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## SELENIUM CONTENT IN HARD AND SOFT HAIR OF SILESIAN AND HOLSTEIN RACE HORSES

### ZAWARTOŚĆ SELENU W SIERŚCI TWARDEJ I MIĘKKIEJ KONI RASY ŚLĄSKIEJ I HOLSZTYŃSKIEJ

**Abstract:** Hair samples were collected from the Silesian (Poland) and Holstein (Germany) horses. The samples were taken from tail and mane as well as sides of the body. Total and assimilated content of selenium(Se) were determined. Element content was from 76.1 to 1343.7  $\mu\text{g} \cdot \text{kg}^{-1}$ .

The obtained results showed a significant difference between content of element among hard and soft hair of both types of horses. It was not found however the exceeding of Se content reference value in horses' hair.

**Keywords:** horses, hair, selenium

Selenium(Se) is the element which is a component of many enzymes participating in important metabolic processes in animals. The biological function of Se is connected with its presence in glutathionperoxidase, being an cellular membranes lipid anti-oxidant, playing similar role to vitamin E ( $\alpha$ -tocopherol). Selenium is also the component of other oxidoreductive enzymes and cytochromes taking part in cells metabolism [1].

Selenium deficiency decreases the circulatory and immunological systems efficiency, causes liver necrosis and thyroid hypofunction. It can also be the factor enlarging the risk of neoplastic diseases. Se excess causes anemia, atrophy, damage of skin formation (hair, nails) or blindness. All of them are the symptoms of alkaline disease – selenosis [2].

The quantity of element is correlated with its content in air, soil or food (fodder). It is possible to detect its presence on animals' body surface. Selenium is also accumulated

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“inside” – blood, in pulpous organs tissues or in hair. Persons who are vegetarians or pastured animals have usually small content of Se in their internal tissues [3, 4].

The toxicological analysis of classic biological materials, like blood or pulpous organs fragments gives only temporary values of studied elements [5]. The time aspect of their concentration changeability is lost in such investigations. The epidermis products like feather or hair have not got this “defect”, because of keratin protection. It prevents the loss of components as well as the penetration of the dirt. Thanks to this the hair is “chemically solid” [6, 7].

Another advantage of hair analysis is the low invasiveness of material collecting process, which permits easy opinion about animals’ health. Hair guarantees good accumulation of the elements (tissue deposit). There is mainly slow and one-way transport of mineral compounds. Hair mineral composition is not changed in short terms like hours or days [8].

The hair investigations can be a reliable source of information, alternative for blood, urine, milk or special liquids investigation [9].

Aim of work was estimation of Se content in hard and soft fur of Silesian and Holstein horses in different breeding environments.

## Material and methods

Hair samples derived from hard and soft hair of Silesian and Holstein horses. Animals came from a farm on the suburbs of Wrocław (Poland) – Silesian horses and from a farm near Schlezwig (northern Germany) – Holstein horses. The investigations were carried out on 12 Silesian and 10 Holstein horses.

The animals were kept in boxes, on bedding, with possibility of everyday playground on circular. Feeding was typical – hay, oat, pithy mixture and vitamin-mineral supplements [10]. Horses were used for riding and recreation. All animals represented a group of young horses (below 7 years old).

Two kinds of hair were taken from each animal – from tail and mane (hard and long hairs, irreplaceable annually) as well as from body sides (soft and short hair, replaceable every year). Hair samples were packed in paper envelopes and marked by codes.

Samples were cleaned initially as well as divided into 2 groups. One of them was washed, fat was removed in demineralised water with detergent addition, and finally material was rinsed 3 times. Washed hair was kept in normal temperature under perforated cover to dry. It was assumed, that Se quantity determined in it was assimilated quantity (related to hair structure).

Second part of hair samples was not washed. Se concentration in this group was qualified as total (the finding element in this type of hair was related both to the hair structure and to “external” environmental).

All samples were additionally crumbled and homogenized. Finally, prepared materials were ready for mineralization in microwave stove MARS-5.

1500.0 mg of material was put to special teflon containers. 5 cm<sup>3</sup> of concentrated nitric(V) acid 1:1 (Suprapur by SIGMA) was poured into all containers. After

mineralization liquid samples were transferred to clean PP test-tubes (Falcon type). Addition of HCl (Suprapur by SIGMA) caused Se reduction to 4th oxidation state.

Se concentration in investigated solutions was measured by the pair of hydrides generation method in the SpectrAA 220 FS apparatus (Varian).

The results were verified statistically (calculation of average values, standard deviations, significance of differences) using Statgraphic ver. 5.0 and GraphPad Prism ver. 5.1.

## Results and discussion

The Se contents in hard and soft fur were given in Tables 1 and 2.

Table 1

Content of Se in hard fur [ $\mu\text{g} \cdot \text{kg}^{-1}$ ]

	Total content		Assimilated content	
	$x \pm s$	range	$x \pm s$	range
Silesian horses	$356.9^a \pm 84.6$	220.0–498.8	$264.8^a \pm 63.2$	157.0–376.8
Holstein horses	$847.2^b \pm 232.7$	503.1–1343.7	$661.8^b \pm 218.7$	400.9–1024.5

a-b –  $p \leq 0.01$  (between races).

Table 2

Content of Se in soft fur [ $\mu\text{g} \cdot \text{kg}^{-1}$ ]

	Total content		Assimilated content	
	$x \pm s$	range	$x \pm s$	range
Silesian horses	$298.9^a \pm 34.7$	212.9–329.8	$224.9^a \pm 34.7$	195.0–309.9
Holstein horses	$156.0^b \pm 59.8$	104.6–278.5	$111.6^b \pm 47.0$	76.1–224.6

a-b –  $p \leq 0.01$  (between races).

The selenium content in hard hair (from tail and mane) was from 220.0 to 1343.7  $\mu\text{g} \cdot \text{kg}^{-1}$ . Holstein horses hair had average Se total quantity twice higher than Silesian ones ( $p \leq 0.01$ ). Average of element assimilated content was from 157.0 to 1024.4  $\mu\text{g} \cdot \text{kg}^{-1}$ . This quantity was also twice higher in Holstein horses' hair ( $p \leq 0.01$ ). It is important that differences between total and assimilated content of Se for both races were 25.8 % and 21.9 % respectively.

In soft hair (from body sides) Se content was from 104.6 to 329.7  $\mu\text{g} \cdot \text{kg}^{-1}$ . Se average total quantity in Holstein horses' hair was much lower than in Silesian ones ( $p \leq 0.01$ ). Average of element assimilated content was from 76.1 to 309.9  $\mu\text{g} \cdot \text{kg}^{-1}$ . This quantity was twice higher in Silesian horses' hair ( $p \leq 0.01$ ). Differences between total and assimilated content of Se for both races were 24.8 % and 28.5 % respectively. It results from environmental influences.

Comparison of Se total and assimilated concentration between hard and soft hair does not show any significant differences for Silesian race ( $p \leq 0.05$ ), but for Holstein horses this kind of differences were highly significant ( $p \leq 0.01$ ). Moreover, average assimilated Se content for both kind of hair was varied for Silesian horses ( $244.8 \mu\text{g} \cdot \text{kg}^{-1}$ ) and Holstein ones ( $386.6 \mu\text{g} \cdot \text{kg}^{-1}$ ). It confirms better Se supply in German horses.

Detected Se contents in horse hair were approximate to values given for healthy horses living in non contaminated regions by Dunnett and Lees [5] –  $370 \mu\text{g} \cdot \text{kg}^{-1}$ , Goullé et al [9] –  $870 \mu\text{g} \cdot \text{kg}^{-1}$ , Hintz [11] –  $700 \mu\text{g} \cdot \text{kg}^{-1}$  as well as by Asano et al [12] –  $581 \mu\text{g} \cdot \text{kg}^{-1}$ .

However Polish scientists Budzyska et al [13] and Budzynski et al [14] give much lower values –  $160\text{--}162 \mu\text{g} \cdot \text{kg}^{-1}$  in hair of Arabian horses (it shows probably deficiency of Se in feed and environment).

The analysis of Se content in hair of both horse groups shows an essential difference of the content of analysed element between them. It shows influence of environment, feeding and race (genotype). It was not affirmed overcrossing of Se content reference value in horses' hair passed by Asano et al [15] –  $1302.5 \mu\text{g} \cdot \text{kg}^{-1}$ .

## References

- [1] Niedzielski P., Siepak M. and Siepak J.: *Występowanie i zawartości arsenu, antymonu i seleniu w wodach i innych elementach środowiska*, Roczn. Ochr. Środow. 2000, **2**, 317–341.
- [2] Seńczuk W.: *Toksykologia*, PZWL, Warszawa 1990.
- [3] Spallholtz J., Boulan L., Palace V., Chen J., Smith L., Rahman M. and Robertson D.: *Arsenic and selenium in human hair*, Biol. Trace Elem. Res. 2005, **106**, 133–144.
- [4] Christodouloupoulos G., Roubies N., Karatzias H. and Papasteriadis A.: *Selenium concentration in blood and hair of Holstein dairy cows*, Biol. Trace Elem. Res. 2003, **91**, 145–150.
- [5] Dunnett M. and Lees P.: *Trace element, toxin and drug elimination in hair with particular reference to the horse*, Res. Vet. Sci. 2003, **75**, 89–101.
- [6] Maia L., de Souza M.V., Bragança R., Fernandes A., Fontes M., de Souza M.W. and Luz W.: *Heavy metals in horse blood, serum, and feed in Minas Gerais, Brazil*, J. Equine Vet. Sci. 2006, **26**, 578–583.
- [7] Taylor A., Branch S., Day M., Patriarca M. and White M.: *Clinical and biological materials, foods and beverages*, J. Anal. At. Spectrom. 2007, **22**, 415–456.
- [8] Wickstrom M. and Blakley B.: *Equine Toxicoses. Investigative strategies and approaches for performance horses*, Clin. Tech. Equine Pract. 2002, **1**, 53–57.
- [9] Goullé J.P., Mahieu L., Castermant J., Neveu N., Bonneau L., Lainé G., Bouige D. and Lacroix Ch.: *Metal and metalloids multi-elementary ICP-MS validation in whole blood, plasma, urine and hair*, Forensic Sci. Int. 2005, **153**, 39–44.
- [10] Fedorski J.: *Poradnik dla hodowców i miłośników koni*, PWRiL, Warszawa 2007.
- [11] Hintz H.F.: *Hair analysis as an indicator of nutritional status*, Nutric. Sci. 2000, **21**, 11.
- [12] Asano K., Suzuki K., Chiba M., Sera K., Asano R. and Sakai T.: *Relation between trace element in mane hair and atrial fibrillation in horse*, J. Vet. Med. Sci. 2006, **68**, 769–771.
- [13] Budzyńska M., Krupa W., Sołtys L., Sapuła M., Kamieniak J. and Budzyński M.: *Poziom biopierwiastków w sierści koni czystej krwi arabskiej*, Ann. UMCS Lublin-Polonia. Sectio EE. 2006, **24**, 199–207.
- [14] Budzyński M., Sołtys L., Budzyńska M., Mazurek E., Sapuła M. and Kamieniak J.: *Powiązania pobudliwości nerwowej z poziomem składników mineralnych w sierści koni arabskich*, Ann. UMCS Lublin-Polonia. Sectio EE. 2006, **24**, 217–226.
- [15] Asano R., Suzuki K., Otsuka T., Otsuka M. and Sakurai H.: *Concentrations of toxic metals and essential minerals in the mane hair of healthy racing horses and their relation to age*, J. Vet. Med. Sci. 2002, **64**, 607–610.

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**Abstrakt:** Zebrano i zbadano próbki włosów z ogona i grzywy (włosy twarde) oraz boków ciała (włosy miękkie) koni rasy śląskiej (Polska) i holsztyńskiej (Niemcy). Oznaczono w nich całkowitą i przyswojoną zawartość selenu (Se). Stwierdzono stężenia pierwiastka w zakresie 76,1–1343,7  $\mu\text{g} \cdot \text{kg}^{-1}$ .

Otrzymane wyniki wskazują na statystycznie istotną różnicę zawartości Se wśród włosów twardych, jak i miękkich koni obu grup. Nie stwierdzono jednak przekroczenia wartości referencyjnych zawartości Se we włosach koni.

**Słowa kluczowe:** konie, włosy, selen