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# THE CONTENT OF SELENIUM IN COW MILK FROM MILK MACHINES IN SZCZECIN IN ACCORDANCE TO A SEASON

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**ABSTRACT**

The aim of this work was to assess the content of selenium in cow milk served in milk machines in Szczecin in accordance to a season. The research material included samples of milk collected in 5 milk machines located in Szczecin. The study was targeted to the evaluation of selenium content in accordance to a season. The mean content of selenium in milk from milk machines was diversified in a particular seasons and ranged from 0.013 to 0.034 μg · ml$^{-1}$. The mean selenium content in cow milk from milk machines was 0.023 μg/ml. The lowest level of selenium was noted in summer (0.013 μg · ml$^{-1}$), whereas the highest was found in autumn (0.034 μg · ml$^{-1}$). No statistically significant differences were observed between the content of selenium in milk in winter and spring but in case of other seasons the noted differences were significant. Our study has shown that a particular attention has to be paid on the content of selenium in cow milk in summer, as in 72.22% of the tested samples the level of Se was marginal, and in 27.78% the level was deficient. Low concentration of selenium in cow milk in summer indicates that the animals residue in an area poorly supplied in this element. Thus, it is particularly relevant to introduce an early-diagnostics program evaluating the levels of selenium in dairy cattle and showing the possible need of selenium supplementation in cows.

**Key words:** selenium, cow milk, milk dispending machines, seasons, Szczecin

## INTRODUCTION

In the recent years, the world interest in consumption of unpasteurized milk has increased, and for instance in the USA and Great Britain, the Westona A. Price Foundation is oriented on education and lobbying in this area. Also in Poland the interest in unpasteurized milk has arisen which resulted in the presence of milk machines, distributing the unprocessed (unpasteurized, non-skimmed and undiluted) milk. Italy is the cradle of milk machines, which for about 10 years are distributing raw milk there. Also in other European countries milk machines gained popularity (Austria, Czech Republic, France, Great Britain), and this trend is starting to go worldwide (India, Japan, USA) [Kosiorowska 2012]. In Poland, the interest in milk machines increased thanks to the Czech who are accustomed to such a form of milk distribution. Milk machines are attractive not only for customers, but also may be an interesting alternative for small and medium milk farmers, as the income obtained from selling milk to the machine is from 50% to 100% higher in comparison to the traditional way of milk turnover through diaries. Finally, milk machines are also an interesting form to encourage the consumers to consume milk. This form of distribution ensures an access to fresh milk (taste values) which may be used to produce home-made cream, butter and soured milk.

Milk is a food product characterized by many health benefits. Macro- and microelements are present in milk in doses that promote their optimal absorbance from di-

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gestive system to blood. The elements that are present in milk positively affect a human organism. Selenium is one of the elements that play a very significant role for human metabolism and its content in milk may be strongly diversified. Between many effects, selenium stimulates the immune system and induces the synthesis of some cytokines (e.g. IFN, TNF, IL-6, IL-10, GM-CNF) that affect and balance different metabolic pathways, and deactivates aflatoxins protecting an organism from the cancerogenic activity of these substances [Mihailovic et al. 1996, Dębski et al. 2001, Daragó and Szamańska 2003, Iqbal et al. 2008].

In geochemical aspect, Poland is an area poor in selenium, thus in animals from Poland selenium deficiencies are observed commonly [Sablik et al. 2011, Pilarczyk et al. 2013, Nowakowska et al. 2015]. Dębski et al. [2001] have indicated that a selenium deficiency applies to 77% of regions of our country, wherein the selenium deficient areas are divided into three groups according to the intensification of deficiency: insignificant, 23%, moderate, 42% and high deficiency, 12%. Such a low content of selenium in Poland results in a low content of this microelement in crop plants, and the concentration of selenium in milk depends on the content of this element in plants that compose the diet of dairy cows [Pilarczyk et al. 2007, 2008, 2010].

The aim of this work was to assess the content of selenium in cow milk served in milk machines in Szczecin, in accordance to a season.

## MATERIAL AND METHODS

### Samples

The research material included milk samples collected in 5 milk machines located in Szczecin. The samples were collected during four seasons (spring, summer, autumn and winter). In total, 73 milk samples were collected.

### Chemical analyzes

Selenium concentrations in milk samples were evaluated with a spectrofluorometric method [Grzebuła and Witkowski 1977]. The samples (1 ml) were digested in $HNO_3$ at 230°C for 180 min and then in $HClO_4$ at 310°C for 20 min. Afterwards, the samples were hydrolyzed with 9% HCl. Molecular selenium was bound with 2,3-diaminonaphtalene (Sigma-Aldrich), and the complex was extracted into cyclohexane. Se concentration was determined fluorometrically using a Shimadzu RF-5001 PC spectrofluorophotometer. The excitation wavelength was 376 nm, and the fluorescence emission wavelength was 518 nm.

The accuracy of a method was verified using the certified BCR 185R reference material (bovine liver) (European Commission Joint Research Centre Institute for Reference Materials and Measurements). The Se concentration noted during the study ranged between 93.4% and 101.5% of the reference values.

### Statistical data analyzes

The data obtained in the study were analyzed statistically using one-way analysis of variance that was calculated with a Statistica PL software. The significance of differences between the groups was calculated using Duncan's test. Prior to the analyses, the data were verified to determine their distribution with a Shapiro-Wilk W test.

## RESULTS

The results of our study on a selenium content in cow milk are shown in Table 1. The data indicate that the mean content of selenium in cow milk from milk machines in Szczecin was diversified in accordance to a season and ranged from 0.013 to 0.034 μg · ml$^{-1}$. The mean concentration of Se in cow milk from milk machines was 0.023 μg · ml$^{-1}$. The lowest mean concentration of selenium was noted in milk samples collected in summer (0.013 μg · ml$^{-1}$), whereas the highest in samples obtained in autumn (0.034 μg · ml$^{-1}$). No statistically significant differences were observed in the content of selenium between the samples collected in winter and spring, and between other seasons the differences were significant (Table 1).

**Table 1.** The content of selenium in cow milk from milk machines

**Tabela 1.** Zawartość selenu w mleku krowim z mlekomatów

| Season<br>Pora roku | N | Selenium concentration, μg · ml$^{-1}$<br>Stężenie selenu, μg · ml$^{-1}$ | | | | |
|---|---|---|---|---|---|---|
| | | mean<br>średnia | ±SD | range<br>zakres | GM | median<br>mediana |
| Spring<br>Wiosna | 20 | 0.022$^{ab}$ | 0.006 | 0.011–0.032 | 0.021 | 0.019 |
| Summer<br>Lato | 18 | 0.013$^{acd}$ | 0.004 | 0.007–0.018 | 0.012 | 0.012 |
| Autumn<br>Jesień | 15 | 0.034$^{bce}$ | 0.003 | 0.029–0.037 | 0.034 | 0.034 |
| Winter<br>Zima | 20 | 0.025$^{de}$ | 0.009 | 0.011–0.040 | 0.023 | 0.024 |

a, b, c… – the same lower-case characters indicate significant differences at $P \leq 0.05$.
a, b, c… – te same małe litery oznaczają istotne różnice $P \leq 0{,}05$.

In summer, in 27.78% of the collected samples a selenium deficiency was noted, and in none of the samples from this season an optimal selenium level was reached. However in autumn, an optimal selenium concentrations were observed already in 93.33% of the tested samples (Table 2).

**Table 2.** Levels of selenium in cow milk, %

**Tabela 2.** Poziom selenu w mleku krowim, %

| Season<br>Pora roku | Levels of selenium concentration<br>Poziom stężenia selenu | | |
|---|---|---|---|
| | deficient<br>deficytowy | marginal<br>marginalny | optimal<br>optymalny |
| | < 0.009<br>μg · ml$^{-1}$ | 0.011–0.029<br>μg · ml$^{-1}$ | > 0.03<br>μg · ml$^{-1}$ |
| Spring<br>Wiosna | – | 85.00 | 15.00 |
| Summer<br>Lato | 27.78 | 72.22 | – |
| Autumn<br>esień | – | 27.78 | 93.33 |
| Winter<br>Zima | – | 65.00 | 35.00 |

## DISCUSSION

According to Puls [1988], the biochemical criteria used to diagnose the presence of selenium deficiency in bovine milk are as follows: below 0.009 g · ml$^{-1}$ – deficiency; 0.011–0.029 μg · ml$^{-1}$ – marginal level; above 0.03 μg · ml$^{-1}$ – optimal level. Our study has demonstrated that a particular attention should be paid to the concentration of selenium in cow milk during summer. Up to 72.22% of the tested samples has shown a marginal selenium level, and in 27.78% the level was deficient.

A seasonal diversification of selenium content in cow milk from milk machines may be explained by the specifics of milk production in Poland, based mostly on the natural fodders from pastures, meadows and farmlands. Plants assimilate selenium mostly as selenates (VI) and selenates (IV) and occasionally as selenides, depending on the species of a plant [Wachowicz 1993]. Most of the crop plants contain less than 25 g · g$^{-1}$ d.m. of selenium, and only a few of them exceed 100 g · g$^{-1}$ d.m. [Ellis and Salt 2003]. As reported by Terry et al. [2000] the collocation of selenium in different parts of plants depends on their species, developmental stage and physiological status. The content of selenium in feed plants is regionally diversified. In Poland, low levels of selenium are noted mostly in grass and cereal. A similar trend has been observed in other countries like e.g. Finland, with selenium levels at 0.014 mg · kg$^{-1}$ d.m. in grass and 0.007 mg · kg$^{-1}$ d.m. in cereals, respectively. In turn some studies performed in Germany have shown a slightly higher level of selenium in plants in general, with 0.045 mg · kg$^{-1}$ d.m. in grass and 0.017 mg · kg$^{-1}$ s.m. in cereals [Harfiel and Bahners 1987, Borowska 2010].

If the content of selenium in milk and milk products targeted to humans is expected to be significant, it is very important to develop such systems of cow feeding that would promote reaching the demanded selenium levels in milk and its derivatives. One of the possible ways to increase the concentrations of selenium in milk is to introduce the dedicated premixes as a regular fodder component used in cow feeding.

In comparison to our result, a clearly lower levels of selenium in cow milk were observed in Slovakia (0.007 μg · ml$^{-1}$) and New Zealand (from 0.001 to 0.014 μg · ml$^{-1}$) [Kadrabova et al. 1997, New Zealand Institute for Crop & Food Research Limited 2000]. Similar results that concerned the content of selenium in cow milk, to presented in our report were shown by Klapec et al. [2004] in eastern Croatia (from 0.017 to 0.029 μg · ml$^{-1}$), McNaughton and Marks [2002] in Australia (from 0.023 to 0.026 μg · ml$^{-1}$) and Iqbal et al. [2008] in Pakistan (0.17 μg · ml$^{-1}$). In turn, much higher concentrations of selenium in milk were noted by Lavi and Alfassi [1990] in Israel, reaching 0.073 μg · ml$^{-1}$ and by Murphy and Cashman [2001] in Ireland (from 0.014 to 0.101 μg · ml$^{-1}$).

Milk offered in milk machines contains a comparable levels of selenium to milk distributed by shopping malls in zachodniopomorskie voivodeship [Pilarczyk et al. 2010].

## CONCLUSIONS

Low concentration of selenium in cow milk from Western Pomerania in summer indicates that the animals residue in a selenium deficient area. Especially in this period, it is strongly indicated to introduce an early-diagnostics program evaluating the levels of selenium in dairy cattle and helping to quickly decide about supplementation.

## REFERENCES

Borowska, K. (2010). Selen w glebie i roślinach w warunkach zróżnicowanego nawożenia organicznego i mineralnego [Selenium in soils and plants in diversified organic and mineral fertilizing]. Wydaw. Uczelniane UT-P, Bydgoszcz, Rozprawa nr 140 [in Polish].

Daragó, A., Szamańska, J. (2003). Selen i jego wybrane związki stosowane w formach farmaceutycznych i kosmetycznych [Selenium and its selected derivatives used in pharmacy and cosmetics]. Pol. J. Cosmet., 1, 26–34 [in Polish].

Dębski, B., Zachara, B., Wąsowicz, W. (2001). Próby oceny poziomu selenu w Polsce oraz jego wpływ na zdrowotność ludzi i zwierząt [The attempts to evaluate selenium levels in Poland and its effect on health of humans and animals]. Folia Univ. Agric. Stein., Zootechnica, 224(42), 53–62 [in Polish].

Ellis, D.R., Salt, D.E. (2003). Plants, selenium and human health, Curr. Opin. Plant Biol., 3, 273–279.

Grzebuła, S., Witkowski, P. (1977). The determination of selenium trace levels in biological materials with fluorometric method. Selenium determination in tissues and bodily fluids. Pol. Arch. Weter., 20, 125–138.

Hartfiel, W., Bahners, N. (1987). Selenmangel in der Bundesrepublik Deutschland. Vita. Min. Spur., 2, 125–131.

Iqbal, S., Kazi, T.G., Bhanger, M.I., Akhtar, M., Sarfraz, R.A. (2008). Determination of selenium content in selected Pakistani foods. Int. J. Food Sci. Technol., 43, 339–345.

Kadrabova, J., Madaric, A., Ginter, E. (1997). The selenium content of selected food from the Slovak Republic. Food Chem., 58, 1–2, 29–32.

Klapec, T., Mandic, M.L., Grgić, J., Primorac, L., Perl, A., Krstanović, V. (2004). Selenium in selected foods grown or purchased in eastern Croatia. Food Chem., 85, 445–452.

Kosiorowska, M. (2012). Milkomats – a new form of direct sales of raw milk in Poland. Enginee. Sci. Technol., 4(7), 72––82.

Lavi, L., Alfassi, Z.B. (1990). Determination of trace amounts of cadmium, cobalt, chromium, iron, molybdenum, nickel, selenium, titanium, vanadium and zinc in blood and milk by neutron activation analysis. Analyst, 115, 817–822.

McNaughton, S.A., Marks, G.C. (2002). Selenium Content of Australian Foods: A Review of Literature Values. J. Food Comp. Anal., 15, 169–182.

Mihailovic, M., Ilic, V., Lindberg, P. (1996). Blood glutathione peroxidase activity, selenium and vitamin E concentrations of race horses in Serbia. Acta Veter., 46, 27–32.

Murphy, J., Cashman, K. (2001). Selenium content of a range of Irish foods. Food Chem., 74, 493–498.

New Zealand Institute for Crop & Food Research Limited (2000). New Zealand Food Composition Database. Ministry of Health. Christchurch.

Nowakowska, E., Pilarczyk, B., Pilarczyk, R., Tomza-Marciniak, A., Bąkowska, M. (2015). The Differences in the Level of Selenium in the Organs of Red Deer (Cervus elaphus) from Various Regions of Poland. Int. J. Environ. Res., 9(4), 1287–1292.

Pilarczyk, B., Balicka-Ramisz, A., Ramisz, A., Vovk, S., Krużel, B., Tomza, A. (2007). Selengehalte im Blutserum von Kühen, Schafen und Schweinen in der Westukraine und Westpommern. Tierärztl. Umschau, 62, 123–126.

Pilarczyk, B., Balicka-Ramisz, A., Ramisz, A., Pilarczyk, R., Sablik, P., Wójcik, J. (2008). Selengehalte im Blutserum von aus Deutschland, Tschechien, Frankreich und Holland nach Polen importierten Rindern. Tierärztl. Umschau, 63, 243–246.

Pilarczyk, B., Tomza-Marciniak, A., Mituniewicz-Małek, A., Wieczorek, M., Pilarczyk, R., Wójcik, J., Balicka-Ramisz, A., Bąkowska, M., Dmytrów, I. (2010). Selenium content in selected products of animal origin and estimation of the degree of cover daily Se requirement in Poland. Inter. J. Food Sci. Technol., 45, 186–191.

Pilarczyk, B., Tomza-Marciniak, A., Pilarczyk, R., Kuba, J., Mituniewicz-Małek, A., Dmytrów, I., Stankiewicz, T. Udała, J. (2013). Selengehalt im Fleisch und in ausgewählten Organen von Ziegenlämmern sowie in der Ziegenmilch und ihren Produkten aus dem Gebiet Westpommern. Züchtungskunde, 85(6), 451–461.

Puls, R. (1988). Mineral Levels in Animal Health. Sherpa International, Clearbrook, B.C., Canada.

Sablik, P., Kobak, P., Pilarczyk, B., Szarkowski, K., Syczewski, A. (2011). Serum selenium concentrations in water buffaloes (Bubalus bubalis) and black-and-white German Holstein-Friesian cows raised in the Notec River region of the Wielkopolska province. Bull. Veter. Inst. Pulawy, 55, 141–144.

Terry, N., Zayed, M., de Souza, M.P., Tarun, A.S. (2000). Selenium in higher plants. Annu. Rev. Plant Physiol. Plant Mol. Biol., 51, 401–432.

Wachowicz B. (1993): Selen w roślinach [Selenium in plants]. Wiad. Bot., 37, 87–89 [in Polish].

## ZAWARTOŚĆ SELENU W MLEKU KROWIM OFEROWANYM W MLEKOMATACH Z TERENU SZCZECINA W ZALEŻNOŚCI OD PORY ROKU

### STRESZCZENIE

Celem pracy było określenie zawartości selenu w mleku krowim oferowanym w mlekomatach z terenu Szczecina w zależności od pory roku. Materiał badawczy stanowiły próbki mleka pochodzące z 5 mlekomatów zlokalizowanych na terenie miasta Szczecin. Celem pracy było określenie zawartości selenu w mleku krowim oferowanym w mlekomatach w zależności od pory roku. Średnia zawartość selenu w mleku w mlekomatach z terenu Szczecina była zróżnicowana w poszczególnych porach roku i mieściła się w przedziale od 0,013 do 0,034 $\mu g \cdot ml^{-1}$. Średnie stężenie selenu w mleku krowim z mlekomatów wyniosło 0,023 $\mu g \cdot ml^{-1}$. Najniższe średnie stężenie selenu odnotowano w mleku w okresie lata (0,013 $\mu g \cdot ml^{-1}$), natomiast najwyższe w okresie jesieni (0,034 $\mu g \cdot ml^{-1}$). Nie stwierdzono różnic istotnych statystycznie w zawartości selenu w mleku pomiędzy zima a wiosną, pomiędzy pozostałymi porami roku różnice te były istotne statystycznie. Z przeprowadzonych badań wynika, że szczególną uwagę należy zwracać na stężenie selenu w mleku krów w okresie lata bo, aż w 72,22% badanych próbek występował marginalny poziom selenu w mleku, a w 27,78% poziom deficytowy. Niskie stężenie selenu w mleku krów w okresie lata wskazuje na to, że zwierzęta znajdują się na terenie niedoborowym w ten pierwiastek. Szczególnie w tym okresie konieczne jest wprowadzenie wczesnej diagnostyki poziomu selenu u krów mlecznych i podjęcia szybkiej decyzji o jego suplementacji.

**Słowa kluczowe:** selen, mleko krowie, mlekowaty, pory roku, Szczecin