
**NONRUMINANT NUTRITION:
AMINO ACID, MINERAL AND ENERGY
NUTRITION IN MONOGASTRICS**

1288 (M162) Calcium level and dEB affect the protein and mineral digestibility of lactating sows.

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Limestone (CaCO₃) and sodium bicarbonate are included in pig diets to supply Ca and increase dietary electrolyte balance (dEB = Na + K - Cl, in mEq/kg diet), respectively. However, both ingredients increase the diet acid-binding capacity and may interfere with the phytate-protein and phytate-Zn complex in the digestive tract. The aim of this study was to assess if diets differing in Ca level and dEB may affect the whole-tract apparent digestibility in lactating sows fed on a typical European sow diet (25.0% corn, 20.0% barley, 20.0% wheat, 18.3% soy meal, 10.0% wheat bran, 2% rapeseed meal) containing a high phytic acid level (2.9 g phytic P/kg), and supplemented with an overdose of phytase (1260 FTU/kg). A total of 48 lactating sows (14 d of lactation) were distributed according to their parity number and number of piglets into six experimental diets (2 × 3 factorial) differing in the Ca level: 6 or 9 g/kg (lowCa or highCa, respectively), and dEB: 40, 176 or 235 mEq/kg (lEB, mEB or hEB, respectively). Calcium chloride (10 g/kg) was added to lEB diets. The rest of Ca was provided as CaCO₃. Sodium bicarbonate was added (5 g/kg) to hEB diets. Titanium dioxide (3 g/kg) was used as indigestible marker. Diets were offered ad libitum for 7 d. Two fecal samples were obtained in two different times on d 21 of lactation for each sow and then pooled. Blood samples from sows fed highCa diets were individually collected on Day 21 to measure acid-base status of the sows. Sows fed highCa diets showed higher ($P < 0.05$) digestibility of CP (87.4%), Ca (21.4%), P (45.2%), and Zn (20.9%) than sows fed lowCa diets (85.8, 14.3, 40.8 and 7.04%, respectively). The use of sodium bicarbonate in lowCa diets (hEB) decreased ($P < 0.05$) DM digestibility as compared to the lowCa-mEB and the three highCa diets. The lBE diet reduced blood pH, bicarbonate and base excess values as compared with mBE and hBE ($P < 0.05$). In conclusion, the results showed that low Ca diets and sodium bicarbonate may reduce nutrient whole-tract digestibility in lactating sows fed on high phytic acid diets, even when phytase was overdosed.

Key Words: calcium, dietary electrolyte balance, digestibility

1289 (M163) Early dietary amino acid restrictions and flaxseed oil supplementation on the leanness of pigs and quality of pork: growth performance, serum metabolites, and carcass traits. C. K. Adhikari^{*1}, L. I. Chiba¹, S. D. Brotzge¹, M. D. S. Vieira², S. P. Rodning¹, W. G. Bergen¹, C. L. Bratcher¹, and E. G. Welles¹, ¹*Auburn University, Auburn, AL,* ²*Federal University of Rio Grande do Sul, Porto Alegre, Brazil.*

A total of 64 pigs were used to assess the effect of early dietary AA restrictions [100 or 80% of the 2012 NRC standardized ileal digestible (SID) Lys requirements during the grower (G) and finisher (F)-1 phases] and lipids (0 or 3% flaxseed oil + 2% poultry fat) on G-F pig. Each phase was based on weight, and at 24.7 ± 0.5 kg, pigs were assigned to 4 G diets with 4 gilt pens and 4 barrow pens/diet, and switched to F-1 diets when they reached 51.2 ± 0.3 kg. Pigs were switched to common F-2 diets at 80.0 ± 0.4 kg, and pigs fed 0 or 5% lipids earlier were continued to receive 0 or 5% lipids until harvest at 110.5 ± 0.5 kg. There were no interactions between dietary AA restrictions and lipids. Pigs fed the AA restricted diets consumed less SID Lys and DE ($P < 0.015$) and had depressed ADG compared with unrestricted pigs during the G phase, but they grew faster ($P = 0.042$) and utilized feed ($P = 0.064$) and SID Lys ($P < 0.001$) more efficiently during the F-1 phase. Dietary AA restrictions had no effect on overall ADG or carcass traits. Overall efficiency of feed, SID Lys, and DE utilization for BW gain ($P < 0.004$) and SID Lys utilization for fat-free lean gain (FFLG; $P < 0.001$) was improved by dietary AA restrictions. Dietary AA restrictions reduced serum urea N ($P < 0.025$) at the end of the G and F-1 phases and increased glucose ($P = 0.027$) at the end of the G-phase, but had no clear effect on triglycerides (TG) and other metabolites. Dietary lipids reduced ADFI ($P < 0.064$) during the G and F-2 phases, improved G:F ($P < 0.047$) during all phases and overall, and improved ADG during the G ($P = 0.003$) and F-1 ($P = 0.066$) phases. Belly firmness was reduced ($P < 0.001$), but dietary lipids had no effect on other carcass traits. Dietary lipids increased TG ($P < 0.075$) at the end of the G and F-1 phases, but reduced urea-N ($P = 0.037$) at the end of the F-2 phase. In conclusion, pigs subjected to early dietary AA restrictions improved overall efficiency of AA and DE utilization for BW gain and FFLG. As expected, dietary lipids improved G:F but reduced belly firmness.

Key Words: early amino acid restrictions, flaxseed oil, pigs

1290 (M164) Effects of supplementation with a commercial source of selenium in a laying hens feeding system. L. Betancourt*, *Universidad de La Salle, Bogotá, Colombia.*

Selenium enriched eggs are included as functional food in the market, because the role of selenium in human health and diseases has been recognized. The objective of this study was to enrich eggs with selenium from an organic source of selenium (seleno-yeast) on production parameters, egg quality and Leukocyte differential counts. Six hundred thirty laying hens of the Babcock line were used, between 27 and 65 wk of age. Hens were kept in cage and randomly distributed into two treatments with five replicated. The control treatment (T0) based on commercial feed without addition of seleno-yeast, and T1 treatment, based on commercial feed plus 450 ppm of seleno-yeast (1000 ppm selenium Kg-1). The eggs were lyophilized and selenium was measured through a plasma spectrophotometer ICAP 6300. The egg production and classification was recorded weekly, laying percentage and the feed conversion ratio were calculated. Egg tasting and conceptual evaluations were done. The egg selenium content was higher ($P < 0.05$) for T1 group with 1.376 mg kg-1 of lyophilized egg compared with T0 with 0.173 mg kg-1 of lyophilized egg. The addition of selenium did not significantly affect the egg production. The egg production percentage was 94.6 ± 3.88 and 95.2 ± 5.15 ; and the feed conversion ratios were 1.49 ± 0.061 and 1.48 ± 0.082 for T0 and T1, respectively. Therefore, leukocyte differential counts were not affected. The heterophile: lymphocyte ratios were 1.22 ± 0.31 and 1.58 ± 0.45 to T0 and T1 treatments, respectively. Egg organoleptic characteristics such as taste, color and texture, did not presented differences. This study confirmed that it is possible to enrich the content of selenium in eggs under an egg commercial production system without affecting the growth performance and the organoleptic characteristics. The cost of feed with selenio-yeast inclusion did not exceed the 1%, thus producing selenium enriched eggs is technically feasible to improve consumer health and competitiveness of the poultry industry.

Key Words: antioxidant, egg, glutathione

1291 (M165) Correlating molecular spectroscopy and chemometrics to explore carbohydrate utilization of co-products from bio-fuel and bio-brewing processing. L. Chen^{1,2}, X. Zhang¹, X. Huang^{2*}, and P. Yu², ¹Dep. of Animal Science, Tianjin Agricultural University, China, ²Dep. of Animal and Poultry Science, University of Saskatchewan, Saskatoon, Canada.

Co-products from bioethanol and brewing industry are excellent resources of protein and energy. Conventional studies often focus on traditional "wet" nutritional profiles. To date, there is little research on the relationship between carbohy-

drate molecular structural and nutritional values of the co-products. In this study, five kinds of corn DDGS and two kinds of barley DDGS with different batches were collected from different manufacturers in the north of China. The objectives of this project were to investigate the correlation between carbohydrate molecular structure and nutritional values, in terms of the carbohydrate chemical profile, true digestible nutrient, energy values, and digestion. The result showed that acid detergent fiber content in corn DDGS and barley DDGS had negative correlation ($P < 0.05$) with structural carbohydrate peak area, cellulose compounds, and carbohydrate component peaks. The correlation between carbohydrate peak area and true digestible neutral detergent fiber (tdNDF) were negative ($P < 0.05$). Spectral peak area of cellulose compounds, carbohydrate peak area had negative correlations ($P < 0.05$) with the dry matter content. There were no correlation between carbohydrate spectral intensities and energy values, carbohydrate sub-fractions partitioned and digestion. The results indicate that carbohydrate spectral profiles are highly associated with carbohydrate utilization in co-products from bio-fuel and bio-brewing processing.

Key Words: carbohydrate nutritional values, molecular spectral features, carbohydrate molecular structure

1292 (M166) Phosphorus utilisation and sodium-dependent phosphate co-transporters gene expression in growing pigs fed low available phosphorus diets. B. B. Pokharel¹, C. M. Nyachoti², and W. K. Kim³, ¹Dep. of Animal Science, University of Manitoba, Winnipeg, Canada, ²University of Manitoba, Winnipeg, Canada, ³University of Georgia, Athens.

Type II sodium-dependent phosphate co-transporters (NaPi) encoded by the SLC34A gene family are involved in renal and intestinal phosphate (Pi) absorption to maintain plasma Pi content. However, the effects of reduced dietary phosphorus (P) content on the expression of these genes and P utilisation in growing pigs are poorly defined. Thus, an experiment was conducted with 54 growing pigs (19.5 ± 1.11 kg BW) to examine the effects of reduced dietary available phosphorus (aP) content on P utilisation and NaPi gene expression. Pigs housed in groups of three per pen were randomly allotted to three experimental diets containing 0.23 (control), 0.17, and 0.11% aP to give six observations per diet and had ad libitum access to feed and water. All diets contained 0.3% TiO₂ as an indigestible marker. After each wk, one pig per pen was housed in a metabolic crate for 24 h to collect fecal and urine sample and then sacrificed to obtain jejunal and kidney sample. Fecal and urine sample were subsampled and analysed for P content. Expression of NaPi co-transporter genes (NaPi-IIb in jejunum, NaPi-IIa and NaPi-IIc in kidney) was analysed using quantitative real-time polymerase chain reaction (qRT-PCR). The expression of the NaPi-IIb gene in the jejunum was enhanced up to 250% ($P < 0.01$) in first wk of

pigs fed diet with 0.11% level of aP compared to the other dietary treatments. During wk 1, 2, and 3, the digestibility of P was lower ($P < 0.05$) in pigs fed diet with 0.11% level of aP (28.23, 27.14 and 23.33%, respectively) compared to control (39.07, 37.71 and 41.51%, respectively). Expression of NaPi-IIa and NaPi-IIc gene in kidney was enhanced ($P < 0.05$) by up to 160 and 180%, respectively, in wk 2 in pigs fed 0.11% aP diet. Urinary P was lower ($P < 0.05$) in pigs fed 0.11% aP diet (26.03 mg/L) compared to control (85.3 mg/L) in wk 3. In conclusion, dietary P content affected NaPi gene expression and P utilisation. Enhanced expression of NaPi-IIb in jejunum was seen in earlier period of reduced aP diets followed by higher expression of NaPi-IIa and NaPi-IIc in kidney later on. NaPi-IIb was not directly associated with the jejunal P uptake suggesting either post-transcriptional regulation or very low amount of aP for intestine to be able to pick up.

Key Words: sodium-dependent phosphate co-transporters, pigs, available phosphorus

1293 (M167) The impact of an inflammatory challenge and dietary omega-6 to omega-3 fatty acid ratios on protein deposition in nursery pigs. L. Eastwood* and D. Beaulieu, *Prairie Swine Centre, Inc., Saskatoon, SK, Canada.*

The objective of this experiment was to determine if decreasing the dietary omega (ω)-6 to ω -3 fatty acid ratio would affect protein deposition in nursery pigs during a prolonged *E. coli* lipopolysaccharide (LPS) inflammatory challenge. Twenty-four barrows were assigned to one of four treatment groups at 21 d of age (d 0). Treatments, arranged as a 2×2 factorial, were diets (10:1 and 5:1 ω -6: ω -3 plant based FA ratios) and challenge (LPS injection, *ad lib* intake; or saline injection, pair fed to match LPS injection intake levels). On d 15 and 18, pigs were injected with 15 μ g/kg BW LPS in saline or saline alone. On d 21, 1.5 h post-feeding, pigs were given a flooding dose of $^2\text{H}_2\text{O}$ and at 2.5 h post-feeding received another LPS or saline injection. Following the final injection, pigs were slaughtered (5.5 h post-feeding). Liver, semi-tendinosus muscle and blood samples were collected, and the remaining carcass was ground and analyzed for N and DM. Whole carcass protein deposition was determined relative to an initial slaughter group of pigs. Liver, muscle and blood samples were analyzed for $^2\text{H}_2\text{O}$ enrichment to determine the fractional rate of protein synthesis (FSR) during final day of the LPS challenge. ADFI (d 0 to 15) was unaffected by diet ($P > 0.05$); however 5:1 fed pigs tended to have higher ADG relative to the 10:1 fed pigs (28.8 vs. 25.0 ± 1.4 g/d; $P = 0.06$). Pigs consuming the 5:1 diet, regardless of challenge group, had higher whole body protein deposition rates for the 3 wk period relative to pigs consuming the 10:1 diet (87.8 g/d vs. 61.3 g/d; $P = 0.04$). Similarly, 5:1 fed pigs tended to have increased FSR in the liver on the final day of the challenge relative to those consuming the 10:1 diet (8.55% synthesized/h vs. 6.16%/h; $P = 0.08$). There was no

effect of LPS challenge on carcass composition, protein deposition rate or on liver or muscle FSR measured using $^2\text{H}_2\text{O}$ enrichment ($P > 0.05$). Protein deposition measured over time and on the final challenge day (FSR) provided similar results. This experiment shows that altering the FA ratio in nursery pig diets can alter the efficiency by which the animal utilizes nutrients for growth, as evidenced by similar feed intakes but improved ADG and protein deposition rates.

Key Words: Swine, omega-3, protein synthesis

1294 (M168) Phosphorus digestibility in high protein canola meals, conventional canola meal, and soybean meal fed to growing pigs. C. K. Parr*, Y. Liu, C. M. Parsons, and H. H. Stein, *University of Illinois at Urbana-Champaign, Urbana.*

An experiment was conducted to determine the digestibility of Ca and P in 2 high protein canola meals (CMA; 45.69% CP and CMB; 46.97% CP) fed to growing pigs, and to compare values obtained in high protein canola meal with digestibility of Ca and P in conventional canola meal (CM-CV; 35.10% CP) and soybean meal (SBM). The Ca and P contents of CMA, CMB, and CM-CV were 0.64 and 1.26%, 0.51 and 1.16%, and 1.25 and 1.16%, respectively. Four cornstarch-based diets were formulated using each source of canola meal or SBM as the sole source of P in the diet. Four additional diets that were similar to the initial four diets with the exception that 500 FTU/kg of microbial phytase were added to each diet were also formulated. Therefore, a total of eight diets were formulated. Forty-eight barrows were divided into two periods and randomly allotted via a randomized complete block design using a 2×4 factorial arrangement to the eight dietary treatments based on initial BW. There were six replicate pigs per dietary treatment. Experimental diets were provided for 12 d with the initial 5 d being the adaptation period. Indigo carmine was added as an indigestible marker to the morning meals on d 6 and 11, respectively. Fecal collections started when the first marker appeared in the feces and ceased when the second marker appeared. The endogenous loss of P was assumed to be 190 mg kg^{-1} DMI. At the conclusion of the experiment, feed intake, Ca and P intake, apparent total tract digestibility (ATTD) of Ca and P, and standardized total tract digestibility (STTD) of P were calculated. Results indicate that ATTD of Ca and P and STTD of P were not different among treatments. Apparent total tract digestibility of Ca was 62, 66, 69, and 73% for CMA, CMB, CM-CV, and SBM, respectively. Standardized total tract digestibility of P was 55, 60, 49, and 66% for CMA, CMB, CM-CV, and SBM, respectively. Inclusion of phytase to the diets reduced both Ca and P outputs ($P < 0.05$). Inclusion of phytase improved ($P < 0.05$) ATTD of Ca and P and STTD of P regardless of the ingredient in the diet and there was no interaction between diet and phytase supplementation.

Key Words: canola meal, phosphorus, pig

1295 (M169) Effect of dietary net energy concentrations on the growth performance of growing gilts housed individually. G. I. Lee¹, K. S. Kim², J. C. Park², and D. Y. Kil¹, ¹Chung-Ang University, Anseong-si, South Korea, ²Rural Development Administration, Cheonan-si, South Korea.

Dietary net energy (NE) concentrations influence pig performance, but the information for their effects on young gilts has been limited. Therefore, the objective of this experiment was to determine the effect of different NE concentrations in diets on the growth performance of growing gilts. A total of 60 growing gilts (Landrace × Yorkshire; initial BW = 15.9 ± 0.55 kg) were allotted to five dietary treatments of 9.6, 10.1, 10.6, 11.1, or 11.6 MJ NE/kg with 12 replicate pens and one pig per pen in an 28-d feeding experiment. Ratios between standardized ileal digestible AA and NE concentrations in all diets were similar. The NE and AA concentrations in diets were calculated based on the values from NRC (2012). Pigs were allowed ad libitum access to feed and water. The NE concentrations of five diets used in the growth trial were also determined based on digestible nutrients, DE, and ME measured in metabolism experiments with replicated 5 × 5 Latin square design using 10 growing pigs (initial BW = 15.9 ± 0.24 kg). Results indicated that calculated NE concentrations in diets were close to measured NE concentrations (9.5, 10.1, 10.4, 11.0, and 11.4 MJ NE/kg) in diets. The final BW, ADG, and ADFI were not affected by dietary treatments. However, there was a quadratic relationship ($P = 0.01$) between feed efficiency and dietary NE concentrations (0.51, 0.50, 0.49, 0.50, and 0.52 for 9.6, 10.1, 10.6, 11.1, and 11.6 MJ NE/kg of diets, respectively). The NE intake per BW gain (MJ NE/kg of BW gain) was increased (linear and quadratic, $P < 0.01$) with increasing NE concentrations in diets. In conclusion, dietary NE concentrations affect feed efficiency and NE intake per BW gain of growing gilts.

Key Words: growing gilts, growth performance, net energy,

1296 (M170) Gluconeogenesis and substrate utilization in chicken embryos during later development determined by *in ovo* continuous infusion of [¹³C₆] glucose and [¹³C₃] glycerol. Q. Hu*, U. Agarwal, and B. J. Bequette, *Dep. of Animal and Avian Sciences, University of Maryland, College Park.*

We aimed to quantify the rates of gluconeogenesis (GNG) and substrate partition to the Krebs cycle in embryonic (e) day e14 and e19 chicken embryos ($n = 5$ to 6 per group). An *in ovo* continuous tracer infusion approach was employed to test the hypotheses that GNG and non-essential amino acid (NEAA) synthesis increase from e14 to e19. [¹³C₆]Glucose or [¹³C₃] glycerol was continuously infused (8 h) into the chorio-allantoic compartment on e14 and e19. Based on [¹³C₆]glucose in-

fusion, glucose entry rate, Cori cycling and GNG were higher ($P < 0.05$) in e19 than in e14 embryos, presumably to support greater deposition of glycogen in the muscle and liver in preparation for pipping and hatching. In the liver, the contribution of glucose to alanine, aspartate, and glutamate synthesis was greater ($P < 0.05$) in e14 than in e19 embryos whereas the synthesis of NEAA from glycerol was higher ($P < 0.05$) in e19 than in e14 embryos. These patterns of glucose and glycerol utilisation by the liver suggest a metabolic shift to conserve glucose for glycogen synthesis and an increased utilisation of yolk glycerol (triacylglycerides) after e14. Although the contribution of glycerol to GNG in e19 embryos was greater ($P < 0.05$) than in e14 embryos, the contribution of glycerol to GNG (1.3–6.0%) was minor. Based on [¹³C₆]glucose tracer kinetics, the activities of both pyruvate carboxylase (PC) and pyruvate dehydrogenase (PDH) in the liver were higher ($P < 0.05$) on e19; however, the higher ($P < 0.05$) relative activity of PC vs PDH on e14 suggests a greater anaplerotic flux into the Krebs cycle of the e14 liver. In conclusion, the *in ovo* continuous tracer infusion approach allowed for measurement of chicken embryo whole body and liver metabolism over a shorter window of development compared to our previous approach of dosing tracer *in ovo* for 3 to 4 d. Lastly, this study provided quantitative estimates of the developmental shifts in substrate utilisation, GNG and NEAA synthesis by chicken embryos, as well as qualitative estimates of the activity of enzymes central to the Krebs cycle, and glucose and fatty acid metabolism.

Key Words: chicken, embryo, metabolism

1297 (M171) Plasma vitamin concentrations are altered by fat-soluble vitamin administration in suckling pigs. Y. D. Jang*, J. Y. Ma¹, J. S. Monegue¹, H. J. Monegue¹, R. L. Stuart², and M. D. Lindemann¹, ¹University of Kentucky, Lexington, ²Stuart Products Inc, Bedford, TX.

Plasma concentrations of some vitamins are purported to be low in nursing piglets raised in confinement. This experiment was conducted to investigate the effect of fat-soluble vitamin administration by different administration routes on plasma concentration of those vitamins in suckling pigs. A total of 45 pigs from five litters were allotted to three treatments at birth (three pigs/treatment within each litter). Treatments were oral and i.m. injection of 400 IU of α -tocopherol, 40,000 IU of retinyl palmitate, and 40,000 IU of vitamin D₃ at d 1 of age with the control treatment that had no vitamin administration. Blood samples were collected at d 0 (initial), 1, 2, 3, 4, 6, 9, 14, and 20 post-administration. Plasma 25-hydroxycholecalciferol (25OHD₃), α -tocopherol, retinyl palmitate, and retinol concentration were analyzed. Growth performance did not differ by vitamin administration. Effects of treatment, d, and d × treatment interaction ($P < 0.01$) were observed in which plasma concentration increased immediately regardless of administration routes to peak at d 2 (4.0, 155.4, and 235.4 ng/

mL) for 25OHD₃ and at d 1 post-administration (3.9, 14.3, and 32.3 ug/mL) for α -tocopherol for control, oral, and injection, respectively. The injection treatment had greater plasma values than the oral treatment. Plasma retinyl palmitate concentration increased only with the injection treatment and peaked at d 1 post-administration (0.13, 0.44, and 3.10 ug/mL for control, oral, and injection, respectively). Plasma α -tocopherol and retinyl palmitate concentration in the oral and injection treatments decreased from the peak plasma values to be similar with the values in the control treatment at d 9 and 3 post-administration, respectively. Plasma 25OHD₃ concentration in the oral and injection treatments was maintained greater than that in the control treatment until d 20 post-administration. These results demonstrate that plasma status of 25OHD₃, α -tocopherol, and retinyl palmitate are changed after administration to newborn pigs, and that the change of plasma profiles of these vitamins is different between types of vitamins administered and between administration routes. The injection administration is more efficient to enhance plasma 25OHD₃ level until weaning than the oral administration.

Key Words: fat-soluble vitamin administration, plasma vitamin concentration, suckling pigs

1298 (M172) Digestibility of amino acids in distillers dried grains with solubles produced in Europe from wheat, maize, or mixtures of wheat and maize and fed to growing pigs. S. M. Curry^{*1}, J. K. Htoo², H. V. Masey O'Neill³, and H. H. Stein¹, ¹*University of Illinois at Urbana-Champaign, Urbana*, ²*Evonik Industries AG, Hanau-Wolfgang, Germany*, ³*AB Vista Feed Ingredients, Marlborough, UK*.

European ethanol plants may use wheat or maize or combinations of wheat and maize as feedstock. The distillers dried grains with solubles (DDGS) produced, therefore, may vary in composition and nutritional attributes according to the grain that was used in the production. There are, however, limited data on how these differences influence the digestibility of AA in DDGS. Therefore, an experiment was conducted to compare the standardized ileal digestibility (SID) of AA by growing pigs in European DDGS produced from wheat, maize, or wheat-maize mixtures. Twelve barrows (average initial BW: 23.0 \pm 2.2 kg) were equipped with a T-cannula in the distal ileum and allotted to a replicated 6 \times 6 Latin square design with 6 diets and 6 periods. The five sources of European DDGS that were used included wheat DDGS from 2011, wheat DDGS from 2012, wheat-maize DDGS (80% wheat and 20% maize), maize-wheat DDGS (70% maize and 30% wheat), and maize DDGS. A diet containing each source of DDGS as the sole source of AA was formulated and a N-free diet was used to determine basal endogenous losses of CP and AA. Results indicated that the SID of CP was greater ($P < 0.05$) in maize DDGS compared with wheat DDGS from 2011, wheat DDGS from 2012, and maize-wheat DDGS. The

SID of all indispensable AA except Trp was also greater ($P < 0.05$) in maize DDGS compared with all other DDGS sources. For Trp, the SID in wheat-maize DDGS, wheat DDGS from 2011 and wheat DDGS from 2012 was not different from that of maize DDGS, but greater ($P < 0.05$) than in maize-wheat DDGS. The SID of all indispensable AA except Leu in maize-wheat DDGS did not differ from the values calculated for wheat DDGS from 2011 and wheat DDGS from 2012, and no differences between SID values for AA in wheat DDGS from 2011 and wheat DDGS from 2012 were observed. In conclusion, the SID of AA in maize DDGS produced in Europe is greater than in European wheat DDGS and DDGS produced from mixtures of wheat and maize.

Key Words: amino acid digestibility, distillers dried grains with solubles, pigs

1299 (M173) The determination of the amino acid requirements of pigs in the nursery phase.

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An experiment using 202 total pigs, assigned to one of four diets was conducted to determine the essential amino acid requirements of nursery pigs. Except for lysine, diets met or exceeded 1998 NRC. Treatment 1 was slightly deficient in lysine relative to the 1998 NRC (1.40, 1.23, and 1.10% of total dietary lysine in phases I, II, and III, respectively). Treatment 2 was equivalent to the 1998 NRC recommendations (1.50, 1.33, and 1.20% of total dietary lysine in phases I, II, and III, respectively). Treatment 3 was intermediate between the 1998 recommendations and the newly revised 2012 publication (1.60, 1.43, and 1.30% of total dietary lysine in phases I, II, and III, respectively). Treatment 4 was equivalent to the 2012 NRC publication (1.70, 1.53, and 1.40% of total dietary lysine in phases I, II, and III, respectively). Crystalline amino acids (LYS, THR, MET) were used to maintain an ideal amino acid pattern (1.00, 0.62, 0.57 respectively) across treatments. Treatments were fed over three phases: Phase I, D0–7; Phase II, D7–21; and Phase III, D21–35. There were no significant differences ($P > .10$) in growth rate or feed intake, but feed efficiency improved linearly ($P < .05$) as amino acid content increased (Gain:Feed of 0.66, 0.69, 0.70, and 0.72 in treatments 1, 2, 3, and 4, respectively). Blood samples were obtained from pigs at the end of each dietary phase (d 7, 21, and 35) for determination of plasma urea concentration. There was a significant linear response to diet on d 7, 21, and 35 ($P < 0.05$), with a significant quadratic response on d 21 and 35 ($P < 0.001$). This suggests that nitrogen excretion is reduced in pigs fed higher levels of crystalline amino acids, which could potentially reduce environmental impact. In contrast to the positive linear correlation between dietary lysine levels and feed efficiency, the blood urea response indicated that the requirement for amino acids was met at 1.33% total lysine diets in Phase II, and 1.20% lysine in Phase III; these results most closely corre-

spond to the 1998 NRC guidelines. These results suggest that the decision whether to feed the higher levels of amino acids in the nursery depends on the added cost associated with those diets. Based on growth rate and feed intake, there is no evidence that the higher dietary levels are needed. However, feed efficiency and plasma urea response indicate that the higher levels may be justified.

Key Words: lysine, nursery, pigs

1300 (M174) Effect of dietary energy level and weaning weight on growth performance and digestibility in weanling piglets. M. D. S. Vieira¹, A. M. L. Ribeiro¹, A. D. M. Kessler¹, L. I. Chiba^{*2}, M. L. Somensi¹, L. Bockor¹, and L. G. Teixeira¹, ¹*Federal University of Rio Grande do Sul, Porto Alegre, Brazil*, ²*Auburn University, Auburn, AL*.

The experiment was conducted to determine the capacity of piglets weaned at light weight to achieve similar growth performance with those weaned at heavy weight by increasing the ME content of the diet and keeping constant Lys:ME. Thirty-two male piglets were classified according to their weaning weight (WW) as light (4.5 ± 0.4 kg) or heavy (6.7 ± 0.5 kg) and housed individually in metabolic cages for 28 d. Six treatments, 2 WW and 3 ME levels (I: 3400; II: 3600; and III: 3800 kcal/kg) in a 2×3 factorial arrangement, were used in pre-starter (PS, d 0 to 14) and starter (ST, d 14 to 28) period. The control diet (I) was formulated with standard energy and nutrient recommendations (Brazilian Tables for Poultry and Swine), whereas indispensable and dispensable AA, Ca, P, and lactose levels in the diets II and III were adjusted for the increased ME (e.g., 4.14 and 3.91 g Lys/Mcal ME for the PS and ST periods, respectively). Fecal and urine samples were collected to determine apparent total tract digestibility (ATTD) of energy and nutrients. Age at weaning was used as covariate in the statistical model. There were no WW x ME interactions for any of the response criteria. Overall, light WW piglets had less ADG and AFDI ($P < 0.05$), but there was no difference in the G:F. Heavy WW piglets ingested more ME, Lys, and N than light WW piglets during the entire phase ($P < 0.05$). During the PS period there was a linear effect of ME on G:F; increasing ME improved G:F ($P < 0.05$). Also in this period, the increment in ME increased ATTD of GE, and DE and ME values ($P < 0.05$). During the ST and total period, there was no effect of increased ME levels on ME and Lys intake, but increasing ME levels increased ATTD of GE, CP, and DM, N retention, and DE and ME values ($P < 0.05$). In conclusion, light piglets did not improve growth performance when fed diets with increasing ME levels. Increased ME levels improved digestibility and utilization of nutrients, but did not improve growth performance.

Key Words: energy density, nursery piglets, weaning weight

1301 (M175) Effect of dietary energy level and weaning weight on body composition and efficiency of energy utilization in weanling piglets.

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The experiment was conducted to evaluate the effects of dietary ME and weaning weight (WW) on body composition and energy utilization in weanling piglets. Thirty-two male piglets were classified according to their WW as light (4.5 ± 0.4 kg) or heavy (6.7 ± 0.5 kg), and housed individually in metabolic cages for 28 d. Six treatments, 2 WW and 3 ME (I: 3400; II: 3600; and III: 3800 kcal/kg) with constant Lys:ME were used. The control diet (I) was formulated with standard energy and nutrient recommendations (Brazilian Tables for Poultry and Swine), whereas AA, Ca, P, and lactose levels in the diet II and III were adjusted for the increased ME. Body composition, energy and nutrient deposition rates, and energy efficiency of gain were measured through comparative slaughter technique. There were no WW x ME interactions for any of the responses. BW, ADFI, and ADG were greater ($P < 0.05$) in piglets with heavier WW than lighter WW, but there was no difference in G:F. Also, heavy WW piglets had greater fasted BW, eviscerated carcass and empty BW (EBW), compared to light WW piglets ($P < 0.05$), but there was no difference in the organ + blood (OB) fraction. When those responses were equalized per kilogram of fasted BW, light WW piglets had greater OB than heavy WW piglets. Gastrointestinal tract and kidneys were greater in heavy WW piglets, while urinary tract and blood were greater in light WW piglets when equalized per kilogram of fasted BW ($P < 0.05$). There was no effect of ME on physical body composition, and ME and WW did not affect chemical body composition. The rates of water, ash, and protein deposition in the carcass and OB were greater in heavy WW piglets ($P < 0.05$). Water and protein deposition in EBW also were greater in heavy WW piglets ($P < 0.05$). Increasing ME did not affect energy and nutrient deposition rates in any of the body fractions. Heavy WW piglets had greater intakes of ME, with higher estimates of ME for maintenance and heat production ($P < 0.05$). Energy efficiency was not affected by the WW or ME content of the diets. In conclusion, heavy WW piglets had greater protein deposition and efficiency of gain than light WW piglets. The ME level did not improve the response criteria evaluated in the current study.

Key Words: energy deposition, metabolizable energy, weaning weight

1302 (M176) Egg quality of brown laying hens fed with different Met + Cys and chelate Cu levels.

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The objective of the current study was to evaluate effects from Met + Cys levels combined with chelated Cu concentrations for brown laying hens. Nine hundred sixty brown laying hens (6 replicates/treatment, 8 birds/replicate) from 22 to 26 wk of age were allotted in a randomized bloc design under factorial scheme 5 × 4 (Met+Cys x Chelated Copper). The diets were formulated according had similar composition (2800 kcal/kg ME, 15.5% CP) and were formulated according with the lineage of the birds, except for Met + Cys and copper levels. At the final day of period two eggs/experimental unit were evaluated for weight, specific gravity-change, % shell, shell thickness, % albumen, % yolk, Haugh unit, yolk index, and yolk color. Statistical analysis was performed using ANOVA and Tukey's test 5%. In conclusion, Met + Cys and Chelate Cu did not affect external and internal quality results of eggs from brown layer hens at 26 wk of age.

Key Words: albumen, yolk, organic mineral

Table 1302. External and internal egg quality of brown laying hens fed with Met + Cys and chelated Cu levels

Variable	Met + Cys (%)					CV (%)
	1.1	0.95	0.80	0.65	0.50	
Weight (g)						
Specific Gravity -change	1.096	1.095	1.097	1.094	1.095	0.49
% shell	10.00	9.83	10.16	9.76	9.86	7.72
Shell thickness (mm)	38.80	38.75	38.79	38.69	38.48	7.13
% Albumen	68.06	68.04	67.71	67.88	67.71	3.68
% Yolk	21.94	22.13	22.59	22.36	22.43	7.69
Haugh unit	101.22	102.63	101.54	100.75	101.23	5.29
Yolk index	49.46	50.75	49.88	50.00	50.65	9.01
Yolk color						
Variable	Chelated Cu (ppm)				CV (%)	
	88	43	22	0		
Weight (g)						
Specific Gravity	1.096	1.096	1.095	1.095	0.49	
% Shell	9.94	9.96	9.93	9.85	7.72	
Shell thickness (mm)	38.68	39.37	38.22	38.62	7.13	
% Albumen	68.34	67.99	67.85	67.35	3.68	
% Yolk	22.09	22.05	22.22	22.81	7.69	
Haugh unit	101.98	101.43	100.44	102.04	5.29	
Yolk index	49.38	50.78	50.27	50.15	9.01	
Yolk color	6.8	6.8	6.6	6.4	15.11	

In line, means do not differ ($P > 0.05$) by Tukey test.

1303 (M177) Validation of net energy system of feed formulation in growing-finishing pigs fed barley based diets with alternative feed ingredients.

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The aim of this study was to determine the growth performance and carcass characteristics of growing-finishing pigs fed diets formulated on net energy (NE) basis thereby validating the NE system of feed formulation. Twenty-four pigs (12 barrows and 12 gilts) with an initial BW of 25 kg were blocked by sex and allotted one of the three treatments, resulting in 8 replicates, 4 barrows and 4 gilts per treatment. Dietary treatments were; a barley-based control diet with alternative feed ingredients (distillers dried grains with soluble, canola meal and peas) formulated on digestible energy (DE) basis (Diet A), control diet formulated on a NE basis (Diet B) and Diet B + Multi-carbohydrase enzyme (Diet C). Pigs were offered their respective diets in a three-phase feeding program for 25 to 50 kg (Phase 1), 50 to 75 kg (Phase 2), and 75 to 110 kg (Phase 3) BW. Diet A was formulated to contain 3402 kcal/kg of DE and Diet B and Diet C to contain 2475 kcal/kg of NE with 0.98, 0.85, and 0.73% SID Lys for phases 1, 2, and 3, respectively. Individual pig BW and feed disappearance were monitored biweekly during each phase to determine average daily gain (ADG), average daily feed intake (ADFI), and gain to feed ratio (G:F) ratio. Pigs were slaughtered once they reached 100 kg BW to determine carcass characteristics. During Phase 1, an improvement in ADFI ($P = 0.02$) was observed for diets formulated on NE basis with enzyme supplementation (1.78 kg/d) when compared to Diet B without enzymes (1.57 kg/d). In Phase 3, a significant difference was observed for ADG ($P = 0.01$), wherein Diet B showed a BW gain of 0.89 kg/d compared to 0.79 kg/d for the control diet. Also a trend for an increase in G:F ratio ($P = 0.072$) was observed between diets formulated on DE and NE basis. For overall performance, when compared to the control diet, pigs fed Diet B showed significant improvement in ADG (0.90 vs. 0.96 kg/d; $P = 0.02$) and G:F (0.43 vs. 0.47; $P = 0.05$). No significant differences ($P > 0.10$) were observed among dietary treatments for any of the carcass characteristics. In conclusion, the results indicate a better growth performance when diets were formulated on a NE basis when compared to the DE system. Though not significant, enzyme supplementation numerically enhanced the overall performance.

Key Words: enzyme, net energy, pig

1304 (M178) Effects of dietary tryptophan:lysine ratio and sanitary conditions on performance of weaned pigs fed antibiotic-free diets. B. Jayaraman^{*1}, J. K. Htoo², and C. M. Nyachoti¹, ¹University of Manitoba, Winnipeg, Canada, ²Evonik Industries AG, Hanau-Wolfgang, Germany.

The aim of this study was to determine the optimum standardized ileal digestible (SID) Trp:Lys ratio for weaned pigs reared in clean or unclean sanitary conditions and fed antibiotic-free diets. Mixed-sex pigs (Duroc x [Yorkshire x Landrace]; average initial BW of 7.0 ± 0.5 kg) weaned at 21 ± 1 d were randomly assigned to 10 dietary treatments in a 2 × 5 factorial arrangement in a 28-d study giving 6 replicates (3 pigs per pen) per treatment. The main factors were sanitary conditions (clean, CL and unclean, UCL) and 5 dietary SID Trp:Lys (16, 18, 20, 22, and 24%) in a completely randomized design. Diets were corn-wheat-soybean meal based with a constant SID Lys of 1.18% that was set to be second limiting AA. For the first 14 d, CL group (*n* = 90) were kept in pens, followed immediately by the UCL group (*n* = 90) for the next 14 d in the same room. Piglets were provided ad libitum access to feed and water. Under the CL condition, the room was disinfected before arrival of piglets and the room was cleaned weekly. For the UCL pigs, the room was not disinfected and cleaned after CL group and manure from swine herd was added (5 kg per pen) to the pens on d 0 and d 7 of the experiment. Pigs BW and pen feed disappearance were recorded weekly to determine ADG, ADFI and G:F. The effect of sanitary conditions was observed (*P* < 0.05) for ADG and G:F throughout the study. During d 0 to 7 and d 8 to 14, the ADG for CL vs. UCL were 206 vs. 160 g and 420 vs. 364 g, respectively. During d 0 to 7 and d 8 to 14, the G:F for CL vs. UCL was 0.73 vs. 0.54 and 0.76 vs. 0.64, respectively. Increasing dietary SID Trp:Lys ratio did not affect ADG and ADFI during d 0 to 14. The highest ADG was achieved at SID Trp:Lys of 20% for CL and 24% for UCL pigs, respectively. Increasing dietary Trp:Lys had a linear trend (*P* < 0.10) towards improved G:F during d 0 to 7 in the UCL group showing that SID Trp:Lys of 24% improved G:F. In conclusion, pigs raised under unsanitary conditions had reduced ADG and G:F in piglets, and increasing the level of SID Trp:Lys 24% could improve G:F after weaning.

Key Words: tryptophan, sanitation, piglets

1305 (M179) Egg quality of brown layers fed with different levels of threonine and chelate zinc. J. E. D. Moraes¹, C. C. Pizzolante¹, A. P. O. Saccomani², E. A. D. Oliveira³, S. K. Kakimoto⁴, J. C. Dadalt^{*5}, and M. A. D. T. Neto⁵, ¹APTA-Unidade de Pesquisa de Brotas-SAA-SP, Brotas, Brazil, ²Instituto de Zootecnia-APTA-SAA-SA, Nova Odessa, Brazil, ³Secretaria de Agricultura de Brotas, Brazil, ⁴Granja Kakimoto, Bastos, Brazil, ⁵University of São Paulo, Pirassununga, Brazil.

The objective of this study was to evaluate effects from Thr levels combined with chelated Zn concentrations for brown laying hens. Nine hundred sixty brown laying hens (6 replicates/treatment, 8 birds/replicate) from 22 to 26 wk of age were allotted in a randomized block design under factorial scheme 5 × 4 (Met+Cys x Chelated Copper). The diets were formulated according had similar composition (2800 kcal/kg ME, 15.5% CP) and were formulated according with the lineage of the birds, except for Thr and Zn levels. At the final day of period, two eggs per plot were evaluated for weight, specific gravity, Haugh unit, yolk index, and for percentages of yolk, albumen and shell. Statistical analysis was performed using ANOVA and contrast between mean for (*P* < 0.05) by Tukey's test. There was no interaction effect of Thr and Zn. Egg weight (56.36 ± ...g), specific gravity (1.099 ±), Haugh units (126.00 ±) yolk index (27.72 ±) and shell thickness (39.61 ±) shell percentage (10.05 ±) had no significant effect under Thr and chelate Zn levels. Effects (*P* < 0.05) were observed for Thr on percentages of yolk and albumen (Table 1305). The lower percentages of egg yolk occurred under 1.1 and 0.80% Thr and albumen under 0.65% Thr levels.

Key Words: albumen, yolk, chelate minerals

Table 1305. Percentages of yolk and albumen of eggs from brown layers fed Thr

	Thr (%)					Mean	CV (%)
	1.1	0.95	0.80	0.65	0.50		
Yolk %	21.92 ^b	22.40 ^{ab}	21.79 ^b	23.08 ^a	22.36 ^{ab}	22.32	9.23
Albumen %	68.03 ^a	67.62 ^{ab}	68.14 ^a	66.77 ^b	67.66 ^{ab}	67.64	3.24

Means bearing different superscript letters within a row differ by Tukey (*P* < 0.05). In conclusion, Thr levels may affect the internal egg quality. Zn concentrations did not affect the external and internal qualities of egg.

1306 (M180) Tryptophan:lysine ratio for pigs from 15 to 30 kg of body weight. T. J. Pasquetti¹, P. C. Pozza², I. Moreira², L. M. Diaz Huepa², L. D. Castilha², M. R. Fachinello², L. A. C. Esteves², V. R. C. Paula², and S. W. Kim³, ¹Universidade Estadual de Maringá, Bolsista CAPES, Maringá, PR, Brazil, ²Universidade Estadual de Maringá, PR, Brazil, ³North Carolina State University, Raleigh.

The aim of this study was to determine the digestible Tryptophan:Lysine (Trp:Lys) ratio for starting pigs (15 to 30 kg). A previous study was performed to determine the true ileal amino acids digestibility of the diet with low Trp and Lys levels. In the growth performance study, a total of 64 individually housed barrows (15 ± 0.23 kg) were allotted in a completely randomized block design, with 16 treatments and four replicates. Treatments were arranged as a 4 × 4 factorial scheme (four levels of digestible Trp: 0.155, 0.185, 0.215, 0.245% and four levels of digestible Lys: 0.972, 1.112, 1.252 and 1.392%). Glutamic acid was used to keep the diets with the same nitrogen levels. At the end of the study, body weight (BW) and feed intake were recorded and feed:gain ratio (F:G) calculated. Ultrasonography was performed using an Aloka (SSD 500) and Sonograder (Renco) equipments, and measurements of backfat thickness and loin depth were performed using the ImageJ software. Considering the regression analysis, the BW ($P = 0.03$) and average daily gain ($P = 0.005$) increased linearly with increased levels of digestible Trp. By surface response method, the average daily feed intake (ADFI) increased linearly ($P = 0.014$) as the levels of digestible Trp increased in the diets, while Lys showed a quadratic effect ($P = 0.004$). For the ADFI the optimum Lys level was estimated at 1.195%. An interaction between digestible Trp and Lys ($P = 0.056$) was found on F:G. Considering the surface response method, there was a quadratic effect ($P = 0.042$) of digestible Trp and Lys levels on F:G, estimating on 0.210 and 1.198% the optimum levels of digestible Trp and Lys levels, respectively, which results in a Trp:Lys ratio of 0.175. No differences ($P > 0.05$) were observed on backfat thickness. A quadratic effect of digestible Trp ($P = 0.021$) and Lys (0.026) levels was observed on loin depth (measured through Aloka SSD 500), which by surface response method the optimum Trp and Lys levels were 0.208 and 1.136%, respectively, providing a Trp:Lys ratio of 0.183%. Using the regression analysis we observed a quadratic effect ($P = 0.042$) of digestible Trp on loin depth (Sonograder- Renco), which was estimated to be optimum at 0.210%. In conclusion, the optimum digestible Trp and Lys levels for growth performance are 0.210 and 1.198%, and for loin depth are 0.208 and 1.136%, which provide a Trp:Lys ratio of 0.175 and 0.183%, respectively.

Key Words: response surface; growth performance, requirements.

1307 (M181) Energy intake and nutrient digestibility in heavy finishing swine fed varying levels of soluble fiber. D. J. Rodrigues^{*1}, M. C. Thomaz¹, U. D. S. Ruiz², M. M. Lima¹, M. S. F. Oliveira¹, M. V. Marujo¹, F. F. Castro¹, and E. Daniel³, ¹Sao Paulo State University, Jaboticabal/SP, Brazil, ²Univ. Estadual Paulista, Dracena, Brazil, ³Dep. of Animal Science, FCAV/UNESP, Jaboticabal/SP, Brazil.

Depending on its characteristics, dietary fiber may depress daily energy intake and utilization of dietary nutrients in growing pigs. These effects are likely lower in finishing pigs. This study was conducted to determine the effect of increasing dietary levels of soluble fiber on daily feed and energy intake, as well as apparent fecal nutrient and energy digestibility in finishing pigs. In total 36 individually housed barrows (commercial crossbred; initial BW 78.38 ± 0.32 kg), were assigned to four dietary treatments in a randomized block design: control (corn and soybean meal based; 3229 kcal/kg calculated ME, 13.9% CP, 1.5% soluble fiber) and three isonitrogenous diets with increasing levels of soluble fibers (4, 8, and 12%; from added pectin, containing 63% of soluble fiber), and consequently decreased levels of calculated ME (3095, 3017, and 2946 kcal/kg). Pigs were fed ad libitum. At a BW of 105 kg, feces were collected twice daily, during 3 d. Insoluble ash was used as marker for determining digestibility. Statistical analyses were performed using the PROC MIXED of SAS. The results showed a linear decrease for both daily feed intake ($P = 0.0157$) and daily DE intake ($P = 0.0005$) between 100.86 and 126.19 kg BW. Quadratic effects ($P < 0.0001$) were observed for the digestibility of DM, GE and CP; the maximum digestibility values were obtained at 0.74, 1.33 and 1.60% additional soluble fiber in diet, respectively. There was linear decrease ($P < 0.0001$) for the digestibility of ash. These results confirm that feedstuffs containing soluble fiber can be used to reduce daily energy intake in heavy finishing pigs through qualitative feed restriction, but its negative effect on the nutrient digestibility must be considered.

Key Words: daily energy intake, feed restriction, soluble fiber

Table 1307. Daily feed (kg/d) and DE intake (kcal/d), as well as apparent fecal digestibility (AFD, %) of energy and nutrients in finishing pigs fed diets containing different levels of soluble fiber (SF)

	Experimental diets (% SF)				SE	Effect of diet SF
	1.5	4	8	12		
Daily feed intake	1.64	1.56	1.61	1.34	0.18	Linear
Daily DE intake	6822	5792	5937	4925	317.32	Linear
AFD						
DM	89.75	89.26	87.54	85.35	0.32	Quadratic
GE	89.92	90.19	88.21	86.29	0.33	Quadratic
Ash	51.91	45.38	34.94	28.05	1.09	Linear
CP	86.64	87.63	84.99	82.90	0.69	Quadratic

1308 (M182) Amino acid digestibility in field peas, fish meal, corn, soybean meal, and soybean hulls.

J. K. Mathai*, and H. H. Stein, *University of Illinois at Urbana-Champaign, Urbana.*

An experiment was conducted to determine the standardized ileal digestibility (SID) of AA in field peas, fish meal, corn, soybean meal, and soybean hulls. Six ileal-cannulated gilts (initial BW: 26.5 ± 0.74 kg) were allotted to a 6 × 6 Latin square design with 6 diets and 6 periods. A N-free diet was formulated to determine basal endogenous losses of AA and CP and to enable the calculation of SID of AA. The remaining diets were formulated with each test ingredient as the sole source of AA, with the exception that the soybean hulls were included in a diet that also contained soybean meal to compensate for the low CP in soybean hulls. The AID and SID values were calculated in the soybean hulls diet using the difference procedure whereas AID and SID in the other ingredients were calculated using the direct procedure. The SID of Lys was greater ($P < 0.05$) in field peas, fish meal, and soybean meal than in corn and soybean hulls (Table 1308). The SID of Trp was greater ($P < 0.05$) in corn than in soybean meal, and greater ($P < 0.05$) in soybean meal than in field peas. The SID of His, Lys, and Trp was less ($P < 0.05$) in soybean hulls than in other ingredients. These data indicate that the SID of AA in most indispensable AA is not different between field peas, fish meal, and soybean meal, whereas the SID of some indispensable AA is less in soybean hulls than in other ingredients.

Key Words: amino acid digestibility, feed ingredients, pigs

Table 1308. Standardized ileal digestibility (SID; %) of AA in field peas, fish meal, corn, soybean meal (SBM), and soybean hulls fed to pigs

Item	Ingredients					P-value
	Field Peas	Fish meal	Corn	SBM	Soybean hulls	
His	92.7 ^{ab}	87.3 ^c	93.3 ^a	90.2 ^b	69.5 ^d	< 0.05
Ile	87.6 ^{ab}	86.7 ^b	90.7 ^a	87.7 ^{ab}	83.4 ^c	< 0.05
Lys	90.6 ^a	87.7 ^a	73.1 ^b	86.3 ^a	69.8 ^d	< 0.05
Met	87.9 ^{bc}	87.2 ^c	92.1 ^b	87.4 ^c	97.1 ^a	< 0.05
Phe	89.2 ^b	86.0 ^{bc}	92.9 ^a	88.4 ^b	89.2 ^b	< 0.05
Thr	86.9 ^{ab}	84.3 ^b	89.2 ^a	85.4 ^{ab}	85.9 ^{ab}	< 0.05
Trp	85.8 ^c	91.2 ^{ab}	95.0 ^a	90.6 ^b	76.4 ^d	< 0.05
Val	86.5 ^{bc}	84.9 ^{cd}	90.2 ^b	85.9 ^c	100.5 ^a	< 0.05

^{a-d} Means within a row lacking a common superscript letter differ.

1309 (M183) Lysine and tryptophan levels in diets for gilts from 15 to 30 kg of body weight.

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The aim of this study was to determine the optimum levels of digestible lysine (Lys) and tryptophan (Trp) in diets for gilts from 15 to 30 kg of body weight. A previous study was performed to determine the true ileal digestibility of amino acids in the basal diet (low Lys and Trp levels), to verify if some deficiencies occurred with other essential amino acids. The growth performance study was performed using a total of 64 individually housed gilts (15.03 ± 0.19 kg), allotted in a completely randomized block design, with 16 treatments and four replicates. Treatments were arranged as a 4 × 4 factorial scheme (four levels of digestible Trp: 0.155, 0.185, 0.215, 0.245% and four levels of digestible Lys: 0.972, 1.112, 1.252 and 1.392%). Glutamic acid was used to keep nitrogen levels similar across diets. The body weight (BW) and feed intake were recorded and F:G was calculated. Ultrasonography was performed using an Aloka (SSD 500) and Sonograder (Renco) equipments, and backfat thickness and loin depth were measured using the ImageJ software. Considering the regression analysis, a quadratic effect of digestible levels of Trp was observed on ADG ($P = 0.038$), in which the optimum level was obtained 0.224%. The increased levels of digestible Trp improved linearly ($P = 0.005$) the ADFI. An interaction between Trp and Lys was observed for F:G ($P = 0.007$). No interaction was observed for ADG ($P = 0.247$), ADFI ($P = 0.233$), backfat measured with Sonograder ($P = 0.603$), and Aloka ($P = 0.462$) and for loin depth measured with Sonograder ($P = 0.632$) and Aloka ($P = 0.086$). By surface response method, a quadratic effect ($P = 0.034$) of digestible levels of Trp and a linear effect of Lys ($P = 0.005$) were observed on F:G, in which the optimum level of digestible Trp was obtained at 0.216%. Trough regression equation method, the backfat thickness (measured through Aloka or Sonograder) increased linearly ($P = 0.052$ and 0.021, respectively) and the loin depth (measure through Aloka) showed quadratic effect ($P = 0.034$) for Trp levels, in which the optimum level was estimated at 0.205%. The loin depth, measured through Sonograder, increased linearly ($P = 0.039$) with digestible levels of Lys. In conclusion, the optimum levels of digestible Trp, to improve average daily gain and loin depth, are 0.224 and 0.205%, respectively.

Key Words: amino acids, ileal digestibility, growth performance.

1310 (M184) Effects of mineral supplementation on the performance of nulliparous and multiparous does fed forage containing diets. L. Verjel-Trigos¹,

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The effect of the mineral supplementation on the performance of nulliparous and multiparous rabbit does fed forage containing diets was evaluated in 18 rabbit does crossed New Zealand and Russian californian with an average live weight 3.65 ± 0.15 kg, placed in individual cages, distributed following a complete randomized design with factorial arrangement 2×3 , with two levels of parity (PA), multiparous (M) and nulliparous (N), and three levels in salt supplementation (S), without salt (NS), with 6% P (S6), 11.4% Ca y 6% P, and 8% P (S8), 15.2% Ca y 8% P, with three replications. The diet consisted of 85% of commercial feed and 15% trichantera forage based in DMI (Mineral composition: 1.4% Ca and 0.56% P). Salts was formulated to keep a constant calcium:phosphorus ratio and levels of trace minerals. The salt was offered in plastic licks from 15 d before mating to weaning. Lactation period was 30 d. To rabbit does performance was evaluated farrowing weight, weaning weight and DMI. In the performance of kits the litter size at birth, at weaning and weight gain in lactation was evaluated. Data were analyzed in module GLM of SAS ver. 9.2. Analysis of covariance to the initial weight of the rabbit does and comparison of means by orthogonal contrasts was performed. The performance of kits was not affected ($P > 0.05$). In rabbit does performance no interaction between S and PA was observed ($P > 0.05$). There were no differences ($P > 0.05$) between groups for DMI, 101.1, 107.7, 109.9, 101.0, 107.8 and 103.0 g/d of DMI to N-NS, N-S6, N-S8, M-NS, M-S6 and M-S8, respectively and 0.42, 0.37, 0.38 and 0.34 g/d of salt to N-S6, N-S8, M-S6 and M-S8, respectively. The farrowing weight of rabbit does was higher ($P < 0.01$) in S8 compared to S6, 3841, and 3388 g to S8 and S6, respectively. S8 increase ($P < 0.05$) the weaning weight of the rabbit does relative to S6, 4055, and 3608 g to S8 and S6, respectively. In conclusion, supplementation with salt 8% P improves the performance of rabbit does fed forage containing diets, but not affect the performance of the litter.

Key Words: phosphorus, rabbit does, salt

1311 (M185) Amino acid digestibility in oilseed meals fed to growing pigs. C. S. Park*, A. R. Son, and B. G. Kim, *Konkuk University, Seoul, South Korea.*

An accurate determination of the standardized ileal digestibility (SID) of AA is important for swine diet formulation, especially in protein supplements. The objective of this experiment was to determine the SID of AA in 11 sources of oilseed meals fed to growing pigs. The oilseed meals used in this study were sesame meal (SM, 50.0% CP), two sources of soybean meal

(SBM) produced in Korea (SBM-K1, 47.4% CP; SBM-K2, 47.1% CP), SBM produced in India (SBM-I, 39.6% CP), high-protein distillers dried grains (HPDDG, 38% CP), perilla meal (PM, 43.2% CP), canola meal (CNM, 37.5% CP), copra meal (CM, 21.7% CP), corn germ meal (CGM, 21.4% CP), palm kernel expeller (PKE, 15.3% CP), and tapioca distillers dried grains (TDDG, 18.4% CP). Experimental diets were prepared to contain each ingredient as a sole source of AA and an N-free diet was also prepared to estimate the basal endogenous losses of AA. Twelve barrows with an initial BW of 29.0 ± 3.0 kg were surgically fitted with a T-cannula at the distal ileum and were allotted to a 12×9 incomplete Latin square design with 12 diets and 9 periods. Following the 5-d adaptation period, ileal digesta were collected for 8 h on d 6 and 7. Values for the SID of Lys in SM, SBM-K1, SBM-K2, SBM-I, HPDDG, PM, CNM, CM, CGM, PKE, and TDDG were 16.6, 81.2, 86.9, 85.3, 66.1, 32.5, 61.6, 21.4, 51.8, 46.0, and 43.3, respectively (SEM = 4.8, $P < 0.01$). Values for the SID of Met in SM, SBM-K1, SBM-K2, SBM-I, HPDDG, PM, CNM, CM, CGM, PKE, and TDDG were 64.6, 91.5, 87.9, 85.8, 91.5, 38.3, 76.6, 55.2, 73.4, 67.4, and 20.8, respectively (SEM = 5.5, $P < 0.01$). In conclusion, values for the SID of most AA in SBM-K1, SBM-K2, SBM-I, HPDDG, and CNM were greater than those in SM, PM, CM, and TDDG.

Key Words: feedstuffs, protein supplements, swine

1312 (M186) Standardized total tract digestibility of phosphorus in oilseed meals fed to growing pigs. C. S. Park¹, Y. D. Jeong², B. G. Kim¹, and S. K. Park², *¹Konkuk University, Seoul, South Korea,*

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We determined the standardized total tract digestibility (STTD) of P in 11 sources of oilseed meals fed to growing pigs. The test ingredients were sesame meal, two sources of soybean meal (SBM) produced in Korea (SBM-K1 and SBM-K2), SBM produced in India, high-protein distillers dried grains (HPDDG), perilla meal (PM), canola meal, copra meal (CM), corn germ meal (CGM), palm kernel expeller, and tapioca distillers dried grains. Experimental diets were formulated to contain each ingredient as a sole source of P and a P-free diet was also prepared to estimate the basal endogenous loss of P. Twelve barrows with an initial BW of 47.9 ± 2.6 kg were allotted to a 12×8 incomplete Latin square design with 12 diets and 8 periods. After 4 d of adaptation period, feces were collected for 4 d of collection period according to the marker-to-marker method. There was a difference ($P < 0.001$) in the STTD of P among oilseed meals (Table 1312). Values for the STTD of P in SBM-K1, HPDDG, CM, and CGM were greater ($P < 0.05$) than that in PM. In conclusion, the STTD of P in oilseed meals were in the range of 58.5 to 76.8% except HPDDG, PM, and CGM.

Key Words: feedstuffs, macromineral, swine

Table 1312. Phosphorus (P) and standardized total tract digestibility (STTD) of P in 11 sources of oilseed meals fed to growing pigs (% as-fed basis, $n = 8$)

Item	P	STTD of P
Ingredient		
Sesame meal	0.63	58.5 ^{bc}
Soybean meal-Korea 1	0.63	74.9 ^{ab}
Soybean meal-Korea 2	0.57	58.6 ^{bc}
Soybean meal-India	0.54	67.4 ^{abc}
High-protein distillers dried grains	0.24	86.4 ^a
Perilla meal	1.29	54.5 ^c
Canola meal	0.99	61.9 ^{bc}
Copra meal	0.56	76.9 ^{ab}
Corn germ meal	0.53	82.6 ^a
Palm kernel expeller	0.54	70.6 ^{abc}
Tapioca distillers dried grains	0.23	70.8 ^{abc}
SEM		4.7
<i>P</i> -value		< 0.001

^{a,b,c} Within a column, means without a common superscript letter differ ($P < 0.05$).

1313 (M187) Standardized total tract digestibility of phosphorus in cereal grains and coproducts fed to growing pigs. Y. D. Jeong¹, C. S. Park^{*2}, B. G. Kim², and S. K. Park¹, ¹*Rural Development Administration, Suwon, South Korea*, ²*Konkuk University, Seoul, South Korea*.

The objective of this experiment was to determine the standardized total tract digestibility (STTD) of P in 2 sources of cereal grain including barley and wheat and nine sources of byproduct ingredient including almond meal, two different sources of corn gluten feed, corn gluten meal (CGM), lupin hull (LH), lupin kernel (LK), rice bran (RB), soybean meal, and wheat bran. Each ingredient was included to an experimental diet as a sole source of P. A P-free diet was formulated

to estimate the basal endogenous loss of P. A total of 12 diets were assigned to a 12×8 incomplete Latin square design with 12 barrows and 8 periods. Pigs with an initial BW of 46.7 ± 3.2 kg were individually housed in metabolism crates. Each period lasted 8 d consisted of 4-d adaptation and 4-d collection periods. Feces were collected based on the marker-to-marker method. Despite of the greatest concentration of P in RB, the STTD of P in RB was lower ($P < 0.05$) than CGM and LK (Table 1313). Value for the STTD of P in LH was also lower ($P < 0.05$) than those in CGM and LK. In conclusion, the STTD of P in barley and wheat were not significantly different and these values were similar to values in cereal coproducts used in this experiment.

Key Words: feedstuffs, macromineral, swine

Table 1313. Phosphorus (P) and standardized total tract digestibility (STTD) of P in 11 sources of oilseed meal fed to growing pigs (% as-fed basis, $n = 8$)

Item	P	STTD of P
Cereal grain		
Barley	0.30	60.3 ^{ab}
Wheat	0.30	63.9 ^{ab}
Cereal coproduct		
Almond meal	0.05	62.3 ^{ab}
Corn gluten feed source 1	0.62	68.3 ^{ab}
Corn gluten feed source 2	0.95	63.4 ^{ab}
Corn gluten meal	0.24	75.7 ^a
Lupin hull	0.17	51.3 ^b
Lupin kernel	0.36	72.3 ^a
Rice bran	1.73	53.3 ^b
Soybean meal	0.62	66.1 ^{ab}
Wheat bran	0.86	69.3 ^{ab}
SEM		4.1
<i>P</i> -value		< 0.001

^{a,b} Within a column, means without a common superscript letter differ ($P < 0.05$).