recently been shown to be involved in neuronal plasticity and neuroprotective mechanisms. The precise function of ovoinhibitor in the brain will be a topic for further research.

**Key Words:** chicken, ovoinhibitor, brain

**1944 Vasotocin receptor mRNA expression in the brain and pituitary of broiler breeder hens.** K. Shaffer*[1], J.A. Vizcarra[1], C.C. Hsu[1], J.Y. Yang[1], M.L. Rhoads[1], L.E. Cornett[2], D. Baeyens[3], N. Ali[3], and J.D. Kirby[1], [1]*Department of Poultry Science, University of Arkansas, Fayetteville, AR,* [2]*Department of Physiology, University of Arkansas for Medical Sciences,* [3]*Department of Biology, University of Arkansas Little Rock, Little Rock, AR.*

Vasotocin receptors (VTR) are members of the seven trans-membrane spanning G-protein associated receptor superfamily. Several members of the vasopressin-oxytocin-mesotocin receptor family have been characterized in vertebrates. We have previously shown that VTR-1 expression occurs primarily in the brain while VTR-2 expression occurs mainly in the pituitary. Our goal was to evaluate the expression of VTR-1 and VTR-2 mRNA in known sites of expression over the ovulatory cycle of hens. In order to study potential changes in VTR-1 and VTR-2 expression, birds (n=4-5 per time point) were killed at 3 hour intervals relative to oviposition over a 24 hour period. Blood samples were drawn within 2 minutes of handling, prior to cervical dislocation. Brain, pituitary, shell gland, and kidney were immediately removed and frozen in liquid nitrogen. Plasma was stored at -20 C prior to determination of corticosterone levels by RIA. Isolated total RNA from the brains and the pituitaries was transferred to nylon membranes for analysis of receptor steady state mRNA levels by slot blot analysis. Full length cDNAs for VTR-1, VTR-2 and 28-S rRNA were used to make random primed cDNA probes. VTR-1 and VTR-2 mRNA expression levels were normalized relative to 28-S expression for each sample. Corticosterone levels were significantly increased at nine hours post oviposition relative to all other times. Neither VTR-1 nor VTR-2 mRNA levels showed any significant variation over the 24 h cycle, in the brain or pituitary, respectively. Based on these results, we conclude that VTR-1 and VTR-2 steady state mRNA levels do not fluctuate dramatically over the ovulatory cycle of broiler breeder hens. Further work on circadian variations in membrane bound receptor concentrations in the brain and pituitary are currently underway.

**Key Words:** Vasotocin Receptor, Pituitary and Brain, Corticosterone

## ASAS Nonruminant Nutrition: Feed Ingredients and Enzymes

**1945 Effect of lactic acid and lactosucrose supplementation in diets for nursery pigs.** Acie Murry*[1], Susan Sanchez[1], and Parshall Bush[1], [1]*The University of Georgia, Athens.*

Swine producers have been adding organic acids to feed for several years. Acidified feed lower the pH of the pig's stomach, inhibit certain pathogenic bacteria, increases nutrient digestibility and results in faster weight gain and more efficient feed conversion. Lactosucrose is considered a nondigestible trisaccharide produced from lactosucrose and sucrose and may be used as a substrate by intestinal bacteria in humans. The influence of these factors has not been documented in nursery pigs. The objective of this study was to evaluate the effects of lactic acid and lactosucrose supplementation in pig's diet on growth performance, feed efficiency and nutrient digestibility. Two experiments with twenty cross bred nursery pigs, average initial body weight 9.6 kg and age 28 days were conducted. All pigs were fed a corn-soybean meal basal diet (18% CP) for a 7-d adjustment period. On day seven after the adjustment period, ten pigs were randomly assigned to receive the basal diet supplemented with either lactic acid (1.8%) or lactosucrose (0.2%) for a 14-d experimental period. Daily feed intake was held constant at 5% of body weight for all pigs in an attempt to reduce the effects of different levels of feed intake on nutrient digestibility. Pigs were weighed every three days and feeding was adjusted according to the pig's individual weight. Pigs fed the lactosucrose diet were heavier ($P < 0.04$) at d 21 (15.40 vs 14.95 kg), but there was no effect of treatment ($P > 0.50$) on average daily gain (0.45 vs 0.43 kg), average daily feed (0.57 vs 0.56 kg), or gain:feed ratio (0.80 vs 0.78 kg) for lactosucrose and lactic acid, respectively. Treatment had no effect ($P > 0.20$) on apparent digestibility of DM (80.96 vs 82.46%), EE (77.45 vs 79.50%), CP (72.30 vs 74.45%), or GE (69.69 vs 69.33%) for lactosucrose and lactic acid, respectively. However, ash digestibility was greater ($P < 0.05$) for pigs fed the lactic acid diet than for those fed lactosucrose (50.43 vs 43.15%). The results from this study show that growth performance was better in pigs fed the lactosucrose diet, but ash digestibility was lower when compared with pigs fed the lactic acid.

**Key Words:** Lactosucrose, Lactic Acid, Digestibility, Pigs

**1946 The potential for egg by-products to replace spray-dried porcine plasma in early-weaned piglet diets.** L.D. Schmidt*, C.M. Nyachoti, D. Boros, and B.A. Slominski, *University of Manitoba Winnipeg, MB, Canada.*

Egg-breaking facilities produce substantial quantities of egg by-products each year that are unsuitable for human consumption. Due to the excellent amino acid profile, the potential for spray-dried egg proteins to replace spray-dried porcine plasma (SDPP) in early-weaned pig diets was investigated in two 3-week performance trials. In both experiments, 5 pens containing four piglets (17 ± 1d old) stratified by sex were assigned to the experimental diets in a completely randomized design. Experiment 1 comprised of four corn-soy diets containing 7% of either SDPP, spray-dried technical albumen (SDTA), heat treated SDTA (hot room storage at 70°C for 72h) or spray-dried whole egg (SDWE). Average daily gain (ADG), average daily feed intake (ADFI) and feed conversion ratios (FCR) were determined. In addition, five piglets per treatment were euthanized to determine ileal amino acid and energy digestibilities. Relative to the SDPP diet, ADG (266, 219, 199,194 g/d), ADFI (323, 304, 277, 278 g/d) and FCR (1.22, 1.38, 1.46, 1.44) were poorer ($P<0.05$) for SDTA, heat treated SDTA and SDWE, respectively. The SDTA diet had numerically better performance parameters than the other diets containing egg proteins. Apparent ileal digestibility of methionine, lysine and threonine in SDPP and SDTA diets ranged from 80-90% and was generally higher ($P<0.05$) than in the SDWE diet. Ileal digestible energy content was similar ($P<0.05$) in all diets (3.1-3.2 Mcal/kg). In the second experiment, the effect of substituting SDPP with 25 or 50% SDTA was investigated. Pig performance was not affected by dietary substitution of SDTA for SDPP as values for control (7% SDPP) and the two SDTA diets were similar ($P<0.05$) for ADFI (380, 402, 376 g/d), ADG (275, 284, 265 g/d) and FCR (1.38, 1.42, 1.45), respectively. The results suggest that technical albumen can replace 25% of SDPP in early-weaned pig diets without compromising performance.

**Key Words:** Egg by-products, Nutritive Value, Early-weaned pigs

**1947 Comparison of edible grade whey, granular whey, and Dairylac 80O as lactose sources for nursery pig diets.** J.M. DeRouchey*, M.D. Tokach, J.L. Nelssen, R.D. Goodband, S.S. Dritz, J.C. Woodworth, and B.W. James, *Kansas State Univesity, Manhattan, KS.*

A total of 210 pigs (BW of 5.6 kg and 18  2 d of age) were used in a 14-d growth assay to determine the ability of granular whey or Dairylac 80® to replace a high quality, edible grade whey in nursery diets. Pigs were blocked by weight and allotted to one of seven dietary treatments. Treatments included a negative control without lactose and a 2 x 3 factorial consisting of two lactose levels (9 and 18%) and three lactose sources (Edible whey, Land O' Lakes; Granular whey, International Ingredient Corp.; and Dairylac 80®, International Ingredient Corp.). There were five pigs/pen and six pens/treatment. All diets were pelleted and contained 3% animal plasma and 2% select menhaden fish meal and were formulated to 1.60% lysine. Either edible whey or granular whey (12.5 and 25%) replaced corn and soybean meal in the control diet. Diets containing Dairylac 80® were formulated to replace the lactose provided in the dried whey diets. Fish meal replaced the amino acids provided by dried whey to maintain a constant soybean meal level. Pigs fed additional lactose from d 0 to 14 had greater ADG ($P<.04$) and ADFI ($P<.07$) compared to pigs fed no supplemental lactose. Pigs fed edible whey had greater ADFI (quadratic, $P<.05$) and ADG (linear, $P<.06$) with increasing lactose from 9 to 18%. As granular whey level increased, ADG and ADFI increased (linear, $P<.02$) over the control diet from d

0 to 7, but not overall. For pigs fed Dairylac 80®, ADG and ADFI were greater (quadratic, P<.01) compared to pigs fed the negative control, while gain/feed improved (linear, P<.02) as the lactose level was increased from 9 to 18%. Pigs fed 9% granular whey and Dairylac 80® had similar performance to pigs fed 18% edible whey. In conclusion, there were no differences in growth performance between sources of lactose used in this study.

| | Control | Edible | | Granular | | Dairylac 80® | | |
|---|---|---|---|---|---|---|---|---|
| Item Lactose,% | 0 | 9 | 18 | 9 | 18 | 9 | 18 | SEM |
| Day 0 to 14 | | | | | | | | |
| ADG, g | 238 | 243 | 283 | 263 | 257 | 291 | 265 | 11 |
| ADFI, g | 248 | 242 | 294 | 261 | 270 | 296 | 256 | 13 |
| G/F, g/kg | 960 | 1000 | 963 | 1001 | 952 | 983 | 1004 | 24 |

**Key Words:** Pig, Lactose, Growth

**1948 Productive performance and carcass characteristics of growing and finishing pigs fed different level of oat groats with and without enzymatic compound.** F. Salvador, C. Rodriguez*, F. Nunez, J. Jimenez, O. Ruiz, and A. Alarcon, *Universidad Autonoma de Chihuahua, Chihuahua, Chih. Mexico.*

An experiment was carried out to determine the optimum level of oat groats and the effect of the addition of the enzymatic compound Allzyme Vegpro® in growing and finishing pig rations on the productive response and carcass characteristics. Thirty two Yorkshire X Landrace-Duroc pigs distributed in individual metabolic cages with a completely randomized design of a 4x2x2 factorial arrangement were used. Pigs were fed a ration containing 0, 15, 30 and 45% oat groats during the growing (26.0 to 54.5 kg of BW) and finishing period (54.5 to 84.7 kg of BW), with and without one kg Allzyme Vegpro® per ton of feed. A tendency to improve (P<.01) feed conversion during the whole feeding period by including oat groats in the ration (3.73, 3.46, 3.32 and 3.17 for 0, 15, 30 and 45% oat groats in the ration, respectively) was observed, with a reduction up to 17.9% with the highest oat groats level in the diet. Males showed higher feed intake (9.1%) and daily weight gain (6.3%) than females. Multivariate analysis showed a true effect during the last phase of the finishing period, with a decrease in pig feed intake of up to 250 g/d and an extra daily weight gain of 21 g per pig in animals fed 45% oat groats plus enzymatic compound rations. A tendency to improve cold carcass yield was detected as the ration oat groat level increased but only when the enzyme was added. Males showed 4 mm higher dorsal fat than females. Those animals eating diets with the enzymatic compound showed 3 mm higher dorsal fat than those without enzyme. With higher levels of oat groats in the ration there was a tendency to decrease (P<.05) the fat content in muscle. It was concluded that the addition of oat groats to diet of growing and finishing pigs improves the animal productive response showing an increase of up to 9.5% in economic return for every 15% addition of oat grots.

**Key Words:** Pigs, Oat groats, Enzymes

**1949 The effects of pretreating soybean meal with fiber-degrading enzymes on ileal and total tract digestibility by growing pigs.** K. L. Saddoris*, M. R. Smiricky, D. M. Albin, V. M. Gabert, and M. R. Murphy, *University of Illinois, Urbana.*

Soybean meal (SBM) contains fibrous components that are poorly digested by pigs. Pigs do not produce the endogenous enzymes necessary to digest the fibrous components of SBM, so fiber-degrading enzymes such as arabinase, cellulase, alpha-galactosidase, hemicellulase, pectinase, and xylanase can be used in an attempt to degrade these components. Four barrows (avg. BW = 75 kg) were surgically fitted with a prececal simple-T cannula and randomly assigned to a 2 × 2 crossover design to evaluate the influence of pretreating SBM with fiber-degrading enzymes on nutrient digestibility. The cornstarch-soybean meal-based diets were formulated to contain 17% CP. Chromic oxide (0.3%) was added as an indigestible marker for determination of nutrient digestibilities. A control cornstarch-soybean meal diet was compared to a diet containing SBM pretreated with enzymes. The pretreatment consisted of dilution with deionized, distilled water at a 1:4 ratio and incubation at 50C, pH 5 for 18 hr with 8.5 g each of the following enzymes/kg of SBM: arabinase, cellulase, alpha-galactosidase, hemicellulase, pectinase, and xylanase. Pigs were fed 2.28 and 2.44 kg/d for periods 1 and 2, respectively, in 2 equal feedings at 0800 and 2000 h. The experimental period lasted 7 d, with 5 d of diet adaptation, fecal collection on d 6, and ileal digesta collection on d 7. Diets, feces, and digesta samples were analyzed for DM, OM, CP, AA, and chromic oxide concentrations. Enzyme pretreatment increased (P < 0.08) ileal digestibility of DM, OM, Asp, Glu, Lys, and total tract digestibility of OM, N, Asp, Thr, Ser, Gly, Val, Phe, His, Lys, Ile, and Tyr. Enzyme pretreatment tended (P < 0.15) to increase ileal digestibility of Pro, Val, Ile, Leu, and total tract digestibility of DM, Glu, Pro, and Leu. In conclusion, enzyme pretreatment of SBM increased DM and AA digestibilities of cornstarch-soybean meal diets fed to growing pigs.

**Key Words:** Pigs, Enzymes, Soybean meal

**1950 Evaluation of a carbohydrase combination on performance in growing-finishing pigs.** M. D. Lindemann[1], G. A. Apgar[2], T. Guthrie*[2], G. L. Cromwell[1], H. J. Monegue[1], K. E. Griswold[2], and N. Inocencio[1], [1]*University of Kentucky, Lexington,* [2]*Southern Illinois University, Carbondale.*

Arabinoxylans increase digesta viscosity and decrease digestibility. A bacterial enzyme product which contained endo-1,4-$\beta$-xylanase and $\beta$-glucanase (105 and 50 IU/g) was used to evaluate its potential for improvement of performance of growing-finishing pigs fed a fortified corn-soy diet (which typically contains 4-5% arabinoxylans). A total of 192 pigs were used in two experiments (Exp. 1: SIU, n=112 crossbred pigs, 45.6 kg BW; Exp. 2: UK, n=80 crossbred pigs, 34.7 kg BW) to evaluate graded levels of the product (0, 80, 100, and 120 mg/kg) on growth performance and carcass characteristics to a market weight of 112.8 kg. Pigs were housed seven/pen at SIU for a total of four replicates and four/pen at UK for a total of five replicates. The diet was formulated to 0.86% lysine; lysine levels were reduced to 0.68% and 0.55% at 58 and 82 kg, respectively. Diets were fed in meal form. All pigs were scanned by real-time ultrasound at 110 kg. There were no experiment x diet interactions for any criteria (P=.20). Performance for the initial grower period was improved (linear, P<.02) for ADG (940, 982, 962, and 1,022 g) but not (P=.10) for ADFI (2.24, 2.26, 2.31, and 2.31 kg) or F/G (2.37, 2.30, 2.39, and 2.26). For the total study, ADG (856, 896, 866, and 875 g), ADFI (2.67, 2.77, 2.74, 2.74 kg), and F/G (3.12, 3.10, 3.16, and 3.13) did not differ (P=.10) due to enzyme inclusion. Carcass characteristics (adjusted to 104 kg) did not differ (P=.10) with regard to backfat depth (20.8, 21.8, 21.1, and 20.8 mm), longissimus area (39.7, 40.6, 40.6, and 40.2 $cm^2$), or scanned lean (52.4, 51.8, 52.4, and 52.5%). Lean gain (352, 360, 356, and 359 g/d) did not differ (P=.10) among dietary treatments. The greatest potential for a product directed at arabinoxylans would appear to be in the earlier stages of the grow-finish period.

**Key Words:** Pigs, Performance, Enzymes

**1951 Amino acids ileal digestibility of hulless barley, barley and sorghum grains in growing pigs .** G. Mariscal-Landin*[1] and J. E. Rodriguez[2], [1]*C. N. I. Fisiologia y Mejoramiento Animal, INIFAP.,* [2]*Nutrientes Basicos de Monterrey, S.A. de C.V. NL, Mexico.*

Nutritive value of grain sorghum, barley and hulless barley was assessed in 2 experiments. In Exp. 1, 4 barrows of initial BW of 40 kg were fitted with simple T cannulae at the terminal ileum. In a 4x4 Latin square arrangement, pigs were fed 4 diets formulated to 16% CP: corn-starch+soybean meal (SBM); sorghum+SBM (SSB); hulless barley+SBM (HBS) and barley+SBM (BAS). Amino acids apparent digestibility was measured using the difference method. A 6-d adaptation period was followed by a 48-h phase, sampling digesta in 2-h intervals. Pigs were fed in 2 meals (0800 and 1700 h) at 2.5x their DE maintenance requirement (110 Kcal of DE/$kg^{.75}$. Lys apparent digestibility was greater (P<.05) for SBM, 86.3 > SSB, 51.6 = HBS, 49.7 and BAS, 55%. Similar differences were found for Thr, SBM, 80.2 > SSB, 55.5 = HBS, 55.5 and BAS, 54.8%; Met, SBM, 87.9 > SSB, 64.6 = HBS, 70.0 and BAS, 66.9% and for most of the amino acids. Experiment 2 was a growth performance trial, in which sorghum grain was substituted by hulless barley at 0, 34, 66 and 100% of the total cereal grains in the diet (*i.e.*, 4 experimental diets). Initial weight of the pigs was 39.3±4.8 kg and the observation period was of 77-d. Barrows ate more (P<.001) than gilts: 2.57 vs 2.31 kg/d. Avg. of daily gain was similar (P>.05), a mean response of .751 kg, but gain:feed ratio was progressively improved

as hulless barley substituted sorghum: .293, .299, .316 and .328 kg. Differences in gain:feed between sexes were a direct response to feed intake. Lean eye area resulted in an diet x sex interaction (P<.05): barrows fed the higher concentration of sorghum (0 and 34% hulless barley) showed the lowest values: 20 and 23 $cm^2$, while the rest had a mean value of 28 $cm^2$. Considering apparent amino acid digestibility, sorghum and hulless barley are of similar nutritive value, but performance in response to hulless barley could be explained in terms of the better amino acid profile and the ME value.

**Key Words:** Sorghum grain, Barley grains, Amino acids digestibility

**1952 Effects of Fibrozyme® supplementation on ileal and total tract digestion of nitrogen and energy by finishing pigs fed diets containing a fibrous soy co-product.** M. R. Smiricky*[1], D. M. Albin[1], V. M. Gabert[1], H. Yang[2], and R. Dvorak[3], [1]*University of Illinois, Urbana, IL,* [2]*ADM Feed Products Group, Quincy, IL,* [3]*Alltech, Inc., Nicholasville, KY.*

Fibrous components in swine diets are incompletely digested and are poorly utilized energy sources. Pigs do not produce the enzymes necessary to hydrolytically digest fibrous components of the diet. Fiber-degrading enzymes, such as Fibrozyme®, have been used in an attempt to degrade these components. Four barrows (avg. initial BW = 85 kg) were surgically fitted with a prececal simple T-cannula and randomly assigned to a 2×2 crossover design to evaluate the influence of Fibrozyme® on nutrient digestibility. The corn-soybean meal-based diets were formulated to contain 12.5% CP, and a fibrous soy co-product containing 27% NDF (as-fed basis), was included at a level of 10% to test the effectiveness of the enzyme source. Chromic oxide was added as an indigestible marker for determination of nutrient digestibilities. The 2 treatments were a control diet and a diet containing 0.022% Fibrozyme® (as-fed basis), an enzyme supplement containing a minimum of 100 xylanase units/g, added at the expense of corn. The pigs were fed twice daily (0800 and 2000 h, 1.5 kg/meal). 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, CP, GE, and chromic oxide concentrations. Dietary treatment did not significantly affect apparent ileal or total tract digestibilities of any of the parameters measured. However, there was a numerical increase in apparent ileal and total tract digestibilities when Fibrozyme® was added to the control diet. The increase in digestibility ranged from approximately 0.3 to 5 percentage units. In conclusion, Fibrozyme® numerically improved apparent ileal digestibilities of DM, OM, N, and GE of pigs fed a corn-soybean meal diet containing a fibrous soybean co-product.

**Key Words:** Pigs, Enzymes, Digestibility

**1953 Effects of dietary supplementation of crude inulin extract on the emission of volatile sulfides from manure slurry of growing-finishing pigs fed corn and soybean meal-based diets.** T.C. Rideout[1], M.Z. Fan[1], Y. Gao[1], C. Wagner-Riddle[1], J.P. Cant[1], P. Stonehouse[1], G. Sheffrin[2], R. Cook[2], B. Raines[2], and R.R. Hacker[1], [1]*University of Guelph,* [2]*Qtf Foods, Inc.*.

A balanced two-period changeover experiment was conducted with 6 Yorkshire barrows, average initial BW of 30 kg, to determine the effect of crude inulin, extracted from Ontario grown chicory, on the emission of volatile sulfides from swine manure slurry. Two corn and soybean meal (SBM)-based dietary treatments, a control diet containing no inulin extract and a treatment diet containing 5% crude inulin at the expense of cornstarch, were formulated to contain 16% CP from corn (51%) and SBM (29%). Each period lasted for 14d with 10-d adaptation and 4-d collection of total urine and representative fecal samples. At the end of each period, fresh manure slurry was prepared by mixing the collected feces and urine at a ratio of 1:2.5 (wt/wt). Accumulative sulfide emission was measured over a 7-d period in an in vitro system that trapped the emitted sulfide gas in a cadmium sulfate-based solution. Samples of the trapping solution were taken at specified time points (0, 4, 19, 24, 48, 96, 144, 168 h, respectively) over the 7-d emission period at room temperature. The amount of total sulfides trapped in the solution was determined in hydrogen sulfide unit through a spectrophotometric-based procedure. Inclusion of the inulin at 5% reduced (P < 0.01) the 168-h cumulative hydrogen sulfide emission rate by 36.4% in comparison with the control (14.96 vs. 22.69 mg $H_2S$/kg DM slurry/h). In conclusion, dietary supplementation of the crude inulin extract at a 5% dietary level is effective in reducing the emission of odour-causing volatile sulfides into the environment.

**Key Words:** Inulin, Sulfide emission, Growing-finishing pigs

**1954 Efficacy of mannan oligosaccharide (Bio-Mos®) addition with two levels of copper sulfate in the diets of growing-finishing pigs.** M. E. Davis*[1], C. V. Maxwell[1], B. Z. de Rodas[2], D. C. Brown[1], Z. B. Johnson[1], and R. A. Dvorak[3], [1]*University of Arkansas, Fayetteville,* [2]*Land O'Lakes Inc., Fort Dodge, IA,* [3]*Alltech, Nicholasville, KY.*

An experiment involving 144 crossbred barrows and gilts was conducted to determine the efficacy of Bio-Mos® in improving performance of growing-finishing pigs fed diets devoid of antibiotics and with and without growth promoting levels of $CuSO_4$. Pigs were moved from a nursery facility, sorted by BW and divided into six weight groups with 24 pigs in each group. Pigs within each group were allotted into four pens (6 pigs/pen) and stratified based on sex and litter. Treatments were randomly assigned to pens within each weight group (6 pens/treatment). Dietary treatments were fed throughout the starter (20 to 32 kg BW), grower (32 to 68 kg BW), and finisher (68 to 106 kg BW) phases. Diets consisted of two levels of $CuSO_4$ (10 ppm in starter, grower, and finisher diets vs. 175 ppm in starter and grower diets and 125 ppm in finisher diets) with and without Bio-Mos® (0 vs. 0.2% in starter, 0.1% in grower, and 0.05% in finisher). Average daily gain and gain:feed (G/F) improved (P < 0.02) in the starter phase when pigs were fed diets containing 175 ppm $CuSO_4$ compared to pigs fed 10 ppm $CuSO_4$. Gain:feed was greater (P < 0.02) in the grower phase when pigs were fed 175 ppm $CuSO_4$ compared to pigs fed 10 ppm $CuSO_4$. During the finisher phase, ADG improved with the addition of Bio-Mos® when pigs were fed 10 ppm $CuSO_4$, but decreased when Bio-Mos® was supplemented in diets containing 175 ppm $CuSO_4$ (interaction, P < 0.04). In the overall experiment (20 to 106 kg BW), ADG and G/F improved (P < 0.03) when pigs were fed diets supplemented with 175 ppm $CuSO_4$ when compared to pigs fed diets containing 10 ppm $CuSO_4$. The results of this experiment indicate that $CuSO_4$ supplemented in growing-finishing diets improves gain and efficiency. Additionaly, Bio-Mos® improves gain when supplemented in growing-finishing diets without antibiotic addition, although the magnitude of response is not as great as that observed with $CuSO_4$ addition.

**Key Words:** Swine, Mannan oligosaccharide, Copper

**1955 Dietary fiber level and xylanase affects nutrient digestibility and waste production in grower pigs.** A.J. Moeser* and T.A.T.G. van Kempen, *North Carolina State University.*

An experiment was conducted with twelve grower pigs to determine if lowering dietary NDF, through selection of available feedstuffs or dietary addition of xylanase, can provide an effective and practical approach for reducing nutrient excretion in pigs. Four diets were formulated, using least cost ration principles, to contain equal digestible lysine to ME ratios and three levels of dietary NDF: 1) control corn soybean meal diet (10.3% NDF), 2) low NDF diet (2.6% NDF) based on degermed, dehulled corn (79%), corn gluten meal (11.5%), meat and bone meal (5%), and blood meal (2.5%), 3) high NDF diet (18.4% NDF) based on corn and soybean meal with 20% soybean hulls, and 4) diet 3 + 0.2% xylanase. Diets were tested in a balance experiment using a 4X4 Latin square design in which each experimental period consisted of a 4-d dietary adaptation period followed by a 3-d data collection period. Lowering dietary NDF increased the digestibility of DM and GE (by 5 and 4%, respectively) but did not affect the digestibility of nitrogen (N) compared to the control diet (P < 0.01). Increasing dietary NDF reduced the digestibility of DM by 8%, GE by 8%, and N by 13% compared to the control (P < 0.01). Addition of xylanase improved the digestibility of DM and GE by 2 and 3%, respectively (P < 0.01) while a trend for improved digestibility of N was observed. Lowering dietary NDF reduced fecal production by 35% compared to the control (P < 0.01). Increasing dietary NDF increased fecal production by 36% compared to the control (P < 0.01). Addition of xylanase reduced fecal production by 10% in high NDF diets (P < 0.01). In conclusion, lowering dietary NDF level and dietary inclusion of xylanase may offer relatively practical and easy methods for reducing waste production in pigs.

| Diet | Control | Low NDF | High NDF | High NDF + xylanase | SE |
|---|---|---|---|---|---|
| Digestibility, % | | | | | |
| Dry matter | $88.2^b$ | $92.3^a$ | $81.6^d$ | $83.5^c$ | 0.63 |
| Gross energy | $87.6^b$ | $91.3^a$ | $80.4^d$ | $82.5^c$ | 0.65 |
| Nitrogen | $86.6^a$ | $85.6^a$ | $75.4^b$ | $77.5^b$ | 0.95 |
| Fecal production, % of DMI | $11.8^c$ | $7.7^d$ | $18.4^a$ | $16.5^b$ | 0.63 |

Values lacking common superscript differ (P <0.01)

**Key Words:** Fiber, Digestibility, Grower Pigs

**1956 Wheat specific weight or added enzyme did not affect weaner performance.** H.M. Miller[1], P. Toplis*[2], and P. Blanchard[3], [1]*University of Leeds, School of Biology, Leeds, LS2 9JT,* [2]*Primary Diets Ltd., Melmerby, HG4 5HP, UK,* [3]*Frank Wright Ltd., Ashbourne, DE6 1HA, UK.*

Livestock industries in many countries use specific weight to indicate nutritive value of grain. The aim of this experiment was to compare 2 specific weights of Riband wheat (64 vs 78 kg/hl) when fed to weaned piglets with or without xylanase enzyme. To amplify possible differences wheats were uncooked and included in the test diets at an atypically high level. We hypothesised that 78 kg/hl specific weight would outperform 64kg/hl specific weight and that enzyme supplementation would improve performance of both wheats. One hundred and twenty eight 21 0.2d old piglets (62.5% Large White, 25% Landrace, 12.5% Duroc) were weaned at 6.3 0.2 kg liveweight into fully slatted flat deck pens. Piglets received no creep feed pre-weaning. Eight piglets were allocated to each pen (1.37 m x 1.43 m) on the basis of litter, liveweight and sex. The experiment was a 2 x 2 factorial design with Riband fed at 2 specific weights, 64 and 78 kg/hl, with or without enzyme. Four pens were randomly allocated to each of the 4 treatments. All diets contained ZnO (Zn 2500 ppm) and were formulated to contain 50% wheat, 16.25 MJ DE/kg, 1.63% total lysine. Enzyme was added to provide 5,500 xylanase units/kg feed and 600 $\beta$-glucanase units/kg feed. Piglets were individually weighed at 0, 7, 14 and 20d post-weaning. Food and water were provided ad libitum throughout the 20d trial. Data were analysed using the GLM procedure of Minitab 12.2. Growth rate (282 11 g/d), feed intake (291 10 g/d) and feed conversion ratio (1.04 .02) were similar for all treatments throughout the trial. End weight after 20d was not different between treatments (11.9 .24 kg). The low bushel weight wheat did not reduce piglet performance, neither did enzyme inclusion improve it. Despite the high inclusion of wheat, piglet performance was typical for the experimental unit. Use of specific weight as an indicator of nutritive value is questioned.

**Key Words:** Specific weight, Piglets, Wheat

**1957 Efficacy of Allzyme Vegpro in swine diets.** L. J. Johnston*[1], H. G. Jung[2], J. A. Wilson[1], and J. E. Pettigrew[3], [1]*University of Minnesota, Morris,* [2]*USDA-ARS, St. Paul,* [3]*Pettigrew Consulting International, Lousiana, MO.*

A growth performance (Exp. 1) and a digestibility (Exp. 2) experiment were conducted to determine the efficacy of an enzyme preparation, Allzyme Vegpro®, in diets for nursery pigs containing soybean meal (SM; 44% CP) or dehulled SM (DSM; 47% CP). Vegpro contains protease, cellulase, pentosanase, $\alpha$-galactosidase, and amylase activity. Pigs (n = 200) were weaned at about 19 d of age for Exp. 1. After consuming a common phase 1 diet for 12 d, pigs were blocked by weight and allotted to 20 pens. Pens were assigned randomly within block to one of four diets in a 2 x 2 factorial arrangement of treatments. Main effects were inclusion of Vegpro (-V or +V) and type of SM. Vegpro was included in phase 2 and 3 diets at .14 and .17%, respectively. Pigs had ad libitum access to phase 2 (1.2% lysine) and 3 (1.1% lysine) diets that were marginal in lysine concentration for 2 and 3 wk, respectively. Pigs fed DSM grew faster (P < .05) than those fed SM regardless of Vegpro inclusion (.529 vs .475 kg/d; SE = .019). An interaction (P < .01) between Vegpro addition and SM type was observed for feed efficiency (1.724, 1.774, 1.692, 1.608 for -V/SM, +V/SM, -V/DSM, and +V/DSM, respectively). In Exp. 2, barrows (n = 20) were weaned at about 18 d and housed individually in stainless steel cages. Pigs received a common phase 1 diet for 14 d then were assigned randomly within litter to the same phase 2 diets as used in Exp. 1. A 7-d adjustment period preceded a 5-d total collection period to determine energy and nitrogen balance. Nitrogen retention (91.23, 92.04, 89.47, 91.81%; SE = .014) and ME (91.52, 91.44, 90.58, 90.96% of GE; SE = .71) were not influenced by diet. Addition of Vegpro tended to reduce (P < .10) digestibility of total dietary fiber polysaccharide (72.6, 66.9, 70.5, 65.8%; SE = 2.72). Addition of Allzyme Vegpro to corn-soybean meal based diets did not improve growth performance of nursery pigs or digestibility of dietary energy or nitrogen.

**Key Words:** Swine, Enzymes, Digestibility

**1958 Beneficial effect of using a blend of flavoring substances in promoting appetite and growth performance in weaned piglets.** A. Piva*[1], M. Morlacchini[2], F. Galvano[3], and A. Prandini[4], [1]*University of Bologna, Ozzano Emilia, Italy,* [2]*CERZOO, Piacenza, Italy,* [3]*University of Reggio Calabria, Reggio Calabria, Italy,* [4]*Universita' Cattolica del S.Cuore, Piacenza, Italy.*

The ban on the use of certain antibiotic feed supplements instituted or planned in several countries has renewed the interest in exploring alternatives to the use of antibiotic growth promoters. The aim of the present study was to investigate a blend of natural and natural identical flavoring substances in promoting appetite and growth performance in weaned piglets. The trial was conducted using 40 weaned piglets (9.31.60 kg BW) divided in 2 homogenous groups and fed the experimental diets for 56 days. The control group received a conventional diet containing 500 g/ton of formic acid and 1500g/ton of lactic acid (CTR diet); the experimental group was fed the CTR diet containing 2 kg/ton of HerBiotic$^{TM}$ HB (HB diet). Feed intake was recorded and pigs were individually weighed at 14, 35, and 56 d after the study commenced. Differences between the dietary treatments were already observed after 14 days of the trial in terms of average daily gain (ADG: 218 vs 268 g/d for CTR and HB, respectively; +22.9%; P<0.05) and live weight (12.4 vs 13.1 kg; P<0.05). During the study, ADG was improved by HB (378 vs 439 g/d; +16.1%; P<0.01) with a noticeable increase in ADG in the period 36-56 d (440 vs 525 g/d for CTR and HB, respectively +19.3%; P<0.05). The feed intake was higher in HB than in CTR fed animals in the periods 0-14 and 0-35 days by 20.7% (P<0.01) and by 12% (P<0.01), respectively, with no statistical difference thereafter. The feed efficiency was higher only in the period 36-56 days of the trial in HB fed animals (1.68 vs 1.91 kg feed/kg weight gain; P<0.05). Overall there was a substantial decrease in time to reach 30 kg l.w. (-8 days) in animals fed the HB diet. In conclusion, compared to the control group fed an acidified diet animals fed HerBiotic$^{TM}$ HB displayed improved feed intake and growth performance.

**Key Words:** Additive, Botanical, Pig

**1959 Effect of plant extracts on the performance and lower gut microflora of early weaned piglets.** E.G. Manzanilla[1], F. Baucells[1], C. Kamel[2], J. Morales*[1], J.F. Perez[1], and J. Gasa[1], [1]*Universidad Autonoma de Barcelona,* [2]*AXISS France, S.A.S. Archamps, France.*

Two hundred and forty early (20±2.0 d) weaned piglets (5.4±0.4 kg LW) were randomly distributed in 24 replicates to carry out a 3×2 experimental design. Three diets were formulated with the same proportion of cereals (42%), milk by-products (25%), and porcine plasma (4%) but differing in crude protein (CP) level and source: FM-18 (18% CP, LT fish meal 10%); partially replaced (SBM-18; FM 5% plus SBM 9%) or supplemented (SBM-20; FM 10% plus SBM 6.3%) with full fat SBM. Diets were supplemented with or without 200 ppm of XTRACT$^{TM}$, a commercial product based on plant extracts, and with chromium oxide (0.15%) as a digestibility marker. After a 14 days production experiment, the feeding cycle followed a 4-day adjustment period of piglets on ad-libitum feeding half an hour over a one hour and a half periods from 8:00 am to 8:00 pm, and *ad-libitum* over the remainder of the day; on day 5 eight piglets per treatment were slaughtered and jejunum digesta, *enterobacteria* and *lactobacilli* counted ($\log_{10}$/g fresh weight content). Feed Intake (FI, g/d), Average Daily Gain (ADG, g/d) and Organic Matter Digestibility (OMD) were unaffected by diet (p≥0.10). However, FM-18 showed lower Gain to Feed (G/F) ratios (0.67 vs 0.76 or 0.77, p=0.01) and SBM-20 higher CP digestibility (0.849 or 0.861 vs 0.876, p=0.08). Supplementation of XTRACT$^{TM}$ did not affect significantly FI (243.0 vs 248.5), ADG (179.8 vs 178.6), G/F (0.74 vs 0.72) and OM (0.888 vs 0.890) or CP (0.864 vs 0.860) digestibilities. The microbial counts were unaffected by the diet but XTRACT$^{TM}$ promoted a slight but not significant decrease in *enterobacteria* (6.52 vs 6.29,

p=0.51) coupled with a significant increase in *lactobacilli* (5.69 vs 6.26, p=0.02). Differences were specially pronounced with the low CP diets (FM-18, SBM-18). It is speculated that microbial differences could improve the digestive stability of the animals and affect performance in a longer time or with stronger stress conditions.

**Key Words:** Plant extracts, Weaned piglets, *Lactobacilli*

**1960 Limiting amino acids in wheat for growing pigs.** M. Cervantes*[1], A. Pichardo[2], M. Cuca[2], M. Cervantes[1], A.B. Araiza[1], and N. Torrentera[1], [1]*Universidad Autnoma de Baja California, Mexicali, Mxico,* [2]*Colegio de Postgraduados, Montecillos, Mxico.*

An experiment was conducted to determine the order of the first limiting amino acids (AA) in wheat for growing pigs. Thirty crossbred (Landrace x Yorkshire x Duroc) pigs (22.5 kg initial body weight) were assigned to 5 dietary treatments according to a randomized complete block design. Wheat was the sole source of dietary protein and energy in the test diets. Treatments were: T1) 97.1% wheat, basal diet, T2) + .46% L-lysine, T3) + .46% L-lysine + .14% L-threonine, T4) +.46% L-lysine + .14% L-threonine + .05% DL-methionine, T5) control, wheat-soybean meal diet formulated to contain .83% lysine. Crystalline lysine, threonine and methionine were added, at the expenses of corn starch, to rise their dietary content to .83, .54 and .25% (.54% methionine+cystine), respectively. Vitamins and minerals were added to meet or exceed the requirements for the 50-80 kg pigs. Feed and water were provided ad libitum. Daily gain, feed intake, feed/gain ratio, and intakes of lysine, threonine and methionine were: 241, 430, 598, 615, 513 g/d; 1.24, 1.75, 1.85, 1.93, 1.80 kg/d; 5.29, 4.35, 3.07, 3.18, 3.53; 4.6, 14.6, 15.3, 16.0, g/d; 4.7, 6.7, 9.6, 10.3, g/d; 2.6, 3.7, 3.9, 5.2, g/d, respectively. Lysine addition to the basal diet increased (P<.05) daily gain, and intake of feed, lysine, threonine, and methionine; it also improved (P<.05) feed/gain ratio. Threonine addition to the lysine-added basal diet resulted in a further increment of growth rate and threonine intake, and improved (P<.05) feed/gain ratio. Further addition of methionine increased methionine intake, but the performance of the pigs was not additionally improved. However, the growth rate tended to increase (P<.15) as a result of methionine addition. The performance of pigs fed the control, wheat-soybean meal diet was similar to that of pigs fed the lysine-threonine-added diet. These data indicate that lysine and threonine are the first and second limiting AA, respectively, in wheat for growing pigs. Methionine appears to be marginal in wheat-diets for growing pigs.

**Key Words:** Pigs, Wheat, Limiting amino acids

**1961 Comparative nutritional value of wheat, grain sorghum and corn in diets for finishing pigs.** A.B. Araiza, M. Cervantes*, S. Espinoza, N. Torrentera, and M. Cervantes, *Universidad Autnoma de Baja California, Mexicali, Mxico.*

Two experiments, involving 60 crossbred pigs, were conducted to evaluate the comparative nutritional value of three cereal grains (wheat, grain sorghum, and corn) in diets for finishing pigs, under two different weather conditions. Thirty finishing pigs were used in each experiment (59.6 and 53.2 kg initial body weight, respectively), according to a complete randomized block design. Dietary treatments, in both experiments, were as follows: T1) wheat-soybean meal, T2) grain sorghum-soybean meal, and T3) corn-soybean meal; there were five 2-pig replicates per treatment. All diets were formulated to meet the lysine requirement of pigs between the 50-80 kg range weight; vitamins and minerals were added to meet or exceed the requirement. Exp. 1 was conducted during late fall (11.9 and 24.3C, average low and high, respectively), whereas Exp. 2 was conducted in early summer (19.4 and 38.3C, average low and high, respectively). Feed and water were provided ad libitum. In Exp. 1, daily gain, feed intake, feed/gain, lysine intake, threonine intake, gain/lysine intake, and gain/threonine intake were: 858, 874, 837 g/d; 2.54, 2.59, 2.67 kg/d; 3.02, 2.99, 3.30; 16.5, 16.8, 17.4 g/d; 13.7, 14.0, 13.6 g/d; 52.2, 53.5, 48.7 g/g; 62.8, 64.4, 62.1 g/g, respectively. There was no difference (P>.10) in daily gain, feed intake, feed/gain ratio, lysine intake and threonine intakes, and gain/lysine and gain/threonine ratios, between pigs fed either the wheat-, the grain sorghum- or the corn-based diets, during the winter time. In Exp. 2, ADG, feed intake, feed/gain, lysine and threonine intakes, gain/lysine intake, and gain/threonine intake were: 718, 706, 775 g/d; 2.23, 2.40, 2.42 kg/d; 3.19, 3.42, 3.17; 14.5, 15.6, 15.8 g/d; 12.1, 12.9, 12.4 g/d; 50.3, 45.5, 50.0 g/g; 60.5, 54.8, 63.7 g/g, respectively. As in Exp. 1, the performance of pigs in this study was not affected (P>.10) by the type of cereal grain used in the diet. In average, daily weight gain was higher (P<.05) and the feed/gain ratio was better (P<.05) during the winter as compared with the summer season. No difference was observed in gain/lysine or gain/threonine ratios between seasons. These data indicate that pigs fed wheat-based diets containing around 50% less soybean meal can perform as well as those fed grain sorghum- or corn-based diets.

**Key Words:** Pigs, Wheat grain sorghum corn, Performance

**1962 Time response effects of cornstarch and raw potatoe starch on the whole-tract digestibility and digestive tract adaptation in growing (20-60 kg) pigs.** D. Martinez-Puig[1], J. Morales*[1], J.F. Perez[1], S.M. Martin-Orue[1], and M.D. Baucells[1], [1]*Universidad Autonoma de Barcelona.*

Twelve growing pigs (Landrace, initial BW 26±3.6) were fed on two diets (6 animals /each) based on ground barley (29%), soybean meal (33%) and purified starch (25%), obtained from either corn (diet C) or raw potatoe (diet P), and characterized by their different content in resistant starch (52g/kg, diet C; 143g/kg, diet P). Diets were offered twice daily at 90% of the predicted voluntary intake. Chromium oxide (0.15%) was incorporated as a flow marker for OM digestibility (OMD) measurements. The experiment lasted 38d reaching the animals an average final weight of 54 kg (55.5 v. 52.9 kg for diet C and P, P=0.11). Faecal samples were obtained at day 7, 14, 21 and 38 for the estimation of the whole-tract OMD. On day 27, single doses of Co-EDTA and Cr mordanted wheat bran were administered and the total tract mean retention time (TMRT) was estimated from the faecal marker excretion. On day 38, animals were slaughtered, the whole gut excised, and the stomach, small intestine, caecum and colon ligated, removed and weighed. Whole tract OMD was significantly higher (P≤0.01) for diet C than diet P on d7 (0.835 v. 0.778) and d14 (0.864 v. 0.790). However, a progresive increase was observed on the diet P digestibility on day 21 (P=0.08) and 38, reaching a value on d38 lower but not significantly different from corn (0.861 v. 0.842, P=0.18). Hindgut adaptation to diet P was also evidenced by the significant heavier weight of the full digestive tract (7031 v. 8115g, P≤0.05), full colon (2267 v. 3255g, P≤0.001), colon digesta (1230 v. 1990g, P≤0.001) and colon length (3.44 v. 4.12m, P≤0.05). Despite these results, no significant differences were observed on the TMRT of Cr and Co between diets (Cr, 37.5 v. 42.2h; and Co, 35.9 v. 40.3h for Diet C and P, respectively). It is concluded that a long term period appears necessary to the growing pigs for hindgut adaptation to ferment resistant starch.

**Key Words:** Resistant starch, Digestive adaptation, Growing pig

**1963 Performance and caecal microbial activity of growing rabbits fed different starch levels.** A. M. V. Arruda*[1], R. D. Carregal[2], R. G. Ferreira[2], and E. S. Pereira[1], [1]*Universidade Estadual Oeste Parana ,* [2]*Universidade Estadual de Sao Paulo, Brazil.*

To evaluate the influence of dietary starch levels on the performance and caecal microbial activity in growing rabbits, four experimental diets were formulated to contain increasing corn starch levels (23, 28, 33 and 38 % total starch levels on a DM basis). White New Zeland rabbits (n=32)were used in a randomized block design. The results showed a decreasing linear effect (P<0.01) on food intake and food conversion, where the better rate (108.67 g/d and 3.216 , respectively) were obtained with 38% total starch level. However, differences for weight gain and carcass yield were not observed. Regarding caecal microbial activity, pH and VFA production were not significantly affected by the treatments, but the propionic acid concentration showed a decreasing linear effect (P<0.05) with the higher molar proportion (12.06 %) observed in the rabbits fed the 23% total starch level. It can be concluded that the starch of corn grain has a higher influence on the caecal microbial activity than purified maize starch, but without significant changes on the performance and carcass yield.

**Key Words:** Rabbits, Starch, Volatile fatty acids

**1964 Apparent digestibility of diets with differents starch levels to growing rabbits.** A. M. V. Arruda*[1], R. D. Carregal[2], R. G. Ferreira[2], and E. S. Pereira[1], [1]*Universidade Estadual Oeste Parana* , [2]*Universidade Estadual de Sao Paulo, Brazil*.

To evaluate the influence of dietetic starch level on the nutrients apparent digestibility in young rabbits, four experimental diets were formulated to contain increasing corn starch levels (23, 28, 33 and 38 %, total starch levels in dry matter basis). For the digestibility trial, it were used 20 White New Zeland rabbits, assigned to metabolism cages, following a complete randomized design. The results showed a crescent linear effect (P<0.01) to the coeficients of apparent digestibility for DM, OM, NDF and Starch, while that increased dietetic starch level in the experimental diets, where it was verified that the best digestibility (87.26%) was obtained with the 38% of dietetic starch level. It was not observed significant diferences to the coeficients of apparent digestibility for CP, CE and ADF by the differents starch levels in the experimental diets. However, the best digestibility of fat (89.46 %) was verified with the animals receiving 23% of dietetic starch level. Through this study, it can be conclued that rabbits were efficient in digesting purified starch maize, when this ingredient have a high participation in total carbohydrate fraction of the diets.

**Key Words:** Digestibility, Rabbits, Maize starch purified

**1965 Studying the effect of protein sources on meat quality of pigs using discriminant analyses.** Cs. Szabo[1], A.J.M. Jansman[2], L. Babinszky*[1], E. Kanis[3], and M.W.A. Verstegen[3], [1]*University of Kaposvr, Department of Animal Nutrition, Kaposvar, Hungary,* [2]*ID-TNO Animal Nutrition, Lelystad, The Netherlands,* [3]*Wageningen Institute of Animal Sciences (WIAS), Wageningen, The Netherlands*.

Effect of four protein sources (soybean meal, sunflower meal, pea and fish meal as the main protein source) in pig diets on meat quality traits were investigated. A total of 96 individually housed animals (24 per treatment in equal number of barrows and gilts) received the diets from 30 to 105 kg live weight at a level of 3.0 times maintenance requirements of energy. The diets were formulated based on ileal digestible amino acid and ideal protein concepts. At slaughter (105 kg) the traits were determined: lean meat percentage, intramuscular fat content, pH at 45 min and 24 h after slaughter, water loss, meat color (CIELAB) measured 24 h and 4 d after slaughter. The statistical analyses were carried out with GLM and DISCRIM procedures of SAS. Significant difference was not found between protein source treatments regard to ADG, FCR and meat quality. After eliminating the variables having multicollinearity (r>0.8) seven variables remained for discriminant analysis (lean meat percentage, $pH_{45}$, $pH_{24}$, WL, $L_{24}$, $Hue_4$, IMF). If observations were classified by chance, a 25% accuracy would be expected for the four protein source groups. The animals classified with a 42-74% accuracy to the right treatment based on the traits used. The value of Wilks' lambda (0.77) show a good discrimination, however, it was not significant (P=0.38). These results indicate that although no significant differences could be detected regarding individual variables, an overall effect of protein sources on meat quality probably exists. Similar fattening performance can be expected if protein sources are substituted on the basis of ileal digestible amino acid content and ideal protein concept.

**Key Words:** Meat quality, Pigs, Protein sources

**1966 Feeding value in broiler chicken diets of a potato expressing a $\beta$-glucanase from *Fibrobacter succinogenes*.** J. Baah*[1], T. A. McAllister[1], T. A. Scott[2], L. M. Kawchuk[1], J. D. Armstrong[3], L. B. Selinger[4], and K.-J. Cheng[5], [1]*Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB,* [2]*Pacific Agri-Food Research Centre, Agassiz, BC,* [3]*Pacific Agri-Food Research Centre, Summerland, BC,* [4]*University of Lethbridge, Lethbridge, AB,* [5]*Academia Sinica, Taipei, Taiwan*.

A transgenic potato cultivar was evaluated as a source of glucanase in barley-based diets for broiler chickens. Six broiler bioassay diets were formulated from each of two barley cultivars, CDC Silky and Falcon. Diets were unsupplemented (control), supplemented with a commercial poultry enzyme (Avizyme), or had 0.6 or 1.2 kg/tonne of the barley replaced with equal amounts of normal potato (NP) or with potato that expressed a $\beta$-glucanase from *Fibrobacter succinogenes* (FSEP). Hubbard High Yield broiler chicks were randomly assigned to the 12 diets (10 birds/cage; 2 cages/diet). After 3 d on a common broiler starter diet, chicks were given ad libitum access to experimental diets for 14 d. Growth and feed conversion ratios (FCR) were determined by cage. All birds were euthanized on d 17 and viscosity of digesta from the upper portion of the intestine (DV) was determined. On the control diets, growth performance was generally better with Falcon than with CDC Silky. Replacing 0.6 kg/t of barley with FSEP improved ($P < 0.05$) FCR with CDC Silky (1.87 vs 2.05) but not with Falcon; FCR on Avizyme diets was best (1.56; $P < 0.05$). Digesta viscosity was lower ($P < 0.05$) with 1.2 kg/t FSEP in CDC Silky diet than with control (152.3 vs 260.5 cP), but was still much higher ($P < 0.05$) than with Avizyme (31.8 cP). Apparent metabolizable energy (AME) of the diets, based on ileal digesta, was not affected ($P > 0.05$) by NP with either cultivar. With Falcon diets, AME was slightly higher (by 16 and 13%, $P > 0.05$) when 0.6 or 1.2 kg/t FSEP were included, than with no potato (2375.7 kcal/kg). Transformed potato may have potential as a supplementary source of enzyme in barley-based diets for broiler chickens.

**Key Words:** $\beta$-Glucanase-expressing potato, Broiler performance, Barley

**1967 Effect of protein fluctuations and space allocation on performance of growing-finishing pigs.** M. S. Edmonds*[1] and D. H. Baker[2], [1]*Kent Feeds, Inc., Muscatine, IA,* [2]*University of Illinois, Urbana, IL*.

Two trials with growing-finishing pigs (PIC line 356 x Camborough 22) were conducted to evaluate the effects of CP levels and/or space allocation on performance and carcass traits. In trial 1, three CP regimens were used with 216 growing-finishing pigs (mixed sex). Average initial weight of pigs was 31 kg. The CP regimens consisted of 1) control (18% CP wk 0-4; 15% CP wk 4-12), 2) moderate CP variations (MCPV = 19.5% CP wk 0-2; 16.5% CP wk 2-6; 13.5% CP wk 6-8; 16.5% CP wk 8-10; 13.5% CP wk 10-12) and 3) extreme CP variations (ECPV = 21% CP wk 0-2; 15% CP wk 2-4; 18% CP wk 4-6; 12% CP wk 6-8; 18% CP wk 8-10; 12% CP wk 10-12). There were six replications (pens) per treatment with 12 pigs per pen (0.93 $m^2$). During wk 8-12, pigs on the ECPV had improved ($P \leq 0.01$) gain and feed efficiency compared to those on the control regimen. Overall (wk 0-12), there were no treatment differences ($P \geq 0.05$) for gain, feed intake, gain/feed, or percent lean. Trial 2 involved 360 finishing pigs (mixed sex) in a 3 x 2 factorial (three CP regimens, two levels of space). Average initial weight of pigs was 49 kg. The diets consisted of 1) control (16% CP wk 0-4; 15% CP wk 4-8; 14% CP wk 8-12), 2) moderate CP variations (MCPV = 17.5% CP wk 0-2; 14.5% CP wk 2-4; 16.5% CP wk 4-6; 13.5% CP wk 6-8; 15.5% CP wk 8-10; 12.5% CP wk 10-12), and 3) extreme CP variations (ECPV = 19% CP wk 0-2; 13% CP wk 2-4; 18% CP wk 4-6; 12% CP wk 6-8; 17% CP wk 8-10; 11% CP wk 10-12). Pigs were provided with either 1.12 $m^2$ (5 pigs/pen) or 0.56 $m^2$ (10 pigs/pen). Overall(0-12 wk), crowded pigs had depressed ($P \leq 0.05$) gains (9.8%) and feed intakes (8.3%) compared to uncrowded pigs. A control vs. ECPV x space interaction for overall gain ($P \leq 0.05$) and gain/feed ratio ($P \leq 0.08$) occurred. Thus, uncrowded pigs fed ECPV performed better than controls, but crowded pigs did not. No treatment differences occurred for percent lean. The data suggest that uncrowded, but not crowded pigs, respond positively to up-and-down levels of dietary CP.

**Key Words:** Pigs, Protein, Space