The number of peripheral blood monocytes tended to be less in infected pigs, with no difference between groups for other white blood cell measures. Tumor necrosis factor-α was greater (P<0.05) in infected pigs: 1) in the mesenteric lymph nodes by 48 h p.i.; 2) at 24 h and 3 wk p.i. in the ileum; and 3) in the cecum and spleen by 3 wk p.i. Interleukin-12, IL-1 and its antagonist, and a porcine specific antimicrobial peptide RNA expression in tissues changed over time, but were not different between groups. Immune data demonstrate that site specific immune changes occurred first, followed by more peripheral responses. These results will enable us to develop and plan the application of intervention strategies that will contribute to increase pork safety.

**Key Words:** swine, salmonella, food safety

# Graduate Student Paper Competition-CSAS Oral Competition: CSAS Graduate Student Competition 2

**218 The effect of animal location during transit on heart rate of pigs transported to slaughter using two vehicle types.** J. A. Correa*[1], H. Gonyou[2], R. Bergeron[3], S. Torrey[4], T. Crowe[5], T. Widowski[3], J. P. Laforest[1], C. Dewey[3], N. Lewis[6], and L. Faucitano[4], [1]*Laval University*, *Quebec, QC, Canada*, [2]*Prairie Swine Centre*, *Saskatoon, SK, Canada*, [3]*University of Guelph*, *Guelp, ON, Canada*, [4]*Agriculture & Agri-Food Canada*, *Sherbrooke, QC, Canada*, [5]*University of Saskatchewan*, *Saskatoon, SK, Canada*, [6]*University of Manitoba*, *Winnipeg, MB, Canada*.

The objective of this study was to assess the effect of the location in the vehicle on heart rate of pigs during transport. A total of 1,597 crossbred pigs (BW:124.2±7.9kg) were transported over 6 weeks (February-March 2008) from a commercial growing-finishing unit to a slaughter plant (2 h journey time) using two types of vehicles, a three-deck pot-belly trailer with internal ramps to upper and lower levels (PB; 181 pigs per week in 8 experimental compartments; 0.41 m2/pig) and a double-decker hydraulic truck without internal ramps (DD; 85 pigs per week in 4 compartments; 0.40 m2/pig). A sub-population of 252 pigs (PB: 28 pigs/week; DD: 14 pigs/week) was equipped with heart rate monitors (Polar Electro Canada) and randomly distributed through the selected compartments in both vehicles. Heart rate was recorded at 5 sec intervals and averaged over the following events: loading (L), wait before departure from the farm (W), transport (T) and unloading (U). Heart rate data were analyzed using the mixed model procedure in SAS, with the pig as the experimental unit. In the DD truck, independently of the deck position, a higher (P<0.05) heart rate was recorded during T in pigs located in the rear compartments (127.4±2.9 beats/min) of the vehicle compared to those loaded in the front ones (118.9±2.9 beats/min). No difference in heart rate was found between these locations in the PB trailer. In the PB trailer, pigs located on the upper deck showed higher (P<0.05) heart rate during W (165.8±3.2 beats/min) compared to those loaded in the middle (158.6±3.5 beats/min) and lower (157.3±4.0 beats/min) decks. During U, pigs from the upper (172.1±4.3 beats/min) and lower (171.1±4.9 beats/min) decks showed higher (P< 0.01) heart rates than pigs from the middle deck (163.6±4.3 beats/min). Overall, the heart rate of pigs during transport can be affected by their position in the vehicle.

**Key Words:** pigs, transport, heart rate

**219 Utilization of electrolytes to encourage early feed and water consumption in weanlings.** A. K. Gigiel*, N. J. Lewis, and M. L. Connor, *University of Manitoba*, *Winnipeg, MB, Canada*.

Three trials were conducted to determine the best management strategy for providing electrolytes to weanlings. Each trial used 90 piglets (19±1d) in a repeated measures design with a 2×5 factorial arrangement of treatments. Piglets were weaned for 12 or 0h and transported (<1h) to an offsite research facility. Trials 1 and 2 were done to determine the effects of providing electrolytes for different durations (T1) and at different concentrations (T2) on feed intake (FI) and growth rate. In T1, electrolytes (Vetoquinol, QC, Canada) were provided at the label dose of 60ml/940ml of water for 0, 6, 12, 18 or 24h on d1–d3. In T2, electrolytes were given *ad lib* at 100, 75, 25, 50 or 12.5% of the label dose on d1–d3. Trial 3 (T3) was done to determine the optimum number of days that electrolytes should be made available in order to maintain piglet weight and encourage FI. Electrolytes, at the label dose, or water (control) were given *ad lib* on d1, d1 and d2, d1–d3, or d1 and d3. All piglets had water *ad lib* from d4–d14. Piglets were weighed daily on d0–d7 and on d14, and FI was recorded daily to d4. ADG was calculated using d7 and d14 weights. Data was analyzed using PROC Mixed. In T1, on d7 percent weight change from d0 (%Wt) was significantly higher in the groups that received electrolytes for 12h and 18h than in the 24h group (9.2±1.65, 10.0±1.59 vs. 6.2±1.56%; P=0.04), but FI on d4 was higher in the 12h group than in the 18h and 24h groups (300.1±29.49 vs. 184.2±29.26, 209.8±27.47g/d; P=0.07). In T2, on d14%Wt was significantly higher in the 25% concentration group than in the 75% group (56.4±5.53 vs. 39.0±5.53%; P<0.05), and ADG was higher in the 25% group than in the 50, 75 and 100% groups (0.4±0.05 vs. 0.3±0.05, 0.3±0.05, 0.3±0.05g/d; P<0.10). In T3, there were no differences after d3 in %WT, FI or ADG. The data suggests that weanlings benefit from electrolytes at lower concentrations (<100%) for a shorter time period (<24h/d) than currently recommended. A subsequent experiment will focus on verifying the best combination of electrolyte concentration and total duration of treatment.

**Key Words:** piglet, electrolyte treatment, performance

**220 Identification of single nucleotide polymorphisms influencing feed efficiency and performance in multi-breed beef cattle using a candidate gene approach.** M. K. Abo-Ismail*[1], M. J. Kelly[1], E. J. Squires[1], K. C. Swanson[1], J. D. Nkrumah[2], and S. P. Miller[1], [1]*University of Guelph*, *Guelph, ON, Canada*, [2]*Igenity Livestock Production Business Unit, Merial Ltd.*, *Duluth, GA*.

Mutations in genes involved in biological processes associated with economically important traits are candidates which can be targeted for QTL detection to facilitate marker assisted selection. Therefore, the objectives of this study were to identify new SNPs in nine genes involved in digestive function and metabolic processes associated with feed efficiency and to examine the discovered SNPs for associations with feed efficiency and performance. An in silico study was conducted to discover SNPs in the candidate genes. Briefly, expressed sequence tags (ESTs) were acquired from the gene bank NCBI, and then ESTs were aligned using DNA sequence assembly software Sequencher. Single nucleotide polymorphisms, change in the sequence of amino acids, and the position of each SNP were detected. Animals (993) were genotyped for selected SNP (43) with 23 SNP identified as real (not fixed).

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A univariate mixed-inheritance animal model was fit in ASREML to evaluate the association of phenotypes with either genotypes or allele substitution effects. Phenotypes included daily dry matter intake (DMI), ADG, midpoint metabolic weight (MMW), residual feed intake (RFI) and feed conversion ratio (F:G) on 660 genotyped crossbred bulls, steers and heifers fed through the University of Guelph feedlot with measured feed intake. Average breed contributions were Angus (41%), Charolais (23%), Piedmontese (11%), Simmental (8%), and Limousin (1%). SNP1 within Pancreatic Anionic Trypsinogen and SNP2 within Cholecystokinin receptor β genes influencing digestive function and satiety were associated with residual feed intake (P<0.01). Allele substitution effects for SNP1 and SNP2 were associated with a decrease of 0.197 ±0.075 (P<0.01) and 0.176±0.088 (P<0.05) kg RFI, and 0.188±0.10 (P<0.059) and 0.229±0.12 (P<0.073) kg in DMI, respectively. Substitution of SNP1 was associated with increased ADG (0.0408±0.025 kg, P=0.105). Further research will identify additional SNP, validate these results in other populations and elucidate the biological mechanism underpinning these discoveries.

**Key Words:** candidate genes, feed efficiency, beef cattle

**221 Heritability estimates of reproductive, growth and carcass traits of tropical pigs: A meta-analysis.** E. C. Akanno*, F. S. Schenkel, V. M. Quinton, R. M. Friendship, and J. A. B. Robinson, *University of Guelph*, *Guelph, ON, Canada*.

Export of pig germplasm (live animals or semen) from Europe and North America into the tropics for the improvement of indigenous populations has been going on for over five decades. Breeding program design for the tropics requires knowledge of genetic parameters for economically important traits determined under tropical conditions. A literature review found a total of 350 heritability ($h^2$) estimates for 37 traits across 85 papers published from 1972 to 2008, covering tropical Africa, Southeast Asia, the Caribbean and Latin America. There were as many $h^2$ estimates for litter as growth traits, but far fewer for other traits relating to reproduction and carcass merit. A meta-analysis was conducted on all of the assembled papers. The weighted mean $h^2$ across these studies for reproductive, growth and carcass traits was 0.06, 0.23 and 0.61 for indigenous breeds and 0.08, 0.30 and 0.50 for exotic breeds, respectively. Weighted least-squares analyses of the $h^2$ estimates were performed by fitting breed (indigenous or exotic), region of tropics, data origin (field or experimental), estimation method and time of recording for each trait as appropriate for the data available. Breed, region, data origin, estimation method and time of recording were found to be significant (P < 0.05) for at least one of the traits analysed. These results indicate the relevance of having local, population-specific genetic parameter estimates for the tropics. When estimates are not available for a specific tropical pig population, the weighted mean $h^2$ estimates from the current study are recommended for use. Where estimates within a population are available, but not reliable enough, they could be combined with the weighted literature average. A simple rule would be to weight each, the local estimate and the pooled mean, by the inverse of its corresponding squared error.

**Key Words:** heritability, economic traits, tropical pigs

**222 Seasonal based genetic regulation of reproductive traits in a male turkey line.** L. A. Case*[1], M. J. Kelly[1], S. P. Miller[1], and B. J. Wood[2], [1]*University of Guelph*, *Guelph, ON, Canada*, [2]*Hybrid Turkeys*, *Kitchener, ON, Canada*.

Environment can affect the genes contributing to phenotypic performance resulting in a genotype by environment (GxE) interaction. The objective of this study was to investigate the expression of potential GxE interactions for turkey reproductive traits. Seasonal re-ranking of turkey reproductive performance was indicative of a GxE for egg production, fertility, and hatchability. The genetic correlation between the traits expressed in the winter and summer season was used to quantify the strength of the GxE. Pure male line large white turkeys from a primary breeder hatched between 1990 and 2008 were used in the study. Egg number was expressed as the percentage of days with an egg produced between 210 and 420 days of age, fertility represented the proportion of hatched eggs that contained a fertile embryo and hatchability was the percent of fertile eggs that produced a live bird. ASREML was used to estimate variance components and heritability. The heritability of ($h^2$) of egg production was 0.32 with the phenotypic ($\sigma^2_p$) and genetic ($\sigma^2_g$) variance, 118.3 and 38.35 percent days with egg produced$^2$, respectively. The $h^2$, $\sigma^2_p$ and $\sigma^2_g$ estimates for fertility were 0.08, 576.9%$^2$ and 48.43%$^2$. The hatchability $h^2$, $\sigma^2_p$ and $\sigma^2_g$ estimates were 0.15, 582.2%$^2$ and 90.01%$^2$. Best linear unbiased prediction (BLUP) was used to calculate estimated breeding values (EBVs) using variance component estimates. EBVS fluctuated annually and resultantly egg number, fertility and hatchability were evaluated as two traits, summer and winter lay in a bivariate model. The correlation between the seasonal traits was lower than unity ($r_{egg\ production}$=0.86, $r_{fertility}$=0.19, $r_{hatchability}$=0.68) suggesting a GxE interaction. Egg production, fertility, and hatchability in turkeys could be considered as two distinct traits in an animal model with traits based on season of lay. By considering independent genetic contribution to reproductive phenotypes based on season of lay, the accuracy of prediction of estimated breeding values by genetic evaluation models could be increased.

**Key Words:** genotype by environment interaction, reproduction, heritability

**223 Effects of feeding solid feed on ruminal pH and expression of genes involved in ketogenesis in dairy calves during weaning transition.** A. H. Laarman* and M. Oba, *University of Alberta*, *Edmonton, AB, Canada*.

The objective of this study was to determine the effects of feeding solid feed on rumen pH and the expression of genes involved in ketogenesis in ruminal epitheila. Eight two-week old Holstein calves (44.4 ± 4.0 kg) were blocked by BW, and assigned to either a diet of only milk replacer (MR: 22% CP and 17% fat) or MR and a commercial calf starter containing 23% CP (MR+S). Calf starter was fed ad libitum, and the MR calves was fed extra milk replacer to maintain metabolizable energy intake between calves within blocks. When a calf consumed 680 g of starter feed for 3 consecutive days, a small ruminant rumen pH-measuring device (20.6 mm diameter, 138 mm length, mass 245 g) was inserted orally to measure rumen pH continuously. Three days later, blood was sampled for glucose analysis and calves were slaughtered (51.1 ± 6.7 days old), then ruminal epithelia was harvested from the ventral sac. Statistical analysis was conducted using the Fit model procedure of JMP with fixed effects of block and treatment. Average daily gain for MR and MR+S was 0.58 ± 0.04 and 0.70 ± 0.04 g/d, respectively (P < 0.11); plasma glucose concentration at slaughter was not different between treatments, averaged at 117.1 mg/dL. Daily mean ruminal pH was 6.03 ± 0.13 for MR+S and 6.41 ± 0.10 for MR (P = 0.13). Relative mRNA abundance of Acetyl-CoA acyltransferase 1 (ACAT-1) was 47% lower for MR+S compared to MR (P < 0.05), even though total RNA content was similar (P = 0.34). Abundance of HMGS-1 mRNA was positively

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related to plasma glucose levels (r = 0.82; $P < 0.05$). While HMG-CoA lyase (HMGL) mRNA abundance was unaffected by treatment, it was positively correlated to the duration of time ruminal pH was less than 5.8 (r = 0.81; $P < 0.05$). These results suggest that feeding solid feed to dairy calves during weaning transition may decrease expression of genes involved in ketogenesis in ruminal epithelia.

**Key Words:** rumen pH, ketogenesis, calf development

**224 The threonine requirement in sows increases in late gestation.** C. L. Levesque*[1], S. Moehn[1], P. B. Pencharz[2], and R. O. Ball[1], [1]*Swine Research and Technology Centre, University of Alberta*, *Edmonton, AB, Canada*, [2]*Sick Children's Hospital, University of Toronto*, *Toronto, ON, Canada*.

The NRC (1998) assumes a constant requirement for amino acids (AA) in gestation; however, metabolic focus changes from maternal tissue gain in early gestation (EG) to fetal and mammary tissue growth in late gestation (LG). This change in metabolic focus may affect the requirement for AA in EG and LG. The threonine (THR) requirement of second parity sows in EG and LG was determined using the indicator amino acid oxidation technique. A basal corn diet was formulated at 60% of NRC (1998) THR requirement based on BW, expected maternal gain and litter size. Each sow was fed six levels of dietary THR and daily THR intake ranged from 4.9 to 16.1 g•d$^{-1}$. [1-$^{13}$C]phenylalanine (PHE) was given orally in 8 1/2-hourly meals as an indicator AA and expired $^{13}$CO2 was quantified. Plasma PHE enrichment was used to calculate protein turnover. A nonlinear Mixed model was used to determine the THR requirement for each period. Sow BW gain and reproductive performance were similar to commercial standards. Sows responded differently to THR intake in early and late gestation. The THR requirement was 6.0 g•d$^{-1}$ ($R^2$=0.59) in EG and 13.6 g•d$^{-1}$ ($R^2$=0.56) in LG. In EG, protein synthesis increased ($R^2$=0.79) and PHE oxidation ($R^2$=0.84) decreased at THR intakes below requirement. In LG, protein synthesis ($R^2$=0.41) and PHE oxidation ($R^2$=0.40) responded linearly to increasing daily THR intake. Total protein breakdown (p=0.27, 44.1 ± 2.2 vs 46.2 ± 2.3 g•d$^{-1}$, respectively) and PHE flux (p=0.12, 57.0 ± 2.5 vs 60.0 ± 2.6 g•d$^{-1}$, respectively) were not different between EG and LG. However, protein breakdown (p= 0.001, 0.25 ± 0.01 vs 0.22 ± 0.01 g•kg $^{-1}$ BW, respectively) and PHE flux (p= 0.001, 0.32 ± 0.01 vs 0.28 ± 0.01 g•kg$^{-1}$BW, respectively) as a proportion of BW were greater in EG than LG. The THR requirement in LG is greater than in EG. Feeding sow diets with constant levels of AA throughout gestation results in overfeeding AA in EG and underfeeding AA in LG. *Support: AB Pork, ON Pork, AB Livestock Industry Development Fund, ACAAF, Ajinomoto Heartland.*

**Key Words:** threonine, gestation, requirement

**225 Energy and amino acid utilization in expeller-extracted canola meal fed to growing pigs.** T. A. Woyengo*, E. Kiarie, and C. M. Nyachoti, *University of Manitoba*, *Winnipeg, MB, Canada*.

Two experiments were conducted to determine the nutritive value of expeller-pressed canola meal (EECM) for growing pigs. In Exp. 1, 6 ileal-cannulated barrows (average initial BW = 26.8 kg) were fed 3 diets in a replicated 3 × 3 Latin square design to determine standardised ileal digestible content (SIDC) of AA. The 3 diets included a cornstarch-based diet with either solvent extracted canola meal (SECM) or EECM as a sole source of protein, and a low casein cornstarch-based diet, which was used to estimate endogenous AA losses for determining SIDC of AA. In Exp. 2, 18 intact barrows (average initial BW = 25.9 kg) were fed 3 diets in a completely randomized design (6 pigs per diet) to determine total tract digestible nutrient content of EECM. The diets included a basal corn-based diet or the basal with corn replaced by 350 g/kg of SECM or EECM; the basal diet was used for determining total tract digestible nutrients by the difference method. The EECM used in both experiments was obtained from Associated Proteins, Ste. Agathe, MB. The SECM, which is commonly used in formulation swine diets, was fed in both experiments for comparison with EECM. The SECM and EECM were similar in CP content (41.8 vs 41.4%). The EECM was, however, slightly higher in ether extract (5.89 vs 5.54%), and lower in NDF content (23.8 vs 29.9%) than SECM. The EECM had also a higher content of all the AA except Met, Cys and Ser by approximately 6.6%; Met and Cys were higher in SECM, whereas Ser was similar between the 2 meals. The EECM compared with SECM had higher ($P < 0.1$) SIDC of Lys (16.38 vs 14.55 g/kg DM). The SIDC of all the remaining AA except Met were also higher ($P < 0.1$) for EECM than for SECM by a mean of 13.4%; the SIDC of Met was similar between the 2 meals. The EECM compared with SECM had higher ($P < 0.01$) DE (4107 vs 3790 kcal/kg) value. The results show that the EECM used in the current study had higher digestible AA and energy contents than the SECM, and hence it may be a better source of protein and energy for growing pigs than the latter.

**Key Words:** canola meal, nutritive value, pigs

**226 Calcium chloride and sodium nitrate as nutritional means to overcome the reduction in performance of pigs fed high potassium diets.** J. Guimaraes*, D. Wey, C. Zhu, and C. F .M de Lange, *University of Guelph*, *Guelph, ON, Canada*.

Co-products from the bio-fuel and food industries are used increasingly as inexpensive pig feed ingredients. However, high dietary potassium (K) levels in co-product based diets contribute to reduced growth performance in pigs and abnormalities in kidney histology. This study was conducted to investigate the addition of calcium chloride ($CaCl_2$) or sodium nitrate ($NaNO_3$) to pig diets as means to overcome the negative effects of feeding 1.4% K containing diets. $CaCl_2$ has been used to manipulate dietary electrolyte balances while $NaNO_3$ has been shown to increase loss of potassium in man. Forty eight purebred Yorkshire pigs (average initial BW 22.8 kg; 2 gilts and 2 barrows per pen) were fed one of the following diets over a 4 week period: (1) Control (standard corn and SBM based diets; 0.7% K in diet), (2) diet $K_2CO_3$ (control with added 1.15% $K_2CO_3$; 1.4% K in diet; previously shown to mimic effect of a 1.4% K containing diet with 20% and 6% diet dry matter from whey permeate and corn steep water, respectively), (3) diet $NaNO_3$ (diet $K_2CO_3$ with 0.4% $NaNO_3$), and (4) diet $CaCl_2$ (diet $K_2CO_3$ with 0.76% $CaCl_2$). Pigs had free access to feed and water. Data were exposed to analyses of variance using GLM of SAS with treatment as the only source of variation; treatment means were compared using orthogonal contrasts. Diet did not influence feed intake or BW gain (P>0.10). Feed to gain (SEM=0.08, n= three pens per treatment) for Control (1.77) was better than the mean of the other treatments (P=0.04). Diets $NaNO_3$(1.91) and $CaCl_2$(1.79) yielded better feed:gain than diet $K_2CO_3$ (2.10; P=0.02). Hot carcass weight, carcass lean yield and loin color did not differ among treatments (P>0.10). Subjective histology observations suggest that the most kidney damage was present with diet $NaNO_3$, followed by diet $K_2CO_3$; diet $CaCl_2$ appeared to alleviate the kidney damage and was comparable to Control. These dietary interventions may allow

for increased co-product usage in pig diets and reduce the reliance on traditional feed ingredients, such as corn.

**Key Words:** pigs, electrolyte balance, co-products

**227 Protein turnover and heat production of sows varies at day 30, 45 and 105 of gestation.** R. S. Samuel*[1], S. Moehn[1], P. B. Pencharz[2], and R. O. Ball[1,2], [1]*Swine Research and Technology Centre, University of Alberta*, *Edmonton, AB, Canada*, [2]*Research Institute, Hospital for Sick Children*, *Toronto, ON, Canada*.

As gestation progresses, an increasing part of the nutrients and energy consumed by sows are used for growth of the conceptus. However, sows are typically fed restrictively and inadequate allowance may be made for changing requirement during gestation. The objective of this experiment was to determine energy and leucine balance of sows in early-, mid-, and late-gestation. Gravid 2nd parity sows (n=5) were fed $2.4 \pm 0.1$ kg of a barley-wheat-SBM diet of 12.5 MJ ME/kg, 0.65% total lysine, and 15% crude protein twice daily throughout gestation. Heat production, by indirect calorimetry, was determined simultaneously with leucine kinetics, by primed-constant IV infusion of L-[1-$^{13}$C]leucine (1.0 mg•kg$^{-1}$•h$^{-1}$) over 24 h. All measurements were made at d 30, 45, and 105 of gestation. The effect of "day" was assessed using mixed model analysis (SAS 2002) with individual animals as a random variable. Significance was taken at $P < 0.05$; a tendency at $P < 0.1$. Leucine flux, appearance from breakdown, and incorporation into protein were greater (P<0.001) on d 45 than on d 30 or 105 of gestation. At constant feed intake, protein gain was lower (P<0.05) on d 45 than (137.6 g/d) than on d 30 (167.6 g/d) or 105 (164.1 g/d). Energy balance (i.e. intake over maintenance) was greater (P<0.01) on d 45 (6.1 MJ/d) than on d 30 (3.7 MJ/d) or d 105 (1.4 MJ/d) of gestation. This greater energy balance allowed lipid deposition only on d 45 where the respiratory quotient (RQ) was greater than 1, indicating lipogenesis. The RQ was not different than 1 on d 30 and 105. Energy intake ($30.5 \pm 0.9$ MJ/d) was not significantly different from HP ($29.1 \pm 1.5$ MJ/d) on day 105. Therefore, sows needed to mobilize body lipid to support fetal growth. These results indicate that after regaining body protein lost in a preceding gestation and lactation, sows deposit lipid during mid-gestation. Feeding a constant daily amount of feed does not provide sufficient energy in late gestation.

**Key Words:** energy, protein, gestation

**228 Prediction of DE content of common ingredients in grower pigs using an in vitro digestibility technique.** P. R. Regmi*[1], N. S. Ferguson[2], A. Pharazyn[2], L. F. Wang[1], and R. T. Zijlstra[1], [1]*University of Alberta*, *Edmonton, AB, Canada*, [2]*Nutreco Canada*, *Guelph, ON, Canada*.

Energy value of feed ingredients can vary widely due to changes in energy digestibility. Prediction of variation in DE value among and within ingredients is important to determine the energy value of ingredients and to balance feed formulations. Previously, a 2-d in vitro digestibility technique, involving subsequent digestion of ground samples in pepsin (2 h), pancreatin (6 h), and Viscozyme, a fiber-digesting enzyme complex (18 h), was used to predict DE content of feed samples in swine. The objective of this study was to test the accuracy of the in vitro technique to predict the variation in DE content across common ingredients (corn, wheat, barley, field pea, soybean meal, corn DDGS, canola meal, and wheat millrun) and within ingredients (wheat and canola meal) in swine. The range of ADF and CP contents (in DM) were, respectively, 3.0 to 16.9 and 9.6 to 52.1% among ingredients, 3.3 to 6.2 and 11.2 to 20.8% among batches of wheat, and 15.2 to 18.1 and 36.2 to 41.3% among batches of canola meal. In vivo DE value was determined using barrows (n = 48) in complete randomized design and ranged among ingredients, within wheat, and within canola meal from 1.82 to 3.18, 3.36 to 3.81, and 3.01 to 3.18 Mcal/kg of DM, respectively. Similarly, in vitro DE value among ingredients, within wheat, and within canola meal ranged from 2.71 to 4.08, 3.50 to 3.94, and 2.96 to 3.33 Mcal/kg of DM, respectively. The relationship of in vitro and in vivo DE values was strong across ingredients ($R^2 = 0.86$, Y = 1.02 X — 0.13) and within wheat ($R^2 = 0.78$, Y = 0.92 X + 0.20), but was poor within canola meal ($R^2 = 0.05$). Higher ADF and ash (6.7 to 8.6%) contents possibly caused discrepancies between in vivo and vitro digestion, and a narrow range of DE content might have contributed to the poor relationship between in vivo and vitro DE values in canola meal. The in vitro technique can be used to estimate the variation in DE content among common ingredients and within wheat; however, the technique needs to be improved to predict DE content within canola meal.

**Key Words:** digestible energy, pig, in vitro digestibility

# Meat Science and Muscle Biology: Symposium: Balancing Live Cattle Performance and Beef Quality

**229 Growth technologies: Performance benefits and quality considerations.** J. D. Tatum*, *Colorado State University*, *Fort Collins*.

Growth enhancement is unquestionably one of the most effective management tools currently available to beef producers for adding value to cattle. Growth-enhancement technologies have been used for more than 50 yr in US beef production systems to improve cattle performance and reduce per-unit cost of beef. In today's commercial cattle feeding industry, most cattle produced in conventional finishing systems receive 1 or 2 growth-promoting (estrogenic, androgenic, or combination) implants. Moreover, growing numbers of implanted feedlot cattle also are fed 1 of 2 recently approved beta adrenergic agonists (BAA) during the final few wk of finishing. Growth enhancement in successive stages of finishing using implants and BAA produces additive, beneficial effects on rate and efficiency of gain and substantially increases pay-weight, thereby improving economic returns to the feeding enterprise. In a 2007 analysis conducted by Iowa State University economists, estimates of

value added to feedlot cattle by a) implanting and b) supplementing implanted cattle with BAA were $71 and $15/animal, respectively. Within the past 2 decades, however, development and subsequent adoption of growth-enhancement products with ever-increasing potency have intensified concerns in the packing, retail, and foodservice sectors of the beef industry about potential adverse effects of growth enhancement on beef quality characteristics. Growth-enhancement programs designed to maximize cattle performance have been shown to reduce deposition of intramuscular fat, increase beef toughness, and decrease consumer acceptability. In addition, aggressive growth enhancement can increase frequencies of heavyweight carcasses and over-sized beef cuts. When growth-enhancement programs, cattle types, and marketing targets are properly matched, use of growth technologies can facilitate efficient production of beef without substantially reducing product quality.

**Key Words:** growth technologies, beef, quality

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