SELENIUM CONCENTRATION IN ROE DEER FROM THE WESTERN POMERANIA, POLAND

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Abstract

The aim of the study was to determine the selenium concentration in the liver and kidneys of the roe deer from the Western Pomerania (Poland) area according to the season of year. The roe deer were shot in 2003-2008. Samples from 153 roe deer were collected. Selenium concentration was determined spectrofluorometrically. Its mean concentration was 0.71 ±0.64 µg·g⁻¹d.w. (dry weight) in the liver and 3.09±1.73 µg·g⁻¹d.w. in the kidneys. The analysis showed selenium deficiency in the kidneys in spring, winter, and summer and in the liver in spring and winter. Autumn was the only period with optimum selenium concentration in both organs. The low selenium concentrations in the liver and kidneys in winter and spring period indicate that their habitats are deficient in this element. It seems necessary to develop a proper prophylactic programme to prevent selenium deficiency in animals during the winter and spring season.

Key words: roe deer, selenium, Western Pomerania, Poland.

There have been relatively few studies of selenium concentration in game animals. Free-living animals are a good indicator of the concentration of heavy metals and other toxic substances. Because roe deer are completely integrated with the natural environment throughout their lives, they provide a good indication of both selenium concentration and environmental pollution.

Many factors determine the distribution and cycling of selenium in the nature. Selenium distribution is highly variable, with selenium-rich soils in large parts of North and South America and some parts of China, and selenium-deficient soils in large parts of Europe (including some regions of Poland), several Chinese provinces, and New Zealand (1, 8, 12, 18). Selenium deficiency in free-living animals is strictly associated with the amount and availability of this element in the soil. Grosicki and Kowalski (6) reported that selenium absorption and distribution in animal tissues may be altered by heavy metal exposure.

Selenium is currently acknowledged as the basic trace element that determines the normal growth and development of animals and humans. It is an essential component of an animal body.

Selenium deficiency in farm and free-living animals may cause white muscle disease and increase the incidence of disseminated necrosis of the liver, may cause the death to the developing foetus and placental retention, and weaken reproductive capacity in males (2, 4, 5, 14).

Material and Methods

Liver and kidney samples, taken from roe deer in the areas of three Hunting Clubs in the Western Pomerania province, were analysed (Fig. 1). The Roe deer were shot in 2003-2008. Samples from 153 roe deer were collected.

Fig. 1. Location of the sampling sites – Hunting Club areas in the Western Pomerania province.
Concentrations of selenium were determined using Watkinson’s spectrofluorometric method (16), modified by Grzebulak and Witkowski (7). The tissues were digested in HNO\textsubscript{3} in 230ºC for 180 min. and in HClO\textsubscript{4} in 310ºC for 20 min. Then, the samples were hydrolysed with 9% HCl. Selenium was derivatised with 2,3-diaminonaphtalene (Sigma-Aldrich) and the complex was extracted into cyclohexan. Se concentration was measured fluorometrically using a spectrophotofluorometer RF-5001 PC Shimadzu. The excitation wavelength was 376 nm; the fluorescence emission wavelength was 518 nm. The accuracy of the analyses was verified by determined Se concentration in the certified reference material BCR 185R (bovine liver). The Se levels ranged between 72% and 105% of the reference values.

The results were analysed statistically, with calculations of mean values ($\bar{x}$) and standard deviations (SD). Significance of differences between seasons was determined with Duncan’s test using STATISTICA SQ software.

### Results

Data on selenium concentration in the liver and kidneys of roe deer are given in Tables 1 and 2. The data show that mean selenium concentration was 0.71±0.64 µg·g\textsuperscript{-1}d.w. in the liver and 3.09±1.73 µg·g\textsuperscript{-1}d.w. in kidneys. In all the animals examined, selenium concentration was higher in the kidneys than in the liver. Most samples with selenium deficiency were found in the area of Hunting Club No.2. Optimum selenium concentrations in the liver (above 0.88 µg·g\textsuperscript{-1}d.w.) were found in autumn (57.2%, 28 samples) and in summer (19.4%, 6 samples).

Mean selenium concentration in the liver and kidneys was significantly (P≤0.05) higher in autumn than in the other seasons. In the liver, significantly (P≤0.05) lowest selenium concentration was found in spring, as compared to autumn and summer. In the kidneys, the lowest selenium concentration was found in summer and it was significantly (P≤0.05) lower when compared to autumn (Table 1).

The analysis of selenium concentration in the liver showed that this element was deficient in winter and spring (Table 1) and optimal in autumn. In summer, selenium deficiency was only found for the Hunting Club No. 2 (Table 2).

### Table 1

Mean selenium concentration in the kidneys and liver of roe deer from Western Pomerania

<table>
<thead>
<tr>
<th>Season</th>
<th>Number of examined samples</th>
<th>Liver (µg·g\textsuperscript{-1}d.w.)</th>
<th>Kidneys (µg·g\textsuperscript{-1}d.w.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>36</td>
<td>0.42 ± 0.11\textsuperscript{a}</td>
<td>2.32 ± 0.67\textsuperscript{a}</td>
</tr>
<tr>
<td>Spring</td>
<td>37</td>
<td>0.29 ± 0.13\textsuperscript{bc}</td>
<td>2.12 ± 0.54\textsuperscript{b}</td>
</tr>
<tr>
<td>Summer</td>
<td>31</td>
<td>0.65 ± 0.23\textsuperscript{cd}</td>
<td>2.03 ± 0.82\textsuperscript{c}</td>
</tr>
<tr>
<td>Autumn</td>
<td>49</td>
<td>1.28 ± 0.85\textsuperscript{abcd}</td>
<td>5.06 ± 1.61\textsuperscript{abc}</td>
</tr>
</tbody>
</table>

Letters indicate significance of differences between groups:
\textsuperscript{a, b} significant differences (P≤0.05) are marked with the same letters.

### Table 2

Mean selenium concentration in the kidneys and liver of roe deer in different Hunting Clubs

<table>
<thead>
<tr>
<th>Season</th>
<th>Number of examined samples</th>
<th>Liver (µg·g\textsuperscript{-1}d.w.)</th>
<th>Kidneys (µg·g\textsuperscript{-1}d.w.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunting Club No. 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td>15</td>
<td>0.42 ± 0.11\textsuperscript{e}</td>
<td>2.21 ± 0.69\textsuperscript{e}</td>
</tr>
<tr>
<td>Spring</td>
<td>15</td>
<td>0.27 ± 0.15\textsuperscript{ac}</td>
<td>2.46 ± 0.40\textsuperscript{ad}</td>
</tr>
<tr>
<td>Summer</td>
<td>11</td>
<td>0.73 ± 0.14\textsuperscript{cd}</td>
<td>1.68 ± 0.90\textsuperscript{de}</td>
</tr>
<tr>
<td>Autumn</td>
<td>20</td>
<td>1.27 ± 0.93\textsuperscript{abcd}</td>
<td>4.82 ± 1.15\textsuperscript{e}</td>
</tr>
<tr>
<td>Hunting Club No. 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td>11</td>
<td>0.37 ± 0.06\textsuperscript{f}</td>
<td>2.70 ± 0.72\textsuperscript{e}</td>
</tr>
<tr>
<td>Spring</td>
<td>11</td>
<td>0.26 ± 0.11\textsuperscript{b}</td>
<td>1.96 ± 0.68\textsuperscript{b}</td>
</tr>
<tr>
<td>Summer</td>
<td>10</td>
<td>0.45 ± 0.13\textsuperscript{f}</td>
<td>2.23 ± 0.92\textsuperscript{c}</td>
</tr>
<tr>
<td>Autumn</td>
<td>19</td>
<td>1.25 ± 0.95\textsuperscript{abc}</td>
<td>5.95 ± 2.01\textsuperscript{abc}</td>
</tr>
<tr>
<td>Hunting Club No. 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td>10</td>
<td>0.49 ± 0.15\textsuperscript{e}</td>
<td>2.06 ± 0.37\textsuperscript{e}</td>
</tr>
<tr>
<td>Spring</td>
<td>11</td>
<td>0.32 ± 0.22\textsuperscript{ed}</td>
<td>1.88 ± 0.47\textsuperscript{e}</td>
</tr>
<tr>
<td>Summer</td>
<td>10</td>
<td>0.75 ± 0.18\textsuperscript{e}</td>
<td>2.21 ± 0.51\textsuperscript{b}</td>
</tr>
<tr>
<td>Autumn</td>
<td>10</td>
<td>1.35 ± 0.42\textsuperscript{bde}</td>
<td>3.94 ± 0.52\textsuperscript{abc}</td>
</tr>
</tbody>
</table>

Letters indicate significance of differences between groups:
\textsuperscript{a, b} significant differences (P≤0.05) are marked with the same letters.
Discussion

Pollock (13) considered that the liver is a better indicator of selenium levels in the body compared to kidneys. Oh et al. (11), reported that lambs receiving selenium-deficient feeds always had a higher selenium concentration in the kidneys than in the liver. The situation was reverse for lambs fed selenium-rich feeds, when selenium levels were higher in the liver than in the kidneys.

According to Pollock (13), the biochemical criteria used to diagnose selenium deficiency in the liver of deer are as follows: less than 0.6 µg·g⁻¹d.w. – deficient level, 0.6-0.88 µg·g⁻¹d.w. – marginal level, and above 0.88 µg·g⁻¹d.w. – appropriate (optimum) level. The analysis of selenium concentration in roe deer liver showed that this element was most deficient in spring (91.9%, 34 samples) and winter (77.7%, 28 samples), and then in summer (41.9%, 13 samples) and autumn (20.4%, 10 samples).

Roe deer feed on various high-quality plants. They eagerly consume grasses, blackberry shoots, twig ends, mushrooms, and cereals (3). The mushrooms tend to accumulate selenium and it is during the autumn that mushrooms are eagerly eaten by roe deer. Lasota et al. (9), and Kabata-Pendias and Pendias (8) reported that edible mushrooms from European countries contain ten times more selenium than plants, with the highest content in boletus mushrooms.

According to McDowell et al. (10), selenium concentration less than 3.0 µg·g⁻¹d.w. in the kidneys of deer indicates the deficiency. Studies on selenium concentration in the kidneys of roe deer showed that 47.7% of the examined animals (73 samples) were deficient in selenium. This element was deficient in all the Hunting Club areas during spring, winter, and summer. This situation probably results from the limited availability of selenium-rich feed during these seasons. Western Pomerania is deficient in selenium. Animal diseases related to selenium deficiency occur mainly in deficient environments (in soil and plants). This conclusion was confirmed by Zablocki (17), who found very low selenium concentrations (less than 0.3 mg/kg d.m.) in soil profiles of Western Pomerania.

In the study of McDowell et al. (10), conducted with white-tailed deer (Odocoileus virginianus) in south Florida (USA) during 1984-1988, selenium concentration varied according to region from 0.04 to 1.3 µg·g⁻¹d.w. (average concentration 0.676 µg·g⁻¹d.w.). These authors reported low selenium concentration in 13% of liver samples (<0.25 µg·g⁻¹d.w.) and 36% of kidney samples (<3.0 µg·g⁻¹d.w.). In a study of Vikøren et al. (15), selenium concentration in the liver of roe deer from five locations in western Norway averaged 0.09 µg·g⁻¹d.w. (0.04–1.0 µg·g⁻¹d.w.).

In summarising, the low selenium concentration in the liver and kidneys of roe deer in the winter and spring periods indicates that the habitats of these animals are deficient in selenium. It seems necessary to develop a proper prophylactic programme to prevent selenium deficiency in animals.

References


