Companion Animal Symposium: Bioenergetics of pet food

546 Pet obesity and bioenergetics of pet food. Kelly Swanson*, *University of Illinois at Urbana-Champaign, Urbana, IL.*

It is estimated that 30 to 40% of dogs and cats in the United States are overweight or obese. Pet obesity increases the risk of several diseases and disorders, including insulin resistance, diabetes mellitus, hyperlipidemia, cancers, and many others, and results in a shorter life span. Although genetics, a sedentary lifestyle, and neutering contribute to weight gain, the over-consumption of energy-dense foods is a major driver. There are many challenges to preventing pet obesity, including owner beliefs and feeding tendencies, estimation of energy density, and development of appropriate feeding guidelines. Owner education, especially as it pertains to body condition scoring and feeding guidelines, is a critical need. Feeding guidelines are required on all pet foods, but many owners either do not read them carefully and/or do not understand the importance of adjusting intake based on body condition score. Ad libitum feeding and excessive feeding of table scraps and treats contribute to overfeeding. Estimating caloric content of ingredients or pet foods may also be difficult and quite different depending on the methodology used. Numerous equations are used to estimate the caloric density of diets based on proximate analysis, but they are all based on assumptions pertaining to the digestibility and metabolism of nutrients. The use of crude fiber, a highly inaccurate method of fiber estimation, also contributes to inaccuracies in determining digestible carbohydrate content and consequent caloric density estimates. In vitro assays that estimate nutrient digestibility have been developed, but in vivo tests are by far the most accurate method by which metabolizable energy content of diets may be determined. Even when an accurate caloric density has been determined, developing accurate feeding instructions are difficult because a large variation among pet animals exists, including differences in physical activity level, age, life stage, and metabolism. Fortunately, AAFCO regulations will be requiring a calorie statement on all pet foods in the near future. Given the issues listed above, however, it is questionable whether that requirement will aid in obesity prevention or provide false hope to veterinarians and pet food professionals.

Key Words: pet obesity

547 Bioenergetics of pet food. Ellen Kienzle* and Britta Dobenecker, *Chair of Animal Nutrition and Dietetics, Ludwig-Maximilians-Universität München, Oberschleissheim Germany.*

Energy of pet food is evaluated as metabolizable energy (ME). To determine ME heat of combustion in food (gross energy, GE), feces and urine is analyzed. Losses by gases are negligible. GE of the food can be calculated by standard values for heat of combustion of nutrients. Given a typical pet food potential errors in the standard values for heat of combustion of nutrients can add up to a deviation of a maximum of about 8% between GE as analyzed and GE as calculated. In practice there are often deviations of up to 30% between analyzed and calculated GE, mostly due to pitfalls of bomb calorimetry. Five repetitions with an intra-analysis variation coefficient of $< 0.4\%$ are necessary to ensure quality. To predict digestibility a fixed value for the digestibility of each nutrient can be used. This works well in a group of rather homogenous foods. Examples are unmodified Atwater factors for homemade western diet type foods for humans and pets. If digestibility is variable within a group of foods it is either necessary to make subgroups of foods with similar digestibilities or to use equations which adjust digestibility such as the prediction of digestibility by fiber in dry matter. For this crude fiber is the analysis of choice because in pet foods it detects mostly unfermentable fiber, which has a stronger impact on energy digestibility than fermentable fiber. Even so subgrouping the foods may present an advantage. The depressive effect of fiber on digestibility is stronger for carbohydrates than for fat, thus subgrouping according to carbohydrate or fat content may increase accuracy of prediction. Subgrouping of foods could even be done by in vitro tests such as an HCl-pepsin test to identify reducing diets with low digestibility of protein. There is little data on renal energy excretion in pets. So far the prediction of renal losses is done by a factor linked to protein intake, which is lower for cats than for dogs in most equations. Presumably the species difference reflects a difference in renal excretion of high energy nitrogen compounds such as hippuric acid, which is derived from phenolic food compounds. Both the content of such compounds in the diet and the ability to degrade these compounds to hippuric acid may contribute to the difference.

Key Words: pet food, bomb calorimetry, prediction of digestibility

548 Animal and in vitro digestion models for estimates of value of energy and energy-yielding nutrients. R. T. Zijlstra* and L. F. Wang, *University of Alberta, Edmonton, AB, Canada.*

In vitro digestion (IVD) techniques can evaluate digestibility of energy and energy-yielding nutrients in feedstuffs or complete diets for pigs and other monogastric species. These techniques can mimic the conditions of the gastro-intestinal tract and may have advantages compared with in vivo models of digestion. For example, IVD analyses require less sample material and less time, and are cheaper than in vivo digestibility analyses. Therefore, IVD provides the possibility to screen many samples and support the development of feedstuff databases and rapid feed quality evaluation systems. However, one critical step for IVD analyses is rigorous validation of in vitro digestibility data using the target animal model. For pigs, considerable validation efforts have been made. Using purified enzymes, buffers, and controlled pH, a 3-step IVD model, mimicking digestion in the stomach, small intestine, and large intestine, respectively can estimate the apparent total-tract digestibility (ATTD) of energy. The impact of evaluating the ATTD of energy is clear instantly, because it relates strongly to the DE value of feedstuffs or diets. Similarly, kinetics of glucose release during in vitro digestion of starch is an excellent indicator of net portal appearance of glucose in pigs. Kinetics of fiber degradation can be characterized by in vitro fermentation models, but these models not been validated quantitatively in the pig model. Nevertheless, kinetics of both starch digestion and fiber fermentation are related to important aspects of metabolism of nutrients, gut physiology, and health. In summary, IVD techniques can be a valuable tool to describe the ATTD of energy and kinetics of starch digestion and fiber fermentation of feedstuffs in swine.

Key Words: in vitro digestion, energy, pig

549 Nature's pet food: Energy of raw meat-based and whole prey diets. Katherine Kerr*[1] and Cheryl Morris[2], [1]*University of Florida, Gainesville, FL,* [2]*Iowa State University, Ames, IA.*

Raw and cooked meat-based and whole prey diets for pets have seen increased popularity in past decades. This rise has been attributed to owner perceptions of increased control of dietary ingredients and processing along with feeding more biologically appropriate foods that contributes to the human animal bond. Nutritional therapy with these diet types can play an integral role in maintaining pet health and, for some pets, in mitigation of disease, such as allergy, gastroenteric diseases, kidney disease and obesity. Meat-based and whole prey diet formulations can mimic the natural history of pets with positive implications for pet health; that is, distribution of energy among macronutrients, dilution of energy and nutrients with moisture – while providing opportunities for modulations that optimize health (i.e., addition of animal or plant fibers). Felines have evolutionarily lacked the need for rapid adaptation to a variety of diet types, and are metabolically prepared for protein and fat energy, with less emphasis on carbohydrate utilization. Similar to the wild type diet of the cat, meat-based and whole prey diets provide > 90% of metabolizable energy (ME) from protein and fat, with little contribution to ME from digestible carbohydrates. Meat-based and whole prey diets also mimic the high moisture of wild type diets (~20 to 30% DM), diluting energy concentration compared with extruded diets (~90% DM). Isocalorically (DM basis), an owner may need to feed 4 times more whole prey on an as-fed basis to provide the same amount of ME as the extruded diet. In wild type diets, fermentable and non-fermentable animal (hide, hair, etc.) and plant fibers play an important role in energy metabolism and gut health: addition of plant and animal fibers, dilutes ME concentrations, decreases inflammation, and beneficially modulates gut bacterial populations. Meat-based and whole prey diets have been underutilized, undervalued, and under-researched as pet foods or as nutritional therapy options. Research has predominately focused on microbial contamination and public health concerns and health implication research are lacking. The flexibility and ingredient control of meat-based diets paired with proper formulations can provide palatable, highly digestible energy sources and targeted nutrient concentrations for pets.

550 Bioenergetics of pet obesity. Dennis Jewell*, *Hill's Pet Nutrition Inc., Topeka, KS.*

Most pet owners in the United States fulfill their pet's nutritional needs through feeding commercially prepared pet foods. These are supplied with suggested feeding amounts which individual pet-parents adjust to maintain body weight and influence body composition. Significant research efforts have been expended to develop methods for estimating energy concentration of pet foods; however, even the poorest estimates of pet food energy are less variable than the variation of energy need between pets. For example, the estimate for canned cat food has an average difference of 9% and including 2 standard deviations, still had an estimate within 20% of the measured value. The variation of dogs and cats, which are living in the same environment, shows that dogs on average maintain weight consuming 121 kcal/kg$^{3/4}$ daily, while the cat uses 73. There is a greater than 2-fold difference between the dog or cat using the least or most amount of energy. Therefore, although the relationship between dietary energy and the bioenergetics of pet food starts with the energy concentration of pet food it is most significantly concerned with the energy use associated with life. Obese dogs and cats use less energy to maintain weight than do their lean counterparts. However, the amount of energy needed to maintain weight in obese pets is subject to change and may be influenced to equal or even exceed the energy needed by normal pets to maintain weight. It has been shown that when dogs were fed a food with increased amounts of fiber there was spontaneous reduction in ad libitum energy intake and repartitioning of energy away from fat so that the energy deficit was completely balanced by energy mobilization from fat. This is also the normal response to food restriction. However, in both dogs and cats a feeding program with controlled weight loss, followed by weight maintenance, when consuming a nutritionally enhanced food, resulted in a significant change in body composition and a significant change in energy needed to maintain weight. This suggests that the bioenergetics of pet obesity is established by the food being eaten, the individual pet, and the feeding regimen.

Key Words: bioenergetics, pet, obesity