Zoo Animal Nutrition II

*Zoo Animal Nutrition II (2003) was edited by A. Fidgett, M. Clauss, U. Ganslo*ß*er, J.-M. Hatt, J. Nijboer. Filander Verlag, Fürth*

ISBN-10: 3-930831-51-1

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Janssens, G.P.J., K. Vanhemelryck, M. Hesta, S. Millet, J. Debraekeleer, R. de Wilde **Ration modelling for growing ostriches (*Struthio camelus*).**	
Kiefer, B., U. Gansloßer, P. Kretzschmar, E. Kienzle **Food selection and food quality in territorial males of a free-ranging population of white rhinoceros (*Ceratotherium simum simum*) in South Africa.**	
Leus, K., A.A. Macdonald, G. Goodall, S. Mitchell, A. Hartley, L. Bauwens **Cardiac glands with a difference – scanning electron microscopy of the cardiac gland region in the stomach of the babirusa (*Babyrousa babyrussa*), domestic pig (*Sus scrofa domestica*), white-lipped peccary (*Tayassu pecari*) and Bennett's wallaby (*Macropus rufogriseus*).**	
Liesegang, A., K. Baumgartner **Metabolic bone disease in juvenile Morelet's crocodile (*Crocodylus moreletii*) caused by nutritional deficiencies.**	
Loehlein, W., E. Kienzle, H. Wiesner, M. Clauss **Investigations on the use of chromium oxide as an inert external marker in captive Asian elephants (*Elephas maximus*): passage and recovery rates.**	
Nijboer, J., H. van Brug, M.A. Tryfonidou, J.P.T.M. van Leewen **UV-B and vitamin D_3 metabolism in juvenile Komodo dragons (*Varanus komodoensis*).**	
Schwitzer, C., W. Kaumanns **Foraging patterns of free-ranging and captive primates – implications for captive feeding regimes.**	
Yang, C.W., A. S. Li, J.C. Guo **Diet, feed adjustment and parasite control for ungulates at the Taipei Zoo.**	

A. Bond

A review of diets fed to two Columbiforme species at Bristol Zoo Gardens

Abstract

When presented with a mixed diet, birds will preferentially select certain food items. It is therefore inappropriate to assess the nutritional content of diets offered to birds with the assumption that all of the nutrients are ingested in the proportions offered. This study used the nutrition software Zootrition (Zootrition™ 1999, Wildlife Conservation Society) to compare the nutritional content of diets offered and diets eaten by Mindanao bleeding heart doves (Gallicolumba criniger) and superb fruit doves (Ptilinopus superbus) at Bristol Zoo Gardens. The nutrients present in both the offered diet and the eaten diet were compared to recommended nutrient requirements for domestic pigeons (Brue 1994), the closest species for which nutrient requirements have been suggested.

For both species, large differences in composition between the diet offered and the diet eaten were identified. These differences were more marked in P. superbus suggesting that these birds are more selective in their food con-sump-tion. The change in composition of the diet as a result of selection caused the proportion of nutrients eaten to differ from the proportion offered. The more selective behaviour of P. superbus lowered the proportions of crude protein and crude fat in the diet by approximately 20 %. Conversely, the proportion of crude protein in the diet eaten by G. criniger was increased by 19 %, and the proportion of crude fat was increased by approximately 30 %.

Neither the nutrients offered to, nor the nutrients eaten by either species matched recommended nutrient levels for domestic pigeons. The health of both species and in particular, the breeding success of the G. criniger, suggests that nutrient recommendations for domestic pigeons are not an accurate representation of the nutrient requirements of these two species.

-click here to go back to the index-

M. Clauss, E. Kienzle, H. Wiesner

Feeding browse to large zoo herbivores: how much is “a lot”, how much is “sufficient”?

Abstract

Diet evaluations in captive browsers are often confounded by the fact that the amount of browse offered is difficult to quantify, especially if whole branches are fed. For a diet survey in captive moose (Alces alces), we established correlations between the diameter at point of cutting of a branch and the amount of foliage and edible twigs on it. Nine different species of trees were investigated. The correlations were allometric, and highly significant. For all tree species combined, e.g., the correlations of the total weight of a branch (y_1) and the weight of its leaves (y_2) with the diameter at point of cutting (x) were $y_1 = 0.84\ x^{1.94}$ and $y_2 = 0.48\ x^{2.48}$, respectively. Given the according equations, it was only necessary to measure the diameter of the branches fed in the institutions that participated in the diet survey. Examples are given for diet evaluations based on the estimation of edible browse derived from the equations.

Keywords

foliage, twigs, bark, moose (Alces alces), weight-diameter correlation

-click here to go back to the index-

M. Clauss, E. Kienzle, J.-M. Hatt

Feeding practice in captive wild ruminants: peculiarities in the nutrition of browsers/concentrate selectors and intermediate feeders. A review

Abstract

We present a review on the feeding practice, the nutritional pathology and the documented nutritional peculiarities of zoo ruminants. The difference in chemical composition between browse and grass his-tori-cal-ly led to the conclusion that browsers need a diet lower in fibre and higher in protein than grazing ruminants. The term "concentrate selectors", coined to describe browsing ruminants, additionally focused the attention on the chemical nature of a browser's diet assumed high in easily fermentable, soluble nutrients; the choice of the term "con-cen-trate" therefore has been criticized in the scientific literature (e.g. Owen-Smith 1996). In comparative nutritional surveys, browsing ruminants in zoos tend to consume less fibre, more protein and more nitrogen-free extracts than grazers. While this could be interpreted as a reflection of their nutritional needs, this feeding type displays, in comparative pathological surveys, a higher incidence of acidotic changes in the rumi-nal mucosa, indicating that this group does not ingest sufficient amounts of fibrous material. Additionally, data from controlled balance trials does not support the notion that browsing ruminants have higher protein requirements. We suspect that the lesser fibre intake in browsers is due to their reluctance to ingest hay, which is usually offered ad libitum. Reluctance to ingest hay and digestive problems after hay ingestion have been reported for different captive browsing ruminant species and is reflected by a similar reluctance of free-ranging browsers to ingest grasses. There is reason to believe that it is the physical rather than the chemical difference between grass and browse that affected the evolution of different ruminant feeding types. Attention within the zoo community should focus on providing browsers with a fibre source that corresponds to the physical characteristics of their natural forage.

Keywords

Grass, browse, hay, lucerne, rumen acidosis, physical structure, ruminant diversification

-click here to go back to the index-

M. Clauss

Tannins in the nutrition of wild animals: a review

Abstract

Many free-ranging wild animals consume significant amounts of tannins and other polyphenolics. Historically, attention has focused on their negative effects: tannins reduce apparent digestibility, impair the use of absorbed nutrients, can be toxic and reduce the palatability of many forages. Thus, tannins act as feeding deterrents. However, re-cently the antioxidant and cardioprotective potential of tannins / poly-phenolics has been emphasized in human nutrition.

Wild animals in captivity are fed a diet relatively low in tannins. It has been hypothesized that this might lead to a "lacking" in species that have evolutionarily adapted to and potentially become dependent on tannins. Potentially positive effects of tannins are a reduction in ruminal protein degradation with an increased flow of valuable amino acids into the lower gut, the prevention of bloat, a reduction of gastro-intestinal parasites and of pathogenic bacteria, and the chelation of iron. With respect to iron chelation, it could be hypothesized that some species have evolutionarily adapted to a natural diet with low iron availability due to its tannin content, and therefore cannot restrict iron absorption on captive diets high in available iron.

Several observations from zoos can be compared to these effects. Especially, but not exclusively during the transition from the wild into captivity, many folivorous animals suffer from gastrointestinal disorders such as bloat, enteritis and helmithic infestations. Long-lived species whose natural diet contains tannins can suffer from cardio-vascular disease in captivity. Additionally, some folivorous, hindgut-fermenting species develop excessive iron storage on captive diets. It is tempting to suggest the lack of tannins as an underlying factor.

The potentially beneficial effects of a more natural dietary tannin supply should be investigated, especially with respect to the antioxidant properties of polyphenolics in the face of iron storage disease. However, studies on the possibility to prevent the mentioned conditions by other dietary means, most notably a reduction in overall concentrate intake, should also be performed.

Keywords

polyphenolics, iron storage disease, bloat, antioxidant, enteritis, concentrate feeds

-click here to go back to the index-

M. Clauss, E. Kienzle, H. Wiesner

The botanical, structural and chemical composition of different pelleted feeds used in a captive browsing ruminant, the moose (*Alces alces*)

Abstract

The commercially available, pelleted moose food sold under the same brand name ("Mazuri Moose Maintenance") in North Amercia and Europe differs drastically in ingredient composition; the European formula does not contain the aspen sawdust that is regarded the crucial ingredient in the North American diet. Apart from these feeds, other pelleted foods designed for horses, domestic ruminants and cervids are used in feeding moose in European facilities. These pelleted feeds, and for comparison grass and browse samples, were submitted to a variety of analyses in order to isolate the potentially beneficial factors of the commercial moose feeds. All pelleted feeds had comparable particle size distributions, with the North American moose feed as the notable exception, as the sawdust particles were not as finely ground as the other ingredients. All pelleted feeds were similar in nutrient com-po-si-tion; however, the commercial moose feeds had higher per-cen-tages of fibre, due to a higher cellulose (and in the European pellets also hemicellulose) content. The commercial moose pellets did not display significantly higher amounts of lignin than the other pelleted feeds, in spite of the sawdust ingredient. Due to their high cellulose content, they even had lower lignin:cellulose-ratios than the other feeds and therefore rather resembled grass than browse in their fibre composition. Thus, the reported success of the commercial moose diets is most likely explained by their comparatively low energy density and high fibre content, and not by the sawdust ingredient itself. Additionally, the fact that they do not contain corn starch is considered beneficial. The nutritional contribution to husbandry problems in captive moose is considered to be generally due to the widespread use of pelleted feeds high in energy density and poor in structural fibre components.

Keywords

nutrition, browse, grass, fibre, starch, lignin

-click here to go back to the index-

E. J. Flach, M. Clauss, A. Hunt

Copper deficiency in yak (*Bos grunniens*) at Whipsnade Wild Animal Park

Abstract

Copper deficiency was suspected in the herd of yak (Bos grunniens) at Whipsnade Wild Animal Park. Animals were suffering from a range of conditions, including chronic diarrhoea, poor body condition and dull coats, despite daily supplementation with 36 mg of copper per animal. The copper concentration in yak blood samples collected in 1994 ranged from 0.8 to 3.3 µmol/L (mean 1.8, n = 10), well below the normal cattle range of 12 to 19 µmol/L. The copper supplement was therefore increased to 720 mg copper per adult per day (1.8 g copper sulphate) and blood copper concentrations rose each year, apart from low concentrations in juveniles in 1998, to plateau between 8.1 and 20.1 µmol/L (mean 13.3, n = 21). Over the same period general body and coat condition improved, again with the exception of 1998, and herd size grew. Other factors which may have been involved in the improvement in the health of the herd were the importation of a new herd male in 1992, and an intensification of anthelminthic treatment over the same period.

Keywords

yak, Bos grunniens, copper, molybdenum, parasitism, fertility, depigmentation

-click here to go back to the index-

K. Foster

Assessing diets for Congo peafowl, *Afropavo congensis,* at Jersey Zoo

Abstract

Congo peafowl, Afropavo congensis, are considered vulnerable in the wild although little is known about their ecology and population density. They have been kept in captivity since the 1940s; however, the captive birds suffer from health and breeding problems. Chick mortality is high, resulting in low population growth. Causes of adult death (n = 15) and disorders identified at post-mortem in Congo peafowl at Jersey Zoo (1998–2000) were reviewed, and included several which may be diet-related: obstruction of the oviduct caused by egg retention, egg peritonitis, kidney failure, heart failure, fat accumulation around the heart, hyperlipaemia, hepatic lipidosis, gout and myocardial degenera-tion. This study was undertaken in order to evaluate the nutrient quality of the Congo peafowl diet.

The diet provided to and consumed by the Congo peafowl was quantified, analysed and compared to the nutrient requirement levels of domestic pheasants. Although the precise nutrients required by Congo peafowl are unknown, this analysis is still a valuable tool in assessing nutrient status, until more work has been done in the wild to understand their specific needs. This study highlighted some imbalances in the Congo peafowl diet, such as insufficient levels of calcium and protein, and an elevated fat content, which correlate with the findings at post-mortem. The diet was modified, to try to rectify some of the nutrient imbalances, to help provide well balanced diets to maintain healthy birds in captivity.

Keywords

Calcium, fat, health, nutrients, protein, reproduction

-click here to go back to the index-

K. Foster, A. Feistner, D. Wormell

Assessing dietary modifications for pied tamarins, *Saguinus bicolor,* at Jersey Zoo

Abstract

Pied tamarins, Saguinus bicolor, have suffered from a number of health and breeding problems in captivity, at Jersey Zoo and elsewhere, such as wasting marmoset syndrome, chronic diarrhoea, metabolic bone disorders and breeding problems. A nutritional study at Jersey Zoo was initiated in order to investigate whether some of these problems may in part be linked to diet. When compared to the requirements of Callitrichids and New World monkeys, the pied tamarin diets contained an imbalance of some nutrients, such as low levels of protein and vitamin E. The diet was modified to try to correct some of these imbalances, and the modified diet provided and consumed was analysed to establish whether the diet modifications had been successful in altering nutrient composition, and whether new food items were palatable. The modified diet increased the total amount of food consumed per tamarin per day, as well as increasing intake of pellets, high-protein items and gum. The modifications to the diet had succeeded in increasing the levels of some key nutrients, such as protein, vitamin E and vitamin D_3, which is hoped will improve the health of the captive population. Further recommendations, primarily in terms of food palatability, have been made to continue to modify the diet.

Keywords

Diet modification, health, nutrition, protein, vitamins

-click here to go back to the index-

K. Foster, D. Preece

Nutrition of Iguanas at Jersey Zoo

Abstract

The diet and nutritional requirements of three species of iguana were studied at Jersey Zoo in order to establish whether the diets were providing nutrients adequate for health and reproduction, and to try to formulate a clearer understanding of the requirements of these species. The diets were quantified for the rhinoceros iguana, Cyclura cornuta cornuta; Lesser Antilles iguana, Iguana delicatissima; and Utila Island iguana, Ctenosaura bakeri.

The diets were quantified by weighing the amount of food provided and remaining each day, allowing analysis of the nutrients consumed per group, and estimates per individual. The iguanas consumed diets that were high in fibre (20–30 %) and low in fat (2–6 %), which mirrors wild diets. The protein consumption by Iguana and Ctenosaura was within an acceptable range for these genera (20–26 %), although protein consumed by Cyclura exceeded the range for this genus (10–20 % re-commended), which could cause health problems. The calcium to phos-phorus ratio of Cyclura and Iguana diets exceeded the recommended minimum of 2 : 1, but the Ctenosaura diet required calcium sup-plementation to raise the Ca : P ratio to 2 : 1, to compensate for the inverse Ca : P of insects and the low calcium content of fruit.

A forage and leafy greens-based iguana diet appears to be contributing well to the husbandry regime, by providing a natural food source that contains a balance of nutrients necessary to maintain health and allow reproduction, as demonstrated by the successful hatching of a complete clutch of Iguana delicatissima eggs at Jersey Zoo in November 2000.

Keywords

diet, health, nutrients, reproduction, reptile

-click here to go back to the index-

R. Gisler, J.-M. Hatt, R.W. Mayes, M. Lechner-Doll, M. Clauss, A. Liesegang, M. Wanner

The practical evaluation of a new digestive marker system in reptiles – *N*-alkanes in Galapagos giant tortoises (*geochelone nigra*)

Abstract

The present study was undertaken to evaluate different aspects of digestive strategies in Galapagos giant tortoises (Geochelone nigra), kept at the Zoological Garden of Zurich, Switzerland. Two trials were conducted, using natural and synthetic n-alkanes as digestive markers. One trial was carried out to determine the mean retention time (MRT) of the digesta in the intestinal tract of the tortoises, and another trial was carried out to determine the following parameters: recovery rates of digestive markers, food composition, diet intake and apparent digestibility. The suitability of alkanes as digestive markers in herbivorous reptiles was evaluated.

With alkane C_{36}, the MRT of the solid digesta phase could be determined very well. Based on direct observations, food composition could reliably be estimated with the alkane method. The use of the double marker method as described by Dove and Mayes (1991) yielded trustworthy results for the estimation of diet intake. No coherence was found between the recovery rates of the alkanes and the length of the carbon chains, as it was found in other hindgut ferments as well. In comparison to direct observation the apparent digestibility was significantly underestimated with three different markers, but the lowest deviation was reached with alkane C_{36}.

The results of the current study clearly show that in herbivore tortoises, alkanes possess a great potential as digestive markers for studies of digestive physiology. Mainly in the wild, where total faecal collection is not possible, alkanes will be suitable markers for the determination of different parameters of digestive physiology.

Keywords

Reptiles, herbivore, hydrocarbons, digestion

-click here to go back to the index-

J.-M. Hatt

Markers in zoo animal nutrition with special emphasis on *n*-alkanes

Abstract

Markers may allow to measure digestibility, intake, faecal output, digesta kinetics and even diet composition, without the use of total faecal collection and individual caging. Due to the fact that zoo animals are not tame (not domesticated) they are more difficult to handle, controlled feeding and sampling are complicated and may even be dangerous. Therefore markers have in the past played an important role in digestive studies in zoo animals. The present paper presents the frequently used internal (which are naturally present in feedstuffs) and external (which are mixed into the diet) marker systems used in zoo animal nutrition. Internal markers discussed are: lignin, acid (HCl)-insoluble ash, and manganese (Mn^{2+}). External markers discussed are: chromic oxide (Cr_2O_3), titaniumoxide (TiO_2), mordants such as of Cr and cerium, cobalt ethylnediamine tretra-acetic acid (Co-EDTA), plastic pieces and dyes. Their advantages but also problems are discussed. A new marker system in zoo animal nutrition, n-alkanes, is introduced, which may be used both as internal and external marker.

Keywords

digestibility, diet intake, ingesta kinetics, digestive physiology

-click here to go back to the index-

J. Hummel, L. Kolter

Passage rate and digestion in captive okapi (*Okapia johnstoni*)

Abstract

Passage rate of ingesta, and organic matter and fibre digestibility was measured in 2 male okapis. Co-EDTA and chromium-mordanted fibres (fibre length < 2 mm) were used as markers for the fluid and particle phase of ingesta. Resulting mean retention times (MRT's) were 36 h for fluid and 47 h for particle phase calculated after Thielemanns et al. (1978) and 34 h for the fluid and 48 h for the particle phase by using the model of Grovum and Williams (1973). The resulting mean ratio of $MRT_{particle\ phase}/MRT_{fluid\ phase}$ was 1,35 and 1,40, respectively. NDF digestibi-li-ty was found to be 47 % in these animals. The rather low $MRT_{particle\ phase}/MRT_{fluid\ phase}$ ratio may be inter-preted as the result of a generally low potential to retain particles in okapis, although comparison with data from studies in captivity or in the wild obviously have to be done very carefully.

Keywords

mean retention time; fibre digestibility; browser

-click here to go back to the index-

G.P.J. Janssens1, K. Vanhemelryck, M. Hesta, S. Millet, J. Debraekeleer, R. de Wilde

Ration modelling for growing ostriches (*Struthio camelus*)

Abstract

Due to the costly procedure of developing a de novo energy evaluation system, alternatives should be presented to estimate proper energy values in feedstuffs for certain animal species, like zoo animals or other species with low economic relevance. In the case of the ostrich, seven existing energy evaluation systems were tested for their feasibility for extrapolation to true metabolisable energy values (TMEo) for ostriches. The Dutch VEP net energy system for horses gave the best fit. In a pilot trial, two groups of 50 growing ostriches received rations differing in roughage/concentrates ratio. The ostriches' ad libitum intake of estima-ted TMEo was not influenced by the roughage/concentrates ratio and no differences in performance could be noted, giving preliminary evidence for the suitability of the extrapolation method to develop a reliable energy evaluation system.

Keywords

Ostriches, energy, modelling, growth, roughage, concentrates

-click here to go back to the index-

B. Kiefer, U. Ganslosser, P. Kretzschmar, E. Kienzle

Food selection and food quality in territorial males of a free-ranging population of white rhinoceros (*Ceratotherium simum simum*) in South Africa

Abstract

As part of a larger, multi-disciplinary approach to white rhino (Cerato-therum simum simum) behaviour, ecology and nutrition, a study was conducted on the foraging and ranging behaviour of three territorial males on a game ranch in Northern Transvaal, South Africa. Animal tracks representing the distance covered between midnight and early morning were followed, feeding sites identified, ingested grass species determined, and quantitative samples of ingested grass taken. Grass samples and additional grass and hay samples fed to white rhino at a German zoo were analysed for nutrient content. Food selection of free-ranging rhinos did not correspond to the frequency of occurrence of the individual grass species in their territory as determined by transect plots. The nutrient content of the diets selected by the three animals were very similar. There was no evident correlation between the distance travelled between feeding sites and the nutrient composition of selected diets. The mineral contents of the natural forages were noticeably lower than those of the zoo forages. This is in accord with similar reports from the literature on mineral contents of African and European forages. The relevance of this finding for captive mineral supplementation regimes should be further investigated.

Keywords

megaherbivore, grass analyses, minerals, protein

-click here to go back to the index-

K. Leus, A. A. Macdonald, G. Goodall, S. Mitchell, A. Hartley, and L. Bauwens

Cardiac glands with a difference – scanning electron microscopy of the cardiac gland region in the stomach of the babirusa (*Babyrousa babyrussa*), domestic pig (*Sus scrofa domestica*), white-lipped peccary (*Tayassu pecari*) and Bennett's wallaby (*Macropus rufogriseus*)

Abstract

The stomach of the babirusa differs from that of other pigs (Leus et al. 1999, Agungpriyono et al. 2000): it is larger and possesses a large diverticulum ventriculi, the gastric glands are confined to a small section at the end of the corpus ventriculi, the cardiac glands occupy a much larger surface area within the stomach (>70 % v. ~30 % in the domestic pig) and there are some variations in the distribution of endocrine cells. It was hypothesised that the babirusa is a non-ruminant foregut fermenting frugivore/concentrate selector (Leus et al. 1999). Scanning electron microscopy of very freshly fixed cardiac gland tissue from the stomachs of nine babirusa revealed that the surface of the whole of the cardiac gland region was characterised by a honeycomb pattern (Leus et al. 2002). At higher magnification the walls appeared to be almost entirely composed of bacteria. No histological study of the stomach of the babirusa or of those of other foregut fermenters with larger areas of cardiac glands has drawn attention to anything like this honeycomb structure. We therefore investigated fresh tissues from domestic pigs (Sus scrofa domestica), white-lipped peccaries (Tayassu pecari) and Bennett's wallabies (Macropus rufogriseus). The 'honey-comb' appearance of the luminal surface of the cardiac gland region of the babirusa stomach was not found in the equivalent regions of the stomachs of the other species. The possibility remains that this structure is a feature unique to the babirusa. Possible hypotheses regarding its function include surface enlargement to increase attachment space and retention time of bacteria in a stomach without strong compartmenta-li-sa-tion and/or to increase the area for absorption of fermentation products. The explanation may be of direct consequence to the feeding requirements of babirusa in zoos, which in turn may be an important factor for the success of its conservation breeding program.

Keywords

histology, bacteria, forestomach, fermentation

-click here to go back to the index-

A. Liesegang, K. Baumgartner

Metabolic bone disease in juvenile Morelet's crocodile (*Crocodylus moreletii*) caused by nutritional deficiencies

Abstract

Calcium and phosphorus are very important minerals in reptile nutri-tion, but many diets in zoos are still not sufficiently balanced. To achieve optimal growth, including a healthy skeleton, a well-balanced supply with these minerals and also vitamin D is the prerequisite. The present case report is intended to share our experiences.

In Nürnberg Zoo, three Morelet's crocodiles hatched for the first time in a European zoo in December 1999. The animals had an average weight of 31.9 g. They had access to artificial UV light (UVA, B and C). The dietary management proved to be difficult, because no data on dietary require-ments exist for this species. The animals were x-rayed after 3½ months with an average body weight of 125.8 g because one had a broken leg. Radiography revealed severe signs of metabolic bone disease in all three crocodiles. The animal with the fracture was treated with a T-buster-splint bandage. In addition, the diet was enriched with mineral and vitamin supplements (0.2 g of Korvimin ZVT was mixed with 2 ml of water; 0.3 ml of this solution was administered to each animal per day). After 6 weeks radiography revealed a healed fracture and a physio-lo-gi-cal ossification in all animals. At this time the crocodiles had an average weight of 445.3 g and a length of 528.3 mm.

In conclusion, this case report demonstrates a quick recovery of cro-codiles with metabolic bone disease following diet supplementation with minerals and vitamins. A diet consisting of crickets especially in combination with meat always requires supplementation due to a low Ca : P ratio.

Keywords

Metabolic bone disease, Ca:P ratio, crocodile

-click here to go back to the index-

W. Loehlein, E. Kienzle, H. Wiesner, M. Clauss

Investigations on the use of chromium oxide as an inert external marker in captive Asian elephants (*Elephas maximus*): passage and recovery rates

Abstract

Digestibility studies in zoo herbivores that are kept in groups are often confounded by the fact that the intake of hay, which is usually offered to the whole group, cannot be measured on an individual basis. This problem can be solved by using a double marker method with an internal and an external marker. In elephants, the internal marker lignin has repeatedly been used successfully; however, no external digestibility marker has been reliably established for this species.

Seven captive Asian elephants were fed 500 g of chromium oxide per animal as a pulse-dose. Faeces were collected in toto for 60 hours afterwards. The amount of faeces from each single defecation was weighed, and a representative subsample was taken for chromium analysis. All faeces defecated during night hours were treated as a single defecation unit. With the individual chromium concentrations and the total weights, the recoveries of the chromium marker could be calculated, and the passage rates for these animals were determined. Additionally, four animals in an elephant orphanage in Sri Lanka were fed the same amount of chromium oxide. For these animals, only the passage rates could be determined.

The average first marker appearance was 24 hours, and the average last marker excretion 54 hours after marker feeding. The average mean retention time for four adult animals was 31.7 ± 2.7 hours. On average, the elephants excreted 3.9 ± 1.2 kg faeces/100 kg of body mass per day. The average chromium oxide recovery was 97 %.

The results confirm that chromium oxide is a reliable external marker in Asian elephants. The passage rate data compares well with other data from the literature. Like perissodactyls, the elephant uses a digestive strategy of passing large amounts of low quality forage through its gut within a relatively short period of time.

Keywords

mean retention time, digestive physiology, feeding trial

-click here to go back to the index-

J. Nijboer, H. van Brug, M.A. Tryfonidou, J.P.T.M. van Leeuwen

UV-B and vitamin D_3 metabolism in juvenile Komodo dragons (*Varanus komodoensis*)

Abstract

The aim of this research project was to assess the vitamin D status in juvenile Komodo dragons held in captivity in Rotterdam Zoo. In addi-tion, the effect of interference with UV-B on the serum levels of vitamin D metabolites and on the serum calcium concentrations were investigated in three Komodo dragons. Supplying 450 IU vitamin D_3 /kg feed orally did not increase 25-hydroxyvitamin D_3 ($25(OH)D_3$), the 24-hydroxylated metabolite of vitamin D ($24,25(OH)_2D_3$), 1,25-dihydro-xy-vitamin D_3 ($1,25(OH)_2D_3$) and calcium levels. In contrast, exposing the Komodo dragons to UV-B altered the levels of vitamin D metabolites. The amount of $25(OH)D_3$ increased in komodo dragon 1 (K1) (18 to 195 nmol/ml) and in komodo dragon no 2 (K2) (31 to 291 nmol/ml). The amount of $1,25(OH)_2D_3$ did not change significant-ly in both komodo dragons (139.5.6 to 235.3 pmol/l). Measurement of 24,25 $(OH)_2D_3$ in K2 showed a dramatically improvement after exposing to UV-B; the amount of $24,25(OH)_2D_3$ rose (7.5 to 448.1 ng/ml). Komodo dragon 3 (K3) was send to Gran Canaria where it received natural UV-B. The level of $25(OH)D_3$ improved from 18 to 272 nmol/l. The amount of $1,25(OH)_2D_3$ did not increase either. In all komodo dragons the calcium level remained stable and within the range 3.18 to 4.44 mmol/l. The present study docu-ments for the first time the levels of three vitamin D_3 metabolites and their regulation by UV-B in Komodo dragons. According to literature low levels of $25(OH)D_3$ have caused bone defects in juvenile Komodo dragons. The current data show a clear effect of UV-B on the $25(OH)D_3$ levels and a concomitant rise in serum $24,25(OH)_2D_3$ levels while $1,25(OH)_2D_3$ levels remained con-stant. Although we have no data on the bone metabolism in our 3 Komodo dragons it is tempting to speculate in view of the published improvements of bone after UV-B treatment, that $24,25(OH)_2D_3$ is involved in bone metabolism in Komodo dragons. This would be in line with data obtained in chicken and human showing a positive effect on bone. Measure-ments of a UV-B radiating lamp show that the amount of UV-B declines rapidly over time. The decay rate also differs from lamp to lamp. If "UV-B" lamps are used for synthesising vitamin D_3 through the skin the UV-B radiation should be measured regularly and the lamp should be replaced before the UV-B radiation is too low for synthesising purposes. This study, although preliminary, clearly shows there is a dramatic change in vitamin D metabolites in juvenile komodo dragons using UV-B light, as compared with offering a dietary vitamin D supplement.

-click here to go back to the index-

C. Schwitzer, W. Kaumanns

Foraging patterns of free-ranging and captive primates – implications for captive feeding regimes

Abstract

In the wild, primates usually spend a large proportion of their active time foraging and feeding. Access to food is influenced by individual factors (e. g. the physiological abilities of the animal), social factors (e. g. dominance hierarchies), and especially by the spatial and seasonal distribution of the food resources.

Food resources in the wild may be scarce and widely distributed throughout the animals' home ranges, and certain food types may be available only during limited periods of the year. The amount of food consumed within a certain time period, and the temporal pattern of nutrient and energy intake, are influenced by these distribution patterns. Ideally, feeding primates in captivity should include such a varied food distribution, both spatially and temporally. However, this is often not possible under captive conditions. Spreading out food can only be done within the limits of the animals' enclosure. Moreover, it is rarely feasible to feed more than four times a day, as there is not enough staff available. Also, the "zoo-day" is usually not more than eight hours long (depending on the working times of the keepers).

A review of the literature on human feeding behaviour suggests that the temporal pattern of food intake is critical for an optimal (species-specific) functioning of satiation processes. Ideally, optimal feeding schedules should be developed with reference to foraging data from the field. The aim of this paper is to analyse relevant studies and, with regard to certain nutrition-related problems, to work out how optimal feeding and foraging patterns in captive primates could be induced.

Keywords

Primates, nutrition, feeding ecology, feeding frequency, energy intake, food intake regulation

-click here to go back to the index-

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Diet, feed adjustment and parasite control for ungulates at the Taipei Zoo

Abstract

As of September 2001, the Taipei Zoo managed 388 specimens of ungulates from 10 taxonomic families of 43 species. Since 1997, we adjusted the types of feeds and formulations, which began with fresh forage and edible hay. Included were six species of fresh grass, branches, and leaves used as the major food for our ungulates. Increased fibre consumption effectively reduced the undesirable condition of soft excrement, which was often seen with our giraffes. We experimented with five kinds of imported hay between 1997 and 1999, eventually eliminating all but one type exclusively; the domestical-ly-produced Pangola hay (Digitaris decumbens), offered ad libitum. In light of the damp weather in Taipei, especially in wintertime, the hay storehouse is air-conditioned, kept at a constant temperature of 16–18 °C, and a relative humidity < 75 %. Improved hay storage conditions has im-proved hay quality, and added variety and quantity in forage components has increased consumption of dietary fibre to improve health and fecal consistency in a number of ungulates. Pelleted feeds were adjusted to increase the content of vitamin E from 100 IU/kg to 400 IU/kg dry matter, resulting in improved health and reproduction. Altered feed placement and oral anthelminthics added to manufactured feeds has controlled parasites in hoofstock herds at Taipei Zoo. Hence a variety of feeding management improvements contributes to success of the ungulate feeding program at Taipei Zoo.

Keywords

Ungulates, feed management, concentrate formulation, parasite control

-click here to go back to the index-