

Companion Animals: Companion and Captive Exotic Animals

200 Ingredient composition of diets offered to black-and-white ruffed lemurs (*Varecia variegata*) from surveyed United States zoological institutions. B. C. Donadeo^{*1}, K. R. Kerr¹, C. L. Morris^{2,3}, and K. S. Swanson¹, ¹University of Illinois at Urbana-Champaign, Urbana, ²Omaha's Henry Doorly Zoo & Aquarium, Omaha, NE, ³Iowa State University, Ames.

Fifty-eight US zoological institutions are registered with the International Species Information System (ISIS) as housing black-and-white ruffed lemurs (*Varecia variegata*), but little data are available on their captive diets. Our objective was to identify feed items and inclusion amounts of diets offered to captive *V. variegata* at US zoological institutions. Institutions were contacted via the Prosimian Taxon Advisory Group listserv and direct email contact to request participation in the study. Diet information (i.e., type and amount of diet items) was collected utilizing a survey (created on SurveyMonkey.com). Respondents were prompted to indicate inclusion level for items expected to be common, including fruits, vegetables, biscuits (and other commercial products), greens, and browse (i.e., twigs, shoots, leaves), and to provide information on items not specifically listed. Thirty-five institutions provided diet information utilizing the survey between July 27 and December 31, 2012, including 33 of the 58 ISIS listed institutions (57%). Data presented here are from 33 institutions which have provided complete information for analysis. The most commonly included items (30 of 33 zoos) were bananas (<5% to 30% of diet). Most institutions offer either Marion Zoological's Leaf Eater biscuit (10 zoos; <5% to 70% of the diet), Mazuri's Leaf-Eater biscuit (14 zoos; <5% to 50% of the diet), or Mazuri's Primate Browse biscuit (10 zoos; <5% to 25%). -seven institutions use browse (<5% to 10%); of these institutions, 10 indicated little to no consumption of browse offered. While *V. variegata* is a frugivorous species, research in our lab shows that Madagascan fruits available to wild *V. variegata* are higher in fiber and lower in carbohydrates than diets offered at US zoos. Therefore, high inclusion of fruit in captive lemur diets may be inappropriate. Further research is needed on the effects of different captive diet types and ingredient inclusions on lemur health.

201 Amino acid composition and standardized digestibility of whole prey diet items intended for captive exotic and domestic felids. K. R. Kerr^{*1,2}, P. L. Utterback², C. M. Parsons², and K. S. Swanson^{1,2}, ¹Division of Nutritional Sciences, University of Illinois, Urbana, ²Department of Animal Sciences, University of Illinois, Urbana.

Whole prey diets are popular for captive exotic and domestic felids. However, research on whole prey has primarily focused on non-nutritive benefits. Our objective was to evaluate the amino acid (AA) composition and bioavailability of 20 whole prey sources: mice (1 to 2 d, 10 to 13 d, 21 to 25 d, 30 to 40 d, and 150 to 180 d of age); rats (1 to 4 d, 10 to 13 d, 21 to 25 d, 33 to 42 d, and >60 d of age); rabbits (still born, 30 to 45 d, > 65 d with skin, and >65 d of age with skin removed); chicken (1 to 3 d of age, ground adult); duck (ground adult); and quail (1 to 3 d, 21 to 40 d, and >60 d of age). We measured AA composition of each whole prey item and evaluated standardized AA digestibility utilizing the cecectomized rooster assay. We calculated the amino acid score (AAS) and protein digestibility corrected AAS (PDCAAS) utilizing the growth requirements for domestic cats as a reference value (AAFCO, 2012). For most the whole prey, AA concentrations were greater than the recommendations for domestic cats: AAS were greater than 88 for all species except rabbits (AAS: 6 to 56). The first limiting AAs were

Cys + Met, Met, Tau, and Trp. In the 30 to 45 d-old rabbit, taurine concentration (0.01% DM) was lower than that recommended for domestic cats (0.10% DM). Standardized digestibility coefficients were quite high, but variable (Arg: 85 to 95%; His: 87 to 96%; Ile: 82 to 92%; Leu: 84 to 94%; Lys: 85 to 93%; Met: 89 to 97%; Phe: 83 to 94%; Thr: 80 to 95%; Trp: 84 to 94%; Val: 80 to 93%). The PDCAAS were 3 to 13 units lower than AAS. Given the AA digestibilities and high protein concentrations in whole prey, meeting the requirements likely would not be an issue for Cys + Met, Met, and Trp. However, some whole prey had Tau concentrations below the recommendations for domestic cats. If Tau concentrations are not measured before feeding, supplementation of whole prey may be beneficial. Standardized AA digestibility coefficients of 80 to 97% are expected.

Key Words: protein digestibility corrected amino acid score, cat

202 The effects of L-carnitine on energy expenditure and fuel selection in adult Miniature Dachshunds, Beagles, and Labrador Retrievers measured using indirect calorimetry. D. Minikhiem^{*}, K. Shoveller, J. DiGennaro, and L. Fortener, *Procter and Gamble, Mason, OH.*

Despite the common incorporation of L-carnitine (LC) in dog food there is little research on the effects of LC on energy expenditure (EE) and fuel selection in healthy, lean dogs. In the present study indirect calorimetry was used to determine if dogs consuming 50 ppm LC (LC+) had lower RQ and greater EE compared with dogs fed control (CON). This study was a 2 × 2 Latin Square with baseline measurements before each period. A total of 16 dogs (6 Labrador Retrievers [Labs], 4 Miniature Dachshunds [Dachshunds], and 6 Beagles) were pseudo-randomly allocated to LC+ and CON diets and balanced for BW and food intake. Dogs were fed Iams ProActive Health MiniChunks with (LC+) and without (CON) 50 ppm added LC (as fed basis) to maintain BW. Indirect calorimetry was conducted during fasting and for 8 h post feeding at baseline, 3, and 6 wk. Area under the curve (AUC) for RQ and EE, and AUC for RQ and EE divided into 4 postprandial time periods (0–120 min, 120–240 min, 240–360 min, and 360–480 min) were analyzed using a random mixed model with breed and diet-by-breed interaction as covariates. There were no differences in RQ between treatments at baseline ($P > 0.05$). RQ tended to increase (contrary to expected results) from baseline at wk 3 and 6 for Dachshunds and Beagles fed LC+ ($P = 0.07$). There were no differences between treatments in EE at baseline for each breed. EE increased in Labs fed LC+ after 3 and 6 wk. Specifically, Labs fed LC+ had greater EE ($P < 0.05$) than Labs fed CON during the last 3 postprandial periods at wk 3 and 6. Fasted EE tended ($P = 0.08$) to be greater in Labs fed LC+ at 6 wk. There were no differences between treatments for Beagles or Dachshunds. In conclusion, effects of LC on dog metabolism are breed-specific. Dogs consuming a maintenance diet supplemented with 50 ppm LC exhibited an apparent increase in carbohydrate metabolism (Dachshunds and Beagles) and an increase in total energy expenditure (Labs).

Key Words: L-carnitine, dog, indirect calorimetry

203 Effect of photoperiod on feline adipose transcriptome profiles as assessed by RNA sequencing (RNA-seq). A. Mori^{*1}, K. L. Keppen¹, and K. S. Swanson^{1,2}, ¹Department of Animal Sciences, University of Illinois, Urbana, ²Division of Nutritional Sciences, University of Illinois, Urbana.

Photoperiod is known to cause physiological changes in seasonal mammals, including body weight (BW), physical activity, and reproductive status. Because cats are seasonal breeders, we recently tested the effects of day length on resting metabolic rate (RMR), voluntary physical activity, and food intake. In that study, RMR, physical activity, and food intake to maintain BW were greater in cats exposed to long days (LD) vs. short days (SD). Because photoperiod has also been demonstrated to affect adipose tissue gene expression in several species, including dairy cows, sheep, and Siberian hamsters, the objective of this study was to determine the effects of day length on the adipose transcriptome profile of cats as assessed by RNA-seq. Ten healthy adult neutered male domestic shorthair cats were used in a randomized crossover design study. During two 12-wk periods, cats were exposed to either SD (8 h light:16 h dark) or LD (16 h light:8 h dark). Cats were fed a commercial diet to maintain baseline BW. Subcutaneous adipose biopsies were collected at wk 12 of each period for RNA isolation and sequencing. A total of 578 million sequences (28.9 million/sample) were generated by Illumina sequencing. Using a raw P -value of $P < 0.005$, 170 mRNA transcripts were differentially expressed between SD- and LD-housed cats. Of the 170 transcripts highlighted, 25 annotated transcripts were upregulated, while 116 annotated transcripts were downregulated by LD. Another 29 un-annotated transcripts (name and function not known) were also different between groups. In general, adipose tissue of LD-housed cats had greater expression of genes involved with cholesterol trafficking, fatty acid synthesis and immune function, and lower expression of genes involved with cell growth and differentiation, cell development and structure, and protein processing, when compared with SD-housed cats. This study has highlighted molecular mechanisms that may contribute to seasonal metabolic changes in cats. Although this area requires more research, these data may be used to develop strategies for feline obesity prevention or treatment.

Key Words: adipose tissue, cat, photoperiod

205 Potato pulp as a dietary fiber source in high quality dog foods. M. R. Panasevich^{*1}, R. N. Dilger^{1,2}, K. S. Swanson^{1,2}, L. Guérin-Deremaux³, G. L. Lynch⁴, and G. C. Fahey Jr.^{1,2}, ¹University of Illinois Department of Animal Sciences, Urbana, ²University of Illinois Division of Nutritional Sciences, Urbana, ³Roquette Frères, Biology and Nutrition Department, Lestrem, France, ⁴Roquette America Inc., Geneva, IL.

Dietary fiber is important in companion animal diets because of its positive effects on gut and systemic health. Potato pulp (PP), a co-product of potato starch processing (Roquette Frères, France), was evaluated as a potential novel fiber source in dog foods. The PP substrate was evaluated for chemical composition and in vivo responses. Ten female dogs with hound bloodlines (5.4 ± 0.0 yr; 22 ± 2.1 kg) were each provided 5 diets with graded levels (0, 1.5, 3, 4.5, or 6%; added in place of cellulose) of PP on an as-is basis in a replicated 5×5 Latin square design. Fresh fecal samples were collected to measure fecal pH and fermentation end products. Chemical composition results revealed that raw and cooked PP contained 55% total dietary fiber, with 32% insoluble fiber and 23% soluble fiber, as well as 4% crude protein and 2% acid-hydrolyzed fat. No differences were observed in total tract digestibility coefficients for dry matter (81.3 to 82.7%), organic matter (84.1 to 85.5%), crude protein (81.7 to 80.2%), acid-hydrolyzed fat (94.1 to 94.6%), or energy (84.9 to 85.7%). Total dietary fiber digestibility was greater ($P < 0.01$) for dogs fed the 3, 4.5, and 6% PP diets compared with dogs fed the 0% PP diet. Fecal pH was lower ($P < 0.01$) when dogs were fed the 4.5 and 6% PP diets compared with the 0% PP diet. Fecal acetate, propionate, and total SCFA were higher when dogs were fed the

3, 4.5, and 6% PP diets, and fecal butyrate was higher when dogs were fed 4.5 and 6% diets compared with the 0% PP diet ($P < 0.05$). Overall, with increasing PP inclusion, linear increases ($P < 0.01$) were observed for all SCFA, with a concomitant linear decrease ($P < 0.01$) in fecal pH. Fecal protein catabolites were physiologically low or undetectable, with the exception of spermidine, which was greater ($P < 0.05$) when dogs were fed the 6% PP diet compared with the 0% PP diet. These findings suggest that increased inclusion of PP elicited favorable fermentation characteristics without negatively affecting nutrient digestibility. Collectively, these data suggest that PP could be a functional dietary fiber in high quality dog foods.

Key Words: potato, fiber, dog

206 Mannoheptulose has acute effects on post-prandial energy expenditure, respiratory quotient and insulin response in adult Beagles fed diets with different macronutrient contents. L. L. McKnight^{*1}, E. A. Flickinger², J. France¹, G. Davenport², and A. K. Shoveller^{2,1}, ¹University of Guelph, Guelph, ON, Canada, ²Procter & Gamble Pet Care, Mason, OH.

Overweight dogs are treated with nutritional management strategies that involve therapeutic diets and/or total calorie restriction (CR). As CR strains the human-animal bond, calorie restriction mimetics (CRM) [i.e., mannoheptulose (MH)] are being investigated. The objective of this study was 2-fold: (1) determine the effects of low carbohydrate CHO; high fat (32% CP; 30.6% CHO; 27.9% fat) and high CHO; low fat (27.0% CP; 53.6% CHO; 11.2% fat) diets on energy expenditure (EE), respiratory quotient (RQ) and glycemic response in adult beagles, and (2) determine whether these outcomes were affected by supplementing the diets with mannoheptulose (MH; 8 mg/kg). This study was designed as a 4×4 repeated Latin square with each dog ($n = 8$) randomly allotted to each dietary treatment (high CHO, HC; high CHO with MH, HC+; low CHO, LC; low CHO with MH, LC+). As indirect calorimetry methodology only allowed for 4 dogs to be measured per day, dogs were divided into 2 groups with each diet \times MH combination represented on each day. Fasting and postprandial (24 h) EE and RQ were determined by indirect calorimetry (d 12 or 14). Glycemic and insulinemic responses (24 h) to the treatment meal were determined on the alternate day (d 12 or 14). Dietary CHO level did not affect fasting or postprandial EE, serum insulin or glucose:insulin as would be expected in lean dogs receiving these diets for 14 d. Dogs fed HC had higher postprandial RQ (indicating an increase in CHO oxidation) but lower serum glucose than dogs fed LC. MH acutely increased postprandial RQ (25–75 min, $P < 0.05$) and EE (5–7 h, $P < 0.05$) and decreased serum glucose:insulin (14–22 h, $P < 0.10$) (implying improved insulin sensitivity) irrespective of dietary CHO content. These findings suggest that MH elicits changes in pathways related to energy sensing and that these effects are at least partly mediated by changes in insulin signaling and not related to the macronutrient content of the diet. This study was funded by Procter & Gamble Pet Care.

Key Words: energy expenditure, macronutrient, mannoheptulose

207 In vitro fermentation characteristics of coconut endosperm and chicory pulp fibers using canine fecal inoculum. M. R. C. de Godoy^{*1}, Y. Mitsuhashi², L. Bauer¹, G. C. Fahey¹, P. R. Buff², and K. S. Swanson¹, ¹Department of Animal Sciences, University of Illinois, Urbana, ²The Nutro Company, Franklin, TN.

The objective of this experiment was to determine the effects of in vitro fermentation of coconut endosperm fiber (CEF), chicory pulp (CHP),

and selective blends of these substrates on short chain fatty acid (SCFA) production and changes in microbiota using canine fecal inocula. A total of 6 individual substrates, including short-chain fructooligosaccharide (scFOS; a well-established prebiotic source), pectin (PEC; used as a positive control), pelletized cellulose (PC; used as a negative control), beet pulp (BP; considered the gold standard fiber source in pet foods), CEF, and CHP, and 3 CEF: CHP blends [75% CEF: 25% CHP (B1); 50% CEF: 50% CHP (B2); 25% CEF: 75% CHP (B3)] were tested. Triplicate samples of each substrate were fermented for 0, 8, and 16 h after inoculation. A significant substrate \times time interaction ($P < 0.01$) was observed for pH change and acetate, propionate, butyrate, and total SCFA concentrations. After 8 and 16 h, pH change was greatest for scFOS (-2.0 and -3.0 , respectively) and smallest for PC (0.0 and -0.1 , respectively). After 16 h, CEF had the highest butyrate production among all the CEF: CHP blends, and it was not different than PEC. The substrate \times time interaction was significant for bifidobacteria ($P = 0.013$) and lactobacilli ($P < 0.001$). After 8 h, bifidobacteria was highest for BP and lowest for PC; 12.7 and $10.0 \log_{10}$ cfu/tube, respectively. After 16 h, PC had the lowest and scFOS had the highest bifidobacteria; 6.7 and $13.3 \log_{10}$ cfu/tube, respectively. In general, CEF, CHP and their blends had similar bifidobacteria populations after 8 and 16 h of fermentation when compared with BP and scFOS. After 16 h, lactobacilli populations were highest for B1, B2, B3, BP, and scFOS, intermediate for PEC, and lowest for PC ($P < 0.05$). Overall, our data suggest that CEF had a butyrogenic effect and that CEF, CHP and their blends had similar bifidobacteria and lactobacilli populations as popular prebiotic and fiber substrates. Future research should investigate the effects of CEF, CHP, and their blends on gastrointestinal health and fecal quality in dogs.

Key Words: dog, fiber, in vitro

208 Pheromones and an interomone change the physiology and behavior of anxious dogs. W. G. Thompson* and J. J. McGlone, *Texas Tech University, Lubbock.*

Pheromones are species-specific odors used in communication and have been shown to have both behavioral and physiological effects. Interomones are pheromones in one species, but have diverse effects on other species. The objective of this study was to assess the efficacy of pheromones/interomones to modulate heart rate (HR) and behavior in adult anxious dogs (trembling, cowering, shy). The dogs (10.2 ± 4.2 kg; estimated 5–10 yr old, intact males) and were professionally diagnosed as anxious. Each dog was housed in a separately-ventilated room with a minimum of 12 m^2 of floor space. Heart rate was measured using a telemetry system (Data Science International, St. Paul, MN). Behavior was recorded and later processed by a trained individual (blind to treatment group) using a scan sample with a recording interval of 5 min over a 24 h baseline period. At the end of 24 h with a treatment or control pheromone collar, each dog was startled with a 110 db fog horn while behavior and HR were recorded. Each dog received each treatment in a Latin square design with repeated measures over time. This model allowed evaluation of effects of treatment, dog, treatment by dog, time, treatment by time and dog by time effects. Treatments were given in the form of a collar containing each pheromone/interomone and included Placebo, Sergeant's Formula H (SERG), 2-methylbut-2-enal-Rabbit Pheromone (RP), or Dog Appeasing Pheromone (DAP) collar. During baseline 24 h, DAP increased HR in 1 dog and decreased HR in 2 dogs; SERG increased HR in 2 dogs and decreased HR in 1 dog and RP increased HR in 2 dogs and decreased HR in 2 dogs (dog by trt, $P < 0.0001$). Dog lying behavior changed with SERG and RP but not DAP. After startle, each treatment changed dog HR in at least one dog (dog by trt, $P = 0.002$). Treatments caused one dog to increase while another decreased lying (dog by trt, $P < 0.001$) after startle. Individual dogs changed behavior and HR differentially in response to the pheromones/interomones evaluated. The pheromones/interomones tested clearly changed dog heart rate and behavior. However, anxious dogs did not respond uniformly to each pheromone/interomone tested.

Key Words: pheromone, interomone, behavior