



Developing a black rhino diet for Zurich Zoo

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EAZA Academy Liberec 2017



**University of
Zurich^{UZH}**



Clinic
of Zoo Animals, Exotic Pets and Wildlife





Initial incentive

- Iron storage disease a problem in black rhinos

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REVIEW OF LABORATORY AND NECROPSY EVIDENCE FOR IRON STORAGE DISEASE ACQUIRED BY BROWSER RHINOCEROSES

Donald E. Paglia, M.D., and I-Hsien Tsu, M.S.



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- Zoo diets differ from natural diets (less fibre, more iron, less tannins, less PUFA)

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

S. F. Helary^{1}, N. Owen-Smith¹, J. A. Shaw¹, D. Brown, D. Hattas²*



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Comparison of the chemical composition of the diet
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Journal of Zoo and Wildlife Medicine 43(3): S48-S54, 2012
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S. F. **BLACK RHINOCEROS (*DICEROS BICORNIS*) NATURAL DIETS:
COMPARING IRON LEVELS ACROSS SEASONS AND
GEOGRAPHICAL LOCATIONS**

Stephane F. Helary, med.vet., M.Sc., Joanne A. Shaw, Ph.D., Derek Brown, Marcus Clauss, M.Sc.,
Dr.med.vet., Dipl. E.C.V.C.N., and Norman Owen-Smith, Ph.D.



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Stephane F.
Dr.med.vet

ORIGINAL ARTICLE

**Mineral absorption in the black rhinoceros (*Diceros bicornis*)
as compared with the domestic horse**

M. Clauss¹, J. C. Castell², E. Kienzle², P. Schramel³, E. S. Dierenfeld⁴, E. J. Flach⁵, O. Behlert⁶,
W. J. Streich⁷, J. Hummel^{6,8} and J-M. Hatt¹



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W. J. Streich⁷, J.

DOI: 10.1111/j.1439-0396.2007.00730.x

ORIGINAL ARTICLE

**Fatty acid status in captive and free-ranging black rhinoceroses
(*Diceros bicornis*)***

M. Clauss¹, E. S. Dierenfeld², K. E. Bigley³, Y. Wang⁴, K. Ghebremeskel⁴, J.-M. Hatt¹, E. J. Flach⁵,
O. Behlert⁶, J. C. Castell⁷, W. J. Streich⁸ and J. E. Bauer³



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- Iron storage disease a problem in black rhinos
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- Tannins (as in natural diet) act as iron chelators

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PLANT PHENOLICS AND THEIR POTENTIAL ROLE IN MITIGATING IRON OVERLOAD DISORDER IN WILD ANIMALS

Shana R. Lavin, M.S., Ph.D.



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- Tannins without apparent adverse (but some positive) effects in feeding trials

DOI: 10.1111/j.1439-0396.2006.00673.x

ORIGINAL ARTICLE

The influence of dietary tannin supplementation on digestive performance in captive black rhinoceros (*Diceros bicornis*)

M. Clauss¹, J. C. Castell², E. Kienzle², E. S. Dierenfeld³, E. J. Flach⁴, O. Behlert⁵, S. Ortmann⁶, W. J. Streich⁶, J. Hummel^{5,7} and J.-M. Hatt¹



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The influence of dietary tannins on the iron status of captive black rhinos (*Diceros bicornis*)

M. Clauss¹, J. J. Streich⁶

J. Vet. Med. A **53**, 319–322 (2006)

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Division of Zoo Animals, Exotic Pets and Wildlife, Vetsuisse Faculty, University of Zurich, Switzerland

Antioxidant Status of Faeces of Captive Black Rhinoceros (*Diceros bicornis*) in Relation to Dietary Tannin Supplementation

M. CLAUSS^{1,8}, N. PELLEGRINI², J. C. CASTELL³, E. KIENZLE³, E. S. DIERENFELD⁴, J. HUMMEL⁵, E. J. FLACH⁶, W. J. STREICH⁷ and J.-M. HATT¹



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Division of

**Antioxidant
Relation**

M. CLAUSS¹
STREICH⁷ and

ORIGINAL ARTICLE

Quantification of enterobacteriaceae in faeces of captive black rhinoceros (*Diceros bicornis*) in relation to dietary tannin supplementation

M. Clauss¹, M. M. Wittenbrink², J. C. Castell³, E. Kienzle³, E. S. Dierenfeld⁴, E. J. Flach⁵, S. K. Macgregor⁵, T. Hoppe⁶, J. Hummel⁷, W. J. Streich⁸ and J.-M. Hatt¹

DOI: 10.1111/j.1439-0396.2007.00687.x



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- Tannins (as in natural diet) act as iron chelators
- Tannins without apparent adverse (but some positive) effects in feeding trials
- => what tannin source should we use?



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Specifically, it is recommended to compare palatable,^{14,16} low-cost, and commercially available products in terms of relative affinities for iron to determine if an appropriate dietary supplement exists for minimizing iron absorption in wild animals sensitive to IOD. Potential sources of phenolic supplements include grape pomace



ORIGINAL ARTICLE

Black rhinoceros (*Diceros bicornis*) and domestic horse (*Equus caballus*) hindgut microflora demonstrate similar fermentation responses to grape seed extract supplementation *in vitro*

N. F. Huntley¹, H. D. Naumann², A. L. Kenny¹ and M. S. Kerley¹

Grape seed extract was found to be an effective iron chelator, and supplementation in black rhinoceros diets up to 4% of DM is unlikely to adversely affect macronutrient hindgut digestibility or microbial viability and fermentation. *In vivo* trials are needed to determine supplementation levels necessary to limit iron absorption and tissue accumulation in captive black rhinoceros.



Aims

- Readily available source of tannins -> red grape pomace
- forage base (also good for PUFA) -> lucerne meal or grass meal
- low iron components -> excludes grass meal
- use fermentable fibre rather than starch -> beet pulp
- no iron added



Nashorn und andere Pflanzenfresser
Rhinocéros et autres herbivores
Rhinoceros and other herbivores

Ergänzung
Complément
Supplement

Zoo-Nashornpellets | Pellets pour rhinocéros de zoos | Pellets for rhinoceros in zoos

Inhaltsstoffe | Substances | Major Nutrients

Trockensubstanz Matière sèche Dry matter	90.0 %
Rohprotein Protéines brutes Crude protein	13.5 %
Rohfett Graisses brutes Crude fat	2.8 %
Rohfaser Fibres brutes Crude fiber	21.0 %
Rohasche Cendres brutes Crude ash	10.0 %
NFE ENA NFE	42.7 %
Bruttoenergie Energie brute Gross energy	14.8 MJ/kg
Verdaubare Energie Energie digestible Digestible energy	10.3 MJ/kg
Stärke Amidon Starch	2.0 %

Aminosäuren | Acides aminés | Amino acids

Arginin Arginine Arginine	0.65 %
Lysin Lysine Lysine	0.60 %
Methionin Méthionine Methionine	0.18 %
Methionin + Cystin Méthionine + cystine Methionine + cystine	0.37 %
Tryptophan Tryptophane Tryptophan	0.15 %
Threonin Thréonine Threonine	0.46 %

Mengenelemente | Macro-éléments | Major mineral elements

Calcium Calcium Calcium	0.85 %
Phosphor Phosphore Phosphorus	0.65 %
Magnesium Magnésium Magnesium	0.25 %
Natrium Sodium Sodium	0.95 %
Kalium Potassium Potassium	1.45 %
Chlor Chlore Chlorine	1.15 %

Spurenelemente | Oligo-éléments | Trace elements

Eisen Fer Iron	400 mg/kg
Zink Zinc Zinc	175 mg/kg
Kupfer Cuivre Copper	34 mg/kg
Jod Iode Iodine	1.20 mg/kg
Mangan Manganèse Manganese	42 mg/kg
Selen Sélénium Selenium	0.35 mg/kg

Vitamine | Vitamines | Vitamins

Vitamin A Vitamine A Vitamin A	29'000 IE U IU/kg
Vitamin D ₃ Vitamine D ₃ Vitamin D ₃	1'000 IE U IU/kg
Vitamin E Vitamine E Vitamin E	850 mg/kg
Vitamin K ₃ Vitamine K ₃ Vitamin K ₃	5 mg/kg
Vitamin B ₁ Vitamine B ₁ Vitamin B ₁	5 mg/kg
Vitamin B ₂ Vitamine B ₂ Vitamin B ₂	14.5 mg/kg
Vitamin B ₆ Vitamine B ₆ Vitamin B ₆	9.5 mg/kg
Vitamin B ₁₂ Vitamine B ₁₂ Vitamin B ₁₂	0.03 mg/kg
Nicotinsäure Acide nicotinique Nicotinic acid	105 mg/kg
Pantothenensäure Acide pantothénique Pantothenic acid	45 mg/kg
Folsäure Acide folique Folic acid	3 mg/kg
Biotin Biotine Biotin	0.75 mg/kg
Cholin Choline Choline	740 mg/kg
Vitamin C Vitamine C Vitamin C	15 mg/kg

Rohstoffe | Ingrédients | Ingredients

Luzernemehl, Traubentrestler, Rübenschnitzel, Melasse, Weizenkleie, Hafer, Sojaextraktionsschrot (NGVO), Mais (NGVO), Mineralstoffe, Vitamine

Farine de luzerne, marc de raisins, pulpe de betterave, mélasse, son de blé, avoine, tourteau d'extraction de soja (sans OGM), mais (sans OGM), substances minérales, vitamines

Alfalfa, grape pomace, beet pulp, molasses, wheat middlings, oats, soybean meal (NGMO), corn (NGMO), minerals, vitamins

Bemerkungen | Remarques | Remarks

- Eisenreduziertes Ergänzungsfuttermittel für Dickdarmverdauung und andere Pflanzenfresser

- Angegebene Gehalte sind berechnete Mittelwerte bezogen auf luft-trockene Substanz

- NDF: 33.8 %

- ADF: 24.7 %

- Aliment complémentaire, pauvre en fer, pour animaux, dont la fermentation se fait dans le gros intestin et autres herbivores

- Les teneurs indiquées sont des valeurs moyennes se rapportant à la matière séchée à l'air

- NDF: 33.8 %

- ADF: 24.7 %

- Low iron supplementary animal feed for hindgut fermenters and other herbivores

- Given values are calculated averages in air-dry feed

- NDF: 33.8 %

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Bestellform | Conditionnements | Delivery form

Pellets 8 mm rund | Pellets ronds 8 mm | Pellets 8 mm round

3695.PD.S25:

25 kg in Papiersäcken

25 kg in sacs en papier

25 kg in paper bags

06/2008



Commercial diet



Nashorn und andere Pflanzenfresser
Rhinocéros et autres herbivores
Rhinoceros and other herbivores

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Selen Sélénium Selenium	0.35 mg/kg



Commercial diet

HERBIVORES



Rhino and tapir

Suitable for: Rhino and tapir

YOUR BENEFITS

- ◊ A recipe low in iron with naturally low-iron raw materials and manufactured without additional iron supplementation for black rhinos and tapirs
- ◊ Also a suitable recipe for white rhinos
- ◊ High content of pectins through beet pulp and grape marc
- ◊ Supplemented with vitamin E and selenium

We are happy to work with you to create an individual feeding recommendation

TYPE OF FEED, FORM, DELIVERY QUANTITY

- ◊ supplementary feed
- ◊ Form: pellet 8 mm round
- ◊ Delivery quantity: 25 kg paper bag
pallets of 750kg



FEED SPECIFICATIONS

Major nutrients (%)

Dry matter	90
Crude protein	13.5
Crude fat	2.8
Crude fiber	18
Crude ash	10
NFE	42.7
NDF	31.6
ADF	22.6
Starch	2.4
Sugar	5.1

Energy (MJ/kg)

Gross energy	16
Digestible energy	10.2

Macrominerals (%)

Calcium	0.9
Phosphorus	0.7
Magnesium	0.3
Sodium	1
Potassium	1.5
Chlorine	1.2

Trace elements (mg/kg)

Iron	400
Zinc	175
Copper	34
Iodine	1.2
Manganese	42
Selenium	0.4
Cobalt	0.3

Vitamins (added, mg/kg)

Vitamin A (IU/KG)	6500
Vitamin D3 (IU/KG)	1000
Vitamin E	850
Vitamin K3	5
Vitamin B1	5
Vitamin B2	14.5
Vitamin B6	9.5
Vitamin B12	0.03
Nicotinic acid	105
Pantothenic acid	45
Folic acid	3
Biotin	0.8
Choline	740
Vitamin C	15

Amino acids (%)

Arginine	0.65
Lysine	0.6
Methionine	0.18
Methionine + Cystine	0.37
Tryptophan	0.15
Threonine	0.46

Ingredients

Alfalfa, grape marc, beet pulp, wheat bran, molasses, minerals, soybean meal (NGMO), vitamins.

Remarks

- ◊ Given values are calculated averages in air-dry feed.
- ◊ Gross energy calculated according to Kamphues et al. 2009
- ◊ Digestible energy calculated according to NRC Horses 2007
- ◊ Nutrients are subject to natural variation of the raw materials and their production process.

OUR FEED RECOMMENDATION

- ◊ The feed is suitable for supplementing a balanced basic diet in terms of protein and energy.
- ◊ Always provide free access to fresh drinking water.
- ◊ Benchmark: 0.3% -1% of body weight per day

We are happy to work with you to create individual feeding recommendations for the respective species

Sources:

Clauss, M. et al. (2005). A contribution to the trace element nutrition of captive black rhinoceroses (*Diceros bicornis*). Nutrition Advisory Groups Proceedings.
Castell, J. (2005). Dissertation. Untersuchungen zu Fütterung und Verdauungsphysiologie am Spitzmaulnashorn (*Diceros bicornis*). Institut für Physiologie, Physiologische Chemie und Tierernährung der Tierärztlichen Fakultät der Ludwig-Maximilians-Universität München (Institute for Physiology, Physiological Chemistry and Animal Nutrition at the Veterinary Faculty of the Ludwig-Maximilian University of Munich).
Kamphues, J. et al. (2009). Supplemente zu Vorlesungen und Übungen in der Tierernährung, 11. Auflage, M.&H. Schaper, Hannover
Litzenich, B. A., Ward, A. M. (September 1997). Hay and Pellet Rations: Considerations in Feeding Ungulates. Nutrition Advisory Group Handbook, Fact Sheet 006.
National Research Council (2007). Nutrient Requirements of Horses, 6th rev. edition, National Academies Press, Washington DC, S. 4



Experiences

- no formal assessment by digestion study or (the really important) long-term study
- no acceptance problems
- no clinical problems observed in black rhinos
- black rhino husbandry at Zurich Zoo discontinued for other reasons
- nutritional logic should apply for tapirs as well