A CONTRIBUTION TO THE TRACE ELEMENT NUTRITION OF CAPTIVE BLACK RHINOCEROSES (*DICEROS BICORNIS*)

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Extended Abstract

Due to the potential involvement of trace mineral imbalances in health problems observed in captive rhinoceroses, there has been recent interest in trace mineral provision by and absorption from captive diets.[2,5,8] In one investigation, forage of free-ranging black rhinoceroses contained, on average, 6.5 (range: 3.0-12.2) mg copper (Cu)/kg dry matter (DM), 113 (29-215) mg iron (Fe)/kg DM, 89 (11-269) mg manganese (Mn)/kg DM, and 18 (3-67) mg zinc (Zn)/kg DM.[4] In another investigation, Fe levels up to 116 mg/kg DM were reported.[6] As compared to horse recommendations (Cu: 10 mg/kg DM, Fe: 40 mg/kg DM, Mn: 40 mg/kg DM, Zn: 40 mg/kg DM),[7] these values appear low in Cu and Zn. Here, we wanted to compare dietary trace mineral content of captive diets to these figures, and test whether obvious deviations in trace element absorption could be detected in black rhinoceroses as compared to data from horses.

Feeding trials were performed with eight black rhinoceroses from three zoological institutions, quantifying intake by weighing of offered feeds and leftovers, and faecal excretion by total faecal collection. Three to five different zoo rations, consisting of varying proportions of roughage, concentrates, and in some cases browse material, were fed (total n of trials = 32). Representative samples of feeds and faeces were analysed for trace element content (Cu, Fe, Mn, Zn, Co) by inductively coupled plasma emission spectrometry. Additional data for black rhinoceroses was available from three hitherto unpublished studies (Paros & Dierenfeld, n=2; Woodfine, n=2; Froeschle & Clauss, n=14; not all minerals analysed in all cases). Mineral content was plotted against absorbable (ingested – excreted) mineral content in 100g dry matter. In these regressions, the regression slope (a) corresponds to the “true” absorption coefficient, and the negative intercept (b) to the endogenous fecal losses (EFL). For comparison, available data for domestic horses was used in the same plots, and differences in the resulting regressions to those derived from literature data on horses were tested by analysis of covariance.

A total of 8 animals had received basically identical diets, with the exception of the inclusion of 5 % tannic acid (a source of hydrolysable tannins) in the pelleted diet compound; a total of 6 animals had received basically identical diets, with the exception of the inclusion of 5 % quebracho (a source of condensed tannins). This resulted in an additional tannin source intake intake of 5-15 g/kg DM. As dietary tannins are known to bind dietary Fe, excretion patterns for Fe were in particular compared between these dietary treatments.

The results are summarized in Table 1. In general, conclusive interpretations were difficult, due to the low number of data available for domestic horses and its large scatter. Additional caution is advised due to the pooling of data from several studies/facilities; the same applies to the pooled horse data. Therefore, statically significant differences must be considered with caution, and in context to evident visual patterns. For Co, no comparative horse data was available. The range of trace mineral content in captive black rhinoceros diets included diets that would be considered deficient in Cu, Mn or Zn for domestic horse maintenance. In contrast, Fe content was 2 to 25 times in excess of assumed horse maintenance requirements. The patterns in the graph plots did not differ in a systematic manner between black rhinos or domestic horses for Cu, Fe, or Zn (regardless of the calculated significance, visual inspection of the respective plots did not reveal evident deviations between horses and black rhinos for Cu and Zn). In contrast, black rhinoceroses seemed to absorb more Mn from rations with comparable Mn content than horses. There was no relevant difference in the absorption pattern for Fe in black rhinos between the three dietary treatments.

The results suggest that, as has been observed in Indian rhinos[2] and elephants,[1] trace element deficient diets do occur in practice; of particular concern in this respect is Zn[2] and Cu; of the latter element, liver concentrations indicative of possible deficiencies have been reported in black rhinoceroses.[5] Similarly, a low Mn status was reported in individual animals.[5]

A visual inspection of the plots, as well as a comparison of the regression equations (Table 1), does not suggest fundamental differences in trace element absorption between black rhinoceroses and domestic horses, with the possible exception of Mn. The potentially lower endogenous losses of this element, as suggested in Table 1, would, however, be of no practical relevance.

As Fe absorption is a function of Fe status, and captive black rhinoceroses are mostly overloaded with Fe,[8] the difference in the regression slope, indicating a less efficient Fe absorption from the gut in black rhinoceroses (Table 1), seems understandable. The fact that black rhinoceroses are probably exclusively overloaded with Fe in captivity, and the excessively high dietary Fe concentrations, explain why potential differences in Fe absorption are difficult to detect in conventional absorption trials. Additionally, the tannin supplementation led to an increased production of tannin-binding salivary proteins,[3] which might have lessened any potential effect of tannins as Fe chelators.

For black rhinoceros husbandry practice, the results suggest that horse recommendations can be used for the formulation of rhinoceros diets, and that it has to be checked by ration calculation that actual mineral levels are not lower or excessively exceed the recommended values. With respect to the common phenomenon of Fe overload in captive black rhinoceroses, it is particularly important that dietary Fe levels are not excessive.

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Table 1. Number of observations, dietary trace element content (mg/kg DM) range (average, standard deviation) and regression characteristics (absorbable trace element mg/100g DM = a * trace element mg/100g DM + b) in domestic horses (*E. caballus*) and black rhinoceroses (*D. bicornis*). P-values for slope and intercept of each individual regression given. Significant differences to horse data indicated in rhinoceroses by * ($p<0.05$).

	Species	n	diet	a	B	R^2	p_{slope}	$p_{intercept}$
Cu	*E. cab.*	21	4.0-42.3 (18.9 ± 11.5)	0.33	-0.03	0.49	<0.001	0.85
	D. bic.	50	5.3-13.8 (9.5 ± 2.8)	0.20	-0.05*	0.17	0.003	0.44
Fe	*E. cab.*	18	77+-1083 (258 ± 222)	0.70	-0.02	0.70	<0.001	<0.001
	D. bic.	50	89+-1009 (374 ± 224)	0.28*	-0.02	0.14	0.008	<0.001
Mn	*E. cab.*	18	45-193 (107 ± 44)	0.23	-0.003	0.09	0.22	0.17
	D. bic.	36	30-117 (65 ± 22)	0.25	-0.001*	0.16	0.02	0.08
Zn	*E. cab.*	21	17-145 (64 ± 34)	0.00	-0.73	0.00	0.99	0.61
	D. bic.	36	30-121 (54 ± 25)	0.27	-0.38*	0.27	0.001	0.41
Co	*D. bic.*	29	0.21-1.75 (0.49 ± 0.42)	0.35	-0.008	0.82	<0.001	<0.001

+ low Fe values in forage-only diets

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