

SERUM FATTY ACID CONCENTRATIONS IN FREE-RANGING AND CAPTIVE GIRAFFE (*GIRAFFA CAMELOPARDALIS*)

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Abstract

Serum concentrations of fatty acids in captive giraffes were compared to values obtained from free-ranging giraffes in an effort to identify potential nutritional differences in the captive population. Captive giraffes have a specific set of maladies, including peracute mortality, energy malnutrition, pancreatic disease, urolithiasis, hoof disease, and severe intestinal parasitism that may be nutritionally related. Serum samples from 20 captive giraffes at 10 zoological institutions in the United States were compared to previously collected samples from 24 free-ranging giraffes in South Africa. Differences in fatty acid concentrations between captive and free-ranging giraffes, males and females, and adults and sub-adults were analyzed using a 2 x 2 x 2 factorial and Fisher's LSD for mean separation. Of the 22 quantified fatty acids, 13 (59%) were significantly different between captive and free-ranging giraffes. Only linoleic, arachidonic, and docosapentaenoic acids were found in higher concentrations in zoo giraffe; all other fatty acid differences were higher in free-ranging giraffes. All significantly different omega-3 fatty acids were 2 – 3x higher in free-ranging giraffes than captive giraffes. Docosahexaenoic acid was the only fatty acid found to be significantly higher in adults than that measured in sub-adult giraffes. Further investigation in captive giraffe diets is needed to address the differences seen in this study and the potentially related health problems.

Introduction

Captive giraffes have a specific set of maladies that may be related to basic nutritional inadequacies. Peracute mortality,⁸⁻¹⁰ chronic wasting,⁶ energy malnutrition,¹ mortality related to cold stress,^{2,16} pancreatic disease,¹² urolithiasis,²⁰⁻²¹ neonatal health concerns,¹³ and intestinal parasitism⁵ may have their source from or be exacerbated by traditional zoo diets. Hoof disease and laminitis are also suspected to have a strong association with nutritional imbalances as seen in domestic ruminants.^{11,14}

Dietary requirements for optimal health in exotic animals are not known. While circulating nutrient concentrations from captive, exotic animals are helpful, free-ranging animal nutrient concentrations may be a better standard for assessing captive animal health and dietary appropriateness. Serum concentrations of circulating fatty acids from free-ranging giraffes in South Africa have been reported.¹⁸ Those results were used as the basis for assessing the nutritional status of the captive giraffe samples analyzed in this study.

Methods

Captive giraffe serum samples were requested from zoos throughout the United States. Twenty samples, each from a different giraffe, from a total of ten institutions were received for analysis. Thirteen of these samples were collected specifically for this study from animals trained for blood collection. Seven giraffe samples were previously banked samples. Some of these banked samples were collected from animals that were anesthetized. Of the twenty samples analyzed, 13 were from females and seven were from males. The giraffe ages ranged from 2 – 28 years of age. According to questionnaires received with the submitted samples, most animals were in good physical health, with one animal having a fractured pedal bone, another being classified as “slightly thin”, and two animals being treated for joint problems.

Eighteen of the captive giraffes received diets based on acid detergent fiber (ADF) 16 herbivore pellets and alfalfa hay. Two giraffes received Mazuri Browser Maintenance (Purina Mills, LLC, Saint Louis, Missouri 63141, USA), one of which also received Mazuri Moose pellets (Purina Mills, LLC). All giraffes received some type of produce, including apples, carrots, yams, and leafy green vegetables. The captive giraffe also received browse of varying quantities and types depending on availability and location of the zoological facility.

The free-ranging giraffe data are from previously published information on seven adult and 17 sub-adult animals that were assessed to be in good physical body condition from Double Drift and Kariega Private Game Reserves.¹⁸ To minimize laboratory differences, the captive giraffe serum samples were sent to the same South African laboratory used for fatty acid analysis of the free-ranging giraffe serum. Fatty acids were quantified using gas liquid chromatography (Varian Model 3300; Varian, Inc., Palo Alto, California 94304, USA) at Medical Research Council (7500 Cape Town, South Africa).⁷

The ANOVA was a 2 x 2 x 2 factorial arrangement of treatments in which there were 2 types (captive and free-ranging), 2 genders (male and female), and 2 age classifications (sub-adult and adult). Mean differences were determined using Fisher’s Least Significant Difference with $\alpha = 0.05$.¹⁷

Results and Discussion

Sources of fatty acids to the ruminant are either microbial or diet-derived. Microbial fatty acids encompass a wide range of length and saturation, but saturated fatty acids predominate in the bacteria and protozoa of Holstein cows fed corn silage, timothy hay, wheat straw and an ADF 16-like concentrate.¹⁵ Diet derived fatty acids must survive the rumen and the associated microbial biohydrogenation in order to be available intact for absorption in the small intestine. Therefore, the presence of significant quantities of blood polyunsaturated fatty acids would suggest that some diet-derived lipids escape the rumen and are available for absorption in the small intestine.

In the current study, free ranging giraffe had higher concentrations of total saturated fatty acids and in particular had elevated levels of palmitic, stearic, arachidic, and behenic acids. These

saturated fatty acids are most likely of microbial origin, and dietary influences have not proven to be extremely important in regulation of these levels in red deer,¹⁹ although sheep fed dried grass had higher levels of stearic acid as compared to sheep on hay diets.³

Free-ranging giraffe also had higher concentrations of total omega-3 fatty acids (7.54 ± 0.26 vs $3.44 \pm 0.35\%$; $p < 0.001$), due to elevations in alpha linolenic, eicosatrienoic, eicosapentaenoic, and docosapentaenoic acids. In contrast, captive giraffe had higher concentrations of total omega-6 fatty acids (36.37 ± 1.36 vs $23.33 \pm 0.98\%$; $p < 0.001$) and total polyunsaturated fatty acids (PUFAs) (39.80 ± 1.51 vs $30.85 \pm 1.09\%$; $p < 0.001$) as a result of elevated linoleic and arachidonic acid concentrations. As a result, free-ranging giraffe had higher ratio of omega-3 to omega-6 fatty acids in their serum as compared to captive giraffe (0.39 ± 0.05 vs $0.10 \pm 0.07\%$; $p = 0.01$). The basis for the elevated omega-3 concentration of free-ranging giraffe is likely a consequence of their wild-type diet. Previous research has shown that wild ruminants have higher PUFA levels, and particularly higher eicosapentaenoic acid levels than do pasture-fed or grain-fed ruminants.⁴ Intact pasture and vegetative materials often have higher PUFA content than diet components that have been subjected to the rigors of processing.²² This higher PUFA content may be a result of true increases in the concentration of PUFA of wild-type versus domesticated plants, but also may be a result of natural protection of plant PUFA by seed coats and intact plant organelles.²²

Though all other omega-3 fatty acids are higher in free-ranging giraffe, docosahexaenoic acid concentrations were not different between captive and free-ranging animals. The reason for this and other differences seen in fatty acid concentrations between captive and free-ranging giraffes needs further investigation.

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