
**COMPANION ANIMALS:
COMPANION ANIMAL NUTRITION
AND PET FOOD PROCESSING**

0180 [Withdrawn]

0181 Indirect calorimetry, real-time interstitial glucose monitoring, and blood sampling to determine effects of low, medium, and high glycemic index cat foods. K. D. Berendt*¹, A. K. Shoveller², and R. T. Zijlstra¹, ¹University of Alberta, Edmonton, AB, Canada, ²Procter & Gamble Pet Care, Mason, OH.

The amount and source of dietary starch affects glucose and insulin responses and contributes to dietary glycemic index (GI) in omnivorous monogastrics. However, limited information exists for GI in carnivorous monogastrics such as cats. Thus, the objective was to study a range in dietary GI in relation to indirect calorimetry and postprandial serum glucose and insulin and interstitial glucose. We used 19 domestic shorthair cats in an incomplete replicated 3 × 3 Latin squares for 19 observations per diet. Initial BW averaged 4.9 kg and ranged from 3.4 to 7.1 kg. Three premium cat diets varying in GI based on ingredient composition (chicken & rice, chicken & chicken by-product meal, and turkey & chicken for high, medium, and low GI respectively) and starch content (36.8, 30.7, and 23.6%, respectively) were fed. Diets contained 38 & 23%, 36 & 22%, and 42 & 16% CP and ether extract, respectively. The respiratory quotient (RQ) decreased ($P < 0.001$) with decreasing GI (0.78, 0.77, and 0.76 for high, medium and low GI, respectively), indicating increased lipid oxidation. Daily resting energy expenditure (REE) did not differ among diets. Postprandial (22 h) fat oxidation was inversely related to GI (0.64, 0.68, and 0.69 g/h for high, medium and low GI, respectively; $P < 0.05$). Postprandial carbohydrate oxidation decreased with reducing GI (0.61, 0.52, and 0.46 g/h for high, medium and low GI, respectively; $P < 0.001$). Postprandial (20 h) interstitial glucose decreased with reducing GI (73.4, 64.4, and 59.7 mg/dL d⁻¹ for high, medium and low GI, respectively; $P < 0.05$). Postprandial (10 h) serum glucose did not differ among diets and did not peak postprandially followed by return to baseline as expected based on data from responses of omnivorous monogastrics. Interstitial glucose may be more sensitive than a limited number of sequential blood samples to study starch metabolism in cats. Postprandial serum insulin was greatest ($P < 0.05$) for the high GI diet and lowest for the medium GI diet. In conclusion, responses of cats to changes in dietary starch content are unique, i.e., more prolonged and less pronounced than in humans or dogs.

Key Words: glycemic index, calorimetry, cat

0182 The effect of extrusion and elevated storage temperatures on vitamin retention in pet food.

A. K. Mooney*, Kansas State University, Manhattan.

Little research has been published in recent years regarding the magnitude of vitamin losses through extrusion manufacturing and storage of pet food. The matrixes of pet diets have changed dramatically within the past twenty years since vitamin degradation was last published. Therefore the objective of our research was to determine the effects of processing conditions and dietary protein content on vitamin retention (vitamin A, vitamin D₃, vitamin E, folic acid and thiamine) during extrusion and drying and the subsequent effect during storage at elevated temperatures. Three diets differing in protein (21.7, 25, and 30% CP; Low, Medium, and High, respectively) were produced. Diets were extruded at 350 and 450 rpm screw speed on a Wenger X-20 single screw extruder (Wenger Mfg, Sabetha, KS) and dried at 104°C for 6 min at each pass or 127°C for 10 min at each pass in a Wenger (Wenger Mfg, Sabetha, KS) triple pass dryer. Samples from each treatment were analyzed immediately following production. Without current established criterion for accelerated shelf life studies of pet food, conditions by industry laboratories were practiced using 50°C and 75% relative humidity for 3, 6, 12, and 18 wk before vitamin analysis. Retention of all vitamins evaluated in this study was not affected ($P > 0.05$) by extruder screw speed or dryer conditions. As time in storage (50°C) increased through 3, 6, 12, and 18 wk vitamin A ($P < 0.05$; 153,708, 95,542, 62,491, 21,713, and 6689 IU/kg, respectively), vitamin D₃ ($P < 0.05$; 6956, 4652, 3572, 1824, and 1421 IU/kg, respectively), vitamin E ($P < 0.05$; 855, 970, 834, 837, and 803 mg/kg, respectively), folic acid ($P < 0.05$; 1.75, 1.81, 2.37, 1.45, and 0.98 mg/kg, respectively), and thiamine ($P < 0.05$; 22.9, 19.7, 16.1, 7.4, and 3.3 mg/kg, respectively) concentrations decreased. These results suggest that the processing parameters in this study had little effect on vitamin losses; but, elevated temperature during storage for 18 wk could reduce vitamin content from initial by 95.65, 79.57, 6.08, 44.00, and 85.86% for vitamin A, vitamin D₃, vitamin E, folic acid and thiamine, respectively. Vitamin fortification of extruded pet diets must take into account these changes to avoid deficiency diseases.

Key Words: vitamin stability, effects of thermal processing, vitamin retention

0183 Effects of processing on water soluble B-vitamins in a canned cat diet. S. DeNoya*, G. Aldrich, and C. K. Jones, Kansas State University, Manhattan.

There has been very little research published regarding the degradation of B-vitamins in a canned cat food. The objectives of these experiments were to evaluate the effect of batter temperature and moisture, or retort-cooking time on B-vitamin retention. In Exp. 1, cat food was produced at a batter temperature of 60°C and moistures of 65, 75, and 85%. In

Exp. 2, cat food was produced at a batter moisture of 78% and temperatures of 50, 60, and 70°C. All foods were held in the retort (121°C) for 45, 60, and 90 min. In Exp. 1, ($n = 3$) thiamine concentration decreased ($P = 0.0031$; 5.11, 4.30, and 2.96 mg/kg for 45, 60, and 90 min, respectively) as time in the retort increased. As batter moisture decreased, thiamine ($P = 0.0072$; 3.57, 3.67, and 5.12 mg/kg for 65, 75, and 85% moisture, respectively), riboflavin ($P = 0.0320$; 10.41, 9.89, and 13.00 mg/kg for 65, 75, and 85% moisture, respectively), pantothenic acid ($P = 0.0240$; 46.32, 49.52, and 67.31 mg/kg for 65, 75, and 85% moisture, respectively), and vitamin B-12 ($P = 0.0004$; 0.0220, 0.0180, and 0.0400 mg/kg for 65, 75, 85% moisture, respectively) concentration decreased. In Exp. 2, ($n = 3$) thiamin ($P = 0.0002$; 5.11, 3.86, and 2.53 mg/kg for 45, 60, and 90 min, respectively), and niacin ($P = 0.0170$; 228.51, 200.51 and 202.60 mg/kg for 45, 60, and 90 min respectively) decreased as retort time increased. Pantothenic acid ($P = 0.0360$) concentration initially increased slightly at 60 min, but returned back to its initial level by 90 min. Folic Acid declined ($P = 0.0330$; 0.85, 0.83, and 0.03 mg/kg for 50, 60, and 70°C, respectively) as batter temperatures increased. In both experiments, thiamine and folic acid losses exceeded 90%, while vitamin B12 losses exceeded 50%. Fortification of canned cat food diets must take these substantial losses into account to avoid nutrient deficiencies.

Key Words: B-Vitamins, pet food, thermal processing

0184 Feeding frequency and dietary water content affect voluntary physical activity in young lean adult female cats. M. R. C. de Godoy^{*1}, K. Ochi², L. F. de Oliveira Mateus³, A. C. C. de Justino³, and K. S. Swanson^{1,4,5},
¹Department of Animal Sciences, University of Illinois, Urbana, ²Nippon Pet Foods Co. Ltd, Tokyo, Japan, ³Department of Animal Sciences University of São Paulo State, Jaboticabal, Brazil, ⁴Division of Nutritional Sciences, Urbana, IL, ⁵Department of Veterinary Clinical Medicine, Urbana, IL.

Obesity is the most common form of malnutrition in the pet population in western countries. Approximately 58.3% of cats are considered overweight or obese in the U. S. It is imperative that in conjunction with the development of effective strategies to manage obesity, preventive measurements for this disease are also exploited. Therefore, the objective of this study was to investigate whether increased dietary water content and feeding frequency increased voluntary physical activity of young lean adult female cats. A replicated 4 × 4 Latin square design with a 2 × 2 factorial treatment arrangement (feeding frequency and water content) was used. The four treatments consisted of: 1) One meal daily dry (without added water); 2) One meal daily wet (dry diet with added water to reach 70% moisture); 3) Four meals daily dry; and 4) Four meals daily wet. Eight healthy adult, lean, intact, young, female domestic shorthair cats were used in this experiment. Voluntary physical activity

was evaluated using Actical activity monitors placed on collars and worn around the cat's neck for the last 7 d of each experimental period of 14 d. Food anticipatory activity (FAA) was calculated based on 2h before feeding periods and expressed as a percentage the total daily voluntary physical activity. The interaction between feeding frequency and water content was not statistically significant ($P > 0.05$). Increased feeding frequency (four vs. one meal daily) resulted in greater average daily activity ($P = 0.0147$), activity during the light period ($P = 0.0023$), and light:dark activity ratio ($P = 0.0002$). In contrast, physical activity during the dark period was not altered by feeding frequency ($P > 0.05$). Cats fed four meals daily had increased afternoon FAA ($P = 0.0029$) compared with cats fed once daily. Dietary water content did not affect any measure of activity. Increased feeding frequency is an effective strategy to increase the voluntary physical activity of cats. Thus, it may assist in the prevention and management of obesity.

Key Words: feline, meal frequency and moisture content, physical activity

0185 Effects of graded dietary resistant starch concentrations on apparent total tract macronutrient digestibility, fecal characteristics, and fecal fermentative end-products in healthy adult dogs. A. N. Beloshapka* and K. S. Swanson, Department of Animal Sciences, University of Illinois, Urbana.

Resistant starch (RS) is fermentable by gut microbiota and effectively modulates fecal short-chain fatty acid (SCFA) concentrations in pigs, mice, and humans. Resistant starch may have similar beneficial effects on the canine gut; however, the dose of a single source of RS that is effective in manipulating fecal fermentative end-products but does not negatively affect stool quality has yet to be determined. Thus, the objective of this study was to evaluate the effects of 0, 1, 2, 3, and 4% dietary high-amylose maize cornstarch (HI-MAIZE 260; RS) on apparent total tract macronutrient digestibility, fecal characteristics, and fecal fermentative end-product concentrations in healthy adult dogs. An incomplete Latin square design was used, with each treatment period lasting 21 d (d0-17 adaptation; d18-21 fresh and total fecal collection) and each dog serving as its own control. Seven dogs (mean age = 5.3 yr; mean BW = 20 kg) were randomly allotted to one of five treatments, which were formulated to be iso-energetic and consisted of graded amounts of 100% amylopectin cornstarch, RS, and cellulose, and fed as a top dressing on the food each day. All dogs were fed the same amount of a basal diet throughout the study and fresh water was offered ad libitum. Data were evaluated for linear and quadratic effects using SAS. Because the RS used in this study is approximately 40% digestible and 60% indigestible starch, the dogs received the following amounts of indigestible starch daily: 0% = 0 g; 1% = 1.8 g; 2% = 3.6 g; 3% =

5.4 g; and 4% = 7.2 g. Dry matter, organic matter, crude protein, fat, and gross energy digestibilities were linearly decreased ($P < 0.05$) in dogs with increased consumption of RS. Fecal output was linearly increased ($P < 0.05$) in dogs with increased consumption of RS. Fresh fecal pH was linearly decreased ($P < 0.05$) in dogs with increased consumption of RS. Fecal scores and fecal fermentative end-product concentrations, including ammonia, SCFA, branched-chain fatty acids, phenols, and indoles, were not affected by the consumption of RS. The results observed in this study compared to previous studies performed in other animal models and humans seem to indicate that RS is slowly fermentable in dogs and may not greatly impact large bowel health in this species.

Key Words: resistant starch; canine; digestibility

0186 Evaluation of common analysis methods for oxidation in rendered protein meals used to produce pet foods. M. Gray*, G. Aldrich, and C. K. Jones, *Kansas State University, Manhattan.*

A significant amount of rendered protein meal is used in pet food to meet the pets' dietary protein and fat needs. These protein meals contain approximately 15-20% fat, which can oxidize and lead to unusable material. Peroxide value (PV) is a common method used to evaluate oxidation in commercial proteins, but it has been criticized as inconsistent and imprecise. Therefore, our objectives were to evaluate alternative methods to measure fat quality in rendered protein meals and to compare the results among different animal sources and rendering plants. It was hypothesized that PV was an inconsistent and unrepresentative method of analysis for measuring fat stability for rendered protein meals. In this experiment, samples of five chicken byproduct meals (CBPM) from each of three locations, and five beef meat and bone meals (BMBM) from each of two locations were evaluated. Samples were analyzed for proximate constituents, anisidine value (AV), thiobarbituric acid reactive substances (TBARS), PV via titration by two laboratories and PV via rapid method (SafTest; peroxysafe). Fat content differed among plants ($P < 0.0001$; BMBM = 8.44 vs. 11.87% and CBPM = 13.24 vs. 15.11 vs. 16.59%) and when aggregated into protein meal type, the ash concentration was greater for BMBM and protein concentration greater for CBPM ($P < 0.0001$). Again, for compiled least square means between the protein meal types, the peroxide values for the BMBM and CBPM were 10.42 and 58.08 meq/kg, respectively from laboratory 1; 4.65 and 3.01 meq/kg, respectively from laboratory 2; and 11.52 and 42.96 meq/kg, respectively from the rapid method test. There was a direct correlation ($r = 0.98$) between PV titration results from laboratory 1 data and the rapid method, but not with titration results from laboratory 2 ($r = 0.46$). This variation among labs is consistent with the anecdotal field evidence

and our hypothesis. As expected, the PV from laboratory 1 did not correlate to the AV ($r = 0.61$); a measure of secondary oxidation products. Oxidation indicated by TBARS differed among both protein meal and plant ($P < 0.0001$). Our data corroborate the inconsistencies noted from commercial quality control laboratories. Combined with the results from the AV and TBARS, there is a clear need for further research to create a more accurate and precise analytical method for fat oxidation in rendered protein meals.

Key Words: oxidation, rendered protein meal, pet food

0187 Broken beans (*Phaseolus vulgaris*) use on extruded diets for cats. B. P. Neto¹, F. C. Sa², N. Musco³, A. P. Maria², B. Agy², B. A. Kamimura⁴, R. S. Vasconcellos¹, and A. C. Carciofi^{*5}, ¹*Universidade Estadual de Maringá, Maringá, Brazil*, ²*Sao Paulo State University, Jaboticabal, Brazil*, ³*Università degli Studi di Napoli Federico II, Napoli, Italy*, ⁴*Universidade de Campinas, Campinas, Brazil*, ⁵*Sao Paulo State University- UNESP, Jaboticabal, Brazil.*

Broken beans (BB) is the result of bean selection for human consumption, mainly composed of open seeds in good sanitary and nutritional quality, with a potential use as protein and energy source for companion animals. Beans have antinutritional factors, among them protease inhibitors (PI) and hemagglutinin (HA) that reduces the ingredient nutritional value. These factors are thermolabile, and the extrusion process used to produce kibble diets for cats may possibly inactivate them. We evaluated the inclusion of BB on extruded diets for cats, and the effect of the extrusion process on PI and HA inactivation. Thirty adult cats, with 7.6 ± 0.3 yr old and 5.0 ± 0.3 kg of BW were used. Five diets with similar composition (average: 94% DM, 30% CP, 16% fat, 2.8% crude fiber, 7% ash) were formulated for cat maintenance, presenting increasing amounts of BB: 0.0%, 7.5%, 15.0%, 22.5% and 30.0%. The BB sample presented 22.1% of CP, 1.5% of fat, 3.7% of crude fiber, and 2.9% of ash, and was included at the expense of the poultry by-product meal. Diets were extruded under similar conditions in a laboratory scaled complete extrusion system, with a single screw extruder. Samples from the mash diet and the food after the preconditioner, extruder, and dryer were collected and used to measure TI and HA. The experiment followed a complete randomized block design, with 2 blocks of 15 cats, and 3 cats per diet in each block, totaling 6 cats per diet. The blocking factor was time. The coefficients of apparent total tract digestibility and nitrogen balance was determined through total collection of feces and urine. Cats were kept in metabolism cages during 14d, and feces and urine were totally collected on the last 7d. Data were submitted to analysis of variance, and means compared by polynomial contrasts ($P < 0.05$). The extrusion process was very efficient

in inactivating the PI and HA of the BB. After the preconditioner, the activity of these compounds was reduced in 40% to 50%, after the extrusion, they were reduced more than 90%, and after the dryer their values were practically zero. Addition up to 30% BB did not change food intake, nutrient and energy digestibilities (average digestibility: DM, 81%; OM, 84%; CP, 85%; acid-hydrolyzed fat, 89%; gross energy,

86%), fecal traits (dry matter, production, and score), and nitrogen balance, suggesting that bean is a suitable ingredient for extruded diets for cats.

Key Words: co-products, protein, antinutritional factors