SELENIUM CONCENTRATION IN MUSK RAT, HARE, COW TISSUES AND IN COW'S MILK, AS AN INDICATOR OF ITS STATUS IN LOCAL ECOSYSTEM.

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Introduction

It is well known that many factors are influencing the value of game animals as bioindicators. The main of these factors are feeding types, the area of individual living territory, gander, age and the distance to pollutant emission sources. It has to be also taken into consideration that in some cases hunting will have direct influence on some minerals content in animals obtained by shooting. It was shown that secondary contamination of carcass might be very much more important that environment pollution. However, it is not a case concerning selenium. Until 1957 selenium was known only for its toxic properties. The biochemical lesion of its toxicity involved inhibition of tissues oxygen consumption mediated by succinic dehydrogenase inhibition caused by oxidation and/or sulfhydryl groups binding. In Poland naturally occurring toxicity of selenium caused by seleniforus diet consumption is not known. The only cases noticed in our country were caused by human mistakes during preparation of medicated mineral premixes when Se was used in extremely high concentration. Right now Se is accepted as essential trace element because it was recognized as an integral part of over 30 selenoproteins detected in mammalian tissues; most important: glutathione peroxidase, iodothyronine 5'deiodinase, thioredoxin reductase and selenoprotein P. The metabolic role of selenium seems to be linked with vitamin E and sulfur amino acids. Sparing effect of Se on vitamin E and delays the onset of deficiency syndromes was shown. It is connected with biochemical reactions catalyzed by selenoproteins which are categorized as follow: antioxidant defense systems, thyroid hormone metabolism and redox control of the cell reactions. Most common pathological lesions observed in Se deficiency include hepatic and pancreatic lesions, nephrosis, hemoglobinuria, cardiac and skeletal muscle myopathy, hemorrhage, acute congestion. Several metabolic disorders relate to Se deficiency: "white muscle disease" (nutritional muscular dystrophy) in cattle, exadutive diathesis and pancreatic degeneration in poultry, hepatosis dietetica and sudden death in swine. Se plays also very

important role in reproduction. Lately Se was recognized as an effective anticarcinogen, especially in prevention of prostate, colon and lung cancer (3). Some antiviral properties of this trace element were also described (2). All these properties and functions of selenium caused that it is very important not only for optimal animal production and animal health but also for human to recognize the local Se status.

The aim of this study is developing more pragmatic assessment procedures that can provide the basis for prioritizing among animal species and sampling procedures to develop non-invasive and easy to use method of Se evaluation in the agro ecosystem.

Methods

Samples of game animals were obtained during a period of winter hunting season. The samples of cow's liver, meat and milk from Lowland Black and White breeds of cows were obtained from the same regions as game animals. Distance between barns and hunting territories was not longer than 5 km. Tissue and milk samples were stored at – 30^{o}C. Se analysis was carried out at the Division of Nutritional Sciences (Pen. State Univ., USA). Se was estimated using Hewlett Packard gas chromatograph model 5890A, equipped with electron capture detector, by the method of McCarthy et al. (8). Powdered cow's milk and cattle liver with known Se content (National Bureau of standards, Gaithesburg, MD, USA) were used as standards.

Results and discussion

Soil is the ultimate Se source for plants, animals and humans. The total Se content of soil, however, does not accurately represent availability of Se in the food chain. Red-ox potential, pH value and antagonistic elements concentration (As, S) were recognized as factors modifying Se bioavailability. The Se content of plants might be useful indicator of animals and human Se status (i.e. for grazing animals) but very high variation of Se concentration in plants, even in relative small territory, was observed. The best and most informative system of Se level evaluation in ecosystem is multifactorial gathering informations concerning this element concentration in soil, plants and animals, but such study is expensive and very complicated. However the most representative information is possible to get from analysis of animal origin tissues. The diagnostics of Se deficiency, which is recognized in Poland, is based on the analysis of this trace element concentration in the liver, or because of relative accessibility of material, in the whole blood or in blood serum. There are results showing significant variation of Se in human and cow's milk depending on the region in Poland (4).

Table 1. The selenium concentration (ng/g wet tissue) in the liver of musk rat, hare and cow and in cow's muscle and milk. Samples originated from different locations in Poland. n=10

Location	Musk rat's liver	Hare's liver	Cow's liver	Cow's meat	Cow's milk
Olsztyn	381,2±93,5[a]	195,2±60,4[a]	154,2±70,2[a]	78,3±40,1[a]	4,6±1,2[a]
Siedlce	688,1±90,4[b]	251,8±53,6[a]	243±110,1[a]	120,6±52,1[a]	6,72±1,5[a]
Legnica	1207,2±304,3[c]	846,8±158,9[b]	720±204,7[b]	307±107,1[b]	17,2±3,7[b]

Mean ± SD; Vertically -mean values marked with different superscript letter differ significantly at P = 0.05
Also In this study high geographical variation among examined territories was stated.

Despite of analyzed material, the lowest level of Se in all analyzed samples originated from Olsztyn province in north-eastern Poland. Grzebula (5) observed in south-eastern part of Poland appearance of the nutritional muscular dystrophy in horses, sheep and cattle, as well as disturbances in reproduction, typical for Se deficiency. It is possible that whole eastern part of Poland is Se deficient. The highest Se concentrations were observed in samples obtained in region of Glogow (Legnica province). That area Legnica Copper District is one of the regions in the greatest ecological danger in the country. A year's emission of dust, containing about 19% lead, 11% copper and 4% zinc amounts over 500 tons. Large amounts of Se in form of SeO_2, H_2SeO_3 and elemental Se are also emitted during industrial coal combustion. The efficiency of cleanup systems in case of Se is only ca. 30% and the rest is emitted to the atmosphere. However, the bioavailability of this Se is very low because simultaneous emission of large amounts of sulphur. Probably this emission of Se is the main source of Se found in animal samples originated from this region. Species of free living animals have been selected for inclusion in evaluation of this trace element are widely distributed around Poland. Among game animals hare (*Lepus europaeus Pall*.) is the accepted bioindicator of xenobiotics, heavy metals and trace elements (6). However the population of these animals is constantly decreasing, because of agriculture intensification (chemization) and rise of red fox population. Musk-rat (*Ondatra zibethica*), very popular in Poland, is an aquatic rodent which burrows in banks of ponds and streams. In opposite to hare its population is increasing however its expansion is slowing down because of growing appearance of wild mink.

The highest Se concentration among examined tissues was found in the liver of musk rat. About 40 times lower values were found in the cow's milk. Both in the state of selenium deficiency and in cases when the Se requirement is met the existence of a correlation between Se content in the fodder and in the cow milk was observed (1). Lean et al. (7) stated that over 60% of herds in the Se deficient part of San Joaqin Valley of California were subjected Se supplementation, so that in that conditions cow's milk can't be a marker of Se-status in the natural agro-ecosystem. Areas of Se deficiency have been mapped worldwide (10). In these areas Se supplementation is common practice but this situation raised a question concerning

safety of such supplementation. When Se is administered directly to animals there is no reason to believe that the very low levels of Se given to livestock would significantly affect the agro ecosystem. In 1992 Ullrey (11) calculated the contribution of this dietary supplementation to be below 0,3% of environmental Se. Different situation may appear when Se is added to mineral fertilizers in amount 5-10 g/ha. Fertilizer amendment technologies may cause appearance of local poisoning especially after heavy rains leading to dramatic increase of Se in run off waters. Evidence was accumulating that use of Se-enriched soil fertilizers as well as directs dietary supplementation of humans might cause higher amount of Se consumption than is usually considered as nutritionally necessary. Concern about Se deficiency influence on human health caused that in Finland it was mandated to use Se enriched fertilizers in croplands. However, initially used Se concentration appeared to be too high. This example is showing that even in Se-deficient ecosystems there is also a need of Se status assessment not only because health but also safety reasons.

The existence of statistically significant correlation was observed between the Se concentration in cow milk and in the liver of hares obtained in the same regions ($p < 0.01$). This results indicated bioindicative role of examined game animals as well as it confirms the fact that cow's milk might be a good indicator of Se level in the agro-ecosystem. However, cow's milk is a good Se status indicator only when cattle are not supplemented with trace elements and when these ruminants consume the locally obtained feeds.

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