Major concerns in comparative animal nutrition

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Introduction: the need for nutritional information

During the past 150 years, the knowledge base to support livestock producers in the area of animal nutrition has substantially increased thanks to work by government institutions, research centers, privately sponsored institutions, and individuals (Kellams and Church, 1989). Today, dairy and beef cattle producers can formulate specific rations for their cattle based on developmental stage and level of milk production. Likewise, dog and cat owners are assured that commercial diets meet or exceed recommendations established from a long line of research and review. Prescription pet foods are available for physical ailments in dogs and cats ranging from dermatitis and poor dentition to gastrointestinal and renal disorders. Pet owners and livestock producers have the luxury of knowing precise feeding strategies and recommendations for a given species. In contrast, comparative nutritionists working with exotic species in captivity are barely beginning to understand the complex role nutrients play in animal health.

Because the vast knowledge base regarding animal nutrition is primarily focused on production, laboratory, and pet animals, it is no surprise that formulation of diets for zoo animals requires substantial extrapolation and guesswork (Ullrey, 1995). Fortunately, the Committee on Animal Nutrition (CAN) of the National Academies National Research Council (NRC) has responded to the growing need for knowledge in the area of exotic animal nutrition. This need has led to the recent release (2002) of Nutrient Requirements of Nonhuman Primates (Lewis, 2005). With energy requirement studies conducted on only 20 of more than 250 primate species, establishing and defining the specific nutrient requirements at various life stages is more than a daunting task. Although specific nutrient requirements are not established for all primate species, similarities in various aspects of physiology allow some extrapolation for formulation of primate diets that typically meet the animal’s nutritional needs for maintenance, reproduction, and growth (Lewis, 2005). Unfortunately, nonhuman primates constitute a small portion of the more than 3,000 species of animals housed at American Zoo and Aquarium Association (AZA) accredited institutions.

The role of nutritional sciences in zoological institutions has traditionally been defined and filled by veterinarians, curatorial, and keeper staff. Only recently, zoological institutions have recognized the necessity of advanced nutrition-related sciences to promote the well being of exotic animals. It was not until 1994 that a specific Nutrition
Advisory Group (NAG) to the AZA was developed to aid in the transfer of nutritional information and data from one institution to another. Although exotic animal nutrition is in its infancy, AZA-accredited institutions are now beginning to employ nutritionists and nutritionist interns. At the end of 2005, seven AZA-accredited institutions in the United States had full-time staff nutritionists holding PhDs in comparative animal nutrition or science. The need for trained comparative nutritionists is now recognized as a necessity.

With growing interest in comparative nutrition, an understanding of related concerns and issues is needed to guide the development of comparative nutrition programs. While some of the concerns are similar to those of other nutrition disciplines, others are unique and deserve special attention. Stemming from my experience as a comparative animal nutritionist at Omaha’s Doorly Zoo, a discussion of a few unique and exceptionally important concerns in comparative nutrition for exotic animals follows.

**Comparative nutrition concerns**

**ZOO KEEPER EDUCATION**

It might be surprising that the first area I choose to list as a concern in comparative nutrition is keeper education. Zoo keepers and animal care staff feel a tremendous amount of responsibility in the daily care of exotic animals, and represent a wide range of educational backgrounds. One of the first things I noticed when I began my work at Omaha’s Henry Doorly Zoo, was the tremendous dedication of the keeper staff to their animals. It would have been extremely difficult to conduct my job had I entered that institution with my own agenda for formulating and maintaining the collection diets. As previously stated, nutrition in zoological institutions has traditionally been handled by curators, zoo keepers, and veterinarians. It would be naïve and counter-productive for a new nutritionist to approach a zoo keeper with a new diet change and assume it will be accepted with no reluctance. A significant portion of my daily activities includes talking with and educating keepers on potential new diet changes. My approach to working with keepers begins with an understanding of the background and history of the current diet, formulation of a new diet, and discussion of the new diet with the keepers. A change is never made without the keeper’s complete understanding of the reasoning behind it. In addition to understanding all reasoning behind diet changes, it is necessary to understand established feeding behaviors and beliefs that keepers have about the animals in their care. Much keeper reluctance to change stems from a history of past attempts that were poorly planned or executed. Common statements of “they won’t eat that” or “we tried that already” can be worked through if the nutritionist attempts to understand the history of previous diet change attempts. In my experience, approaching a diet change with keepers as a possibility for education has been a welcomed training session for both myself and the keepers involved.

In addition to staff training at the institution, there is tremendous need to incorporate comparative nutrition education in university curriculums. Comparative nutrition should be available to students studying animal and biological sciences. Universities with existing animal nutrition programs should take a proactive approach to developing comparative nutrition experiences, coursework, and research opportunities for students, including the addition of comparative nutrition lectures and exercises to existing courses and the establishment of internships and partnerships with AZA-accredited institutions.
CURRENT NRC PUBLICATIONS AND DATA EXTRAPOLATION

Fortunately, the similarities among many species allow for extrapolation of knowledge from published nutrient requirements for domestic species such as cattle and swine. Nutrient requirements of domestic cattle are useful for diet formulations for many ruminant species including deer, giraffe, antelope, llamas, camels, and other wild ruminants. Nutrient requirements of horses are valuable in formulating diets for tapirs, hippopotamus, zebra, rhinoceros, and other non-ruminant herbivores. Nevertheless, although such resources are extremely valuable in aiding the diet formulation process it should be remembered that formulations for domestic species are typically designed with the goals of maximum weight gain and productivity, goals that are not necessarily consistent with the dietary goals for exotic animals housed in zoos (Ullrey, 1995).

In addition, as our understanding of the unique metabolism and idiosyncrasies of exotic species continues to develop, it becomes increasingly evident that caution should be used when utilizing domestic animal NRC recommendations. For example, giraffe species in captivity are prone to several disorders potentially linked to nutrition, including peracute mortality, chronic wasting syndrome, and cold stress, which are well documented and may be related to energy malnutrition (Kearney et al., 2005; Ball, 2005).

In addition to potential metabolic issues, some species should be considered individually due to anatomic and/or physiological idiosyncrasies. For example, okapi tend to have comparatively small rumens and low rumen musculature, consistent with other ruminant species classified as browsers. However, they also tend to have relatively small salivary glands and livers, deviating from traditional ruminant classification (Clauss et al., 2002a; Clauss et al., 2002b). These are just two examples of unique ruminant biology that must be considered when comparing exotic diet formulations with current beef cattle or dairy NRC publications.

DIETARY FIBER ANALYSES

While we determine the concentration of total dietary fiber (TDF), soluble dietary fiber (SDF), and insoluble dietary fiber (IDF) in human foods, much of the animal industry, including the exotic sector, is still struggling with the concept of crude fiber (CF). Although there is tremendous value in the proximate analysis system of measurement, it is limited by the underestimation of dietary fiber due to losses during analyses. Analysis of acid detergent fiber (ADF) and neutral detergent fiber (NDF) underestimate potentially beneficial indigestible carbohydrates (Kearney and Dierenfeld, 2005). To complicate matters further, the majority of diets fed to animals housed in zoos may contain a substantial amount (up to 75%, in some cases) of human-grade produce. Because many zoos feed high levels of produce along with commercial complete diets, it is often impossible to accurately estimate levels of dietary fiber constituents using the current crude fiber system of analysis.

Many keepers and zoo staff also mistakenly believe that inclusion of produce (fruit and vegetables) in animal diets substantially increases the amount of fiber animals are receiving. Due to the water concentration in produce, it provides little dietary fiber, and many species are being severely underfed fiber. While it is obvious that ruminant species require substantial amounts of dietary fiber to promote an efficient bacterial population in the rumen, this concept is not so clear with other species. Many species are often
overlooked regarding dietary fiber due to a lack of understanding and knowledge of anatomy and physiology. One such animal is the rock hyrax. In appearance, the rock hyrax resembles a rabbit-sized rodent; however, phylogenetically its closest relative is the elephant. The rock hyrax indeed is an ungulate with an extremely complex gastrointestinal tract, and is capable of fermenting large quantities of fiber in the forestomach, therefore requiring substantial amounts of dietary fiber (Slifkin, 2004). If this animal’s fiber needs are not understood and a rodent diet is fed along with excessive amounts of produce, the animal’s health will be jeopardized.

Similarly, many other species require substantial amounts of dietary fiber. Some unique species with complex gastrointestinal tracts include the sloth and some monkeys such as colobine and langur species (Edwards and Ullrey, 1999; Clauss, 2004). Because these animals consume high quantities of leaves in the wild, have a substantial capacity to ferment fiber, and a complex gastrointestinal tract, it is essential that advances in fiber analysis be made such that appropriate diets can be formulated to better maintain these species in captivity.

Many animal species are subject to the same diseases that humans suffer. Among these, diabetes and glucose intolerance have been documented in several exotic species including both primates and non-primate species (Sanchez et al., 2005; Ammon, 2001). A vast amount of data exist regarding the inclusion of soluble dietary fiber sources (e.g., guar gum, psyllium, oat bran) in human diets to promote beneficial physiologic responses such as attenuation of blood glucose and cholesterol concentrations (Institute of Medicine, 2001). It makes sense to study these same dietary constituents in exotic species with regard to their effects on physiologic responses. However, without a shift in analytical measurement away from crude fiber, progress in this type of research will remain elusive.

LIMITED DATA

Beef cattle nutritionists, equine nutritionists, and human nutritionists can rely on a vast array of scientific data and knowledge to support dietary decisions and formulations. Comparative nutritionists charged with formulating diets for thousands of animals housed in accredited zoos have little data to review. Ullrey (1996) stated that a comparative nutritionist should follow some useful principles in dealing with diet formulation of exotic animals: 1) learn as much as possible about a given species, 2) explore morphology and physiology of the gastrointestinal tract, 3) use specific nutrient requirement information generated with the species, 4) apply all information gathered, and (5) “pray or cross your fingers, whichever is politically correct in your culture”. While there is humor in this statement, there also is unfortunately a great deal of truth. Comparative nutritionists often have little information available upon which to base necessary decisions.

Conclusion

Comparative nutrition is in its infancy compared with many other animal nutritional disciplines. Still, the future holds much promise for researchers studying the role of nutrition in promoting the health and well being of animals in captivity and in conservation programs, and there is tremendous opportunity for academic and industry
involvement. Studies are needed regarding every aspect of comparative nutrition ranging from field observation studies and simple intake and nutrient digestibility work, to complex nutrient-interaction experimentation. Without doubt, there are limitations to conducting nutritional experiments in zoological institutions that are typically not encountered in traditional nutritional experimentation. Even though many of these limitations will need to be addressed before designing appropriate experiments, academic and feed industry professionals should not overlook the benefit their involvement could have in the future of comparative animal nutrition.

References