigs with few errors were selected and visits with errors were replaced by error-free visits from the same pig. Resulting DFI and ADFI were assumed to be the true trait values. Error visits were then introduced to create long test period data (average 12 weeks), representative of real data. The last 4 weeks per pig were used to create short test period data. Data were edited using 6 methods (EM1-6). For EM1, a DFI record was deleted if $\text{DFI} < 1000\text{g}$ or $> 4500\text{g}$. For EM2-6, the 16 criteria were used to identify errors in each visit. For EM2 and 3, all DFI records with ≥ 1 and ≥ 2 error visits were deleted. For EM4-6, DFI was obtained by summing feed intake over error-free visits. For EM5 and 6, DFI records were then adjusted for the effects of presence of error visits on unadjusted DFI, which were estimated from a linear model analysis of the complete data set (591 pigs) for EM5 or from the data sets being edited (124 pigs) for EM6. For EM1-4, missing DFI records were replaced by linear or quadratic regression estimates of DFI on test day for each pig. DFI and ADFI from the edited data sets were correlated to true values. Correlations were high (.89 to .99) for both traits for all editing methods except EM1. EM6 had the highest correlations for DFI in both test periods ($\geq .96$). EM2 and EM6 had the highest correlations for ADFI (.98 to .99). EM1 had the lowest correlations for both traits and test periods (.76 to .94). Results indicate that editing methods affect the accuracy of data from electronic feeders. EM6 is recommended for maximum accuracy.

Key Words: Swine, Feed Intake, Editing Methods

764 Effects of piglet birth weight and liquid milk replacer feeding during lactation on pig performance to slaughter weight. B. F. Wolter^{*}, M. Ellis, B. P. Corrigan, and J. M. DeDecker, University of Illinois, Urbana, IL.

The effects of piglet birth weight and liquid milk replacer feeding during lactation on growth performance to slaughter was evaluated in a study