

Selenium concentration in the muscle tissue of wild boars (*Sus scrofa*) from selected regions in Poland

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The aim of the study was to determine the concentration of selenium in the meat of wild boars from three selected regions of Poland. Selenium concentration was analysed in relation to the region (Masuria, Pomerania and Greater Poland) and in relation to the carcass weight and sex of the animals. The average content of selenium in the material was 0.093 µg/g. The highest mean concentration was observed in the meat samples from Greater Poland (0.099 µg/g) and in the muscle tissue of females (0.098 µg/g). The most valuable source of selenium was the meat of animals with carcass weight ranging from 21 to 40 kg (0.101 µg/g). A 100 g portion of wild boar meat meets about 20% of the daily requirement for selenium for adults and 30% for children.

KEY WORDS: wild boar / *Sus scrofa* / selenium / muscle tissue

Game meat in Poland, including wild boar meat, is eaten mainly in good restaurants and in some households. The high biological value of its protein, its wealth of minerals and trace elements (such as selenium), and high content of unsaturated fatty acids make this meat very healthy and beneficial in the human diet. A 100 g portion of wild boar meat contains on average 118 kcal, 19.5 g of protein, and 3.4 g of fat, of which *n-3* make up 7% [15]. Moreover, this meat comes from wild animals, which are subject to natural selection, choose their own food, and live a life that is free of the stress factors typical of farm animals [13].

Selenium content in food products varies substantially, which is linked to the high variation in the content of this element in the soil and water in different parts of the world. Soils in Poland are considered to be poor in selenium. Both an excess and a deficiency of this micronutrient can have harmful effects. Daily intake of selenium of under 0.1 µg/kg body weight leads to a deficiency of this element in the body [4, 16]. Selenium is fairly

rare in nature, but is essential to proper functioning of the body [14]. Its most important functions are as follows:

- antioxidant activity, as an integral part of the enzyme glutathione peroxidase [3, 11]
- neutralizing the effect of aflatoxins [10]
- antagonistic activity against absorption of heavy metals: cadmium, lead, arsenic, and inorganic and organic mercury compounds [4]
- catalysing synthesis of active thyroid hormone [2]
- stimulating the immune system to increase antibody production and immune cell activity [6]
- improving transmission of nerve impulses in the central nervous system [6]

The most easily assimilated form of selenium is organic selenium-protein complexes. Furthermore, the concentration of the element is associated with the quantity and quality of the protein [8]. This means that high-protein foods may be a valuable source of selenium. Game meat, including wild boar, is unquestionably one of these, and the differences in the protein content of the muscle tissue as compared to the muscles of livestock animals can be as high as 5% [17]. The selenium requirement in the human population varies depending on place of residence, age, sex, physiological state, and lifestyle. The averaged recommended daily intake of selenium (RDI) in Poland is 20-30 µg for children, 40-55 µg for teenagers, and 55 µg for adults [5].

The aim of the study was to analyse the content of selenium in the muscle tissue of boars from selected regions of Poland, taking into account the sex and carcass weight of the animals.

Material and methods

The meat samples for the study came from wild boars harvested in the 2013/2014 hunting season. Samples were taken from the carcasses of boars received by a game processing plant on the basis of the plant's internal quality classification. The animals were shot down in three regions of Poland: Masuria, Pomerania and Greater Poland. All samples (102) were collected from the cleaned shin muscle and divided according to the origin, carcass weight after skinning (weight ranges: up to 20 kg; 20-40 kg; 40-60 kg; and over 60 kg) and sex (females and males) of the animals. The meat for analysis was chilled at a temperature of up to +7°C, for a period of no longer than 7 days. Selenium content was determined by fluorescence spectroscopy using 2,3-diaminonaphthalene. First each sample (1 g) was subjected to wet mineralization using concentrated HNO₃ (230°C, 180 min) and HClO₄ (310°C, 20 min). The measurement was performed at an emission wavelength of 518 nm and an excitation wavelength of 378 nm. The precision of the measurements was based on the reference material NCS ZC 71001 (for beef). The selenium concentration in the muscle tissue of the boars was 93% of the

reference value. The measurements were performed with an RF 5001 PC fluorescence spectrophotometer by Shimadzu.

Statistical analysis of the data was performed by one-way analysis of variance, in which the factor was the carcass weight of the animals or the region where they had lived. Where significant differences were found, significance of differences for pairs of means was tested by Duncan's test. The computations were performed in the SAS statistics package (2012) [12].

Results and discussion

The mean selenium concentration in the muscle tissue of the boars was similar in different regions and was 0.093 $\mu\text{g/g}$, with considerable variation (0.039-0.193 $\mu\text{g/g}$) – Table 1. The mean selenium concentration in the muscle tissue of the boars was higher than in a study conducted on similar samples in the Czech Republic, in which it was 0.0276 $\mu\text{g/g}$ [7]. A higher selenium concentration, of 0.130 $\mu\text{g/g}$, was noted in the meat of boars harvested in Hungary [1]. Comparison of the results from the three regions showed the highest selenium concentration in the meat of the boars from Greater Poland (0.099 $\mu\text{g/g}$), although the differences between regions were statistically non-significant.

Table 1
Selenium concentration in muscle tissue of wild boars by place of origin ($\mu\text{g/g}$)

Region	Number of samples	Mean ($\mu\text{g/g}$)	Standard deviation	Range
Masuria	29	0.088	0.036	0.044-0.162
Greater Poland	14	0.099	0.027	0.048-0.193
Pomerania	59	0.092	0.035	0.039-0.165
Total	102	0.093	–	0.039-0.193

Analysis of selenium content in relation to carcass weight after skinning revealed the highest concentration, at 0.101 $\mu\text{g/g}$, in the carcasses weighing 21-40 kg (Tab. 2). The meat of individuals with carcass weight above 60 kg contained significantly ($P < 0.05$) the least selenium (0.012 $\mu\text{g/g}$) as compared to the other groups. This may have been due to the small size of this group (only 5 animals). Confirmation of these results requires further research.

Table 2
Selenium concentration in muscle tissue of wild boars by carcass weight ($\mu\text{g/g}$)

Carcass weight	Number of samples	Mean ($\mu\text{g/g}$)	Standard deviation	Range
<20 kg	21	0.081 ^a	0.031	0.046-0.151
20-40 kg	53	0.100 ^a	0.033	0.045-0.165
40-60 kg	23	0.086 ^a	0.034	0.042-0.162
>60 kg	5	0.012 ^b	0.012	0.039-0.069

Values marked with the letters a and b are significantly different at $P < 0.05$

Analysis of the selenium concentration in the muscle tissue of the boars in relation to sex showed that it was higher in females (0.098 $\mu\text{g/g}$), but was statistically non-significant as compared to the data obtained for the meat of males (0.085 $\mu\text{g/g}$) – Table 3.

Table 3
Selenium concentration in muscle tissue of wild boars by sex ($\mu\text{g/g}$)

Sex	Number of samples	Mean ($\mu\text{g/g}$)	Standard deviation	Range
Adult females	53	0.098	0.035	0.045-0.165
Adult males	49	0.085	0.032	0.039-0.158

The results of the present study and other studies on selenium concentration in the muscle tissue of livestock animals indicate that wild boar meat is a good source of this element (Tab. 4). Wild boar meat has higher selenium content than pork, which according to Skrobak et al. [13] may contain 0.018 $\mu\text{g/g}$ of this element, which is less than 20% of the values obtained in the present study for boar meat. Beef contains selenium in the amount of 0.070 $\mu\text{g/g}$, which is 75% of the value obtained in the boar meat [6, 13]. According to Pilarczyk et al. [9], the liver and kidneys of animals are a more valuable source of selenium in food of animal origin, as the level of this element may be even several dozen times higher (wild boar liver – 0.19 $\mu\text{g/g}$, wild boar kidneys – 1.21 $\mu\text{g/g}$). It should be noted, however, that these organs are rarely if ever eaten and are not recommended for children [9, 10].

Interestingly, according to Kuczyńska and Biziuk [6], the mean selenium concentration in pork may reach a level of even 0.160 µg/g, but high concentrations of this element are usually due to the use of selenium supplements in pig feed, so this is not selenium of natural origin. Similarly, Slencu et al. [14] reported a high level of selenium in the muscle tissues of slaughtered animals from East Asia, which was the effect of supplementation of their feed with selenium. In European countries the selenium concentration in the muscle tissue of animals raised for meat was at a similar level (Tab. 4).

Table 4
Comparison of the results with values for livestock animals raised for meat (µg/g)

Type of meat	Mean Se concentration in muscles (µg/g)	Origin	Source
Wild boar meat	0.093	Poland	Our own results
	0.027	Czech Republic	Kursa et al. [7]
	0.130	Hungary	Bodname et al. [1]
Pork	0.094	Greece	Slencu et al. [14]
	0.130	Croatia	
	0.172	Thailand	
Beef	0.048	Greece	Slencu et al. [14]
	0.324	South Korea	
	0.390	Saudi Arabia	
Poultry	0.079	Greece	Slencu et al. [14]
	0.147	South Korea	
	0.097	Slovenia	

To sum up, wild boar meat is a good source of selenium in comparison to meat from livestock animals. The average daily requirement for selenium in Poland is 55 µg/day/person, and a 100 g portion of wild boar meat satisfies 20% of the requirement for adults and about 30% for children [5].

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