

(5%) concentrate on growth, development and blood glucose concentrations in weanling horses. The HS was based on corn and oats and LSF was based on beet pulp, soybean hulls and soybean oil. Twenty foals (14 Thoroughbreds and 8 Quarter Horses) were weaned at 112 d of age and assigned at random within breed and gender subgroups to one of the two diet groups. The concentrates were fed to appetite for 2, 1.5-hr feeding periods daily and 1.0 kg C. bermudagrass hay/100 kg BW was group fed daily. The ratio of concentrate to hay was 64:36. The weanlings were weighed and measured on d 0 and at 14 d intervals for 112 d. Glucose tolerance tests were conducted at the start and completion of the experiment. There were no differences in the concentrate, hay or total intake for the two diet groups. Weight gains were higher for the weanlings fed HS (.81 vs .67 kg/d, $P = .01$) than those fed LSF. Body length gains also favored the weanlings fed HS (15.5 vs 13.2 cm, $P = .04$). No other body measurements were different. Fasting blood glucose concentrations were consistent over time and between diet groups (86.4 + .7 mg/l). Blood glucose peaks, 90 min post feeding, at the start of the experiment following a sweet feed meal or an oral glucose challenge (.25 mg/kg BW) were not different between the treatment groups. At the end of the experiment, weanlings fed HS had higher ($P = .02$) blood glucose values (155.7 + 8.9 mg/l) than those fed LSF (131.0 + 3.3 mg/l). However, after the glucose challenge, weanlings from the HS group had lower ($P = .01$) blood glucose (117.1 + 3.4 mg/l) than those fed LSF (130.8 + 3.1 mg/l). Results suggest that HS diets result in higher blood glucose concentrations than LSF diets. Even though the analyses of the diet detected no starch, a glucose peak still occurred following a diet challenge, probably as a result of the natural sugars in the ingredients. The weanlings fed the LSF concentrate apparently had a reduced ability to control blood glucose when challenged with oral glucose.

Key Words: Horses, Starch, Glucose tolerance

643 The effects of guar gum (GG), hydroxypropylated starch (HPS), and xanthan gum (XG) on digestive dynamics in dogs fed canned foods. S.E. Kitts*¹, R.M. Yamka¹, A.D. True¹, W.D. Schoenherr², T.M. Dubbs¹, L.A. White¹, E.S. Vanzant¹, and D.L. Harmon¹, ¹University of Kentucky, Lexington, KY, ²Hill's Pet Nutrition, Topeka, KS.

Gums and starches are added to pet foods as stabilizers/thickeners and to create the gravy portion of canned foods. These additives can produce undesirable effects on fecal quality. The goal of this research was to determine the physiological effects of GG, HPS, or XG in canned diets fed to dogs. GG (Exp. 1), HPS (Exp. 2), and XG (Exp. 3) were included at 2.5%, 11.3%, or 1.2% of DM, respectively. Each diet was compared to a control diet containing 10.7% (DM basis) corn starch (CS). Diets were evaluated in separate experiments by comparing 5-d control and 5-d test periods. Eight or nine mature dogs (18.9 kg ± 0.2 kg), fitted with an ileal T-cannula were used. In Exp. 1, DMI (g/d) decreased while fecal pH and ileal digesta pH increased for GG ($P < 0.001$). Fecal acetate and propionate ($\mu\text{mol/g DM}$; $P < 0.03$) and fecal quality ($P < 0.003$) decreased although defecation frequency was not affected by GG. Breath hydrogen concentration (BH) increased at 5 and 6 h postprandially for GG ($P < 0.01$). In Exp. 2, DMI (g/d) decreased ($P < 0.0001$) for HPS. Fecal acetate, propionate, butyrate, isovalerate, and valerate ($\mu\text{mol/g DM}$) decreased for HPS ($P < 0.05$). HPS decreased plasma electrolytes; K^+ from 4.5 to 4.3 meq/L ($P < 0.007$), and Na^+ from 146.3 to 140.1 meq/L ($P < 0.04$). In Exp. 3, DMI (g/d) decreased ($P < 0.0001$) for XG. Fecal moisture increased from 57.3 to 62.5% in dogs fed XG ($P < 0.0003$). Fecal acetate and propionate ($\mu\text{mol/g DM}$) decreased for XG ($P < 0.05$). Ileal digesta pH increased ($P < 0.005$) and valerate in ileal digesta ($\mu\text{mol/g DM}$) decreased for XG ($P < 0.04$). Fecal quality decreased for XG ($P < 0.04$), but defecation frequency was not affected. BH increased 1 h postprandially with the XG diet, then decreased from 3 to 8 h ($P < 0.03$). These data indicate that decreases in fecal quality with inclusion of GG, HPS, or XG were not associated with increased fermentation.

Key Words: Gums, Canine, Canned diets

Nonruminant Nutrition Mineral and Vitamin Nutrition

644 Unraveling mineral essentiality in swine. Bud Harmon*, *Purdue University.*

A century ago mineral nutrition for swine was as sophisticated as offering ashes or bone meal free choice. Rickets was thought to be caused by insufficient mineral matter in the feed. Henry (1890) observed a 40% increase in bone ash and 93% increase in bone breaking strength when hardwood ashes were offered free choice to pigs receiving corn, salt, and water. Henry (1898) stated that ashes from wood or coal will always be in place in the feeding pen. In retrospect, ashes were a blend of many minerals now considered crucial in balanced swine diets. Minerals received minimal consideration as critical nutrients into the early 20th century because of beliefs such as: "Ordinarily the rations of farm animals contain all the necessary mineral matter, at least in small quantities, and since the body retains them with great tenacity when the supply is meager, these small amounts usually suffice." Many mineral studies were initiated in response to observations on swine farms. Iodine is such an example. Although goiters had been diagnosed in man and animals, the mineral I was not associated with goiters until the late 1800s. Welch and Smith (1917) investigated the cause of large numbers of dead hairless newborn pigs. They discovered these pigs had abnormally large thyroid glands with quite low levels of I. Unraveling the cause of an extremely severe exudative dermatitis, called parakeratosis, was just as remarkable. This gruesome condition seen sporadically in growing swine responds to Zn supplementation (Tucker and Salmon, 1955). Elevated levels of dietary Ca also precipitated Zn deficiency and parakeratosis. Recognition of Se by Schwarz and Folz (1957) as an essential nutrient and eventual fortification with 0.3 ppm to practical swine diets has saved countless pigs. Fe deficiency anemia in young pigs was often called "thumps" because of labored breathing, thought to be caused by lack of exercise and irritation of the digestive tract. McGowan and Crichton (1924) first attributed this malady to Fe deficiency in nursing pigs. Mineral elements have unique roles and even more unique manifestations of deficiency.

Key Words: Swine, Minerals

645 Effect of feeding chromium tripicolinate as a top dress to boars upon sperm production. M. E. Wilson*¹, T. J. Gall², K.J. Rozeboom¹, R. A. Moser³, D. E. Orr³, and K. W. Purser⁴, ¹Minitube of America, Inc., Verona, WI, ²Pork Technologies, Danville, IA, ³United Feeds, Inc., Sheridan, IN, ⁴Prince Agri Products, Inc., Quincy, IL.

Chromium tripicolinate (CrTp) has been shown to positively influence reproductive performance in sows. This study was designed to test if supplementation of CrTp to boars had an impact on sperm production and sperm quality. 158 PIC boars were blocked for genetic line, age, collection frequency, and total sperm output/week and were randomly allotted to one of two treatments. All boars were fed a corn soybean meal diet (15.5% CP, .85% lysine) according to body weight to meet or exceed NRC 1998 requirement estimates. Treatment 1 (T1) were fed a top-dress of 15 g consisting of 95.25% sodium bentonite, 3.75% ground limestone and 1% mineral premix. Boars in treatment 2 (T2) were supplemented with the same top dress with CrTp substituted for a portion of the limestone to provide 30 mg/kg Cr in the top-dress (equivalent to 200 ppb Cr in 2.27 kg complete feed). Boars were fed their respective dietary treatments for 45 days prior to beginning the 90 d study. Boar ejaculates were collected on a regular schedule throughout the trial. An average of 3 ejaculates were used to set the beginning sperm count and all sperm and semen parameters and at the end of study for comparison to beginning values. ANOVA was analyzed using the GLM procedure in SAS. Bonferroni mean comparisons were used when treatment effects were detected. The beginning and ending sperm parameters were not different between the treatments. There was no difference between T1 (16.23 ± 2.5) and T2 (14.5 ± 2.5) in total sperm count (billion) per ejaculate. Although total sperm counts were different between genetic lines ($P < 0.01$), treatment x genetic interactions were non-detectable. These data suggest that addition of CrTp did not improve important sperm

production parameters in these genetic lines in healthy boars maintained in an environmentally controlled boar stud.

Key Words: Boars, Chromium tripicolinate, Sperm

646 Effect of dietary protein and mineral content on water utilization patterns in growing pigs. M.I. Shaw^{1,2}, A.D. Beaulieu*¹, and J.F. Patience¹, ¹*Prairie Swine Centre, Inc., Saskatoon, SK*, ²*University of Saskatchewan, Saskatoon, SK*.

Concerns relating to the use of water resources by the livestock industry, combined with the rising cost of manure management, have resulted in greater interest in more precisely defining water consumption of pigs. Limited information is available on the impact of diet composition on ad libitum water intake. The objective of this experiment was to investigate the impact of diets differing in protein and mineral content on water utilization patterns in 35-kg pigs. A total of 48 crossbred barrows (3 replicates of 16 pigs each) were randomly assigned within replicate to one of four dietary treatments for a 14-day experimental period. Each diet was based on wheat, barley and soyabean meal. A medium protein diet serving as control (MedP) at 20.9% crude protein was compared to either high (HiP, 25.7% CP) or low (LoP, 16.9% CP) protein diets. The low protein diet was supplemented with lysine, methionine, threonine and tryptophan to attain ideal amino acid ratios, and sodium bicarbonate was added to achieve recommended dietary electrolyte balance. A fourth diet (HiMin) at 20.6% CP was formulated similar to the control but with elevated calcium (1.00% vs 0.60%), available phosphorus (0.46% vs 0.24%) and salt (0.90% vs 0.40%) to attain a higher mineral level. Water consumption and spillage were measured daily, and urine and faeces were collected quantitatively on d 11-14 of the experimental period. Water intake and urine output were higher in pigs on the HiP diet ($P < 0.10$), and the water to feed ratio was higher in pigs on the HiP diet ($P < 0.01$). Average daily feed intake was elevated on the LoP diet ($P < 0.01$), while pigs on the HiP and HiMin diets had improved average daily gain (ADG, $P < 0.05$) and gain:feed (FC, $P < 0.10$). ADG, FC and water balance data in pigs on the LoP and MedP diets were not different ($P > 0.05$). In conclusion, elevated dietary protein increased water utilization, but elevated dietary minerals did not. Feeding a low crude protein diet did not result in reduced water intake.

Key Words: Swine, Water, Protein

647 Bioavailability of supplemental minerals to animals with emphasis on method of determination. C. B. Ammerman* and P. R. Henry, *University of Florida*.

Diets formulated from common feed ingredients are frequently inadequate in various minerals to assure efficient animal production and health. Thus, supplemental minerals must be included in the diet and bioavailability of the mineral source must be known. The most useful expression of mineral utilization in diet formulation is relative bioavailability. This value is generated frequently by a slope-ratio procedure in which the response from the mineral source in question is compared to that from a highly soluble source of the same mineral element. Earlier, the response stressed the utilization of the mineral element in normal metabolic processes within the animal. Examples include hemoglobin formation in response to iron supplementation and bone ash deposition in response to phosphorus supplementation. These responses satisfy the strictest definition of bioavailability. More recently, a less strict definition of bioavailability has evolved in which the term is defined as the degree to which an ingested mineral element is absorbed in a form that can be utilized in metabolism by the animal. This concept of bioavailability has allowed the development of bioavailability assays for several mineral elements which can be conducted with less difficulty with regard to basal diet requirement and measurement of limited metabolic response than would otherwise be the case. Bioavailability assays conducted under this concept include those using tissue mineral accumulation from elevated dietary intakes and those using urinary excretion of the element in question. Tissue accumulation has been used in the determination of bioavailability for manganese, copper and zinc sources, for example, and urinary excretion has been used to determine the bioavailability of magnesium and potassium compounds.

Key Words: Bioavailability, Mineral nutrition, Animals

648 Bioavailability of phosphorus associated with conventional corn is underestimated for growing pigs. Y. Shen*, M. Z. Fan, A. Ajakaiye, and T. Archbold, *University of Guelph, Guelph, Ontario, Canada*.

The objectives of this study were to determine true phosphorus (P) digestibility and the endogenous P outputs associated with conventional corn for growing pigs by using the regression analysis technique. Four barrows, an average initial BW of 25 kg, were fitted with a T-cannula and fed four diets according to a 4 x 4 Latin square design. Four cornstarch-based diets, containing four levels of P at 0.7, 1.5, 2.2 and 2.8 g/kg DMI, were formulated from corn. Each experimental period comprised 8 d with 4-d adaptation and 4-d collection of ileal digesta and fecal samples. The apparent ileal and fecal P digestibility values in corn were affected ($P < 0.05$) by P contents in the assay diets. The apparent ileal and fecal P digestibility values increased from -51.0 to 33.3% and from -41.4 to 39.1%, respectively, as P content increased from 0.7 to 2.8 g/kg DMI. Linear relationships ($P < 0.05$), expressed as g/kg DMI, between the apparent ileal and fecal digestible P and the total intake of dietary P, suggested that true P digestibility and the endogenous P outputs associated with corn can be determined by the regression analysis technique. There were no differences ($P > 0.05$) in true P digestibility values (54.0 ± 6.5 vs $59.8 \pm 8.5\%$) and the endogenous P outputs (0.693 ± 0.128 vs 0.670 ± 0.160 g/kg DMI) between the ileal and the fecal levels. The endogenous fecal P output represented 12.3% and 25.8% of the daily total and available P requirements in growing pigs recommended by NRC (1998). The present literature data, averaging 22%, of apparent digestibility and availability underestimate the true digestive utilization of P in corn for growing pigs by 38%. Current diet formulation on the bases of total, apparent P digestibility and availability values in corn inevitably leads to P overfeeding and excessive P excretion in pigs.

Key Words: True phosphorus digestibility, Corn, Growing pigs

649 Effect of lower dietary concentrations of zinc polysaccharide versus zinc oxide on growth performance and zinc excretion by weanling pigs. C. E. Huntington*¹, D. W. Bollinger¹, T. L. Veum¹, and W. A. Brommelsiek², ¹*University of Missouri Columbia, MO*, ²*Quali Tech, Inc. Chaska, MN*.

Lower dietary levels of an organic source of Zn as Zn-polysaccharide (Zn-SQM, Quali Tech) were compared with 2,000 ppm of inorganic Zn as ZnO, with growth performance and Zn excretion as the criteria. Fifty pigs averaging 6.2 kg were weaned at 21 days of age and allotted to five treatments. Pigs were fed to appetite twice daily in individual metabolism pens. The Basal Phase 1 (d 0-14) diet contained corn, 30% dried whey, SBM, 6% animal plasma, 2% corn oil, and vitamin and mineral supplementation to meet all NRC (1998) requirements. The Basal Phase 2 (d 14-35) diet contained 20% dried whey and 2% animal plasma. Treatments were: 1) Phase 1 or Phase 2 Basal diet containing 125 or 100 ppm added Zn, respectively, as Zn sulfate. 2) Basal plus 150 ppm Zn as Zn-polysaccharide (Zn-P). 3) Basal plus 300 ppm Zn as Zn-P. 4) Basal plus 450 ppm Zn as Zn-P. 5) Basal plus 2,000 ppm Zn as ZnO. Phase 2 diets contained 0.05% chromic oxide. Fecal samples and total urine collections were made twice daily from day 22 to 26. Pre-determined ANOVA single df contrasts were linear, quadratic, Diet 1 vs 5, and Diets 3 plus 4 combined vs Diet 5. There was a linear trend ($P = 0.10$) for overall gain:feed ratio to increase with increasing Zn-P up to 300 ppm Zn, with no further increase at 450 ppm. Overall ADG, ADFI and gain:feed ratio were not different ($P \geq 0.2$) for the 300 plus 450 ppm Zn as Zn-P treatments combined compared with ZnO. Pigs fed ZnO tended to have higher ($P \leq 0.07$) overall growth performance than pigs fed the control diet. There were linear increases ($P \leq 0.001$) in the mg of Zn absorbed, excreted and retained/day with increasing dietary Zn-P. However, pigs fed ZnO retained and excreted more mg of Zn/day ($P = 0.001$) than pigs fed Zn-P. In conclusion, 300 ppm Zn as Zn-polysaccharide maintained pig growth performance and reduced Zn excretion by 76% compared with pigs fed 2,000 ppm Zn as ZnO (333 vs 1,396 mg/day).

Key Words: Growth performance, Zinc, Weanling pigs

650 Contributions of swine research to understanding the roles of selenium and vitamin E. James Oldfield*, Oregon State University.

Despite the much-publicized findings of protective effects of selenium against myopathies in young ruminants (white muscle disease), the earliest discovery of selenium's health benefits was made with swine, in 1957. Since the body fat of pigs more closely resembles the fat in their diets than does that of ruminants, swine were useful subject animals for the investigation of dietary antioxidants and much has been learned from them concerning the metabolic functions of both selenium and vitamin E. Swine research, too, played an important role in establishing nutrient essentiality status for selenium and in gaining approval from regulatory agencies (FDA), for its supplementary addition to livestock diets. These findings, of course, added significantly to the developing knowledge of selenium's role in animal nutrition and subsequently to its acceptance as a production practice with various species of farm animals, worldwide. This paper will examine steps along the way in the assembly of information concerning dietary antioxidants, including more recently implications in human nutrition and disease control.

Key Words: Selenium, Vitamin E, Swine

651 Influence of feeding system and diet on α -tocopherol concentration in muscle and microsome membranes of Iberian pigs. C. J. Lopez-Bote¹, G. G. Mateos*², A. Daza², B. Isabel¹, and R. Lazaro², ¹Universidad Complutense de Madrid, Spain, ²Universidad Politecnica de Madrid, Spain.

A trial was conducted to determine the concentration of α -tocopherol in muscle and microsome membranes of Iberian pigs reared under different feeding regimes. Six groups of 10 pigs each were fed in confinement a basal diet based on barley and soybean meal with 4% of three different mixtures of fats, varying in fatty acid composition, and two levels of α -tocopherol acetate supplementation (0 vs 200 ppm). The fat mixture consisted of a combination of lard and olive and sunflower acid oils, selected in order to vary the ratio between mono- and polyunsaturated fatty acids without modifying the saturated fatty acid portion of the diets. An additional group of 10 pigs was fed on acorns (the fruit of *Quercus ilex*, rich in starch and oleic acid) and grass under range conditions during the same period of time (56 d). The α -tocopherol content varied from 35.9 to 31.1 mg/kg dry matter for the acorns and from 244.5 to 276.5 mg/kg dry matter for the grass from the beginning to the end of the trial (100 to 160 kg of body weight), respectively. The α -tocopherol content of the fresh samples of *Longissimus dorsi* and the microsome extracts of the cellular membranes were lowest for pigs fed the non-supplemented control diet (2.51, 4.44, and 4.58 g/kg in muscle and 4.2, 10.8, and 12.7 g/kg in microsome extracts, for non-supplemented, 200 ppm α -tocopherol acetate supplemented, and extensive fed groups, respectively; $P \leq 0.05$). Composition of dietary fat, however, did not influence α -tocopherol content of the muscle or the microsomes and no interaction was observed between these two main effects ($P \leq 0.05$). Microsomal extracts of *Longissimus dorsi* from pigs fed acorns and grass had lower induced oxidation rate than extracts from pig fed the basal diet under intensive conditions (2.57 vs 3.93 vs 4.75 nmol MDA/mg protein at 120 min, for pigs fed acorns and grass, α -tocopherol supplemented, and non-supplemented diets, respectively; $P \leq 0.001$). The results indicate that some dietary constituents of the acorns or the grass consumed by pigs under range conditions, others than α -tocopherol, may play a role in the stabilization of microsomal lipids.

Key Words: Iberian pigs, α -tocopherol, Oxidation

652 Efficacy of pantothenic acid as a modifier of body composition in pigs. B.A. Autrey*, T.S. Stahly, and T.R. Lutz, Iowa State University, Ames, IA.

The efficacy of dietary pantothenic acid (PA) as a modifier of body composition was evaluated in pigs fed from 8 to 119 kg BW. Pigs from a high lean strain were weaned at 21 d and randomly allotted from outcome groups based on gender and weight to a basal diet (analyzed 8 ppm) supplemented with d-calcium pantothenate to provide 0, 15, 30, or 45 ppm added PA. Four pens of gilts (5 pigs/pen) and four pens of barrows were allotted to each of the four diets. The basal diet consisted of a corn-SBM-3% choice white grease mixture and contained 1.8, 1.5, 1.2, and .95% lysine for pigs fed from BW of 8 to 15, 15 to 40, 40 to

75, and 75 to 119 kg, respectively. All vitamins except PA were fortified to 600% of NRC (1998) for each stage of growth. Dietary PA additions did not alter BW gain or G:F ratios. However, PA additions linearly ($P < .01$) reduced backfat depth (16, 15, 14, 13 mm, respectively, at tenth rib off-midline; 21, 20, 19, 17 mm at last rib midline) and increased estimated carcass fat-free lean content (54.5, 55.5, 55.8, 56.5%) independent of gender as measured on chilled carcasses using backfat ruler and loin tracing. PA additions also resulted in linear reductions in backfat depth (19, 18, 17, 16 mm) and increases in estimated carcass lean content (54.0, 55.0, 55.5, 56.25%) as measured on hot carcasses using the Fat-O-Meater probe as well as CVT ultrasound (20, 19, 17, 16 mm backfat; 54.3, 54.7, 54.9, 55.6% lean). Based on these data, pantothenic acid at dietary concentrations above that needed to maximize BW gain is an efficacious modifier of body lean content of pigs.

Key Words: Pigs, Pantothenic acid, Carcass muscle

653 Dietary vitamin B₁₂ supplements in gestating gilts and B₁₂ transfer to piglets during lactation. F. Simard¹, F. Guay¹, J. P. Laforest¹, A. Giguère², C. L. Girard², and J. J. Matte*², ¹Université Laval, Quebec, Qc, Canada, ²Agriculture and Agri-Food Canada, Lennoxville, Qc, Canada.

Thirty-eight nulliparous (Large-White x Landrace) sows were randomly assigned, during gestation, to 5 dietary levels of vitamin B₁₂ (B₁₂) at 0, 20, 100, 200, and 400 ppb. Concentrations of B₁₂ in colostrum and milk as well as plasma B₁₂, homocysteine (Hcy) and BW of piglets were measured during lactation (21 d). Hcy is a detrimental intermediate metabolite of the B₁₂-dependent remethylation pathway of methionine. Treatments were applied for 2 estrous cycles before mating and throughout gestation. For all sows, the lactation diet contained 25 ppb of B₁₂. Blood samples were collected at birth (d 0, before the first suckling) and on d 1, d 7, d 14 and d 21 of lactation on 3 selected piglets per litter; colostrum and milk samples were collected at the same times. Colostrum B₁₂ (d 0) increased (dietary B₁₂ quadratic, $P < 0.01$) with the dietary B₁₂ in gestation. Average values (\pm SE) (ng/mL) were 4.8 \pm 0.7, 6.1 \pm 0.4, 7.5 \pm 0.7, 10.2 \pm 0.8, and 9.9 \pm 0.8 for 0, 20, 100, 200 and 400 ppb of dietary B₁₂. The maximal colostrum B₁₂ was estimated to be reached with 300 ppb of dietary B₁₂ ($R^2 = 0.96$). On d 1, milk B₁₂ decreased by 40 % but a residual effect of the gestation treatments persisted (dietary B₁₂ linear, $P < 0.01$). Plasma B₁₂ of piglets on d 0 (592.9 \pm 53.3 pg/mL) was similar ($P > 0.59$) among treatments. On d 1, the overall plasma B₁₂ in piglets doubled but also increased with the dietary level of B₁₂ in dam's diet (dietary B₁₂ linear, $P < 0.05$). Plasma Hcy of piglets on d 0 decreased (dietary B₁₂ linear, $P < 0.01$) as the levels of dietary B₁₂ increased. The overall plasma Hcy in piglets increased during lactation (2.6 \pm 0.1 μ M on d 0 to 28.8 \pm 1.1 μ M on d 21). However, plasma Hcy in piglets decreased (dietary B₁₂ linear, $P < 0.01$) as B₁₂ increased in the gestation diet. Residual treatment effects were still apparent on litter weight (dietary B₁₂ quartic, $P < 0.06$) on d 7 but disappeared, thereafter. In conclusion, the dietary B₁₂ during gestation can modulate the transfer of B₁₂ and the Hcy metabolism of piglets during lactation. Most of the transfer of B₁₂ to piglets occurred after birth via the colostrum and the milk. The importance of dietary B₁₂ during both gestation and lactation of sows on growth of suckling piglets needs to be evaluated.

Key Words: Vitamin B₁₂, Milk, Gilts

654 Effect of the meal on the utilization of some nutrients and vitamins by the mammary gland in lactating sows. J.Y. Dourmad*¹, J.J. Matte², and D. Renaudeau¹, ¹INRA-UMRVP 35590 Saint-Gilles, France, ²Agric. and Agri-Food Canada, Lennoxville (QC), Canada, J1M 1Z3.

The effect of the meal on the uptake of some nutrients and vitamins by the mammary gland was measured in six lactating sows. After farrowing, catheters were fitted in the right anterior mammary vein and in the carotid artery. Blood samples were drawn following an overnight fast on d 9, d 14 and d 21 of lactation, every 30-min from 60 min before to 300 min after the morning meal (2.5 kg of a lactation diet). Plasma concentrations of glucose, lactate, triglycerides (TG), NEFA, glycerol, α -amino N, folates and vitamin B₁₂ were determined on all samples. Vitamin B₂ and amino acid (AA) concentrations were measured 30 min before and 120 min after the meal only. For the vitamins, the arterio-venous (A-V) difference was not different from zero. However, the decrease of plasma

concentrations of folates and vitamin B₁₂ between d 9 and d 21 suggests that they could play a role for lactation, but in other metabolic pools. Arterial and venous plasma concentrations of glucose, lactate and α -amino N increased after the meal ($P < 0.01$), whereas concentrations of NEFA, glycerol and TG decreased ($P < 0.01$). Arterio-venous differences increased after the meal for glucose, lactate and α -amino N ($P < 0.01$), remained constant for TG, and decreased for NEFA ($P < 0.01$) and glycerol ($P < 0.05$). Arterial concentrations of all AA increased after the meal but changes of A-V with the meal differed among AA. The pattern of AA uptake was affected by the nutritional status. For instance

the valine:lysine ratio was higher (1.11) in fasted than in fed sows (.82). Arterio-venous difference of energy (7.7 kJ/L plasma) was similar in fasted and fed sows. The relative contributions of glucose, TG, lactate, NEFA, and AA to energy uptake by the mammary gland amounted to 24.0, 25.5, 2.1, 34.1 and 13.9% in fasted sow and, 51.0, 26.7, 3.9, 0 and 18.5% in fed sows, respectively. These results indicate that the mammary uptake of nutrient is greatly depending on the nutritional status of the sow.

Key Words: Sow, Lactation, Milk precursor

Undergraduate and Graduate Education

655 The use of peer review in an animal science course focusing on societal issues. W. A. Scheer* and J. N. Spain, *University of Missouri, Columbia, MO.*

This study was a post-facto analysis of the use of peer reviews to evaluate student research papers. Students ($n=72$) in a sophomore-level animal science course were assigned a research paper. Each student selected a topic that they considered to be the most critical societal issue facing animal agriculture. Students were expected to write the paper using the format of the *Journal of Animal Science* and to utilize a minimum of 15 refereed journal articles. The first edition of the paper was graded by the instructor or graduate teaching assistant. Three copies of the second edition were submitted with only student identification numbers identifying the author. Students were randomly allocated three papers to evaluate. Each student completed a review sheet and awarded up to 50 points with 20 points available for topic development, 20 points for grammar and spelling, and 10 points for proper citation format. Students were given 3 days to complete the evaluations. Peer reviews were then returned to the student writers for final revision. Students were asked to evaluate reviewers in three categories using a scale of zero to one in each category, with up to 3 total points available. The final edition of the paper was then graded by the instructor or graduate teaching assistant. The relationships between average peer review grade, grade as a reviewer, and final edition grade were evaluated. A significant ($P < 0.05$) positive correlation was found when comparing average peer review grade and final edition grade. As students' peer review grades and final edition grades increased, their grade as a peer reviewer also increased. Students who wrote papers that received higher second (peer-assigned) and final edition (instructor-assigned) grades were considered to be better reviewers as scored by their peers, indicating that students who wrote better papers provided more meaningful feedback. Peer review of research papers was a useful and effective component of this sophomore-level animal science course that allowed students to improve their writing skills and become more actively involved in the evaluation process.

Key Words: Teaching, Peer Review

656 Practical student experiences aid in the education on controversial animal topics. K. D. Ange*, *North Carolina State University, Raleigh, NC.*

The animal rights versus animal welfare conflict is an important issue for all animal scientists involved in undergraduate education. Students need to be taught the difference between animal rights and animal welfare so they can understand the current issues facing the field of animal science. Some animal rights groups frequent the media spreading propaganda about animal industries and it is important that animal science students are taught the facts so that they can form their own opinions. Undergraduate students enrolled in NCSU's Companion Animal Management course were given the opportunity to examine a current controversial animal topic first hand. The animal rights groups People for the Ethical Treatment of Animals and Humane Society of the United States have been criticizing circus animal treatment in the mainstream media (NBC News). The opinions of these animal rights groups were discussed in class and then the students were allowed to tour the animal compound of a very large traveling circus and meet with the animal care staff. The animals in this compound included alpacas, camels, elephants, horses, tigers, and zebras. After visiting the circus, students were asked to complete a questionnaire regarding their opinion of animal care in circuses. Fifteen of 18 students completed the survey. Prior to the tour, the average student opinion of circus animal care was 2.6 and their average opinion of circus animal staff (trainers and veterinarians)

was 2.9 on a 1 (very poor) to 5 (very good) point scale. After their tour, student opinion of animal care and the animal staff improved to 4.4 and 4.5, respectively ($P < 0.001$). Although all 15 students stated that they felt the circus tour improved their opinion of animal care at circuses, a few students listed enlarging animal cages, increasing exercise and changing elephant restraints as ways to improve animal care. In addition to classroom education, the results from this tour show that personal experiences dramatically affect what students think about controversial animal issues.

Key Words: Teaching, Active learning, Welfare

657 A novel method for teaching animal welfare concepts: animal welfare judging teams. C.R. Heleski*¹, A.J. Zanella¹, and E.A. Pajor, ¹*Michigan State University, East Lansing MI, USA*, ²*Purdue University, West Lafayette, IN, USA.*

Examining the welfare of animals in various production systems and making ethical evaluations of which is most appropriate continues to be a priority issue affecting many levels of animal agriculture. We have developed a model to increase education of animal welfare issues, while aligning ourselves with a traditional curriculum feature within animal science departments; i.e. judging teams.

We proposed one year ago that developing teams to educate young people about farm animal welfare then establishing competitions to assess their skill level would be one way to integrate welfare science into the mainstream of animal science curricula. Three other universities opted to join Michigan State in this pilot endeavor: Purdue University, University of Guelph and University of Wisconsin. Each team is being coached in the basics of understanding farm animals# evolutionary biology, their biological needs, indicators of differing levels of welfare and how to holistically evaluate different facilities, stockmanship and management.

Based on pedagogical principles, the concept of integrating learning with competition is known to enhance learning and retention. Students are currently preparing for a competition, March 1, 2002. The competition will use CD-ROM#s with indicators of animal welfare ranging from physiological data, video and still clips, to behavioral responses and time budgets. Students will evaluate two scenarios for each species being judged, prepare their analysis, then make an oral presentation. The knowledge of welfare science, the integration of multiple measures and the persuasion of the oral presentation will be key in scoring the students.

Preliminary observations indicate that preparing the students for this competition has increased their knowledge base and has enhanced networking with university farm managers. It should be noted that while the assessment of various aspects of animal welfare can be objective and quantifiable, judgment decisions of what threshold level on the continuum between poor and good welfare is acceptable still come down to ethically examined choices.

Key Words: Animal Welfare, Welfare Assessment, Judging Teams

658 A pre-capstone seminar to foster student interaction to improve educational quality of independent learning experiences. M. A. Wattiaux*, *University of Wisconsin-Madison.*

Our objective was to develop a class to facilitate communication among students and better prepare sophomores to take full advantage of independent learning experiences (ILE) typically available to juniors or seniors such as internships, team projects in capstone courses, summer research programs and study abroad. Thus, a one credit seminar series