

and LEAN%: $R^2=.76$ ($\sqrt{\text{MSE}}=3.77$) for USDA. Slightly higher relationships exist for LVG (FAT%: $R^2=.85$, $\sqrt{\text{MSE}}=1.6$; LEAN%: $R^2=.84$, $\sqrt{\text{MSE}}=1.65$; BM%: $R^2=.38$, $\sqrt{\text{MSE}}=1.9$). In addition, there is a high agreement between DXA fat% and chemical lipid% (IV: $R^2=.84$, $\sqrt{\text{MSE}}=1.94$, USDA) or dissection fat% (IV: $R^2=.74$, $\sqrt{\text{MSE}}=1.70$, LVG). The observed site differences in the relationship between *in vivo* (IV) and carcass (C) results may depend on several factors like different genetic material (distribution of fat tissue within the body), software versions, beam hardening due to 'age' differences of the DXA scanners, feeding, and housing conditions. Though, there is a moderate to high general agreement between *in vivo* and carcass results, site-specific constraints have to be considered in multi-site studies using comparable DXA scanners.

Key Words: Dual energy x-ray absorptiometry, Body composition, Accuracy

383 Development and evaluation of a growth model to assist individual cattle management. L. O. Tedeschi* and D. G. Fox, *Cornell University, Ithaca, NY 14853.*

A deterministic and mechanistic growth model was developed to dynamically predict growth rate, accumulated weight, days required to reach target body composition, carcass weight and composition of individual beef cattle for use in individual cattle management systems. Two iterative methods based on gain composition were derived to compute the efficiency of metabolizable energy to net energy for growth. This growth model was evaluated with data from 362 individually fed steers with measured body composition and feed energy values predicted with the NRC (2000). The model accounted for 89% of the variation with bias of -2.6% in predicting individual animal ADG and explained 83% of the variation with bias of -1% in estimating the observed weight at the actual total days on feed. When ADG was known, the growth model predicted the dry matter required for that ADG with a bias of 2% and r^2 of 74%. A sub-model was developed to predict accumulated body fat (FAT) for use in predicting carcass quality and yield grades during growth. This sub-model explained 84% of the variation and had a bias of -14.3% in actual body fat when animal ADG was known. Additionally, an equation developed with 407 animals to predict yield grade from empty body fat (% of empty BW) had an r^2 of 0.49. Equations developed to predict carcass weight from empty BW that adjust for stage of growth accounted for 89% of the variation with a bias of 3 kg. We conclude this growth model can be used to predict ADG, BW, days required to reach a target body composition, dry matter required, and carcass weight of individual growing beef cattle with an acceptable degree of accuracy.

Key Words: Modeling, Simulation, Marketing

384 A feedlot model: predicting carcass quality and yield grade at re-implant time using real-time ultrasound. P. B. Wall*, G. H. Rouse, D. E. Wilson, R. G. Tait, and W. D. Busby, *Iowa State University Ames, IA.*

Commercial feedlot steers ($n=404$) were serially scanned using Real-Time Ultrasound (RTU) at 30-day intervals from re-implant time until slaughter. Cattle were evaluated for rump fat depth, longissimus muscle area (REA), 12th rib fat thickness (FTK), and percent intramuscular fat (%IMF) to determine the predictability of carcass composition at extended periods before slaughter. Additional background information

on the cattle, such as weight, gain, breed of sire, implant, and frame score was also utilized. Carcass data was collected by trained personnel at "chain speed," and samples of the 12th rib longissimus muscle were taken for ether extract analysis to determine %IMF estimates. Simple correlation coefficients showed moderately high positive relationships between RTU measures taken less than 7 days before harvest and carcass measures: REA ($r=.66$); FTK ($r=.74$); and %IMF ($r=.61$). Correlation coefficients for RTU measures taken 96- 105 days before harvest and carcass values were: REA ($r=.52$); FTK ($r=.58$); and %IMF ($r=.63$). Regression equations were then developed for the carcass measurements; 46% of the variation could be explained for REA, 40% of FTK and 45% of marbling at re-implant time. Average daily gain ($p<.01$) and frame score ($p<.10$) were significant predictors of REA. RTU 12th rib fat and rump fat were significant predictors of FTK ($p<.0001$). When predicting pre- slaughter ultrasound measures, R-squared values were higher for REA ($R^2=.64$), FTK ($R^2=.62$), and %IMF ($R^2=.46$). Additional regressions at 60-70 days and 30-40 days before harvest showed similar results, with R-squared values logically explaining more of the variation towards the slaughter date. Live ultrasound measure is a viable option for assessing carcass composition at re-implant time and predicting final quality and yield grades. These models may allow feeders to make marketing decisions in multiple phases of the feeding period.

385 Phenotypical characterisation regarding growth, hormones, and meat quality in bulls of two types of cattle as a source for segregating family structures. O. Bellmann*, J. Wegner, F. Schneider, F. Teuscher, and K. Ender, *Research Institute for the Biology of Farm Animals.*

The physiological and genetical background for transforming nutrients into body fat in secretion type of cattle or into body muscle in accretion type of cattle is still unknown. For that reason, we designed a study of segregating family structures using a population of Charolais (CH) cattle as a model for the accretion type and a population of German Holstein (H) cattle as a model for secretion type of cattle. In a first step the P0-generation was characterised phenotypically. The results presented in this paper were obtained from bulls starting at birth up to slaughter (18 months of age). 13 bulls of each metabolic type (CH and H) were raised using a tethering system with individual feeding. Samples of the semitendinosus muscle were taken by shot biopsy at 6, 8, 10, 13, and 16 months of age. Blood samples were taken by a single injection from the jugular vein on the same days as the muscle biopsy but prior to both biopsy sampling and feeding. At nine months of age blood sample collection in a frequent manner was started. At this time growth rate was at maximum, i.e. the transformation of nutrients into accreted protein and fat was at high levels. CH bulls did show higher body weights and the carcass contained more muscle protein and less fat than H bulls did. The higher body weight of the CH bulls is linked with higher muscle fiber cross section area. No differences were seen in the fiber type frequencies. The average plasma concentration of growth hormone did not differ, but differences in pulse frequency (CH 4.7 vs. H 3.5 pulses/6h) and amplitude were observed (CH 6.3 vs. H 10.1 ng/mL). Plasma concentrations of insulin, glucagon, and leptin also differed (insulin: CH 18.7 vs. H 28.1 U/mL; glucagon: CH 82.3 vs. H 120.8 pg/mL; leptin: CH 2.4 vs. H 3.0 ng/mL). The results suggest that different genetic based utilization of nutrients leads to pronounced protein synthesis in CH and elevated fat synthesis in H to meet the episodic energetic demands during lactation in this type.

Key Words: Cattle, Growth, Development

Nonruminant Nutrition: Minerals and vitamins

386 WITHDRAWN. , .

387 Effects of dietary L-carnitine on semen characteristics in boars. D. M. Kozink, M. J. Estienne, A. F. Harper*, and J. W. Knight, *Virginia Polytechnic Institute and State University, Blacksburg, VA.*

The objective was to determine the effects of dietary L-carnitine on semen characteristics in boars. In Exp. 1, terminal-line boars (270 d of age) were fed daily a control diet ($n = 9$) or the control diet with L-carnitine (500 mg/d; Carniking; Lonza, Inc., Fairlawn, NJ) ($n = 9$). Semen was collected weekly from wk 0 to 15 and on four consecutive days

during wk 16. For the weekly collections, there were no effects of treatment or treatment x time ($P > 0.1$) for gel-free volume (148.0 ± 3.3 mL), or total (55.9 ± 1.4 billion), morphologically normal (85.3 ± 0.7 %), or motile (87.2 ± 0.7 %) spermatozoa. Sperm concentration (billion/mL) was affected by treatment ($P = 0.08$; controls: 0.42, L-carnitine: 0.36, $SE = 0.02$) but not by treatment x time ($P > 0.1$). During the intensive collections, volume and total spermatozoa were not affected ($P > 0.1$) by treatment or treatment x time. Sperm concentration (billion/mL) was affected by treatment ($P = 0.08$; controls: 0.28, L-carnitine: 0.23, $SE = 0.02$) but not by treatment x time ($P > 0.1$). Experiment 2 was similar to Exp. 1 except boars ($n = 10$ /treatment) were 525 d of age.

For the weekly collections, there were no effects of treatment or treatment \times time ($P > 0.1$) for volume (165.1 ± 2.3 mL), or total (47.8 ± 1.1 billion) or motile (72.4 ± 0.7 %) spermatozoa. Sperm concentrations were similar between groups at wk 0 (0.18 ± 0.03 billion/mL) but from then on were generally higher for L-carnitine-treated boars (treatment \times time, $P < 0.01$). During the intensive collections, volume was affected by treatment ($P = 0.07$; controls: 176.4, L-carnitine: 144.5, SE = 12.1) but not treatment \times time ($P > 0.1$). Sperm concentration was affected by treatment \times time ($P < 0.01$), with concentrations being higher for L-carnitine-treated boars on d 0, 1, and 2, but not 3 (0.12 ± 0.07 billion/mL). Total spermatozoa was not affected by treatment or treatment \times time ($P > 0.1$). Overall, there were no consistent positive effects of dietary L-carnitine supplementation on semen characteristics in boars.

Key Words: L-carnitine, Semen, Boars

388 Vitamins B9 (folic acid), B12 and methionine in growing-finishing pigs. A. Giguere*, C. L. Girard, and J. J. Matte, *Agriculture and Agri-Food Canada, Lennoxville (QC), Canada.*

The utilization of dietary methionine and its modulation by the supply in vitamins B9 and B12 was investigated in growing-finishing pigs using criteria such as growth performance, serum vitamin B12, sulfur amino acids and antioxidant status. Seventy eight pigs (37.8 ± 0.4 kg) were distributed in 13 repetitions of six factorial treatments with (M) or without (C) a dietary addition of 0.2 % synthetic DL-methionine (Met) and 3 combinations of dietary additions of vitamins B9 (ppm) and B12 (ppb), respectively, 0 and 0 (V1), 10 and 25 (V2) and 10 and 150 (V3). The basal corn-soybean meal diet contained 0.25 and 0.28% of Met (0.32 and 0.27% of cysteine (Cys)) for growing and finishing periods, respectively. Growth performance was recorded and blood samples were collected every 2 wk during 8 wk for determinations of serum B12, homocysteine (Hcy), Met, Cys, FRAP (as total antioxidant activity) and TBARS (as an index of oxidative stress). During the growing period (0 to 4 wk), ADG tended to be higher ($P < 0.08$) in M than in C pigs (1.07 ± 0.02 vs 1.02 ± 0.02 kg/day, respectively), an effect probably related to a decrease ($P < 0.05$) of feed conversion ratio (2.35 ± 0.03 and 2.43 ± 0.04 for M and C pigs, respectively). During the finishing period (4 to 8 weeks), ADG tend to be higher ($P < 0.07$) in V2 than in V1 pigs (1.10 ± 0.03 and 1.04 ± 0.02 kg/day, respectively), and apparently linked to an increase ($P < 0.05$) in ADFI (3.10 ± 0.06 to 3.28 ± 0.08 kg/day for V1 and V2 pigs, respectively). There was no treatment effect on profiles of serum Cys ($P > 0.13$), Met ($P > 0.12$), FRAP ($P > 0.15$) and TBARS ($P > 0.17$). Plasma B12 was increased ($P < 0.01$) (137.7 ± 4.8 , 185.3 ± 6.4 , 212.3 ± 9.0 nM for V1, V2 and V3 pigs, respectively) and Hcy was decreased ($P < 0.01$) (23.6 ± 0.5 , 19.9 ± 0.6 , 18.1 ± 0.5 μ M for V1, V2 and V3 pigs, respectively) by the vitamin treatments. There was no interaction between Met and vitamin treatments whatever the criteria. Additional Met, during the growing period, and supplements of B9 and B12, during the finishing period, appeared beneficial for growth performance. The importance of the Hcy response to B9 and B12 remained to be further investigated on other aspects of metabolism in pigs.

Key Words: Vitamins, Methionine, Pigs

389 Transport of zinc chloride radiotracer in small intestine brush border membrane vesicles prepared from weanling pigs. C. E. Huntington*¹, D. W. Bollinger¹, J. S. Morris², and T. L. Veum¹, ¹University of Missouri, Columbia, MO USA, ²University of Missouri Research Reactor Columbia, MO USA.

This study was conducted to measure the transport of Zn into a pig intestinal brush border membrane vesicle (BBMV) preparation using radiolabeled Zn with cellulose as the carrier. Fresh samples of duodenum, jejunum and ileum were obtained from the small intestines of five crossbred pigs at 21 days of age. The BBMV were prepared using a magnesium chloride aggregation method. Assays for two apical enzyme markers, sucrase and alkaline phosphatase, were used to determine the purity of the BBMV. An increase in the marker enzymatic activities in the BBMV indicates an increase in the markers relative to crude lysate. An *in vitro* procedure designed to simulate the digestive system of the pig (Liu et al., 1998; Tsunoda et al., 2001) was used to 'digest' the sample prior to BBMV uptake studies. Preliminary trials with non-radiolabeled Zn found effective digestion of Zn with cellulose carrier between 0.25-0.5 g. Based on these results, we conducted transport assays at 2.0 and 10.0 ppm Zn as ZnCl₂ with ⁶⁵Zn radiotracer using the

BBMV to determine Zn uptake. T_{1/2} of Zn uptake in duodenum was between 1.0 and 2.5 minutes. Maximal duodenal uptake at 2.0 and 10.0 ppm Zn was ~12.0 and 27.0 nmol Zn/mg protein, respectively. In the jejunum, T_{1/2} of Zn uptake was less than 1 minute. Maximal jejunal uptake at 2.0 and 10.0 ppm Zn was ~3.5 and 9.0 nmol Zn/mg protein, respectively. T_{1/2} of Zn uptake in ileal vesicles was between 1.0 and 2.5 minutes. Maximal ileal uptake at 2.0 and 10.0 ppm Zn was ~6.0 and 25.0 nmol Zn/mg protein, respectively. This suggests that BBMV from the duodenum and the ileum have a higher capacity for Zn uptake than the jejunum. This *in vitro* technique will allow us to determine if the rate of Zn transport in BBMV is affected by dietary source and concentration of Zn, factors that are important in minimizing supplementation and reducing excretion in manure.

Key Words: Weanling pigs, Zinc transport, Small intestine

390 Available phosphorus requirement to maximize growth and bone mineralization in 24 to 50-kg pigs. R. W. Fent*¹, G. L. Allee¹, D. M. Webel², J. D. Spencer², A. M. Gaines¹, D. C. Kendall¹, and J. W. Frank¹, ¹University of Missouri-Columbia, ²United Feeds Inc., Sheridan, IN.

Eighty barrows initially weighing 23.7 kg BW were utilized in a 30-d feeding experiment to determine the dietary available phosphorus (aP) concentration that maximizes growth performance and bone mineralization. Prior to experimentation, pigs received dietary aP concentrations as recommended by NRC (1998) from weaning to 24 kg BW. Pigs were individually penned and allotted by weight to one of eight dietary treatments in a completely randomized design with eight replications per treatment. Experimental diets were formulated with varying concentrations of aP (0.075% to 0.425% at 0.05% increments) by the addition of monosodium phosphate (MSP). All diets were corn-soybean meal-based (1.15% true digestible lysine) and formulated to a fixed 1.2:1 calcium:total P ratio. The basal diet contained no added MSP. Average daily gain (ADG) was measured and feed intake calculated at the end of the 30-d test period. Breaking load and ash content of the left fibula were also determined on all pigs at termination of the experiment. ADG increased quadratically ($P < 0.05$) as aP concentration increased in the diet. Average daily feed intake (ADFI) and gain:feed increased linearly ($P < 0.01$) as aP concentration increased in the diet with ADFI having a tendency to increase quadratically ($P = 0.09$). Bone breaking load, grams of fibula ash, and percentage of fibula ash increased quadratically ($P < 0.01$) as dietary aP concentration increased. Two-slope regression was performed to estimate dietary aP requirements. Although the growth responses to increasing aP did not lend itself to accurate break-point analysis, the point of inflexion for bone breaking load and grams of fibula ash both occurred at 0.32% dietary aP concentration. These results indicate a dietary aP requirement of 0.32% for maximal bone mineralization for the 24 to 50-kg pig.

Key Words: Phosphorus, Pigs, Bone

391 Effect of dietary available/digestible phosphorus regimen on P and N utilization in pigs. T. S. Stahly* and T. R. Lutz, *Iowa State University, Ames.*

Pigs were self-fed diets containing .2, .3, .4, .5, .6 or .7% bioavailable P (aP, based on analyzed P \times % availability [NRC, 1998] of P in each ingredient) from 7 to 32 kg BW. Fifteen sets of six littermate barrows were allotted within litter to one of six P regimens consisting of a basal, corn-soy-whey diet (.56% analyzed P) supplemented with incremental additions of dicalcium phosphate at the expense of starch-limestone. Dietary calcium was either fixed in each of 6 diets at 1.15% (1.1 to 1 Ca/total P ratio in highest P diet) or adjusted in each diet to achieve a 2.5 to 1 Ca/aP ratio. P and N digestibility and accretion were determined in each pig for 4 days at BW (± 1.3 kg) of 10 and 30 kg. Digestible dietary P (dP) was determined to be .32, .42, .51, .56, .63 and .70% for the six P regimens. The P digestibility values for the basal and dical P were 1.6 and .7 times, respectively, of the bioavailable reference values. Daily body P accretion (3.1, 4.1, 5.1, 5.5, 5.6, 6.0 g, $P < .01$) and N accretion (22.6, 24.2, 26.2, 26.0, 23.5, 25.2 g, $P < .03$) increased but at a diminishing rate (quadratic response) as dietary concentrations of dP increased (pooled across Ca/P regimen and BW). The magnitude of responses in P accretion to increased dP was greater ($P < .05$) in 2.5/1 Ca/aP regimen and at 10 kg BW. The P (5.0, 6.6, 7.9, 8.1, 8.1, 8.7 g/kg) and N contents of BW gain and the ratio of P to N accrued in the body also increased but at a diminishing rate (quadratic dP, $P < .03$) as dP

concentrations increased with the greatest responses in body P contents occurring in the 2.5/1 Ca/aP regimen and at 10 kg BW. Based on these data, the dietary dP concentration needed to optimize accretion of proteinaceous tissues as well as efficiency of phosphorus utilization in 10 to 30 kg pigs is .48-.53% in both Ca/P regimens. But, the biological response (i.e. accretion-excretion of P) to ingestion of higher amounts of dP is dependent on the dietary Ca/dP regimen which influences whether the additional dP is retained (likely in bone because N accretion not altered) or excreted in urine.

Key Words: Phosphorus, Nitrogen, Calcium

392 Evaluation of EcoPhos™ phytase in growing pigs weighing 36 to 56 kg. R.W. Fent*¹, D.M. Webel², J.D. Spencer², T.S. Torrance², B.W. Ratliff¹, and G.L. Allee¹, ¹University of Missouri-Columbia, ²United Feeds Inc., Sheridan, IN.

Sixty-four barrows initially weighing 35.7 kg BW were utilized in a 24-d feeding experiment to examine the phosphorus-releasing efficacy of increasing dietary concentrations of phytase (EcoPhos™, Phytex LLC, Portland, ME). Pigs were individually penned and allotted by weight to one of eight dietary treatments in a randomized complete block design with eight replications per treatment. A corn-soybean meal-based basal diet (1.0% true digestible lysine) was formulated to contain 0.06% available phosphorus (aP) (0.71% calcium). A standard curve, from which bioavailable phosphorus release could be calculated, was achieved by supplementing nonosodium phosphate to the basal diet at 0.06, 0.12, and 0.18%. Four concentrations (250, 500, 1000, and 2000 FTU/kg) of phytase premix were added to the basal diet to comprise the other four experimental diets. Average daily gain (ADG) was measured and feed intake calculated at the end of the 24-d test period. Following termination of the experiment, breaking load and ash content of the right fibula were also determined for all pigs. Increasing aP quadratically increased ADG ($P < 0.01$) and gain:feed ($P < 0.03$). No effect ($P > 0.10$) was observed for feed intake. Bone breaking load and grams of fibula ash increased linearly ($P < 0.02$ and $P < 0.01$, respectively) with increasing dietary aP from MSP. Increasing phytase supplementation from 0 to 2000 FTU/kg quadratically increased ADG ($P < 0.01$) and gain:feed ($P < 0.01$). Phytase supplementation quadratically increased grams of fibula ash ($P < 0.01$) and linearly increased bone breaking load ($P < 0.06$). Based on the linear regression of grams of fibula ash on supplemental phosphorus intake ($r^2 = 0.50$), phosphorus-releasing values for 250, 500, 1000, and 2000 FTU/kg dietary phytase concentrations were 0.136, 0.140, 0.184, and 0.196%, respectively. These results demonstrate the efficacy of EcoPhos phytase to improve the availability of dietary phosphorus for the 36 to 56-kg pig.

Key Words: Phytase, Phosphorus, Pigs

393 Effects of a solid-state fermented phytase on growth performance, bone traits and P digestibility of growing pigs fed corn-soybean meal diets containing wheat middlings. J. S. Park*¹, S. D. Carter¹, J. D. Schneider¹, T. B. Morillo¹, and J. L. Pierce², ¹Oklahoma State University, Stillwater, ²Alltech, Inc., Nicholasville, KY.

A total of 24 barrows (avg BW = 20.9 kg) was used in a 35-d study to determine the effects of the addition of a solid-state fermented phytase complex (Allzyme SSF; Alltech, Inc) to low available P, corn-soybean meal (SBM) diets containing 20% wheat middlings (WM) on growth performance, bone traits, and P utilization. Pigs were blocked by weight and ancestry, and randomly allotted to one of four dietary treatments (6 pigs/trt). A basal diet (Diet 1) consisted of corn, SBM, and WM (20%) and was adequate in all nutrients, except available P. This diet contained 0.50% total P (0.13% avail. P), all of which was provided by corn, SBM, and WM. Diets 2 and 3 were the basal plus SSF to provide 250 and 500 phytase units (PU)/kg, respectively. The positive control diet (Diet 4) was corn-SBM-based with 20% corn starch (0.50% total P, 0.24% avail. P). All diets were formulated to 0.77% app. dig. Lys and a Ca:total P of 1.2:1. Pigs were housed individually with ad libitum access to feed and water. There were two 5-d periods (d 10-15 and d 25-30) for collection of feces and urine. On d 35, all pigs were killed and the femurs and 3rd/4th metacarpals and metatarsals (MM) were extracted. Overall, ADG and gain:feed (G:F) were, respectively: 590, 629, 637, 747 g/d and 467, 470, 491, 515 g/kg. Phytase did not affect ADG or ADFI ($P > 0.22$), but it increased G:F (linear, $P < 0.04$). Digestibility of P

increased (linear, $P < 0.03$) with SSF addition, resulting in a 10% reduction in P excretion for pigs fed 500 PU/kg. Bone breaking strength (BS) of MM and femurs and ash (%) increased (linear, $P < 0.04$) with SSF (37, 46, 49 kg; 140, 171, 177 kg; 49.1, 50.9, 51.9%, respectively). However, pigs fed PC had higher ($P < 0.01$) ADG, G:F, BS, and bone ash compared to those fed diets containing WM. These data indicate that the addition of a solid-state fermented phytase improves P utilization of corn-soybean meal diets containing wheat middlings for growing pigs.

Key Words: Pigs, Phytase, Bone

394 Comparative effectiveness of *Aspergillus niger* wild-type and variant phytases in the hydrolysis of phytate-phosphorous in the diets for weanling pigs. S. E. Crowe*, T. W. Kim, K. R. Roneker, and X. G. Lei, Cornell University, Ithaca, NY USA.

Aspergillus niger PhyA phytase has a pH optimum (5.5) above the pH level in the stomach of swine. To improve its feeding efficacy, we have developed a series of PhyA mutants with altered pH profiles. The objective of this experiment was to test the relative effectiveness of two mutants with single mutations in the 300th amino acid sequence (Lys300Arg, Lys300Thr), compared with the wild-type enzyme, in diets for young pigs. Thirty-five male weanling pigs (5-wk old, 9.5 kg BW) were divided into five treatment groups. A corn-soybean meal basal diet (BD, no added inorganic phosphorus) was fed for 4 wk to each of the groups either alone, with 0.15% inorganic phosphorus, or with wild-type, Lys300Arg, or Lys300Thr phytases at 300 units per kg feed. At the end of the trial, pigs fed BD alone had lower ($P < 0.05$) ADG, ADFI, and plasma inorganic phosphorus concentration, but higher ($P < 0.05$) plasma alkaline phosphatase activity than those fed BD + 0.15% inorganic phosphorus. Pigs fed the wild-type enzyme had improved growth performance and higher ($P < 0.05$) plasma inorganic phosphorus concentration than pigs fed BD. However, there was no significant difference in any of the measures between the pigs fed the wild-type and the mutant enzymes. In conclusion, the two mutants did not show efficacy improvements over the wild-type enzyme, indicating possible inadequate alterations in pH profile of these two mutants or inappropriate dietary and stomach conditions in the present study for an overall feeding effectiveness difference.

Key Words: Phytase, Pig, Mutation

395 Pharmacological levels of zinc reduce phytase efficacy *in vivo*. N. R. Augspurger*¹, D. M. Webel², J. D. Spencer², and D. H. Baker¹, ¹University of Illinois at Urbana-Champaign, ²United Feeds Inc., Sheridan, IN.

The efficacy of phytase has been shown to be negatively affected by zinc (Zn) and several other cations *in vitro* (Maenz et al., 1999). Therefore, the objective of this work was to determine the effect of growth-promoting levels of Zn from two sources on the efficacy of phytase in young pigs fed phosphorus (P)-deficient diets. Ninety-nine individually-fed pigs (7.2 kg) were given ad libitum access to one of 11 experimental diets for a period of 21 d. Pigs were fasted overnight before final body weights were taken, after which the five median-weight blocks of pigs were euthanized and the right fibula was harvested for determination of bone ash. Fibula ash (mg) was regressed against supplemental inorganic P (iP) intake (g) to set up the standard curve to which phytase treatments were compared to determine P-releasing efficacy. The basal diet was a corn soybean meal diet with no supplemental P (21% CP, 0.075% estimated available P, 129 mg/kg Zn). Diets included three graded levels of supplemental iP (0, 0.075, 0.150%) from reagent-grade KH_2PO_4 , two levels of phytase (500 and 1,000 FTU/kg) from EcoPhos™ (Phytex LLC, Portland, ME), 1,500 mg/kg of Zn from either Wael ZnO or tetra-basic Zn chloride (TBZC, $\text{Zn}_5\text{Cl}_2(\text{OH})_8$; Micronutrients Corp., Indianapolis, IN), and all combinations of EcoPhos™ and Zn. All response criteria responded linearly ($P < 0.01$) to supplemental iP. EcoPhos™ improved ($P < 0.01$) weight gain, feed intake and gain/feed ratio, as well as fibula ash (% and mg). Bone ash (mg) was highest ($P < 0.01$) for 1,000 FTU/kg EcoPhos™. Supplemental Zn had no effect ($P > 0.10$) on growth performance, but reduced ($P < 0.05$) fibula ash (% and mg). Regression of fibula ash on supplemental iP intake resulted in an excellent fit ($r^2 = 0.87$). In the absence of Zn, 500 FTU/kg of EcoPhos™ released 0.130% P, while in the presence of TBZC or ZnO,

P-release values were reduced ($P < 0.01$) to 0.085 and 0.099% P, respectively. At 1,000 FTU/kg of EcoPhosTM, Zn reduced ($P < 0.01$) P-releasing efficacy from 0.195% P to 0.140 and 0.124% P for the TBZC and ZnO treatments, respectively. These results suggest that growth-promoting levels of Zn chelate the phytate complex, thereby reducing its availability for hydrolysis by phytase.

Key Words: Pigs, Phytase, Zinc

396 Differences in total tract and ileal digestibility coefficients of calcium and phosphorus in growing pigs fed low phytate corn, normal corn, soybean meal, and corn soybean meal based diets. R. A. Bohlke*, H. H. Stein, A. R. Wirt, and R. C. Thaler, *South Dakota State University*.

The primary objective of this experiment was to determine the apparent ileal digestibility coefficients (AID) and the apparent total tract digestibility coefficients (ATTD) of calcium (Ca) and phosphorus (P) in low phytate corn (LPC), normal corn (NC), soybean meal (SBM), and corn-soybean meal-based diets by growing pigs. The second objective was to determine if there were differences between the AID and the ATTD for Ca and P. Eight diets were formulated and fed to nine growing barrows. Three diets contained LPC, NC, and SBM as the sole source of Ca and P. Three similar diets contained supplemental inorganic Ca (iCa) and P (iP) to bring the contents up to the requirements of the animals (i.e. 0.5% Ca and 0.2% digestible P). Two diets containing LPC-SBM and NC-SBM were also supplemented with iCa and iP to reach the animals requirements. Each diet was fed to the pigs for nine days with ileal digesta being collected from 0800 to 2000 on d 8 and d 9. Fecal samples were collected on d 7 and d 8. The AID and the ATTD (70 and 69%, respectively) of Ca in LPC were higher ($P < 0.05$) than in NC (47 and 50%) and SBM (51 and 47%). The addition of iCa did not affect ($P > 0.05$) the AID or the ATTD of Ca for any of the three feed ingredients. No differences ($P > 0.05$) in the AID of Ca were found between the LPC-SBM (55%) and NC-SBM (51%) diets. The AID and the ATTD of P in the LPC diet were higher ($P < 0.05$) than that of the NC and SBM diets (57 and 55% vs. 28 and 29% and 37 and 38%). When iP was added to NC and SBM, the AID and the ATTD of P increased ($P < 0.05$). However, the addition of iP did not ($P > 0.05$) improve the AID or the ATTD of P in LPC. For both Ca and P, there were no differences ($P > 0.15$) between the AID and the ATTD. In conclusion, LPC has a higher Ca and P digestibility than NC and SBM. There appears to be no net absorption or excretion of Ca and

P in the large intestine of growing pigs fed corn or soybean meal based diets.

Key Words: Pigs, Digestibility, Low phytate corn

397 Phytase additions to conventional or low-phytate corn-soybean meal diets on performance, bone traits, and phosphorus excretion of growing pigs. E. G. Xavier*, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky, Lexington*.

Effects of phytase in diets containing low-phytate (LP) or normal (N) corn and LP, low-oligosaccharide or N soybean meal (SBM) were evaluated. The corn and SBM were provided by Pioneer Hi-Bred International, Johnston, IA. The LP-corn, N-corn, LP-SBM, and N-SBM contained 0.26, 0.31, 0.77, and 0.70% total P and 0.09, 0.25, 0.22, and 0.48% phytate P with estimated P bioavailabilities of 75, 20, 50, and 20%, respectively. Individually-penned pigs (six/treatment) were fed eight corn-SBM diets (1.05% lysine, 0.65% Ca) from 15 to 42 kg (40 d). Diets 1-5 were N-corn + N-SBM with 0.20, 0.10, 0.10, 0.00, and 0.00% added P from monocalcium phosphate. Diets 6-8 were LP-corn + LP-SBM with 0.10, 0.00, and 0.00% added P. Phytase (Natuphos[®], BASF) was added to Diets 3, 5, and 8 at 750 units/kg. The N and LP diets without added P contained 0.39 and 0.37% total P and 0.08 and 0.23% bioavailable P, respectively. Diet 1 met the P requirement for pigs of this weight range (NRC, 1998). At termination, metatarsals, metacarpals, and femurs were obtained from all pigs. Reducing dietary P negatively affected ($P < 0.01$) growth rate, feed/gain, and mean bone strength (relative to pigs fed Diet 1) to a greater extent in pigs fed N vs LP diets (751, 700, 723, 571, 660, 791, 685, and 706 g/d; 1.80, 1.95, 2.01, 2.55, 2.23, 1.86, 1.87, and 1.88; 100, 73, 98, 45, 67, 103, 78, and 97 for Diets 1-8), and phytase prevented ($P < 0.01$) some of the effects of reducing dietary P level. Apparent digestibility of P (using Cr₂O₃) for Diets 1-8 was 44, 33, 49, 25, 40, 60, 55, and 70% ($P < 0.01$). Fecal P excretion was influenced ($P < 0.01$) by type of corn-SBM, P level, and phytase addition (4.49, 4.45, 3.67, 4.26, 3.39, 2.79, 2.11, and 1.45 g/d). Soluble P in feces was low (1.69, 1.74, 1.63, 1.56, 1.96, 1.81, 1.94, and 2.16% of total P), but increased when phytase was added to the low-P, N ($P < 0.01$) or LP ($P < 0.05$) diets. The results indicate that growing pigs fed LP-corn and LP-SBM require less P to optimize performance and bone density; and when phytase is included in LP-corn-SBM diets, pigs excrete up to 68% less fecal P than pigs fed conventional corn-SBM diets without phytase.

Key Words: Pigs, Phosphorus, Phytase

Physiology: Nutrition-reproduction, stress, and growth

398 Effects of experimental fascioliasis on pubertal development in heifers. M. J. Paczkowski*, T. M. Craig, D. D. Magee, J. A. Thompson, and D. W. Forrest, *Texas A&M University, College Station, TX*.

Angus-sired heifers were allotted by age (mean=4 mo), BW (mean=135 kg), and sire (n=4) to either a control (uninfected, n=10) or infected group (n=11). Metacercariae of *Fasciola hepatica* were administered (intraruminally, d 0) to study effects on interval to puberty, circulating ovarian steroids, serum liver enzymes and BW. Blood samples were collected bimonthly from d 0 to 56 and biweekly from d 60 through 210 for analysis of serum estradiol 17 β (E₂) and progesterone (P₄) concentrations by RIA. At 2-wk intervals, BW was recorded, a blood sample was obtained to quantify serum aspartate-aminotransferase (AST) and γ -glutamyltranspeptidase (GGT) and a fecal sample was collected to assess excretion of *F. hepatica* eggs. Puberty was defined by the occurrence of the first luteal phase (serum P₄ concentrations >1.0 ng/ml for a minimum duration of 10 d). A univariate ANOVA using the RANDOM statement in PROC GLM was used to determine significant linear and curvilinear responses to treatment in prepubertal heifers (from d 0 to 113) for BW, E₂, P₄, AST, and GGT. Treatment effects at d 113 were determined by one way ANOVA. *F. hepatica* eggs were detected in all infected heifers after day 92. Linear ($P < 0.01$) and curvilinear ($P < 0.05$) responses for AST and a linear ($P < 0.05$) response for GGT concentrations were detected over time in infected heifers. On d 113, mean GGT levels were higher ($P < 0.01$) in infected than in control heifers (116.4 \pm 31.2 vs 20.2 \pm 2.8 U/L, respectively). Mean BW, serum AST, E₂, and P₄ concentrations did not differ between treatment groups on d 113. By

d 210, 60% (six of 10) of heifers in the control group and 36% (four of 11) of heifers in the infected group attained puberty. We conclude that *F. hepatica* infection induced elevated levels of serum enzymes which are indicative of liver damage, and there was a more persistent elevation in GGT than the elevation in AST levels. Experimental fascioliasis resulted in a lower percentage of heifers that reached puberty within 7 mo of infection as compared to control heifers.

Key Words: Heifer, Fascioliasis, Puberty

399 Leptin modulates fertility in oMt1a-oGH transgenic mice. A. T. Thomas*, T. R. Famula, J. D. Murray, and A. M. Oberbauer, *University of California, Davis, California*.

Elevated growth hormone (GH) changes body composition and suppresses fertility in livestock and rodents. The ovine metallothionein 1a-ovine growth hormone (oMt1a-oGH) transgenic mouse model allows the study of GH effects on body composition and fertility, as the transgene is easily activated and inactivated to express GH by provision of 25 mM zinc in the drinking water. Chronic expression of the transgene results in a lean phenotype and activation followed by inactivation of the transgene causes obesity. Plasma leptin concentrations reflect adipose stores within the body and also influence reproduction. We hypothesize that reproductive function will be reduced in obese oMt1a-oGH mice due to elevated leptin levels. Thus, the purpose of this study was to determine how fertility changes as a function of body composition