Original Report

Relationship between the content of various elements in fur of nutria *(Myocastor coypus)*

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Summary

The aim of this work was to analyse the correlation between different mineral elements in nutria fur. The analyses are based on about 400 hair samples representing two colour types, Greenland and Standard , both males and females. Additionally the hair samples were taken from two body locations (dorsal and ventral) and at 3 stages of animal development, at 60, 135 and 240 days of age.

Altogether 20 elements were analysed: As, Br, Ca, Cl, Co, Cr, Cu, Fe, K, Mn, P, Pb, Rb, S, Se, Sr, Ti, V, Zn and Zr. The concentration of the elements was determined with disperse roentgen fluorescent spectrometry. The obtained results were mathematically evaluated using the SAS statistical programme (*SAS Inst. Inc. 1987*).

In about half of the cases the correlation between the two minerals was significant. Most correlation coefficients were positive. However, sulphur (S) showed negative correlation with most other minerals. Only the correlation of S with Ca and P was positive.

Introduction

Besides the organic elements mineral elements are also important in the fur (*Tjurnina, 1981*). Minerals are firmly bound to protein structures *(Eads and Lanbdin, 1973; Katz, 1979*) in fur and blood and their content is relatively stable (*Jenkins, 1979*).

It is known from studies on human hair as well as fur of some animal species that an increase of mineral content in the diet can cause an increase of their concentration in the hair, and a deficiency of the minerals can be detected in the hair. In earlier studies with mink significant correlations between feed and fur were found for calcium, magnesium, sodium and selenium (*Hornshaw et al., 1985; Mejborn, 1989; Hansen et al., 1992; Lohi and Jensen, 1991*). On the other hand Lohi and Jensen (1991) did not find significant correlation between the contents of zinc, copper and phosphor in feed and fur.

Fur samples can be cut painlessly and they are easy to store. Fur is therefore a very suitable material for research. However, in order to use fur as a measure for the nutritional or health condition of animals, it

is necessary to know the optimum concentration of elements in hair. From variations of this known concentration the lack or surplus can be detected or the health problems judged.

Other authors have reported that interactions between different minerals can exist and have an important role for mineral utilisation. Lohi and Jensen (1991) found an interaction between the content of Ca, Mg and P as one group and the content of Mg, Na and K as another group. In the present paper we report about analyses of correlation between different mineral elements in nutria fur based on a large investigation conducted at the Research Institute of Animal Production in Nitra (*Mertin et al.,1994a, b, c, 1995*).

Material and methods

The experiment was performed at the Fur Animal Farm of the Research Institute of Animal Production in Nitra. The animal material, feed and management conditions and sampling of fur and analysis methods are described in the earlier report of Hanusova et al. (2000) published elsewhere in this magazine. The statistical analyses of correlation between minerals presented in this paper are based on samples from about 80 animals divided evenly in two colour types, Greenland and Standard, and within colour types in both sexes. Each animal was sampled 3 times, at the age of 60, 135 and 240 days and each time two samples per animal were taken, from the back and belly respectively. Due to some missing values the total material includes about 400 fur samples.

For statistical analyses the programme package SAS (*SAS Inst. Inc. 1987*) was used. Correlation between mineral elements was analysed by Pearson correlation coefficients.

Results and discussion

The mean values of different mineral elements in nutria fur based on the total material are shown in Table 1. The arithmetic mean values per colour type, sex, age and body location are presented in earlier articles concerning this investigation *(Mertin et al.,1994a, b, 1995a; Hanusova et al., 1995*). In a report elsewhere in this issue we have discussed the effect of the four factors (colour type, age, sex and sample location) on the mineral content of the nutria fur (*Hanusova et al., 2000*).

Table 1. Basic variation and statistical characteristics of concentration of individual elements (mg/kg dry matter)

Element	n	%	SD
As	401	0.031	0.025
Br	374	7.735	4.735
Ca (%)	400	0.150	0.056
Cl (%)	404	0.059	0.034
Co	405	0.173	0.100
Cu	405	15.930	7.423
Cr	406	0.420	0.203
Fe	372	92.405	44.225
K (%)	406	0.105	0.054
Mn	404	42.349	14.330
P (%)	406	0.476	0.188
Pb	401	0.276	0.081
Rb	402	2.796	1.176
S (%)	405	8.096	1.588
Se	405	0.174	0.072
Sr	405	5.800	2.317
Ti	404	1.250	0.933
V	400	0.132	0.053
Zn	404	224.500	32.781
Zr	402	0.374	0.165

The interaction between different minerals is of great importance in the metabolism of mineral elements, and therefore it is necessary to pay attention also to this aspect (*Lohi and Jensen, 1991*). Correlation between minerals can also be used to trace deviations from normal conditions. In Table 2 are presented all correlation coefficients showing significant values. In altogether 93 cases (about half of the total) correlation between two minerals was significant.

Most correlation coefficients (Table 2) are fairly low and only 24 of them reach a value $r \geq 0.20$. The highest correlation coefficients were detected between Ca and Sr ($r = 0.52$) and between Br and Rb ($r = 0.42$).

It is interesting to notice that sulphur (S), which is involved in the amino acids methionine and cystine, and thus is important for the structure of fur, showed a negative relation to many other minerals. With eleven other elements the correlation was negative,

i.e. an increase of sulphur content caused a decrease in the content of another element. Positive correlation was found only in relation to calcium (Ca; r = 0.13, p < 0.01) and phosphor (P; r = 0.21, p< 0.001). Zinc and selenium are also supposed to be important for fur quality. Zinc showed significant correlation with Br, Co, Cu, K, Mn, Pb, Se, Ti (P < 0.01), and Rb, S, Zr (p < 0.05). For selenium significant positive correlation was found with As, Co, Cu, Mn, Pb, Rb, V, Zn (p < 0.001). Correlation between Se and Ca was negative (p < 0.01). Previous works dealing with problems of mineral elements in fur and/or in organs of fur animals are more or less aimed at the study of relations between the content of elements in feed and content of elements in fur and/or organ, and their mutual relation. In studies with mink Lohi and Jensen (1991) found a positive correlation between Se content in feed and mink hair. High levels of other minerals in the feed had a negative effect on Se concentration in fur. Generally more mutual relations between different minerals were found in nutria fur than reported by Lohi and Jensen (1991) for mink fur. They found a positive correlation between the levels of Ca, Mg, and P as one group and between Mg, Na, and K as an other group. We also found a significant correlation between the content of Ca and K (r = 0.20, p < 0.01) but could not document a significant relation between Ca and P.

Table 2. Correlation between some mineral elements in nutria fur

Mineral	Br	Ca	Cl	Co	Cr	Cu	Fe	K	Mn	P
As	.	-0.18***	.	0.14**	-0.15**	0.19***	.	.	0.14**	.
Br		.	.	.	.	.	.	0.17***	.	-0.10*
Ca			-0.19***	-0.18***	0.21***	-0.11*	.	0.20***	.	.
Cl				.	.	.	0.24***	0.32***	.	0.16**
Co					-0.15**	0.28***	.	.	0.34***	.
Cr						-0.29***	0.19***	0.16***	.	.
Cu							-0,12*	-0.13**	0.20***	.
Fe								0.36***	.	.
K									.	.
Mn										.

Mineral	Pb	Rb	S	Se	Sr	Ti	V	Zn	Zr	No[1]
As	-0.11*	0.11*	.	0.21***	.	.	.	.	.	8
Br	0.16**	0.42***	-0.17***	.	0.11*	.	.	0.17***	.	9
Ca	.	.	0.13**	-0.13**	0.52***	-0.15**	.	.	-0.17***	11
Cl	.	.	-0.15**	.	-0.18***	0.28***	.	.	.	8
Co	0.11*	0.11*	-0.13*	0.19***	.	0.15**	0.11*	0.14**	0.19***	13
Cr	0.19***	.	-0.12*	.	-0.15**	.	0.28***	.	.	10
Cu	.	0.17***	.	0.27***	0.26***	.	.	0.20***	0.13**	12
Fe	0.12*	.	-0.28***	.	-0.11*	.	.	.	.	7
K	0.14**	0.15**	-0.13**	.	.	.	0.12*	0.17***	.	11
Mn	0.16**	.	.	0.19***	.	.	0.12*	0.18***	.	7
P	.	.	0.21***	.	.	0.18***	.	.	.	4
Pb		0.26***	-0.16***	0.34***	0.17***	.	0.14**	0.23***	0.12*	14
Rb			-0.13**	0.28***	0.12*	.	0.14**	0.11*	0.15**	12
S				.	0.15**	.	.	-0.12*	-0.11*	13
Se					.	.	0.22***	0.16***	.	9
Sr						-0.10*	.	.	.	10
Ti							.	0.13**	.	6
V								.	.	7
Zn									0.13**	11
Zr										7

* = p<0.05; ** = p<0.01; *** = p<0.001

1. No = number of mineral elements showing significant correlation with this one

Conclusion

The correlation analyses have revealed several significant relations between the levels of different minerals in nutria fur. These relations can be due to mineral levels in the feed or metabolic interactions between minerals. Even though the feed of herbivorous animals is fairly constant it would be important to investigate the effect of feed on mineral content of nutria fur as well as the relation of minerals in fur with colour intensity and fur quality. The knowledge of interaction between mineral elements is important also for the study of mineral metabolism.

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