




















Zoo Animal Nutrition IV

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Conservation collaborations: nutrition outside the zoo!

*E. S. Dierenfeld*¹

Introduction

Although field-based diet and feeding observations form the basis of managed feeding programs in zoos, and nutrition is recognized as an essential scientific discipline within the captive environment (Dierenfeld 1997), the increasing need to reach outside zoo boundaries and incorporate nutritional components within in situ conservation projects (Reid et al. 2008) adds new dimension(s) to the nutritionist's challenge. In addition to functioning in an advisory capacity – as, for example in evaluating the adequacy of dietary nutrient balance, and/or identification of suitable substitute ingredients in a given situation – other roles of the nutrition specialist as a co-investigator in collaborative research endeavors can include diverse activities in analytical support and nutritional resource identification to assist in habitat assessments and enhance development of management plans. Examples of some of these interactions between field-based biologists and zoo- or university-based nutritionists highlight the breadth of topics that can be addressed, as well as some of the applied conservation outcomes to consider.

Challenges in Field-Based Vitamin E Assessments

With many nutrients, including vitamin E, assessment of “normal” physiologic values in biological tissues can be made through comparison with livestock or domestic species for which data from controlled studies are available (Dierenfeld and Traber 1992; Crissey et al. 1999). For some species, however, livestock and domestics remain poor models, and comparison with free-ranging animals provides more appropriate evaluation. Thus various studies of vitamin E status.

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Do probiotics have a role to play in zoo mammal nutrition?

M. Campbell-Ward^{1*,2}, J.-A. Murray²

Abstract

The term 'probiotics' refers to viable microorganisms that, when ingested, confer a health benefit on the host by supplementing the established population of organisms present within the gastrointestinal tract. Disease associated with gastrointestinal dysbiosis is a common cause of ill-health amongst captive wildlife in zoological collections and the use of probiotics to counteract any changes that occur subsequent to diet alterations, antibiotic therapy, stress and/or during the neonatal/weaning period has been largely unevaluated until recently. The mechanisms of action of probiotics and their proposed efficacy are currently debated by researchers in both human and domestic animal science and although the situation is improving, there have been very few controlled, independent studies to rigorously evaluate the variety of commercially available products. In humans certain types of diarrhoea have been shown to respond to probiotic supplementation, and in livestock a number of production parameters have been seen to be enhanced by particular bacterial strains. The effect of probiotics in the majority of zoo mammals is largely unknown and whilst adverse effects appear to be rare, extrapolation from domestic animal science in relation to strain, dose, frequency of supplementation and indication should be conducted with caution. A study in juvenile cheetahs suggests that administration of probiotics derived from healthy adult cheetah faeces may reduce the risk of bacterial diarrhoea; conversely, limited studies evaluating various probiotic strains in some other species have failed to show any benefit. Before the potential role of probiotics in the maintenance of zoo mammal health can be fully evaluated, our understanding of species-specific differences in intestinal microbial ecology in health and disease needs to improve. The recent development of a number of molecular tools may greatly accelerate the advancement of knowledge in this field and preliminary work evaluating the intestinal flora of giant pandas, a gorilla and a jaguar demonstrates great promise.

Keywords

intestinal, microflora, Lactobacillus

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Effectiveness of the probiotic, Biomin[®] PoultryStar, for improving health in canaries

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Abstract

Probiotics are added to animal diet, often to improve health. In this study the synbiotic, Biomin PoultryStar (BPS) was given 6 months to a group of 10 canaries (*Serinus canarius*). The health status of the birds (at beginning and end of experiment) is compared with the health status of 10 canaries not receiving the product. Biomin PoultryStar consists of 5 isolates belonging to the genera *Enterococcus* *Enterococcus faecium*, *Pediococcus* *Pediococcus acidilactici*, *Lactobacillus* *Lactobacillus salivarius* and *Lactobacillus reuteri*, *Bifidobacterium* *Bifidobacterium animalis* and a prebiotic (fructo-oligosaccharides (FOS), extracted from chicory (*Cichorium intybus*)). All canaries were housed per two in separate cages and kept in a building within normal temperature range. All birds received the same diet, i.e. Kenner Canary Seed with Avian Ultimate Balance Egg Food Maintenance twice a week. BPS was supplied daily through the drinking water (5g/1000 ml water). Contamination was prevented by using different cleaning tools for every cage. Faecal samples (6 times during the feeding period) of the birds were taken and checked on total aerobic counts, *Enterobacteriaceae* numbers, *Lactobacillus* numbers, *Salmonella* and coccids to measure the influence of the synbiotic on the gut flora. No significant differences between the groups were found in the measurements of excreta or in health scores.

Keywords

probiotic, feed, birds

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A simple and effective egg-based hand-rearing diet for flamingos

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Abstract

*An egg-based diet, composed of whole, peeled hard-boiled chicken eggs, with added hard-boiled yolks, water, and supplemental minerals, vitamins, and fat, was developed to duplicate the nutrient composition of crop milks fed to flamingo chicks. Dietary intake and growth were recorded in 44 Caribbean (*Phoenicopterus ruber*) and 21 Chilean (*P. chilensis*) flamingo chicks housed at four US zoological facilities. Feeding protocols, amounts fed, and significant developmental milestones are detailed. Diets made from fresh eggs, as well as dried egg product powders, appeared equally palatable and resulted in similar chick responses. Transition to adult diets was uneventful; this diet represents a practical, nutritionally balanced, and successful formula for hand-rearing flamingos.*

Keywords

avian, crop milk, Ciconiiformes, growth

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Trypsin inhibitor content of 'parrot cooking diets' and other diet components

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Abstract

Many animals rely heavily on their ability to extract nutrients from plant material but plants contain a wide array of secondary metabolites, such as trypsin inhibitors (TIs), which are often toxic. TIs greatly reduce amino acid digestibility by forming an irreversible complex with trypsin in the gut. The aim of this work was to examine the trypsin inhibitor activities (TIAs) of loose seeds and 'parrot cooked diets' (legume mixes for zoo animals). Samples were de-husked (where appropriate) and analysed for TIA levels by a microtitre technique based on a traditional TIA analysis technique. TIA was measured in mg of pure trypsin inhibited per g of dry sample. The TIA levels of the loose seed samples were all below the threshold considered acceptable to poultry at inclusion levels of up to 25% of total diet (4 mg/g). Prior to cooking, TIA levels of the 4 cooking diet samples were 6.2 mg/g, 1.1 mg/g, 0.5 mg/g and 12.3 mg/g. The TIA's of the first 3 samples were 0.2 mg/g, 0.1 mg/g and 0.3 mg/g after preparation as per guidelines. However, the 4th sample offered 2 possible preparation methods: heating or soaking. Whilst heating satisfactorily reduced the TIA of the 4th diet to 0.3 mg/g, soaking barely altered the TIA. In contrast to expectations, screening of several varieties of sunflower seeds has shown they contain very low levels of TIs. Several cooking diets had TIA levels high enough to be detrimental if not cooked correctly according to the guidelines, and one diet suggested a preparation method where TIA was unchanged. Cooking guidelines for these types of diet must ensure there is no risk of exposing birds to dangerously high (> 4 mg TI/g sample) levels of TI. If legume seeds are used in parrot diets, heat is always recommended to denature TIs.

Keywords

Trypsin Inhibitor, Parrot, Raw materials, Diets

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Feeding fish in zoos and aquaria: challenges and sustainable alternatives

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Abstract

The use of fish as diet items for captive piscivorous animals presents concerns for nutrition, quality and availability. In particular, frozen fish must be supplemented with thiamin and vitamin E to account for deficiencies in frozen fish, and quality of frozen fish declines immediately post-harvest. Multiple freeze/thaw cycles will increase the risk of pathogen growth and reduce product quality. Finally, sourcing sustainably harvested fish can be problematic, and wild fisheries are often over fished. Therefore, availability of a diverse fish population may be limited in the future. A sustainable alternative to the use of frozen fish has been developed, using Menhaden fishmeal. This fishmeal is harvested from sustainable populations, using harvesting techniques that prevent by-catch. In combination with this fishmeal, ingredients are added to a dry meal or a frozen gel diet to provide an alternative to frozen fish. Nutrient analysis demonstrates similarity to wild caught fish, and protein and lipid content may be varied to meet needs. Undetectable levels of organochlorines, polychlorinated biphenyls (PCBs) and mercury provide additional quality assurance. This product has been demonstrated to be effective and palatable in penguins, seals, sea lions, polar bears, dolphins, beluga whales and many other species. As sustainable fishery management becomes more critical for ocean health, alternatives to feeding wild caught fish need to be carefully considered.

Keywords

Fish, sustainability, toxin, nutrients, environmental contaminants

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Speculations on pathogenesis of metabolic bone disease in captive polar bears (*Ursus maritimus*) with links to taurine status

G. E. Hedberg^{1*}, E. S. Dierenfeld², R. Chesney³, Q. R. Rogers⁴

Abstract

A calcium and/or vitamin D₃ deficiency can lead to metabolic bone disease. There has been evidence in human pediatric medicine that the amino acid taurine (TAU) might enhance the absorption of vitamin D. Metabolic bone disease in captive polar bears has been historically problematic, and we speculate may be linked to TAU status. Whole blood and plasma TAU content was measured in wild caught (est. 4–5 mo of age; n = 2) and captive (1.3–35 yr; n = 10 individuals from 4 North American zoos) polar bears to determine if dietary differences influenced the concentrations of TAU available for its biologic activities. Plasma TAU (n = 9) in captive bears was significantly lower (99 ± 16 nmol/ml) than measured from the free-ranging bear cubs (237 ± 10 nmol/ml); (t-test; $p < 0.02$). Whole blood TAU concentrations also differed significantly ($p < 0.05$), (253 ± 37 nmol/ml (n = 13) in captive vs. 453 ± 8 nmol/ml (n = 2) for free-ranging bears, respectively. No significant differences in plasma or whole blood TAU concentrations were found with regard to sex or age of the captive animals. TAU concentrations in the wild-caught cubs were monitored over 4 yr in a captive environment, and decreased to levels similar to those reported for other captive polar bears (102 ± 18 and 258 ± 32 nmol/ml for plasma (n = 5) and whole blood (n = 9, respectively). These preliminary results indicate that circulating plasma and whole blood TAU concentrations from wild caught polar bear cubs are higher than considered normal plasma TAU values in domestic carnivores (cats 80–120 nmol/ml, dogs 60–120 nmol/ml), humans (40–100 nmol/ml), or rats (50–95 nmol/ml). The values likely reflect the impact of maritime diets (known to be high in TAU) on free-ranging polar bears, thus likely higher TAU concentrations transferred through maternal milk, that may be altered on a captive diet. A current comprehensive nutritional assessment of free-ranging polar bear milk would identify specific nutrient values. This information should improve hand-rearing diets and perhaps minimize MBD in captive polar bears.

Keywords

amino acid, Ursidae, nutrition, protein, taurine

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Plants are not all the same nutrition-wise

R. H. Marrs ¹

Abstract

This paper provides a short, selective, idiosyncratic review of animal nutrition from the perspective of a plant scientist. It looks at some of the factors that control nutritive quality in both plants and vegetation. As grazing animals and plants have co-evolved, it is reasonable to suggest that plant nutrition of natural vegetation may give a clue as to best nutrition practice for captive-animals. We must also remember that the “the bit that is bit can bite back”, and the role of plant poisoning is briefly mentioned.

Keywords

plant nutrition, plant poisons, co-evolution, soils

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Herbaceous forages as components in diets of herbivorous reptiles

J. Hummel^{1*}, D. Bickel², T. Ziegler³, A. Fidgett⁴

Abstract

*Herbs and salads are regularly used feeds for herbivorous reptiles. However, relatively little information is available on the nutritional qualities of different types. In a small survey, nutrient composition and in vitro fermentative behaviour was analysed for dandelion (*Taraxacum officinale*), clover (*Trifolium repens*), ribwort (*Plantago lanceolata*, *Plantago minor*), dock leaves (*Rumex obtusifolius*), sow thistle (*Sonchus oleraceus*), mulberry (*Morus alba*) and endive (*Cichorium endivia*) from two institutions (and seasons). While herbs had nutrient contents in the range of 20–42% neutral detergent fibre (NDF), 2.7–20% acid detergent lignin (ADL) and of 12.5–38% crude protein (CP), endive had a NDF content of 18 %, ADL of 1.1 and CP of 29% (all in dry matter). In accordance with the low ADL content, optical evaluation of degradation under in vitro conditions revealed a faster complete degradation of the physical structure of endive compared to dandelion and especially mulberry. The Ca:P ratio of herbs is typically above 2.5, except for dock leaves with a considerably lower ratio of 1.5–1.8, while ratio in endive and salads like lettuce are close to 1.0. If feeding of larger amounts of salads like endive is the only option to provide forage to herbivorous reptiles in the winter season, it may pay to consider measures to increase the amount of other fibre sources in the diets, e. g. by using herbs conserved by drying.*

Keywords

Herbs, salad, nutrient composition, in vitro fermentation

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Effects of two levels of energy allowances and of hibernation on growth in hatchling *Testudo hermanni boettgeri* (Mojsisovics, 1889)

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L. Istasse¹, C. Remy^{3,4}

Abstract

Captive breeding of *Testudo hermanni* is often associated with rapid growth and carapace deformation. The objective was to determine the minimum level of energy allowing growth and to test the effects of different levels of energy allowances and of hibernation on growth during the first year of life. Forty hatchling *Testudo hermanni boettgeri* were divided into 5 groups of 8 animals of similar body weight (BW) (mean \pm SD, 12.3 \pm 1.3 g). The groups differed in terms of their hibernation status: either hibernating (H+, groups A, B, E) or not (H-, groups C, D) and in terms of the energy allowances: either low Energy I (E-I, groups B, D) or high Energy (E-II, groups A, C); group E was fed *ad libitum*. The starting point for determining energy allowances was the equation: Standard Metabolic Rate (SMR; kcal/day) = 32 (BW^{0.75}), BW in kg (Donoghue and Langenberg 1996). Two levels of energy allowance – 0.15 and 0.30 SMR – were offered in groups A to D; food was given in the form of fresh plants. Repeated measures of BW were analyzed using a mixed linear model. A SMR of 0.15 allowed weight gain. During the first 5 months of life, the 5 groups grew at the same rate while receiving different energy allowances, corresponding to 2.8, 5.6 and > 5.6 % of BW as fresh food. After 5 months, the energy allowance and the hibernation status had an effect on weight gain along with BW at birth and time. Bone density was higher in hibernating tortoises, in comparison with non hibernating ones. Energy requirements for growth appear very low. Hibernation and energy allowances strongly influence growth rate in hatchling *Testudo*, but only after 5 months of life.

Keywords

Testudo, growth, energy allowance, hibernation

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Fruits as foods – common misconceptions about frugivory

Chr. Schwitzer^{1*}, *S. Y. Polowinsky*², *C. Solman*¹

Abstract

*Primate species known or thought to be mainly or partly frugivorous in the wild are usually provided with a fruit-based diet in captivity. However, cultivated fruits as available on European markets are grown for human consumption and have been selectively bred for high sugar and low fibre content. They may thus not be representative of wild fruits. In this paper we compared the nutritional characteristics of fruits consumed by primates in the wild to those of such fruits that are commonly used in diets for captive primates in European zoos. We compiled data on nutrient and energy content of wild fruits from different primate habitats in the Neotropics, Africa, Asia, and Madagascar from the literature. Additionally, we collected fruit samples from 68 plant species that were utilized as food resources by blue-eyed black lemurs (*Eulemur flavifrons*) in northwest Madagascar. Samples were subjected to Weender analysis and detergent fibre analysis. Nutrient and energy values of fruits fed to captive primates were taken from Zootrition®. Wild fruits had higher contents of neutral and acid detergent fibre as well as acid detergent lignin than fruits fed in zoos, and were also higher in protein, but lower in non-fibre carbohydrates and metabolizable energy content. Wild and zoo-fed fruits moreover differed in sugar composition, with the ratio of monosaccharides (glucose, fructose) to disaccharides (sucrose) being lower in cultivated fruits. Overall, fruits consumed by wild primates are more comparable in their nutrient composition to vegetables used in zoo diets. We therefore recommend not to simply translate a frugivorous nutritional strategy of a species in the wild to a captive diet for that species that mainly consists of fleshy fruits, but to look at nutrient composition and try to mimic this as closely as possible in order to avoid diet-related problems such as obesity.*

Keywords

Eulemur flavifrons, obesity, frugivory

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Nutritional ecology of the blue-eyed black lemur (*Eulemur flavifrons*): Integrating *in situ* and *ex situ* research to assist the conservation of a critically endangered species

S. Polowinsky¹, Chr. Schwitzer^{2*}

Abstract

The nutritional ecology of blue-eyed black lemurs in the wild has not been studied so far; usually *Eulemur flavifrons* is classified as a generalist frugivore. In zoos, lemurs are highly susceptible to obesity, which is reported to negatively affect their reproductive output. An obese captive population puts future conservation and reintroduction efforts at risk. This study investigates aspects of the feeding ecology of blue-eyed black lemurs, using data obtained from individuals kept at different European zoos as well as from wild *Eulemur flavifrons*. Comparing the mean nutrient composition of food plants available to free-ranging blue-eyed black lemurs to the diet offered in captivity, significant differences were found with respect to NDF, ADF, ADL and crude protein content, whereas ash and crude lipid content only varied slightly. The non-fibre carbohydrate (NFC) and energy contents in the zoo diet were almost twice as high as in the food items available to free-ranging blue-eyed black lemurs. The high NFC, crude protein and metabolizable energy and low NDF, ADF and ADL content of the zoo diet as compared to the wild food items, paired with a relatively high apparent digestibility, clearly seem to promote obesity in captive *Eulemur flavifrons*. We suggest rethinking the conception of frugivory and systematically reassessing the zoo diet for *Eulemur flavifrons*, increasing fibre content and decreasing energy density.

Keywords

Nutritional ecology, obesity, *Eulemur flavifrons*, conservation

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Energy and nutrient intake and digestibility in captive mongoose lemurs (*Eulemur mongoz*)

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S. Polowinski⁴, Chr. Schwitzer^{5*}

Abstract

For many lemur species it is not known to what extent they utilise the energy and nutrients in their diets, which makes it difficult to predict how much food they need to consume to meet their requirements. Mongoose lemurs in zoos are reported to be particularly susceptible to obesity. In this study we examined the energy and nutrient intake and digestibility in three mongoose lemurs at Bristol Zoo Gardens. To establish activity budgets, behavioural observations were made for each individual over a 24-hr period using focal sampling and continuous recording. During a five-day digestibility trial, food and leftovers were weighed daily and faeces collected. As total collection of faeces could not be ensured, we used TiO₂ as an external marker. Food and faeces samples were freeze-dried and analysed for dry matter (DM), crude protein (CP), crude ash (CA), crude fibre (CF) and ether extract (EE) as well as for neutral detergent fibre (NDF) and acid detergent fibre (ADF). Nitrogen-free extracts (NFE) were calculated as 100-CP-CA-CF-EE. Body weights of the three individuals were taken prior to the trial period. Comparing body weights of the captive lemurs with those of wild conspecifics, the adult male (3.35 kg) was more than two standard deviations heavier than the mean wild weight of the species (1.48 ± .15 kg) and was thus considered obese, whereas the adult female (1.40 kg) and sub-adult male (1.30 kg) could not be considered overweight. The results of our study showed that the diet consumed by the lemurs was high in easily available carbohydrates and relatively low in fibre. The animals preferred fruits and vegetables over the rest of their diet. Dry matter and nutrient digestibility was high (75–90 %). There was little difference in nutritional composition of wild (as taken from the literature) and captive diets. However, the captive lemurs consumed more energy than their wild conspecifics per animal and day, which, together with a stable year-round supply, is likely to have led to obesity in the male.

Keywords

Body weights, Activity budgets, Obesity

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Should zoo food be chopped?

A. Plowman^{1*}, K. Green², L. Taylor²

Abstract

Food provided for zoo animals is often chopped into small pieces even if the animals are capable of processing much larger items. Chopping food takes time and increases the risk of bacterial contamination and nutrient loss. Anecdotally keepers chop food because: it enables all individuals in a group to obtain enough of each food type and reduces aggression; it prevents wastage caused by animals taking one bite and discarding the rest of a large item; it enables a wider scatter feed to encourage foraging behaviour and prolong feeding time. We investigated these explanations in a primate (*Macaca nigra*) and an ungulate (*Tapirus terrestris*) species. Food was provided in four conditions: chopped/clumped, chopped/scattered, whole/clumped and whole/scattered, during which study subjects were observed individually at feeding time recording the number and type of each food item eaten, instances of aggression, and total feeding time. The behaviour of each subject was also observed for two 30 minute sessions at other times throughout the day. Randomisation tests were used to determine the effects of food size and/or distribution on total weight of food consumed, diversity of food consumed, total feeding time, aggression during feeding, total food wasted and behaviour throughout the day. Food size or distribution did not significantly affect any of the variables measured for most of the subjects. However, the most subordinate primate was able to obtain significantly more food ($P = 0.008$) when it was whole rather than chopped and the chopped/clumped condition resulted in significantly less foraging throughout the day ($P = 0.013$) by the ungulates in one of three zoos. Chopping food does not appear to have any of the advantages keepers assume suggesting that if animals are capable of processing it, food should be provided whole to avoid the increased risk of contamination and nutrient loss and save keeper time.

Keywords

Behaviour, food presentation, food size, *Macaca nigra*, *Tapirus terrestris*

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Comparison of the chemical composition of the diet of three free-ranging black rhinoceros (*Diceros bicornis*) populations with zoo diets

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Abstract

We documented seasonal changes in the dietary chemical contents of three free-ranging black rhino populations showing contrasting reproduction performances in three different habitats. The study was carried out in the Waterberg Plateau Park in North Central Namibia, Tswalu Kalahari Reserve in the Northern Cape, South Africa and in the Great Fish River Reserve in the Eastern Cape, South Africa from May to November. Browse species contributing 80% of the dry mass of the diet were analysed for NDF, ADF, ADL, crude protein, condensed tannins and minerals. We compared the dry season average dietary contents and monthly average ranges of these chemical components with dietary averages and ranges reported for zoo diets. Captive diets are low in cell wall constituents (NDF and ADF) and extremely low in indigestible fibre (ADL) compared to free-ranging diets. Dietary iron content in captive diets is 2 to 5 times higher than in free-ranging diets. Phosphorus, zinc and copper are in excess in captive diets compared to free-ranging diets. Therefore we recommend that special attention should be given to the type and proportion of roughage when formulating diets for black rhinos, and the addition of browse should be encouraged whenever possible to reduce overall digestibility. Iron levels in captive diets should be reduced to levels similar to those observed for free-ranging diets. The results of this study also raise the question of the adequacy of the horse model for minerals and protein requirements for browsing rhinos as the average dietary contents of these nutrients in the diet of a high performance population are below or close to the maintenance requirements for horses. Metabolic allometry needs to be taken into consideration when estimating requirements for black rhinos.

Keywords

Browse, fibre, mineral, nutrition, protein, tannin

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Frothy bloat and serous fat atrophy in a giraffe (*Giraffa camelopardalis*) with chronic respiratory disease

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Abstract

Malnutrition is a common cause of morbidity and mortality in captive giraffe (*Giraffa camelopardalis*). Frothy bloat, a nutrition-related disease of domestic ruminants, has not previously been reported in Giraffidae. A 10-year-old female reticulated giraffe (*G. c. reticulata*) had a chronic cough and died in February 2007 following a two-month period of weight loss. Multiple nutrition-related abnormalities were identified post mortem: frothy bloat appeared to have been the immediate cause of death; there was no fibrous material in the forestomachs; and rumen contents were mildly acidotic. There was also serous atrophy of multiple fat deposits and acute exudative interstitial pneumonia. The giraffe's low (structured) fibre intake was associated with provision of ad libitum (ad lib) pelleted food, lucerne hay that had appeared unpalatable, and insufficient browse. The low fibre intake would have predisposed to frothy bloat and ruminal acidosis. Serous fat atrophy (emaciation) was probably due to inadequate overall food intake (associated with respiratory disease, frothy bloat and rumen acidosis) and increased energy demands (respiratory disease and winter temperatures). Sufficient fibre intakes in giraffe must be assured, by restricting concentrate provision and by feeding high quality, palatable roughage. Zoos should endeavour to find methods of feeding ad lib browse to giraffe.

Keywords

Giraffidae, browsers, malnutrition, acidosis, pneumonia

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Comparison of two differing diets on digestion and copper status in captive red-flanked duikers (*Cephalophus rufilatus*)

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Abstract

Red-flanked duikers, and other duiker species, have a history of medical and dietary problems in captivity, including, but not limited to, copper (Cu) deficiency and ruminitis. The goal of this study was to determine if a minor change in diet would affect digestibility of the over-all diet by captive duikers as well as reduce the presumed occurrence of ruminitis and improve copper status. Nine red-flanked duikers from the Los Angeles Zoo were randomly assigned to two feeding groups; control and experimental. Each diet offered a different type of squash, and the experimental diet offered fewer yams, included banana peels and added a Cu supplement. Intake and digestion data were collected for each animal on both diets. Full compositional analysis was done for both diets, and for each animal's faecal output, during each collection period. Also, blood was collected to measure copper levels and observations of rumination were made as a potential indicator of ruminitis. Overall nutrient composition of the diets did not differ significantly nor did overall digestibility of the diets within or between animals. However, copper digestibility was significantly different ($p = 0.01$), with this mineral having higher digestibility in the experimental diet. However, serum copper levels did not differ significantly between diets, nor did the time budgets for rumination. Overall, the differences between these two diets are not significant enough to alter digestibility. However, changing other components, such as the browse, hay, and pellets or removal of some concentrates entirely, may certainly have such an effect.

Keywords

Frugivorous ruminant, duiker, digestion

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Rumen pH and hoof health in two groups of captive wild ruminants

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Abstract

*The connection between a feeding regime with a high proportion of concentrates and laminitis is well recognized in domestic animal medicine but has received little attention in captive wild hoofstock. We used the occasion of a transport of two ruminant groups, that necessitated immobilization, for an evaluation of the appearance of the hooves on the one, and of the pH of the rumen fluid gained by ruminocentesis on the other hand. A group of eight Himalayan tahr (*Hemitragus jemlabicus*) had a median rumen pH of 7.2 and a low hoof ring score, indicative of good hoof health. A group of seven blackbuck antelope (*Antelope cervicapra*), in contrast, had a median rumen pH of 6.0, and an intermediate hoof ring score and elevated hoof temperatures, indicative of a chronic laminitis. In relation to body weight, the feeding regime of the blackbuck included a higher proportion of concentrates. These observations suggest that a connection between concentrate feeding, low rumen pH, and hoof health could exist in captive wild ruminants, and that a feeding regime that prevents a drop of rumen pH could support hoof health.*

Keywords

Laminitis, acidosis, feeding, zoo ruminant, hoof health

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Macroscopic digestive anatomy of a captive lowland anoa (*Bubalus depressicornis*)

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Abstract

While little is known about the actual diet of free-ranging anoas, a study on their digestive physiology yielded results similar to other intermediate feeders. Among the ruminants, this species is particularly interesting, as, on the one hand, most of its closer relatives – the bovini, i.e. cattle and buffaloes – show extreme adaptations to grazing niche, but on the other hand, the anoa has a (secondarily) reduced body size usually associated with a more intermediate or browsing dietary niche. Here, we report the digestive macroscopic anatomy of a 21 year-old, 53 kg captive lowland anoa that was euthanised after a longer period of therapy-resistant diarrhoea and inability to stand. The results were compared to measurements published for other ruminants. The anoa showed several anatomical characteristics typical for the bovini (and considered typical for other grazers), such as an unapillated dorsal ruminal mucosa, unapillated, thick rumen pillars, pronounced reticular crests with secondary and tertiary crests, four orders of omasal laminae, and a large masseter muscle. In contrast, the omasal laminar area was small compared to data published for other species, and the parotis glands were comparatively large. The findings represent an unusual combination of anatomical characteristics for a ruminant that should be corroborated in more individuals, and could represent a retrograde change from a grazing back to an intermediate adaptation. It could be suspected that the anoa can make better use of grass-based diets than other intermediate feeders.

Keywords

Anatomy, bovini, intermediate feeder

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