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ASSESSMENT OF SELENIUM CONTENT IN SOILS NEAR INDUSTRY PLANTS IN OPOLE (SOUTHERN POLAND)

WYSTĘPOWANIE SELENU W GLEBACH W BEZPOŚREDNIM SĄSIEDZTWIE ZAKŁADÓW PRZEMYSŁOWYCH W OPOLU

Abstract: Selenium is an essential element necessary for animals and humans. Its compounds have anticancer and antimutagenic character. However high uptake of it from environment eg with food or water could lead to different diseases including embryonic deformity decreased hatchling survival and causing death to aquatic organisms. Soil pollution with selenium lead to accumulation in plant tissues what is the beginning of selenium fate in food chain. In this work a cultivated layer of soils localized near some industry plants in the Opole city (southern Poland) were investigated. Selenium content in soils is an effect of two factors: natural occurrence of it in rocks (natural content) and human activity - especially chemicals agriculture use) or as an effect of industry production. Obtained results of selenium concentration covered range from 108.0 to 614.4 μg/kg d.m. these results are a bit higher than concentrations noted in natural or non-polluted soils, but still low. These amounts of selenium could have more positive than negative effects. Selenium concentrations were discussed parallel with base soils parameters as pH, EC and granulometric fractions composition.

Keywords: selenium, soil, industry

Soil research so rare focus on selenium content. It is so important especially in cultivated layer according to bioavailability and potential toxicity of it. Selenium is an essential element necessary for animals and humans. Low selenium concentrations or lack of it in water and food lead to several diseases eg Kashin-Beck and Keshan [1]. Its compounds have proofed anticancer and antimutagenic character and could be antagonistic to mercury [2, 3]. However too high uptake of it from environment eg with food or water could lead to different diseases including embryonic deformity decreased hatchling survival and causing death to aquatic organisms [1, 4, 5]. Strong soil pollution with selenium compounds lead to accumulation of it in plant tissues what is the beginning of selenium fate in food chain [6]. In some areas organic fertilization of soils could be a main source of selenium [7].

Materials and methods

We were focused on surface layer (20 cm) of investigated soils because this is the most suitable layer for plants roots. All collected samples were taken in the Opole city (southern Poland). Samples were taken during summer 2008 from 5 points around an industry plant. One sample was collected from 50 single points covered area about 100 m^2. After sampling procedure, all samples from single points were mixed, dried at room conditions to air-dry humidity. After that were sieved through 1 mm sieve. For general soils characteristic a basic parameters as: pH, EC (electrochemical method) and granulometric fractions share

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(Casagrande's method in Proszyński modification) and organic carbon - TOC (by Tiurin's method) and humus content were determined. For selenium determination soil samples (0.5 g) were mineralized with 12 cm^3 *aqua regia* in Teflon® bombs with microwave furnace MARS-X. Selenium determination on apparatus Varian SpectrAA 220-FS was made.

Results and disscusion

Investigated soils are mostly sands and loamy sands with low content of organic matter (Table 1).

Table 1

Basic parameters of investigated soils

No. of object	Sample	Sampling depth [cm]	pH		EC [mS/cm]	C_{org} [%]	Humus content [%]
			H_2O	1M KCl			
11	51	0÷30	8.16	7.48	0.157	4.15	7.15
	52	0÷30	7.81	7.42	0.145	2.21	3.81
	53	0÷30	7.38	7.01	0.238	7.01	12.08
	54	0÷30	7.75	7.10	0.126	4.58	7.89
	55	0÷30	7.56	7.13	0.184	4.44	7.65
12	56	0÷30	7.42	7.00	0.116	1.98	3.41
	57	0÷30	7.51	6.90	0.134	1.87	3.22
	58	0÷30	7.60	6.90	0.139	1.45	2.49
	59	0÷30	7.58	7.13	0.149	2.30	3.96
	60	0÷30	7.43	7.03	0.126	1.02	1.76
13	61	0÷30	7.22	6.75	0.274	5.14	8.86
	62	0÷30	7.54	7.09	0.168	2.59	4.46
	63	0÷30	7.28	6.83	0.096	2.09	3.60
	64	0÷30	7.46	6.98	0.126	2.25	3.88
	65	0÷30	7.52	6.98	0.142	3.02	5.21

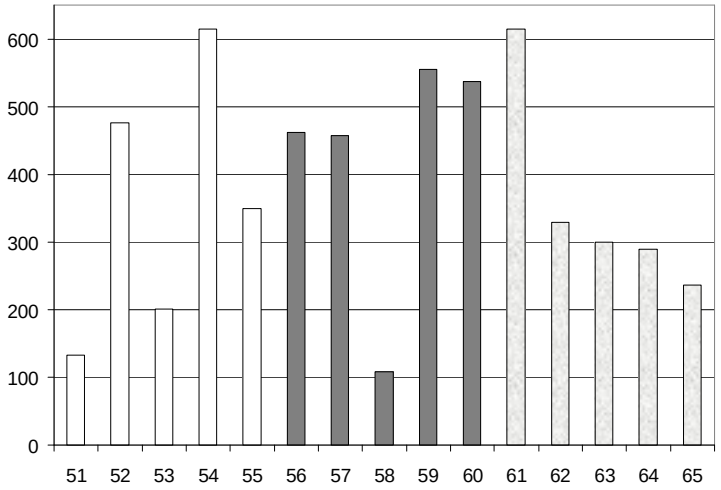

Fig. 1. Selenium content in investigated soils [µg/kg d.m.]

This is a typical for soils in investigated area where dominates sandy and limestone soils. Obtained in this work results of selenium concentration covered range from 108.0 to 614.4 μg/kg d.m. (Fig. 1).

These results are a bit higher than concentrations determined in natural or non-polluted soils, but still low [8]. Researches show that determined concentrations are not toxic but even in this level of contents selenium could be accumulated in plant tissues up to 4÷6 mg/kg d.m. [6, 9]. Especially in two points (51 and 58) selenium content was low and not exceed 135 μg/kg d.m. [10]. High concentrations (614.1 and 614.4 μg/kg d.m.) were also observed at two points (54 and 61). In this case concentrations are 10÷12 times higher than determined in Yangtze river delta [11], but at neutral pH value still not toxic and occurred in many samples [12]. Extremely low amounts of selenium in cultivated soils could lead to diseases and in this case a fertilization with selenium (eg manuring) could be necessary [1, 11]. There was no observed correlation between wind direction and selenium content, so we can excluded investigated industry plants (cement plant, bitumic factory, agricultural machine park) as selenium sources. Selenium as an important micronutrient and essential element for humans could have different effects depending from not only total content but also from type of chemical compounds [2]. Neutral pH (effect of high contenty of calcium and magnesium carbonates in rocks) of investigated soils minimizes mobility of selenium ions from soil to groundwater. Obtained results are in no-toxic range (toxic dose for humans is 5 mg/day) and it is possible to cultivate food plants even if selenium will be accumulated in plants tissues. Maximum level of selenium concentration for soils (incl. agricultural) according to Canadian Quality Guidelines is 1 mg/kg d.m. so all investigated samples comply with this requirement. However in researches with strawberries and barley, a toxic effect (low leaves growth) of selenium (additionally under UV-B radiation) was observed in concentration 1.0 mg/kg in soil [9]. Observed low and medium amounts of selenium in investigated soils could have more positive than negative effects for plants and animals or humans in case of use plants cultivated in these areas for feed or food production.

Conclusion

In this work a cultivated layer of soils (topsoil layer) localized near some industry plants in the Opole city (southern Poland) were investigated. Selenium content in soils is an effect of two factors: natural occurrence of it in rocks (natural content) and human activity - especially chemicals agriculture use or as an effect of industrial production. Obtained results of selenium concentration covered range from 108.0 to 614.4 μg/kg d.m. These results are a bit higher than concentrations determined in natural or non-polluted soils, but still low. These amounts of selenium (taking into account soil conditions, especially neutral pH and low EC value) could have more positive than negative effects. However it is necessary to investigate amount of mobility forms of selenium in these areas.

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WYSTĘPOWANIE SELENU W GLEBACH W BEZPOŚREDNIM SĄSIEDZTWIE ZAKŁADÓW PRZEMYSŁOWYCH W OPOLU

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Streszczenie: Selen postrzegany jest jako pierwiastek niezbędny dla zwierząt i człowieka. Jego związki wykazują działanie antynowotworowe i antymutagenne. Jednak pobieranie go ze środowiska w większych ilościach, np. wraz z pokarmem, może oddziaływać toksycznie na zwierzęta i człowieka, powodując deformacje, spadek przeżywalności zarodków, także w stosunku do organizmów wodnych. Zanieczyszczenie gleb tym pierwiastkiem prowadzi do kumulacji w tkankach roślinnych, a to powoduje włączenie go do łańcucha pokarmowego. W pracy badano warstwę orną gleb wokół wybranych zakładów przemysłowych na terenie miasta Opola. Zawartość selenu w glebach jest wynikiem dwóch czynników - uwarunkowań naturalnych oraz gospodarki człowieka w szczególności związanej z rolnictwem (opryski środkami ochrony roślin) lub działalnością przemysłową. Zanotowane stężenia selenu nie były duże i zawierały się w przedziale od 108,0 do 614,4 ppb. Są to jednak wartości nieco podwyższone w stosunku do spotykanych w glebach niezanieczyszczonych, zawierających zwykle kilkadziesiąt mikrogramów selenu w kilogramie gleby. Zanotowane w tej pracy stężenia nie stanowią zagrożenia dla zdrowia ludzi nawet w przypadku uprawy roślin jadalnych na badanych glebach.

Słowa kluczowe: selen, gleba, przemysł