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# CONTENT OF SELECTED HEAVY METALS IN SOIL IN VARIOUS AREAS OF THE SWINE FARM

## ZAWARTOŚĆ WYBRANYCH METALI CIĘŻKICH W GLEBIE Z RÓŻNYCH MIEJSC FERMY ŚWIŃ

**Abstract:** Heavy metals are present not only in the highly industrialized regions, but also in natural ecosystems and farm lands. Since the productivity of farm animals increases, more and more microelements are added to the feed, which may cause their excessive accumulation in the environment. Therefore, research was undertaken to determine the degree of soil contamination with heavy metals in various areas on a swine farm. The samples for tests were collected from the following places: the swine yard and at the distance of 4 metres from the yard fence, the dung plate – at the distance of 5 and 10 m, and the fattening house – at the distance of 20 m. The samples for analysis were taken in spring from the surface layer of the soil: 0–20 cm.

The content of lead and manganese in soil in various areas of the swine farm was within the limits qualifying the soil for the zero degree contamination. The highest concentration of zinc characterized the soil in the swine yard 141.8 mg · $kg^{-1}$), which qualifies the soil for the first degree of contamination. In the other areas, the content of zinc was within the limits characteristic of the zero degree contamination.

When the droppings are managed rationally, swine farms do not constitute any significant danger for the soil environment.

**Keywords:** heavy metals, soil, swine farms

Heavy metals are not only present in highly industrialised regions, but also in natural ecosystems and in those used agriculturally [1–3]. The extent of heavy metal contamination of soil depends on many factors, among others – on the type of land use [4]. The farmyards where swines are bred can, in some way, be sources of natural environment contamination. The problem itself is important, as in Poland over 1 million farms breed swine. In the environment of animals, heavy metals can be present in the atmospheric air, drinkable water and in soil, which animals may absorb either directly or indirectly with feed or plants [5]. Trace elements in the form of inorganic salt and oxides are added to farm animal feed. Microelements from these mixtures are characterised by low nutrient availability [6]. Higher and higher productivity of farm animals requires that high amounts of microelements should be added to feed, which

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may exceed the necessities of the animals, which in consequence leads to excessive accumulation of these microelements in the environment [7, 8].

Most of the research done so far was concerned with the effect of animal droppings on croplands contamination. Little research has been done concerning the problem of heavy metal soil contamination on swine farms. Therefore, research has been undertaken to estimate the degree of soil contamination with selected heavy metals at various farm objects characteristic of swine breeding.

## Material and methods

The examined soil was collected from a swine farm situated in Tomaszów County of Lublin Province. The analysed farm produced about 5000 fattening pigs a year. The animals were kept on thin bedding. The manure was removed from the farm everyday and accumulated on the dung plates, situated near the pig houses. The soil samples were taken from the surroundings of the following farm objects: the sow yard, about 4 m from the yard fence, the dung plate – at the distance of 5 and 10 m and the fattening house – at the distance of 20 m. The samples for analyses were gathered in spring from the surface layer of soil: 0–20 cm.

In the analysed soil samples, the contents of general forms of lead, zinc and manganese were determined. The soil samples underwent hot mineralization in concentrated nitric(V) acid and chloric(VII) (perchloric) acid, and then the content of analysed metals was established using the method of atomic absorption spectrometry.

The results of the analyses were compared with the limit contents of heavy metals established by IUNG [9] and limit numbers for metals in selected countries of the European Union.

## Results and discussion

The minimum, maximum and average contents of lead in soil collected at various farm objects on a swine farm are shown in Table 1. The highest content of lead was

Table 1

The content of the total lead in analysed farm soil [mg · kg$^{-1}$]

| Object | Content Pb [mg · kg$^{-1}$] | | |
|---|---|---|---|
| | min. | max | average |
| Sows yard | 17.0 | 23.5 | 19.7 |
| 4 m from the yard fence | 31.5 | 32.0 | 31.8 |
| Dung plate 5 m | 27.5 | 29.5 | 28.8 |
| Dung plate 10 m | 20.0 | 21.5 | 20.7 |
| Fattening house 20 m | 11.5 | 15.5 | 14.0 |
| Average | | | 23.0 |

noted in soil collected from the layer of 0–20 cm at the distance of 4 m from the fence of the swine yard. The average content of lead in this area was 31.8 mg · $kg^{-1}$) and the maximum – 32.0. Literature gives various values of geochemical background for lead in soils. The natural content of lead in the Polish soils is 8–25 mg/kg, and the admissible value is 50–100 mg, depending on the type of soil [5]. The contents of lead established by us should be treated as natural because they are within the zero degree soil contamination with heavy metals, according to the IUNG scale designed by Kabata--Pendias et al [9]. The limit numbers defining the zero degree lead soil contamination in selected countries of the European Union (England, Holland, France, Germany) are also higher than those estimated in the soil on the analysed farm [4].

Table 2 shows minimum, maximum and average contents of zinc in soil at various objects on a swine farm. The highest average concentration of zinc was determined in the soil collected from the swine yard (141.8 mg · $kg^{-1}$). The maximum content of zinc in soil samples collected in this area was 148.0 mg · $kg^{-1}$. According to the classification designed by Kabata-Pendias' team [9], the zinc concentration established by us, in the soil characterized by high content of organic matter (> 10 %) on a swine farm, qualifies the soil for the zero degree contamination with heavy metals. Terelak et al [10] state that the natural contents of zinc in cropland soil in Poland are within 0.5–100.0 mg · $kg^{-1}$. The authors found that the highest areas of such soils are, among others, in the Lublin Province. The limits of zinc content in soil are too high for the human health, and in many EU countries are much higher than in Poland [4]. However, the substantial toxicity of the element to living organisms and the easiness with which it enters food chains explains why ecologists and toxicologists are so much interested in the occurrence of this element in the natural environment.

Table 2

The content of total the zinc in analysed farm soil [mg · $kg^{-1}$]

| Object | Content Zn [mg · $kg^{-1}$] | | |
|---|---|---|---|
| | min. | max | average |
| Sows yard | 137.0 | 148.0 | 141.8 |
| 4 m from the yard fence | 22.5 | 30.5 | 27.7 |
| Dung plate 5 m | 48.5 | 53.5 | 51.3 |
| Dung plate 10 m | 31.5 | 34.0 | 32.3 |
| Fattening house 20 m | 26.0 | 27.0 | 26.7 |
| Average | | | 56.0 |

The manganese concentration in swine farm soil is shown in Table 3. The highest concentration of manganese has been found in the soil collected at the distance of 5 m from the dung plate. The average content of this element was 368.8 mg · $kg^{-1}$, and the maximum content of manganese in soil samples collected from the above enumerated area was 391.5 mg · $kg^{-1}$. High average contents of manganese were found in soil collected from the swine yard (260.3 · $kg^{-1}$), at the area situated at the distance of 20 m from the fattening house (221.8 mg · $kg^{-1}$), and in the other analysed areas (> 200 mg · $kg^{-1}$). The general content of manganese in soils is most often within 100–1000

Table 3

The content of total the manganese in analysed farm soil [mg · kg$^{-1}$]

| Object | Content Mn [mg · kg$^{-1}$] | | |
|---|---|---|---|
| | min. | max | average |
| Sows yard | 252.0 | 270.0 | 260.3 |
| 4 m from the yard fence | 212.5 | 222.0 | 218.3 |
| Dung plate 5 m | 352.0 | 391.5 | 368.8 |
| Dung plate 10 m | 192.0 | 227.0 | 203.8 |
| Fattening house 20 m | 206.5 | 252.0 | 221.8 |
| Average | | | 254.6 |

mg · kg$^{-1}$ [11]. The main source of manganese flow into the soil is rain waters [12], and in our case, an additional source of manganese flow was liquid manure and manure water from swine droppings. Mazur [13] claims that with liquid manure much more manganese enters soil in comparison to manure. Manganese soil contamination is connected with its form and not quantity [14]. The authors claim that excessive quantities of easily dissolving manganese can appear in soils fertilized with manure, which often contains its higher concentration as a result of using mineral additives in feed.

## Conclusions

1. In swine farm soil, a natural content of lead was found. Soil samples collected at the distance of 4 m from the swine yard were characterized by the highest concentration of this element; the maximum content was – 31.8 mg · kg$^{-1}$.

2. The highest concentration of zinc was determined in the soil of the swine yard (141.8 mg · kg$^{-1}$), which qualifies the soil as being characterized by the zero degree contamination. The content of zinc at the other farm areas was within the limits specified for the zero degree contamination.

3. The average content of manganese in soil samples collected at various farm objects was between 203.8 to 368.8 mg · kg$^{-1}$. The highest concentration of manganese was determined in the soil samples collected in the area situated at 5 m from the dung plate.

4. When swine droppings are managed rationally, swine farms do not constitute any significant danger of contamination with heavy metals for soil environment.

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## ZAWARTOŚĆ WYBRANYCH METALI CIĘŻKICH W GLEBIE Z RÓŻNYCH MIEJSC FERMY ŚWIŃ

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**Abstrakt:** Obecność metali ciężkich stwierdza się nie tylko w rejonach silnego uprzemysłowienia, ale także w ekosystemach naturalnych i rolniczo wykorzystywanych. Coraz większa produkcyjność zwierząt gospodarskich wymaga stosowania dodatku mikroelementów do pasz w znacznych ilościach, które mogą przekraczać zapotrzebowanie zwierząt, konsekwencją czego może być zbyt duża ich akumulacja w środowisku. W związku z tym podjęto badania, mające na celu określenie stopnia zanieczyszczenia gleby wybranymi metalami ciężkimi przy różnych obiektach fermowych, które towarzyszą hodowli świń. Próbki do badań pobierano wokół następujących obiektów: wybieg dla loch i w odległości 4 m od ogrodzenia wybiegu, płyta gnojowa – w odległości 5 i 10 m oraz tuczarnia – w odległości 20 m. Próbki do analiz pobierano w okresie wiosennym z wierzchniej warstwy gleby: 0–20 cm.

Zawartość ołowiu i manganu w glebie przy różnych obiektach fermowych była w granicach kwalifikujących glebę do zerowego stopnia zanieczyszczenia. Największe stężenie Zn odnotowano w glebie na wybiegu dla loch (141,8 mg · kg), co kwalifikuje ją do pierwszego stopnia zanieczyszczenia. Przy pozostałych obiektach fermowych zawartość cynku w glebie mieściła się w granicach wyznaczonych dla zerowego stopnia zanieczyszczenia.

**Słowa kluczowe:** metale ciężkie, gleba, fermy świń