IMPLICATIONS OF CARBOHYDRATE FEEDING FOR CAPTIVE HERBIVORE NUTRITION AND WELFARE

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Abstract

Carbohydrates comprise the major portion of most herbivore diets. Research is limited regarding the effect of carbohydrates as provided in commercial feeds, forage, and browse on the nutrition and health of captive herbivores. However, the diversity of carbohydrates, their digestion characteristics, nutrients they supply, impacts of their physical form, and potential impact on animal health strongly recommend that they be evaluated more closely. Feed carbohydrates can be analyzed and partitioned into at least five nutritionally relevant categories:[7] 1) organic acids from the citric acid cycle and secondary plant compounds may be used by the animal, but offer less energy to rumen microbes than do sugars; 2) sugars (mono- and oligosaccharides) and 3) starch may be digested in the small intestine by some species and offer very fermentable energy sources to rumen microbes; and 4) soluble fiber is comprised of nonstarch polysaccharides (NSP) excluding 5) neutral detergent fiber (NDF). Comprised of pectic substances, gums, and similar NSP, they can be an excellent substrate for rumen microbes, may ferment rapidly, and cannot be digested directly by the animal. Neutral detergent fiber (hemicelluloses + cellulose) serves the dual purpose of supplying fermentable carbohydrate as well as physical form which can enhance rumination, rumen function, and, potentially, rumen outflow. Analysis of a limited number of samples suggests that native browse contains little starch, and relatively greater proportions of sugars and soluble fiber.[3] The carbohydrates differ in their yields of microbial protein,[6] types of fermentation acids (e.g., acetate, propionate, butyrate), and thereby their potential effect on ruminal pH,[11] all of which can affect the amount and type of proteinaceous, glucogenic, and lipogenic nutrients available to the animal. The 2001 National Research Council recommendations for dairy cattle[10] recognized that increased consumption of starch could lead to decreased ruminal fiber digestion and possibly to ruminal acidosis, though similar problems are less commonly reported for sugars. Ruminal dysfunction (acidosis and bloat) has been reported in captive browser species (E. S. Dierenfeld, personal communication)[4].

Physical form of NDF is of particular concern for ruminants. While grazers readily consume and thrive on the long fiber of grass, the folivorous,[2] frugivorous, and woody plant-eating browsers consume particles of a more polygonal nature. The long particles in grasses enhance the formation of a floating "mat" and stratification in the rumen. Polygonal particles are hypothesized to cause a more amorphous structure of digesta in the rumen.[2] They have been

shown to increase rate of liquid and solid passage from the rumen in cattle.[1,9] The change in rate of passage as well as decreased ruminal mat formation may alter digesta mixing and movement in the rumen. This may partly explain reports of decreased papillation of the dorsal surface of the rumen in captive giraffe (*Giraffa camelopardalis*).[8] Low intake was noted for browsers fed alfalfa or grass hay, but intake was noticeably decreased with the grass hay.[5] A better understanding must be developed regarding the roles of carbohydrate complement and physical form of the diet if we are to further improve captive herbivore health and nutrition. Combining data from domestic livestock with careful observation of the captive species should offer an excellent start.

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