Concentration of selenium in serum samples was determined using a modified Watkinson's spectrofluorometric method. Selenium concentration averaged 0.021 ± 0.008 µg/mL for water buffaloes and 0.074 ± 0.017 µg/mL for dairy cows. The analysis of selenium concentrations in cows showed deficiency level in 2.0%, marginal level in 64%, and optimal level in 34% of the examined samples. In water buffaloes, deficiency level was found in 96.55% and marginal level in 3.45% of the animals. Selenium levels in cattle and water buffaloes should be periodically diagnosed to provide data for veterinarians to make appropriate decisions. The implementation of suitable prophylactic programmes will enable optimum levels of this element to be maintained.

Key words: water buffalo, dairy cows, selenium, Notec River region, Poland.

Selenium plays diverse functions in animal and human organisms. As a constituent of selenoproteins it has structural and enzymatic roles, and is essential to the function of glutathione peroxidase (GSH-Px), an enzyme that protects cells against free radicals (18, 34, 36).

Selenium stimulates the immune system and assists in removing toxic metals (such as cadmium, copper and arsenic) and organic compounds released during infections and stress. Animals living in selenium-deficient areas are affected by white muscle disease, muscular weakness, myositis, impairment of erythrocytes, and pancreatic degeneration. Excessive amounts of this element can cause selenosis, which is characterized by muscular degeneration, rough and dull hair coat, difficult breathing, and cardiovascular problems (5, 31, 36).

In cattle, selenium deficiency may cause nutritional muscular dystrophy (white muscle disease), diarrhoea in young animals, increased incidence of disseminated liver necrosis in fattening bulls; abnormal development and death of foetuses in cows, placental retention after calving and extension of days open; and impairment of reproductive ability in affected bulls (3, 11, 14, 30). Deficiency of selenium may cause immune disorders (7, 22) and contribute to mastitis in cows (8).

In the nature, selenium occurs irregularly, with some areas rich in selenium (considerable areas of North and South America and part of China) and some deficient in this element (a considerable part of Europe, including some regions of Poland, several provinces of China, and New Zealand). Selenium deficiency in animals is strictly related to the level of this element in the soil (1, 16, 24-27, 39).

Low levels of selenium in the soil translate into low selenium content of plants, which results in animals being deficient in this element (16). Ruminants have limited absorption of selenium because its mineral compounds are reduced to unavailable forms by rumen bacteria (22). A special attention should be focused on animal nutrition, because some elements considerably reduce selenium absorption (e.g. magnesium), whereas vitamins C and E facilitate its absorption (17).

The aim of the study was to determine the concentration of selenium in serum of water buffaloes and dairy cows grazed on grassland in the Notec River region.
Material and Methods

Analysis was conducted on serum samples collected from water buffaloes (*Bubalus bubalis*) and Black-and-White German Holstein-Friesian dairy cows grazed on grassland in the Notec River region. The study was carried out in October 2008.

The herd of water buffaloes had 29 cows and was raised under extensive conditions (on pasture all year round). Hedges and shrubs on pasture provided the only shelter for animals. In winter, the animals were fed additional hay and straw. Buffaloes received no mineral-vitamin supplements or concentrates.

The herd of dairy cows consisted of 50 animals and was housed in a loose-housing system. Cows used pasture during the summer. In the analysed period, cows also received maize silage, barley straw, concentrate, and mineral-vitamin supplements (without selenium).

Serum concentrations of selenium were determined using Watkinson's spectrofluorometric method (37), modified by Grzebula and Witkowski (12). The serum samples were digested in HNO₃ at 230°C for 180 min and in HClO₄ at 310°C for 20 min. Then the samples were hydrolyzed with 9% HCl. Selenium was derivatized with 2,3-diaminonaphtalene (Sigma-Aldrich, USA) and the complex was extracted into cyclohexane. Selenium concentration was determined fluorometrically using a Shimadzu RF-5001 PC spectrophotofluorometer. The excitation wavelength was 376 nm, the fluorescence emission wavelength was 518 nm. The accuracy of the analyses was verified using a certified reference material BCR 185R (bovine liver).

The results were analysed statistically by calculating means, standard deviations, geometric means, and significance of differences between the means using Student’s *t*-test and STATISTICA PL software.

Results and Discussion

Results of the analysis of serum concentration of selenium in cows and water buffaloes are presented in Tables 1 and 2. The data show that mean selenium concentration was 0.021 ±0.008 µg/mL in water buffaloes and 0.074 ±0.017 µg/mL in cows. The selenium concentration in the cows was almost four times higher (P<0.01) than that in water buffaloes.

The available Polish literature contains no studies concerning selenium concentrations in the serum of water buffaloes, and in foreign literature this issue was given little attention (6, 29).

Currently, no standards are available for serum selenium concentrations in water buffaloes. Due to the lack of literature data on the serum concentration of this element in water buffaloes, selenium requirements for cattle were used. According to Grace (10), biochemical criteria used to diagnose serum selenium deficiency are as follows: below 0.041 µg/mL – deficiency level; 0.041 – 0.079 µg/mL – marginal level; above 0.079 µg/mL – desirable (optimal) level for cattle.

Our study has shown a deficiency level of selenium in water buffaloes from the Notec River region and marginal levels of this element in dairy cows. Such low selenium content is probably due to its low abundance in feeds given to animals. The amount of selenium absorbed by plants depends on soil pH, oxidation-reduction conditions in the soil and degree of selenium oxidation (16). Research conducted at the District Agrochemical Station in Poznan in 2000-2004 revealed that acid pH soils predominate in both Pila and Miedzychod Counties (which cover the Notec River region). In this environment, selenium occurs in the form of selenides (Se²⁻), which have low bioavailability (18). Likewise, lakes in the National Park of Wielkopolska and the Drawa National Park are characterised by low selenium content (less than 0.15 ng/mL) (20-21). This provides evidence of overall selenium deficiency in the Wielkopolska province, which may be the cause of its low serum concentrations in the investigated buffaloes and cows.

The analysis of serum selenium concentrations in cows showed deficiency level in 2.0% and marginal level in 64% of the cows. In 34% of the cows, the selenium concentration exceeded 0.08 µg/mL, which is considered optimal according to the values reported by Grace (10). The situation was different for water buffaloes: 96.55% of the animals showed selenium deficiency and 3.45% had marginal levels. None of the analyzed water buffaloes had the optimal level (Table 2).

Other authors from different countries also reported selenium deficiency in cows. In Austria, Hain *et al.* (13) found selenium levels to be below 0.040 µg/mL in 79% of cows, between 0.040 and 0.070 µg/mL in 20% of cows, and above 0.070 µg/mL in only 1% of cows. In 18 U.S. states, Dargatz *et al.* (4) showed selenium to be deficient in 7.8% of cows and marginal in 10% of cows. Zust *et al.* (39) reported 60% of the cows in Slovenia to be deficient in selenium. In the group receiving no, or irregular selenium supplements, serum content of this element ranged from 0.0137 to 0.0174 µg/mL. In the Czech Republic, Pavlata *et al.* (23) found deficient or marginal selenium levels in 50% of animals studied (in 42% of cows, 80% of calves, 100% of heifers, and 90% of bulls). Likewise, studies in Germany and Estonia showed a considerable deficiency of this element in farm animals (9, 19). Boehnke *et al.* (2) reported that over 50% of cows in Germany are deficient in selenium. Gierus *et al.* (9) found that selenium requirement was not completely fulfilled in cows fed grass and grass or maize silage. Stec *et al.* (35) demonstrated that selenium levels in cows depend on season of the year, physiological status of animals, housing, and feeding systems.

In a study by Pilarczyk *et al.* (24), serum selenium concentration averaged 0.063 µg/mL in cows from Western Ukraine, which constituted half of the value obtained for cows from Western Pomerania (0.031 µg/mL). The same authors found selenium to be deficient in all serum samples collected in the cows from Western Pomerania.
Table 1
Mean serum concentrations of selenium in the animals studied

<table>
<thead>
<tr>
<th>N</th>
<th>Selenium concentrations (µg/mL)</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
<th>GM</th>
<th>Median</th>
</tr>
</thead>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water buffaloes</td>
<td>29</td>
<td>0.021*</td>
<td>±0.008</td>
<td>0.011-0.047</td>
<td>0.019</td>
<td>0.020</td>
</tr>
<tr>
<td>Cows</td>
<td>50</td>
<td>0.074*</td>
<td>±0.017</td>
<td>0.013-0.116</td>
<td>0.072</td>
<td>0.074</td>
</tr>
</tbody>
</table>

* - P≤0.01; GM – geometric mean; SD – standard deviation.

Table 2
Serum selenium levels in the animals studied

<table>
<thead>
<tr>
<th>N</th>
<th>Selenium level (µg/mL)</th>
<th>deficient (&lt;=0.041)</th>
<th>marginal (0.041-0.079)</th>
<th>optimal (&gt;=0.079)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Percentage of herd</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water buffaloes</td>
<td>29</td>
<td>96.55</td>
<td>3.45</td>
<td>-</td>
</tr>
<tr>
<td>Cows</td>
<td>50</td>
<td>2.0</td>
<td>64.0</td>
<td>34.0</td>
</tr>
</tbody>
</table>

In buffalo calves, Prasad and Arora (29) found that mean serum selenium concentration was 0.19 µg/mL. The country from which the water buffaloes were imported (Romania) is an area deficient in selenium (32-33). Some regions of Poland are also deficient in this element (38). Zabłocki (38) reports that in Western Pomerania, the mean selenium concentration in the soil ranges from 0.026 to 0.293 mg/kg. Piotrowska (28) showed that the concentration of this element in the South Poland is higher by 0.27 mg/kg. Selenium deficiency in animals occurs mainly where selenium is deficient in the soil and plants.

Since some areas of Poland are deficient in selenium, this element has to be supplemented in the form of mineral feed supplements or selenium salt licks to ensure normal growth and development of farm animals, to maintain their productivity at a high level and to keep them in good health.

Selenium levels in cattle and water buffaloes should be periodically diagnosed to provide data for veterinarians to make appropriate decisions. The implementation of suitable prophylactic programmes will enable optimum levels of this element to be maintained.

References


