Original Report

Factors affecting the mineral composition of nutria fur (*Myocastor coypus*)

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Summary

The influence of colour type, sex and age (ontogenetic stage of fur cycle) on the concentration of As, Br, Ca, Cl, Co, Cr, Cu, Fe, K, Mn, P, Pb, Rb, S, Se, Sr, Ti, V, Zn, and Zr in nutria fur was studied in two body areas – the back (dorsal) and the belly (ventral). The concentration of elements was determined by the method of disperse roentgen fluorescent spectrometry. The results were evaluated statistically by means of the GLM model of the SAS statistical program (*SAS Inst. Inc. 1987*). The results showed good correlation between dorsal and ventral samples except for the minerals Co, Mn, P, Pb, V and Zr. Variation in all elements was large and only for Ca, K and S did the statistical model explain over 25% of the total variation. The following significant effects were found:

Effect of colour type on: As, Ca, Cl, Co, Cr, Cu, Rb, S, Se, Sr, Ti and Zr.
Effect of age of the animal on: Br, Ca, Cl, Cr, Cu, Fe, K, P, S, Sr and Zn.
Effect of sex on: Cl, Co, Cr, P, S, Sr and Ti.
Effect of sample location on: Br and K.

Introduction

Fur can be considered non-vital for the animal and changes in its chemical composition can thus give information about factors that influenced the animals during their growth. This property of fur can be used to control the feed composition, to optimise the mineral nutrition and to study the relations between the concentration of elements and performance indices. A precondition of such utilisation of fur is the knowledge of the normal variation of the element concentrations and genetic and environmental factors influencing it (*Mertin et al., 1990*). The number of works dealing with the concentration of mineral elements in fur increased with the development of analytical methods in chemistry. However, only a small part of them aimed at the study of concentration of elements in farm-raised fur animals. Tjurnina, 1981; Berestov et al., 1984; Lohi and Jensen, 1991; Mejborn, 1989 and Hansen et al., 1992 studied the content of mineral elements in carnivorous fur animals. The content of mineral elements in fur of herbivorous fur animals was not given much attention before the 1990's. Buleca and Sviatko (1991 a, b) were the first ones to study the content of mineral elements in nutria. Since then a large study has been conducted at the Research Institute of Animal Production in Nitra and arithmetic mean values of different minerals are given in reports by Mertin et al. (1994a,b, 1995a) and Hanusova et al. (1995). The genetic disposition as well as the environment (mainly nutrition) influence the quality and composition of fur in animals. With a precisely defined feed ratio the content of mineral elements in fur can be influenced mainly by genotype component, age, location etc. (colour of hair, ontogenetic stage of hair cycle, area of body etc.) (*Jarosz, 1993*). The aim of this study was to analyse effects of colour type, sex, age and dorsal/ventral location on the mineral content of nutria fur based on the data from the above mentioned studies at the Research Institute of Animal Production in Nitra.

Material and methods

The experiment was performed at the Fur Animal Farm of the Research Institute of Animal Production in Nitra. The animals were kept in cages with pools in a shed. They were fed pelleted feed mixture KK and they were given green feed – alfalfa or fodder beet as supplementary feed. The animals were clinically healthy and in optimum breeding condition.

There were approximately 20 nutria males and 20 nutria females of two colour mutations – Greenland and Standard - the exact number varying between age categories studied in the experiment. The experiment lasted 8 months. Fur samples were cut from two topological areas of body – middle of back and middle of belly under halothane narcosis. One sample consisted of approximately 2 g of fur. Fur samples were cut at individual stages of the fur cycle, the animals being 60, 135 and 240 days old. Before determination of element concentration, the fur samples were cleaned thoroughly and defatted. The disperse roentgen fluorescent spectrometry (*Tumanov and Stepanok, 1986*) was used to determine As, Br, Ca, Cl, Co, Cr, Cu, Fe, K, Mn, P, Pb, Rb, S, Se, Sr, Ti, V, Zn, and Zr in the fur samples. The concentration of the same chemical elements was also studied in the feeds. For data analyses the SAS statistical program package (*SAS Inst. Inc. 1987*) was used. The effect of colour type, sex, age and sample location was analysed by GLM procedure LSMEANS. The relation between ventral and dorsal samples was studied by Pearson correlation coefficients.

Results and discussion

A marked increase of certain elements in the feed can cause a higher concentration in the fur and the deficiency of some elements can be detected by fur analysis. Earlier investigations have shown that the concentration of mineral elements in the fur can be influenced by the ontogenetic stage of hair cycle, body area and hair colour (*Kossila et al., 1972; Berestov et al., 1985; Lohi, 1987*). With a constant mineral content in the feed these are the main factors influencing the mineral content of fur. In our study all animals were given the same feed ration during the experiment and thus the effect of feed was stabilised. The mineral content of feed materials is shown in Table 1.

Table 1. Arithmetic means of studied mineral elements in feed components (mg/kg dry matter)

Mineral	Alfalfa	KK	Fodder beet
Ca (%)	1,380	0,813	0,210
P (%)	0,630	0,403	0,471
K (%)	3,480	1,160	2,280
S (%)	0,170	0,023	0,078
Cl (%)	0,526	0,236	3,640
Fe	128,000	250,000	330,000
Zn	15,400	57,700	28,000
Sr	42,400	25,400	24,100
Cu	4,620	3,660	4,080
Br	7,920	3,340	6,780
Mn	34,800	39,300	31,900
Pb	1,040	0,700	1,380
Rb	3,240	3,580	24,000
Se	0,090	0,033	0,071
Co	0,060	0,070	0,160
Cr	0,495	0,589	1,300
As	0,072	0,056	0,093
Zr	3,120	2,630	3,710

KK – pelleted feed mixture

There was a large variation in the values of all elements studied. In most cases only a small part of this variation could be accounted for by the four factors: colour type, sex, age and location as can be seen from the R^2 values in Table 2. Thus either the error variation in general is high or there must be additional factors having influence on the mineral content in fur.

Effect of colour type

The lsmeans values for each colour type are presented in Table 2. The effect of colour type was significant for the concentration of As, Ca, Cl, Co, Cr, Cu, Rb, S, Se, Sr, Ti and Zr. The difference between colour types can be related to the type and amount of melanin in the fur. However, in our material no information about colour intensity of individual animals was available and thus only the simple effect of colour type could be studied. Lohi and Jensen (1991) found that the colour intensity of hair influenced the concentration of some elements in scanblack mink hair.

Table 2. Minerals in nutria fur in relation to colour type. Least square means ! standard error. In mg/kg; Ca, Cl, K, P and S in %..

Mineral		Colour type Greenland	Standard	Significant differences	R^2
		lsmean ! s.e.	lsmean ± s.e.		
As	mg/kg	0.036 ! 0.002	0.025 ± 0.002	***	0.07
Br	mg/kg	7.170 ! 0.345	7.324 ± 0.322		0.10
Ca	%	0.109 ! 0.003	0.187 ± 0.003	***	**0.55**
Cl	%	0.066 ± 0.002	0.053 ± 0.002	***	**0.15**
Co	mg/kg	0.199 ± 0.007	0.145 ± 0.007	***	0.12
Cr	mg/kg	0.370 ± 0.013	0.470 ± 0.013	***	**0.18**
Cu	mg/kg	16.85 ± 0.49	14.67 ± 0.48	***	**0.16**
Fe	mg/kg	93.79 ± 3.04	92.77 ± 3.03		**0.15**
K	%	0.104 ± 0.003	0.105 ± 0.003		**0.27**
Mn	mg/kg	43.17 ± 1.00	41.05 ± 0.96		0.01
P	%	0.496 ± 0.013	0.476 ± 0.012		**0.15**
Pb	mg/kg	0.277 ± 0.006	0.273 ± 0.006		0.03
Rb	mg/kg	2.965 ± 0.083	2.596 ± 0.079	***	0.06
S	%	7.910 ± 0.094	8.434 ± 0.090	***	**0.33**
Se	mg/kg	0.199 ± 0.005	0.170 ± 0.005	***	0.05
Sr	mg/kg	4.995 ± 0.151	6.409 ± 0.145	***	**0.19**
Ti	mg/kg	1.465 ± 0.064	1.088 ± 0.062	***	0.10
V	mg/kg	0.134 ± 0.004	0.131 ± 0.004		0.03
Zn	mg/kg	227.6 ± 2.29	220.4 ± 2.20		0.07
Zr	mg/kg	0.410 ± 0.012	0.335 ± 0.011	***	0.07

* = p<0.05 ** = p<0.01 *** = p<0.01
R^2 = the fitness of GLM model

Ontogenetic stage of fur cycle (animal age)
The effect of age is shown in Table 3. The age of the animals (i.e. the ontogenetic stage of fur cycle) influenced mainly the concentration of Br, Ca, Cl, Cr, Cu, Fe, K, P, S, Sr, Zn. The concentration of Br, Ca, Cl, Cr, Fe, K and Zn decreased with age, whereas the amount of S increased with age.

Effect of sex
Significant difference between males and females was found only for Cl, Co, Cr, Cu, P, S, Sr and Ti (Table 4). No explanation for sex difference has been found in earlier literature.

Difference between back and belly samples
The correlation between back and belly samples of fur was significant for all elements except Co, Mn, P, Pb V and Zr (Table 5). The reason for discrepancy in these cases is not known. For Ca, Cl, Fe and K the content was higher in the dorsal samples than in samples from belly. Ventral values were on average higher for Br, Cu, Mn, Sr, Ti and Zn. The effect of sample location was highly significant only for Br and K.

Table 3. Minerals in nutria fur in relation to the age of animal. Least square means ! standard error.

Mineral		Age of animals 1 = 60 days	2 = 135 days	3 = 240 days	Significant differences		
		lsmean ± s.e.	lsmean ± s.e.	lsmean ± s.e.	1-2	1-3	2-3
As	mg/kg	0.029 ± 0.002	0.035 ± 0.002	0.029 ± 0.002			
Br	mg/kg	8.300 ± 0.427	7.837 ± 0.387	5.604 ± 0.422		***	***
Ca	%	0.165 ± 0.003	0.152 ± 0.003	0.128 ± 0.004	**	***	***
Cl	%	0.068 ± 0.003	0.055 ± 0.003	0.056 ± 0.003	***	**	
Co	mg/kg	0.168 ± 0.008	0.189 ± 0.008	0.158 ± 0.009			
Cr	mg/kg	0.497 ± 0.016	0.367 ± 0.016	0.398 ± 0.017	***	***	
Cu	mg/kg	14.05 ± 0.58	17.48 ± 0.58	15.75 ± 0.64	***	*	*
Fe	mg/kg	113.37 ± 3.83	93.26 ± 3.54	73.22 ± 3.88	***	***	***
K	%	0.133 ± 0.004	0.098 ± 0.004	0.082 ± 0.004	***	***	**
Mn	mg/kg	42.32 ± 1.17	42.71 ± 1.17	41.29 ± 1.29			
P	%	0.471 ± 0.015	0.431 ± 0.015	0.554 ± 0.016		***	***
Pb	mg/kg	0.291 ± 0.007	0.276 ± 0.007	0.258 ± 0.007		**	
Rb	mg/kg	2.983 ± 0.097	2.806 ± 0.097	2.552 ± 0.107		**	
S	%	7.165 ± 0.110	8.120 ± 0.111	9.232 ± 0.121	***	***	***
Se	mg/kg	0.183 ± 0.006	0.187 ± 0.006	0.182 ± 0.007			
Sr	mg/kg	5.533 ± 0.176	6.571 ± 0.177	5.001 ± 0.195	***	*	***
Ti	mg/kg	1.409 ± 0.075	1.123 ± 0.075	1.299 ± 0.083	**		
V	mg/kg	0.142 ± 0.005	0.127 ± 0.004	0.128 ± 0.005	*	*	
Zn	mg/kg	230.5 ± 2.67	228.0 ± 2.69	213.5 ± 2.96		***	***
Zr	mg/kg	0.390 ± 0.013	0.359 ± 0.014	0.368 ± 0.015			

* = p<0.05 ** = p<0.01 *** = p<0.01

Table 4. Minerals in nutria fur in relation to sex and body location. Least square means ! standard error. In mg/kg ; Ca, Cl, K, P and S %

Mineral	Sex Females	Males	Significant	Body location Dorsal	Ventral	Significant
	lsmean ± s.e.	lsmean ± s.e.	differences	lsmean ± s.e.	lsmean ± s.e.	differences
As	0.033 ± 0.002	0.029 ± 0.002		0.029 ± 0.002	0.033 ± 0.002	
Br	7.581 ± 0.323	6.913 ± 0.353		6.244 ± 0.323	8.250 ± 0.343	***
Ca %	0.147 ± 0.003	0.150 ± 0.003		0.154 ± 0.003	0.143 ± 0.003	**
Cl %	0.050 ± 0.002	0.069 ± 0.002	***	0.063 ± 0.002	0.056 ± 0.002	*
Co	0.191 ± 0.006	0.153 ± 0.007	***	0.174 ± 0.007	0.170 ± 0.007	
Cr	0.381 ± 0.013	0.460 ± 0.014	***	0.418 ± 0.013	0.423 ± 0.013	
Cu	14.05 ± 0.58	14.05 ± 0.58		17.48 ± 0.58	15.75 ± 0.64	
Fe	88.83 ± 2.84	97.74 ± 3.35	*	95.26 ± 3.03	91.31 ± 3.03	
K %	0.100 ± 0.003	0.108 ± 0.004		0.122 ± 0.003	0.087 ± 0.003	***
Mn	42.85 ± 0.94	41.37 ± 1.04		41.52 ± 0.98	42.70 ± 0.98	
P %	0.421 ± 0.012	0.550 ± 0.013	***	0.490 ± 0.012	0.482 ± 0.012	
Pb	0.274 ± 0.005	0.276 ± 0.006		0.272 ± 0.006	0.278 ± 0.006	
Rb	2.953 ± 0.078	2.607 ± 0.086	**	2.743 ± 0.081	2.817 ± 0.081	
S %	7.763 ± 0.089	8.581 ± 0.098	***	8.191 ± 0.092	8.154 ± 0.092	
Se	0.191 ± 0.005	0.178 ± 0.005		0.184 ± 0.005	0.185 ± 0.005	
Sr	6.148 ± 0.142	5.255 ± 0.158	***	5.445 ± 0.148	5.958 ± 0.148	*
Ti	1.068 ± 0.060	1.486 ± 0.067	***	1.239 ± 0.063	1.315 ± 0.063	
V	0.128 ± 0.004	0.136 ± 0.004		0.134 ± 0.004	0.131 ± 0.004	
Zn	224.9 ± 2.15	223.1 ± 2.41		220.6 ± 2.25	227.5 ± 2.24	*
Zr	0.392 ± 0.011	0.353 ± 0.012	*	0.370 ± 0.011	0.375 ± 0.011	

* = p<0.05 ** = p<0.01 *** = p<0.01

Table 5. Correlation between dorsal and ventral samples in mineral content of nutria fur.
Pearson correlation coefficients

Mineral	Correlation dorsal/ventral	Significance
As	0.22	***
Br	0.45	***
Ca	0.62	***
Cl	0.43	***
Co	0.12	
Cr	0.40	***
Cu	0.41	***
Fe	0.60	***
K	0.58	***
Mn	0.13	
P	0.17	*
Pb	0.11	
Rb	0.40	***
S	0.72	***
Se	0.25	***
Sr	0.45	***
Ti	0.23	***
V	0.15	*
Zn	0.51	***
Zr	0.07	

Conclusions

If the influences of feed ration and rearing conditions are standardised, the concentrations of most elements in fur depend on the genotype and the stage of fur development. In some minerals differences between sexes can occur.

The correlation between samples from the dorsal (back) and ventral (belly) parts of the body is generally good meaning that samples from one standard location of the animals would be enough to make comparisons between animal groups. However, the lacking correlation in minerals Co, Mn, P, Pb V and Zr needs further studies.

As the four factors analysed in this study only explain a minor part of the total variation further studies on other factors are still required.

References

Berestov, V.A., Tjurnina, N.V., Tjutjunnik, K.N. 1985: Mineral composition of mink and fox hair. Institute of biology, Academy of Sciences of the USSR, Petrozavodsk.

Buleca, J. and Sviatko, P. 1991 a: Minerálny profil makroelementov vkrvi a srsti nutrií. In: Zbor. Ref. Ved. Symp. „Produkcia a zdravie v chove kož ušinových zvierat, ZSVTS, Košice, p. 34-35.

Buleca, J. and Sviatko, P. 1991 b: Analýza mikroelementov v srsti nutrií. In: Zbor. Ref. Ved. Symp. „Produkcia a zdravie v chove kož ušinových zvierat, ZSVTS, Košice, p. 93-94.

Hansen, N. E., Glen-Hansen, N., Jorgensen, G. 1992: Effects of dietary calcium – phosphorus ratio on growth, skin length and quality in mink (Mustela vison). Scientifur, 16, 4, p. 293-297.

Jarosz, S. 1993: Hodowla zvierzat futerkowych. Wydawnictwo naukowe PWN. Warszawa-Krakow, p. 274

Kossila, V., Virtanen, E., Hakatie, H. and Luoma, E. 1972: Calcium, magnesium, sodium, potassium, zinc, iron, copper and manganese in the hair and in the mane of the horses. Journal of the Scientific Agricultural Society of Finland 44, p. 207-216.

Lohi, O. 1987: Mineralindhold i minkhår i relation til pelsegenskaber. Scandinavian Association of Agricultural Scientists (NJF). Report No. 33, Oslo. Norway.

Lohi, O. and Jensen, L.V. 1991: Mineral composition of mink feed and hair. National Institute of Animal Science, Report 688, p. 99-114.

Mejborn, H. 1989: Effect of copper addition to mink feed during the growth and moulting period on growth, skin production and copper retention. Scientifur, 13, 3, p. 229-234.

Mertin, D., Rafay, J., Stepanok, V. 1990: Koncentrácia niektorých minerálnych prvkov v srsti strieborných líšok vobdobí kož ušinovej zrelosti. Pol´nohosp. 36, 9, p. 830-836.

Mertin, D., Süvegová, K., Oravcová, E. and Stepanok, V. 1994 a: Concentration of some trace elements in the fur of standard nutria during ontogenesis. Scientifur, 18, p. 161-164.

Mertin, D., Süvegová, K., Oravcová, E. and Stepanok, V. 1994 b: Concentration of some macroelements in the fur of standard nutria during ontogenesis. Scientifur, 18, p. 165-168.

Mertin, D., Hanusova, E., Süvegová, K., and Stepanok, V. 1995 a: Concentration of some macroelements in the fur of greenland nutria during ontogenesis. Scientifur, 19, p. 107-110.

Hanusova, E., Mertin, D., Süvegová, K., and Stepanok, V. 1995: Concentration of some trace elements in the fur of greenland nutria during ontogenesis. Scientifur, 19, p. 277-280.

Mertin, D., Hanusová, E., Süvegová, K. and Stepanok, V. 1995 b: Koncentrácia niektorých mikroelementov v srsti grönlandských nutrií v priebehu ontogenézy.. Živ. výroba, 40, p. 115-118.

SAS Institute Inc., 1987. SAS/STAT guide for Personal Computers Ver. 6. Edition, Cary, NC, 1028 p.

Tjurnina, N.V. 1981: Sezonnyje izmenenia v soderž anii mineralnych vešcestv vvolosjanom pokrove vualevych pescov. In: Biologia i patologia pušnych zverej. Tez. dokl. 3. vsesojuz. nauc. konf., Petrozavodsk, p. 101-102.

Tumanov, I., and Stepanok, V. 1986: Metodiceskije ukazanija po ispolzovaniu otecestvennoj apparatury pri prevedenii energo-dispercionnogo-rentgeno-fljurescentnogo analiza polvennych obrazcov i biomaterialov (metodiceskije ukazanija). Vserosij. naucno-issled. inst. selchoz. ispolzov. meliorov. zemel, Kalinin. 31 pp.