PRELIMINARY DETERMINATION OF NUTRITIONAL REQUIREMENTS OF THE PREGNANT BLACK RHINOCEROS (*Diceros bicornis*)

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INTRODUCTION

The black rhinoceros husbandry in zoological gardens is attracting considerable attention because its census in the wild is rapidly diminishing (Cumming, 1987) and its reproduction in the captivity does not reach a level ensuring the survival of this species (Klös, 1987).

Recent research on the black rhinoceros includes studies on its reproduction (Platz *et al.*, 1979; Ramsey *et al.*, 1987), biochemical and hematological indices (Kock 1987; Beverley *et al.*, 1988), blood vitamin levels (Ghebremeskel *et al.*, 1988), breeding and health care (Kock, 1987; Maruska *et al.*, 1986), and nutrition.

The available literature contains several studies on nutritional ecology of the black rhinoceros in the wild. The black rhinoceros is classified as a browser specialized on consumption of food from trees, bushes, herbs, and succulents (Goddard, 1968; Hall-Martin *et al.*, 1982; Hitchins, 1979; Joubert and Eloff, 1971; Loutit *et al.*, 1987; Mukinya, 1977; Owen-Smith, 1988). A few studies deal with the morphology and physiology of the digestive system (Clemens and Maloiy, 1982, 1983; Foose, 1982; Stevens, 1982).

This study deals with the nutrition of the black rhinoceros in captivity. Feed intake, coefficients of apparent digestibility of some nutrients (dry matter, organic matter, crude protein, crude fiber, nitrogen-free extract, fat, ash, energy), and daily intake of some digestible nutrients (dry matter, organic matter, protein, energy) have been determined.

MATERIALS AND METHODS

The study involved an adolescent male (Sado, born August 26, 1986 in the Dvur Kralove Zoo) and two adult females (Sali, born July 5, 1978 in the Dvur Kralove Zoo; Jimina, imported from Africa in 1970 at the age of about 2 years). Both females were pregnant during the study; Sali gave birth on October 1, 1989 and Jimina on May 21, 1989. The study was divided into two feeding trials performed on August 11-21, 1988 and May 11-21, 1989. With the estimated pregnancy lenght of 450 days, Sali was about 1.5 and 10.5 months pregnant and Jimina about 5.5 and 14.5 months pregnant during the trials. The animals were kept in stall boxes of 20 m^2 in size and at ambient temperatures 15-20°C.

Due to the risk involved the animals were not weighed during the study. The body weights of the two females were estimated to be about 1000 kg based on literature data (King, 1969) and weights of other animals wighed at various occasion in the Dvur Kralove Zoo. The male was weighed on October 13,1989, before transport to the USA, and his body weight at that time was 800 kg. The estimated weights during the trials were 600 and 750 kg.

The daily rations consisted of 1 kg granulated concentrate ZOO I (Spala *et al.*, 1987), 2 kg crushed oat grain, and meadow hay *ad libitum*. The regular ration contained in addition 1 kg granuled alfalfa hay and 3 kg vegetables, but these supplements were omitted during the trials to simplify the analytical procedures. In each trial, there was a 5-day preparation phase in which the grain was carefully weighed and the consumption of hay given *ad libitum* was monitored each day. During the next five days the grain was portioned as before (consuned completely) and the comsumption of hay given in a 10% excess was

determined by daily weighing of the carefully collected leftovers. Fecal samples about 1.5 kg in size were collected daily.

Feed samples for analyses were collected before the study. The fecal samples were desiccated and pooled. All samples were analyzed for nutrient content in 6 replicates using standard methods (Czechoslovak State Norm 46-7007). Ash insoluble in 2 M HCl was used as an internal marker for the calculation of apparent digestibility coefficient (Block *et al.*, 1981). The energy equivalents used were 17.2 kJ (4.1 kcal)/g of crude protein, fiber, and nitrogen-free extract, and 38.9 kJ (9.3 kcal)/g of fat.

RESULTS AND DISCUSSION

A) Nutrient composition of the ration: The results of feed analyses are given in Table I. Although the hay used in the two trials was of different provenance, the ration composition was fairly similar. Only the levels of crude protein, calcium, and phosphorus showed larger differences between the two trials. Most of the small differences in the nutrient composition of the rations within single trials resulted from differences in feed intake of the hay.

The nutritional composition of the diet in captivity is difficult to compare with nutrient intake of the black rhinoceros in the wild because there are few comparable data. Loutit *et al.*, (1987) give the composition of 11 herbs frequently consumed by the black rhinoceros in the arid zone of Damaraland in Namibia, but the actual nutrient intake depends on the unknown proportions of these herbs in the daily ration. The average dry matter nutritional composition of these herbs indicated 25.9% fiber, 13.3% ash, 8.5% protein, 48.5% nitrogen-free extract, 3.7% fat, and 16.24 kJ energy/g dry matter. Clemens and Maloiy (1982) give the nutritional composition of the stomach digesta of 3 black rhinoceroses. The dry matter of the digesta in the cranial and caudal parts of the stomach contained on average 45.3% fiber, 6.3% ash, 13.4% protein, 31.4% nitrogen-free extract, 3.5% fat, and 18.2 kJ energy/g dry matter. The difference in these two sets of data are further obscured by an extensive fermentation in the stomach of the black rhinoceros which decreases the proportions of nitrogen-free extract and increases the proportions of the other components.

B) Feed intake: The amounts of feed and dry matter consumed by each animal are given in Table I. The male consumed about the same amounts of dry matter in both trials (15.33 and 16.26 kg/day), while the females increased the dry matter consumption in the second trial taking place in more advanced pregnancy (12.55 and 11.62 increased to 15.44 and 15.98 kg/day, respectively). The increased feed consumption may reflect seasonal influences and differences in the ration composition, diet digestibility, and physiological status of animals (e.g.pregnancy). Foose (1982) has determined the organic matter intake in the black rhinoceros in the range of 11.5 - 17.7 kg/day depending on feed quality.

Comparison of feed intake in the male and the females suggests seasonal variation can be disregarded. Also the ration composition in both trials was very similar (Table I). The digestibility of nutrients (Table II) in the male increased, while in the females it decreased in the second trial. This suggests that differences in the nutrient intake and digestibility resulted largely from physiological changes in the animals, e.g. growth in the male and advancing pregnancy and preparation for lactation in the females.

C) Nutrient digestibility: The coefficients of apparent digestibility of dry matter, organic matter, fiber, protein, nitrogen-free extract, fat, ash, and energy are given in Table II. The values differ between the feeding trials and between the male and the females. In the second trial the male increased the digestibility of all nutrients except protein, while the females decreased the digestibility of all nutrients except fat.

The nutrient digestibility may be influenced by the feed nutrient content, ration composition, feed intake, resulting rate of digesta passage through the gastrointestinal

system, and metabolic requirements of the animal. In this study the differences in the feed and ration composition between the two trials as well as among animals were minimal (Table I) and probably did not influence the resulting digestibility. The increasing apparent digestibility in the male likely resulted from increasing nutritional needs during his growth. The decreased digestibility in the females may have resulted from increased volume of feed consumed and subsequent accelerated passage through the digestive system.

Despite these digestibility changes as well as feed intake changes, the nutritional intake in both females was fairly stable, and nutritional requirements of the females were apparently met as judged from the good body condition during pregnancy, normal parturition, and healthy offspring growth and development.

The literature gives few data on nutrient digestibility coefficients in the black rhinoceros. Clemens and Maloiy (1983) give coefficients of apparent digestibility at 7 points along the lenght of the digestive tract. Ullrey (1980) compares the coefficient of apparent digestibility in two black rhinoceroses fed sudan grass hay with those of other ungulates fed with the same hay. Foose (1982) gives the digestibility of plant cell walls 42 - 48% depending on the feed type. However, comparison of these data with the results of this study would be largely speculative.

D) Nutritional requirements of the pregnant black rhinoceros: Table III compares the intake of crude and digestible dry matter, organic matter, protein, and energy in the 3 animals during the two feeding trials.

The male was in the period of growth (24 and 33 months of age) while the females were in various stages of pregnancy (Sali 1.5 and 10.5 months, Jimina 5.5 and 14.5 months).

The data show that the intake of digestible nutrients was fairly stable in both females. Since both females were in good body condition during the entire pregnancy, had normal delivery, and successfuly raised healthy young, the following values of digestible nutrient intake can be considered as preliminary ascertainment of daily nutritional requirements of the female black rhinoceros (estimated body weight 1000 kg) during pregnancy (mean ± SD, range):

digestible dry matter	(g)	6835 ± 189	(6560 - 6960)
digestible organic matter	(g)	6500 ± 145	(6290 - 6610)
digestible protein	(g)	718 ± 25	(686 - 741)
digestible energy	(MJ)	116 ± 4.5	(112 - 122)

CONCLUSION

A nutritional study in an adolescent male and two pregnant females of the black rhinoceros yielded values of feed intake and coefficients of apparent digestibility of dry matter, organic matter, fiber, protein, nitrogen-free extract, fat, and energy.

The daily digestible nutrient requirements for a 1000 kg pregnant female were estimated at 6560 - 6960 g dry matter, 6290 - 6610 g organic matter, 686 - 741 g protein, and 112 - 122 MJ energy.

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Table I. The composition of feeding rations per animal and day and the composition of dry matter

		Trial I			Trial II		
		Sado M	Sali F	Jimina F	Sado M	Sali F	Jimina F
Pellets Zoo I.	(kg)	1.0	1.0	1.0	1.0	1.0	1.0
crushed oats	(kg)	2.0	2.0	2.0	2.0	2.0	2.0
meadow hay	(kg)	13.8	10.6	9.6	15.0	14.1	14.6
total	(kg)	16.8	13.6	12,6	18.0	17.1	17.6
dry matter	(kg)	15.5	12.6	11.6	16.3	15.4	15.9
org. matter	(%)	92.5	92.6	92.6	92.2	92.2	92.2
crude protein	(%)	10.9	11.0	11.0	12.6	12.6	12.6
crude fiber	(%)	29.0	28.0	27.6	27.8	27.6	27.7
fat	(%)	2.3	2.5	2.5	2.3	2.3	2.3
N-free extract	(%)	50.3	51.1	51.5	49.5	9.7	49.6
ash	(%)	7.5	7.4	7.4	7.8	7.8	7.8
energy	(MJ/kg DM)	16.4	16.4	16.5	16.3	6.3	16.3
Ca	(g/kg DM)	8.9	9.1	9.2	3.2	3.2	3.2
P	(g/kg DM)	6.3	6.3	6.3	2.3	2.3	2.3
Na	(g/kg DM)	8.9	8.9	8.9	7.6	7.6	7.6
K	(g/kg DM)	18.4	17.5	17.5	20.9	20.8	20.8
Mg	(g/kg DM)	1.4	1.4	1.4	1.4	1.4	1.4
Fe	(mg/kg DM)	287	276	272	274	246	247
Cu	(mg/kg DM)	9.3	9.3	9.3	7.3	7.3	7.3
Zn	(mg/kg DM)	99	97	96	73	71	71

Table II. Coefficients of apparent digestibility.

	Trial I.			Trial II.		
	Sado M	Sali F	Jimina F	Sado M	Sali F	Jimina F
dry matter (%)	45.7	54.7	59.9	63.4	42.5	43.8
org. matter (%)	46.9	56.1	61.4	65.0	44.2	44.9
crude protein (%)	49.6	53.9	57.6	51.1	35.3	35.6
crude fiber (%)	34.5	49.0	55.5	56.8	21.7	26.1
fat (%)	29.3	21.5	27.5	59.5	45.0	38.4
N-free extract (%)	54.4	62.2	67.0	73.3	58.8	58.0
ash (%)	30.5	36.6	41.2	45.3	22.5	30.8
energy (%)	46.4	55.0	60.3	64.8	44.2	46.9

Table III. The intake of

A) dry matter, organic matter, crude protein, and energy per animal and day

B) digestible dry matter, organic matter, crude protein, and energy per animal and day

		Trial I.			Trial II.		
		Sado M	Sali F	Jimina F	Sado M	Sali F	Jimina F
A	dry matter (g)	15530	12550	11620	16260	15440	15890
	org. matter (g)	14360	11620	10760	14990	14240	14650
	crude protein (g)	1690	1370	1280	2040	1940	2000
	energy (MJ)	254	206	191	265	252	260
B	dry matter (g)	7100	6860	6960	10310	6560	6960
	org. matter (g)	6740	6520	6610	9740	6290	6580
	crude protein (g)	839	741	735	1042	686	710
	energy (MJ)	118	113	115	172	112	122