

## SELENIUM CONTENT IN FEEDSTUFFS IN VOJVODINA (SERBIA)

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*We examined 142 samples of various feedstuffs (grain and hay) from 31 communities in Vojvodina, a region of the utmost importance for cereal production in Serbia. Selenium content was measured using atomic absorption spectrometry. The results were expressed as  $\mu\text{g/kg}$  dry weight (ppb) and were as follows: maize ( $n=37$ )  $38.46 \pm 17.04$ ; wheat (28)  $50.94 \pm 22.25$ ; oats (19)  $58.75 \pm 22.80$ ; all grains (117)  $46.19 \pm 20.82$ ; hay (25)  $65.08 \pm 37.01$ ; all feedstuffs (142)  $49.52 \pm 25.33$ . In 59.1% of the feedstuffs examined Se content was lower than  $50 \mu\text{g/kg}$  and only in 2 samples of hay did it exceed  $100 \mu\text{g/kg}$ . Se content in feedstuffs from two sub-regions, Banat and Bačka, did not differ significantly from the Vojvodina average, but in Srem it was significantly lower ( $41.22 \pm 21.18 \mu\text{g/kg}$ ). Although these values are twice as high as corresponding data for the rest of Serbia, Vojvodina is still a region of low Se content.*

*Key words: selenium, feedstuffs, grain, hay.*

## INTRODUCTION

It has been generally established that selenium (Se) concentrations in crops between 50 and  $100 \mu\text{g/kg}$  (ppb) are minimal values that prevent apparent selenium responsive syndromes in livestock, such as nutritional muscular dystrophy (Kubota et al., 1967). A daily selenium intake of  $0.85 \mu\text{g}$  Se per kg body mass is considered to be sufficient for the adult human population (Combs and Combs, 1986).

The geo-botanical map presented by Gissel-Nielsen (1976) revealed that broad regions of Europe, from Iceland on the north-west to Russia on the east, are selenium adequate. Spotwise toxic areas occur in Ireland and Wales, while in Scandinavian countries (Lindberg and Bingefors, 1970; Oksanen and Sandholm, 1970; Frøslie et al., 1980) levels are very low or extremely low, ranging from 2 -  $46 \mu\text{g/kg}$  in cereals.

Research on the selenium content of Yugoslav and Serbian plant cultures has been in progress for more than two decades but only since the late eighties did it become more detailed and systematic. Serbia was shown to be selenium

deficient, but the extent and severity of the deficiency is not uniformly distributed over the country. The deficiency is greatest in the south on the Sjenica-Pešter plateau, where all collected samples of grain and hay had contents below 25  $\mu\text{g/kg}$  (Mihailović et al., 1990).

Vojvodina is the major agricultural region in Serbia, producing some 60% of all agricultural goods. As such it is the main contributor to the Se intake of both human and animal populations in this country. Vojvodina covers the northern part of Serbia and consists of three major sub-regions: Srem, Banat, and Bačka. According to Živković et al. (1971) major soil parental substrates in the region are derived from Quaternary sediments. They may be divided into three major classes: loess which is dominant, followed by alluvial deposits, while the third distinct class consists of sand deposits. The sole exception to this rather uniform soil composition is the north-western part of Srem, where Fruška Gora mountain is situated.

The purpose of our study was to determine the selenium content in plant cultures (most important for human and animal nutrition) grown in Vojvodina, as well as to depict its spatial distribution.

#### MATERIAL AND METHODS

Samples of feedstuffs (117 samples of grain and 25 of hay) were collected from 31 communities throughout Vojvodina, over the period 1992 - 95, on farms belonging to local farmers. Selenium content was determined using atomic absorption spectrometry (Welty et al., 1987).

#### RESULTS AND DISCUSSION

The selenium content in feedstuffs from Vojvodina (Table 1) was low. Thus, the average selenium content in all feedstuffs ( $n=142$ ) was  $49.52 \pm 25.33 \mu\text{g/kg}$ , 59.1% of the values being under 50  $\mu\text{g/kg}$ , and 98.6% under 100  $\mu\text{g/kg}$ . The selenium concentration in hay ( $65.08 \pm 37.01 \mu\text{g/kg}$ ) was significantly higher ( $p < 0.001$ ) compared to that in grain ( $46.19 \pm 20.82 \mu\text{g/kg}$ ). Among cereals, the highest concentration was found in oats ( $58.75 \pm 22.80 \mu\text{g/kg}$ ). Se concentration in wheat ( $50.94 \pm 22.25 \mu\text{g/kg}$ ) was significantly higher ( $p < 0.01$ ) than in maize ( $38.46 \pm 17.04 \mu\text{g/kg}$ ). A similar pattern of selenium distribution among different feedstuffs has been presented by numerous authors, as summarized by Combs and Combs (1986). One exception in our samples was the large difference in Se content between oats and barley ( $p < 0.05$ ).

According to Živković et al. (1972) the composition, mechanical and chemical characteristics of the soil in most parts of Vojvodina are very favorable for agricultural production. The same authors state that the average annual precipitation in the region is low, ranging from 500 to 750 mm, implying that Vojvodina is a semi-arid area. Such condition should be favorable for selenium uptake by plants (Gissel-Nielsen, 1977). Nevertheless, the Se content in crops was relatively low, indicating low Se concentration in the soil. Data presented by Dangić et al. (1995, 1995a) confirm such low Se status because the average Se content in Danube river bank sediments was  $72 \pm 48 \mu\text{g/kg}$ , ranging from 9-177, and in loess  $23 \pm 18 \mu\text{g/kg}$ , ranging from 5 - 50.

Table 1. - Selenium content (mg/kg) in various feedstuffs in Vojvodina

No.	Corn	Wheat	Barley	Oats	Soybean	Sunflower	Hay	All Grain	All Feedstuffs
mean $\pm$ SD	37 38.46 $\pm$ 17.04	28 50.94 $\pm$ 22.25	19 46.10 $\pm$ 17.51	19 58.75 $\pm$ 22.80	9 45.11 $\pm$ 21.97	5 31.4 $\pm$ 13.95	25 65.08 $\pm$ 37.01	117 46.19 $\pm$ 20.82	142 49.52 $\pm$ 25.33
range	15.1 - 94.0	16.0 - 87.6	22.0 - 92.0	15.0 - 94.0	27.3 - 82.0	19.0 - 52.5	12.0 - 168.0	15.0 - 94.0	12.0 - 168.0
%<50mg/kg	78.4	53.5	68.4	36.8	66.7	20.0	40.0	63.2	59.1

Table 2. - Selenium content (mg/kg) in various feedstuffs in three major sub-regions of Vojvodina

	Corn	Wheat	Barley	Oats	Soybean	Sunflower	Hay	All Grain	All Feedstuffs
GREM	No.	6	2	1	2	-	3	17	20
	mean $\pm$ SD	34.55 $\pm$ 8.14	37.27 $\pm$ 25.06	29.15 $\pm$ 9.4	49.7	43.1 $\pm$ 22.34	66.4 $\pm$ 30.26	36.77 $\pm$ 16.68	41.22 $\pm$ 21.18
	range	26.7 - 49.0	22.1 - 87.6	22.5 - 35.8	-	27.3 - 58.9	32.5 - 90.7	22.1 - 87.6	22.1 - 90.7
BANAT	No.	10	4	2	4	-	5	27	32
	mean $\pm$ SD	43.82 $\pm$ 23.51	50.85 $\pm$ 23.51	39.25 $\pm$ 18.39	82.82 $\pm$ 16.97	45.33 $\pm$ 25.01	66.40 $\pm$ 37.72	48.01 $\pm$ 23.78	50.89 $\pm$ 26.31
	range	17.0 - 94.0	16.0 - 80.0	22.0 - 65.0	70.0 - 94.0	27.3 - 82.0	18.0 - 112.0	16.0 - 94.0	16.0 - 112.0
BAČKA	No.	21	15	13	16	3	5	59.3	56.3
	mean $\pm$ SD	37.03 $\pm$ 15.37	56.45 $\pm$ 19.52	50.82 $\pm$ 16.74	56.41 $\pm$ 22.84	46.17 $\pm$ 27.14	64.46 $\pm$ 39.79	47.54 $\pm$ 20.40	50.88 $\pm$ 25.73
	range	15.1 - 70.0	19.2 - 85.5	24.1 - 92.0	15.0 - 92.0	30.0 - 77.5	12.0 - 168.0	15.0 - 92.0	12.0 - 168.0
	%<50mg/kg	76.2	46.7	61.5	37.5	33.3	20.0	58.9	55.6

SUB - REGIONS:

Data for the three main sub-regions of Vojvodina, Srem, Banat and Bačka, are presented in Table 2. The mean concentration of selenium in feedstuffs grown in Banat ( $50.89 \pm 26.31 \mu\text{g/kg}$ ) and Bačka ( $50.88 \pm 25.73 \mu\text{g/kg}$ ) did not differ significantly, but in Srem ( $41.22 \pm 21.18 \mu\text{g/kg}$ ), it was significantly lower ( $p < 0.05$ ) than in Bačka. The main contribution to this difference was due to grains, while no significant difference was detected between samples of hay. The reason for the lower Se concentration in grains from Srem could be the presence of the mountain Fruška Gora covered by soil of different composition from that in other parts of the region. The average selenium content in samples collected from communities situated on the foothills of the mountain: Šid, Pećinci and Sremski Karlovci, was under  $50 \mu\text{g/kg}$ , and in Ruma under  $25 \mu\text{g/kg}$ , while at the other places in Srem it was equal to or higher than the Vojvodina average.

Selenium concentration was lower in samples of feedstuffs from communities situated on the soils derived from alluvial deposits in the vicinity of the river Danube (mostly below  $50 \mu\text{g/kg}$ ), compared to those on the loess plains (mostly between  $50$ - $100 \mu\text{g/kg}$ ). The reverse relation of selenium concentrations in soil and crops can be explained by the fact that a large portion of the selenium in river sediments is concentrated in the clay fraction (Dangić et al. 1995), which is unavailable to plants.

In the last few years reports on selenium responsive diseases of livestock in Vojvodina have become rare, as a consequence of obligatory selenium supplementation of mineral-vitamin premixes for animal nutrition. However, such reports were rather frequent until this protective measure was introduced in 1989.

Although the average selenium level in samples collected in Vojvodina, was 2 to 6 fold higher compared to the corresponding plants from the rest of Serbia (maize  $16.43 \pm 16.17 \mu\text{g/kg}$ ; wheat  $23.91 \pm 14.92 \mu\text{g/kg}$ ; oats  $19.59 \pm 19.79 \mu\text{g/kg}$ ; hay  $37.58 \pm 21.24 \mu\text{g/kg}$  - Mihailović et al. 1996) it can be concluded that Vojvodina is a region of low Se concentration in feedstuffs.

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## SADRŽAJ SELENA U HRANIVIMA VOJVODINE

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### SADRŽAJ

Sakupljeno je 142 uzorka različitih hraniva (zrnastih i kabastih) sa 31 mesta u Vojvodini. Sadržaj selena meren je metodom atomske apsorpcorne spektrometrije. Rezultati su izraženi kao  $\mu\text{g/kg}$  suve mase (ppb) i bili su sledeći: kukuruz ( $n=37$ )  $38.46 \pm 17.04$ ; pšenica (28)  $50.94 \pm 22.25$ ; ovas (19)  $58.75 \pm 22.80$ ; sva zrnasta hraniva (117)  $46.19 \pm 20.82$ ; sena (25)  $65.08 \pm 37.01$ ; sva hraniva zajedno (142)  $49.52 \pm 25.33$ . Od svih hraniva, sadržaj selena u 59.1% uzoraka bio je niži od  $50 \mu\text{g/kg}$ , a u svega dva uzorka sena prelazio je  $100 \mu\text{g/kg}$ . Sadržaj selena u hranivima u dva subregiona, Banatu i Bačkoj, nije se značajno razlikovao od proseka za Vojvodinu, ali je u Sremu bio značajno niži ( $41.22 \pm 21.18 \mu\text{g/kg}$ ). Iako su naši rezultati u proseku dvostruko viši od odgovarajućih podataka za ostatak Srbije, Vojvodina se ipak može smatrati područjem sa niskim sadržajem selena.

