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ASSESSMENT OF SELENIUM (Se) CONCENTRATION IN SELECTED ORGANS OF RANCH MINK (*MUSTELA VISON*)

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Abstract. The aim of the study was to determine selenium concentration in the liver, kidneys and spleen of ranch mink (*Mustela vison*) (n = 25). Selenium concentration in samples was determined spectrofluorimetrically using 2,3-diaminonaphtalene (DAN). Concentration of Se in the liver, kidneys and spleen averaged 0.38 ± 0.09, 1.18 ± 0.21 and 0.30 ± 0.07 $\mu g \cdot g^{-1}$ wet weight, respectively. Kidney Se concentration was significantly ($P < 0.05$) higher than in liver and spleen. In view of scarce literature data concerning selenium content in farmed mink organs and no reference values it is difficult to conclude whether the Se levels obtained fall within the optimum range for these animals. Higher Se concentration in kidney than liver may indicate selenium deficiency. It seems necessary to continue research in order to establish reference values for this species.

Key words: American mink, kidney, liver, selenium, spleen

INTRODUCTION

Selenium is one of the basic trace elements affecting the growth and development of animals. As an essential component of animal organisms, this element is found in all tissues, with the highest concentrations in the liver and kidneys and also in spleen as selenoprotein W [Kuczyńska and Biziuk 2007]. Selenium-deficient animals are affected with reproductive disorders, muscular dystrophy, dietary hepatic necrosis, mulberry heart disease and diarrhoea, as well as increased incidence of disseminated hepatic necrosis, fetal death due to fetal growth abnormalities, and placental retention [Bostedt and Schramel 1990, McGuire et al. 1993, Grela and Sembratowicz 1997, Ramisz et al. 1997, Radostits et al. 2000].

For decades, selenium has been considered a toxic element [Rosenfeld 1964, Danch 1991]. It was not until the 1960s that selenium was discovered to play important roles in the body and today it is ranked among trace elements of great importance to animals and humans [Żbikowska 1997, Rayman 2000, Dębski et al. 2001]. Selenium has been ascribed an an-

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tioxidant role due to its presence in the molecule of glutathione peroxidase (GSH-Px), which is found in many tissues and bodily fluids. High GSH-Px activity was found in reproductive organs. Along with vitamin E, this enzyme protects cellular and subcelullar membranes against the harmful effect of reactive oxygen species [McKenzie et al. 2002, Musik et al. 2003].

Because of low environmental concentration of selenium in Poland, many animals are ill as a result of dietary selenium deficiency. The low selenium content of feeds has an adverse impact on animals, leading to degeneration of some organs (e.g. heart and liver) and abnormal development of hard tissues such as teeth, pelage and feathers. Selenium-deficient organisms have lower concentrations of this element in all tissues [Gabbedy et al. 1977, Pinkiewicz et al. 1986, Radostits et al. 2000].

In Poland and throughout the world, research on Se concentrations focused mainly on farm animals whose meat is used for consumption. Studies on selenium concentration in the tissues of fur animals, in particular mink, are scarce and mainly concern mink living in the wild [Stejskal et al. 1989, Harding et al. 1998, Gamberg et al. 2005, Basu et al. 2007].

In fur animals, selenium plays a considerable role through its positive effects on reproduction, improved body condition and resistance of animals, thus limiting the incidence of diseases and impinging on profitability of breeding [Hanusova et al. 2000, Flohè 2007]. No minimum selenium requirement has been determined for mink [NRC 1982].

The aim of the study was to determine selenium (Se) concentration in the liver, kidneys and spleen of ranch mink (*Mustela vison*).

MATERIALS AND METHODS

Subjects were 25 pearl American mink (*Mustela vison*) with light beige fur, produced on a farm as a result of crossing platinum, silver blue mink with palomino mink. Mink were fed fish scraps, poultry waste and protein and vitamin concentrates. Samples of liver, kidneys and spleen were subjected to chemical analysis.

Selenium content was determined spectrofluorimetrically according to Grzebuła and Witkowski [1977] method. Samples of organs (0.5–1.5 g) were wet mineralized in concentrated HNO_3 (230°C per 180 min) and $HClO_4$ (310°C per 20 min). Mineralized samples were hydrolyzed using 9% HCl to reduce selenates (Se VI) to selenites (Se IV). Selenites were then complexed with 2,3-diaminonaphtalene (Sigma) and the complex obtained was extracted with cyclohexane (Chempur). Fluorescence was determined in the organic (cyclohexane) layer using an emission wavelength of 518 nm and an excitation wavelength of 378 nm. Accuracy of the analytical method was determined using reference material BCR–185R (bovine liver) from the European Commission Joint Research Centre Institute for Reference Materials and Measurements (LGC Standards GmbH, Germany). The Se concentration was 87–96% of the reference value.

The results were analysed statistically using Statistica® 7.1 and arithmetic means, medians and standard deviations were calculated. Significant differences were determined based on Student's t-test.

RESULTS AND DISCUSSION

Fertility disorders are of major economic importance to fur farming. Selenium deficiency increases the incidence of periparturient complications, abortions and stillbirths. The number of normal births increases after correction of this deficiency [Bostedt and Schramel 1990]. In addition, dietary deficiency of some minerals, including selenium, has an adverse influence on fur quality and colour [Lohi and Jensen 1991, Hanusova et al. 2000].

Mean selenium concentrations in the liver, kidneys and spleen of ranch American mink (*Mustela vison*) are given in Table 1.

Table 1. Selenium concentration in organs of mink (*Mustela vison*)
Tabela 1. Stężenie selenu w narządach norek (*Mustela vison*)

Organ Narząd	N	Selenium concentration, μg·g^{-1} wet weight Stężenie selenu, μg·g^{-1} mokrej masy				
		min.	max.	mean średnia	SD	median mediana
Liver Wątroba	25	0.14	0.62	0.38[a]	0.09	0.40
Kidney Nerka	25	0.80	1.76	1.18[b]	0.21	1.16
Spleen Śledziona	25	0.18	0.48	0.30[a]	0.07	0.30

a; b – different letters indicate significance of differences, $P < 0.05$.
a; b – różne litery wskazują różnice statystycznie istotne, $P < 0,05$.

Of all the organs studied, the kidneys had the highest Se concentration of 0.8–1.76 μg · g^{-1} w.w. (1.18 ± 0.21 μg · g^{-1} w.w. on average). This result is comparable with that of Halbrook et al. [1996], who found that Se concentration in the kidneys of wild mink living in Illinois was 1.75 μg · g^{-1} wet weight. Harding et al. [1998] reported that Se concentration in mink inhabiting the Kootenay River area (USA) averaged 4.0 ± 1.23 μg · g^{-1} d.m.

In our study, we observed that most kidney samples had Se content ranging from 1.0 to 1.2 μg · g^{-1} w.w. (Table 2). These samples formed 44% of all kidneys studied. Concentrations above 1.4 μg · g^{-1} w.w. were found in 36% of kidney samples.

Table 2. Percentage and proportion of samples of mink organs with specific Se concentration
Tabela 2. Procentowy i liczbowy udział próbek narządów norek o określonym stężeniu selenu

Organ Narząd	Proportion [% (n)] of samples with specific Se concentration, μg·g^{-1} wet weight Udział próbek [% (n)] o określonym stężeniu Se, μg·g^{-1} m.m.		
Liver Wątroba	below – poniżej 0.3 12 (3)	0.3 – 0.6 84 (21)	above – powyżej 0.6 4 (1)
Kidney Nerka	below – poniżej 1.0 20 (5)	1.0 – 1.2 44 (11)	above – powyżej 1.4 36 (9)
Spleen Śledziona	below – poniżej 0.2 4 (1)	0.2 – 0.4 88 (22)	above – powyżej 0.4 8 (2)

Analysis of liver selenium content showed that the concentration of this element in fresh matter of mink liver was several-fold lower than in kidneys and ranged from 0.14 to 0.62 μg · g^{-1} (0.38 ± 0.09 μg · g^{-1} w.w. on average), with significant ($P<0.05$) differences. The concentrations obtained are much lower than those reported by Gamberg et al. [2005], who found liver selenium concentration to average 1.40 ± 0.84 μg · g^{-1} w.w. in 98 wild mink (*Mustela vison*) from Yukon. Our data revealed that Se content ranged from 0.3 to 0.6 μg · g^{-1} w.w. in 84% of the analysed liver samples and exceeded 0.6 μg · g^{-1} w.w. in only 4% of the samples.

Mean selenium concentration in spleen, in which it appears as selenoprotein W, ranged from 0.18 to 0.48 μg · g^{-1} w.w. (0.30 μg · g^{-1} w.w. on average). The selenium concentration in spleen was comparable with that observed in the liver, but it was significantly ($P < 0.05$) lower than in kidneys.

For lack of reference data, the ratio of this element in kidneys and liver can serve as an indicator of selenium deficiency in animals. As reported by Oh et al. [1976], animals exposed to dietary Se deficiency have higher Se levels in kidneys than in the liver. The same authors observed an opposite situation when animals were given selenium-rich feeds, because the concentration of this element was higher in the liver than in kidneys. In our study, we found selenium concentration in the kidneys of analysed mink to be approximately three times that in the liver, which allows a conclusion that mink were given Se-deficient diets and their bodies had Se deficiency.

When investigating selenium levels in wild mink, Norheim et al. [1984] detected selenium in only 35 out of 71 animals analysed.

Stejskal et al. [1989], who examined the concentration of this element in the diet, liver and kidneys of ranch mink found selenium neither in the diet (although it contained poultry meat, fish and selenium-rich beef offal) nor in the organs (the limit of detection for the analytical method used was 4 μg · g^{-1}). In our study, we did not analyse selenium content in the feeds offered to mink.

CONCLUSIONS

In view of scarce literature data concerning selenium content in mink organs and no reference values, it is difficult to conclude whether the Se levels obtained fall within the optimum range for these animals. Assuming that Se deficiency is when the ratio of Se concentration in kidneys and liver is greater than 1 ($[Se]_{kidney}/[Se]_{liver}>1$), it can be stated that the analysed mink had Se deficiency, which was probably due to inadequate amounts of this element in the diet or the fact that Se was poorly available.

It would be advisable to study selenium concentrations in mink bodies and feeds while analysing reproductive parameters. This would make it possible to establish reference values for these animals.

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OCENA STĘŻENIA SELENU (Se) W WYBRANYCH NARZĄDACH NOREK (*MUSTELA VISON*) Z CHOWU FERMOWEGO

Streszczenie. Celem pracy było określenie stężenia selenu (Se) w wątrobie, nerkach i śledzionie norek (*Mustela vison*) (n = 25) pochodzących z chowu fermowego. Zawartość selenu oznaczano metodą spektrofluorymetryczną przy użyciu 2,3-diaminonaftalenu (DAN). W wyniku przeprowadzonych badań stwierdzono, że średnie stężenie selenu w wątrobie, nerkach i śledzionie wynosiło odpowiednio: 0,38 ± 0,09 μg · g^{-1}, 1,18 ± 0,21 μg · g^{-1} i 0,30 ± 0,07 μg · g^{-1} mokrej masy. Stężenie selenu w nerkach było istotnie wyższe ($P < 0,05$) niż w wątrobie i śledzionie. Ze względu na nieliczne dane literaturowe, dotyczące stężenia selenu w narządach norek fermowych i brak wartości referencyjnych, trudno jest dokonać jednoznacznej oceny, czy stwierdzona zawartość tego pierwiastka mieściła się w zakresie, który można byłoby przyjąć za optymalny. O niedoborze selenu może świadczyć wyższe stężenie tego pierwiastka w nerkach niż w wątrobie. Konieczne wydaje się prowadzenie dalszych badań, umożliwiających ustalenie wartości referencyjnych dla tego gatunku.

Słowa kluczowe: nerka, norka amerykańska, selen, śledziona, wątroba

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