

Wiesław SZULC¹, Beata RUTKOWSKA,
Wojciech STĘPIEŃ and Anna PODKOŃSKA

**EVALUATION OF THE POSSIBILITY
OF AGRICULTURAL USE OF SEWAGE SLUDGE COMPOST
PRODUCED BY THE MUNICIPAL WASTEWATER PLANT
IN THE CITY OF ŁOWICZ**

**OCENA MOŻLIWOŚCI ROLNICZEGO ZAGOSPODAROWANIA
KOMPOSTU Z OSADU ŚCIEKOWEGO
Z MIEJSKIEJ OCZYSZCZALNI ŚCIEKÓW W ŁOWICZU**

Abstract: Evaluation of chemical properties of municipal sewage sludge compost was carried out in view of the possibility of agricultural use. The results obtained indicated neutral to acidic reaction of tested compost and the high content of nitrogen calcium and organic matter. At the same time, the levels of heavy metals did not exceed the norms for compost agricultural use. Therefore, this waste material can be used for plant fertilization in field cultivation. The maximum application rate of the analysed compost calculated taking into account the results obtained as well as the levels permitted in the Regulation of the Minister of Environment is limited by the content of zinc and it amounts to approximately 5 Mg of dry mass per ha annually, being equivalent to 11.5 Mg of fresh mass.

Keywords: compost, sewage sludge, fertilizer components, heavy metals, fertilization

Changes that have taken place in Polish agriculture have resulted in a reduction of farm animal stock, and then again the use of mineral fertilizers decreased. These have led to insufficient supply of nutrients and organic matter into soils. Such circumstances can lead to a decrease of indicator values of soil fertility and fecundity. Therefore, new sources of nutrient and organic matter supply into soils have been sought. One of these sources is sewage sludge from municipal wastewater. Currently, the production of sewage sludge in Poland amounts to 501.3 thousand tons of dry mass and only 16.07 % is used for agricultural purposes [1].

¹ Department of Soil Environment Sciences, Warsaw University of Life Sciences (SGGW), ul. Nowoursynowska 159, 02-776 Warszawa, Poland, phone +48 22 593 2628, fax +48 22 593 2631, email: wieslaw_szulc@sggw.pl

Several studies have shown advantageous effects of sewage sludge application on physiochemical properties of soil as well as plant productivity and quality [2–6]. Municipal sewage sludge belong to the group of waste materials that should be a subject to the stabilisation process before designation to the use in agriculture. One of the methods of waste stabilisation is composting that allows to obtain valuable organic fertilizer, which at the same time is safe in terms of sanitary requirements [7–10].

Hence, this research was undertaken in order to evaluate changeability of the chemical content of sewage sludge compost as well as its environmental usefulness.

Material and methods

The trials were carried out on samples of compost obtained from sewage sludge collected at the Municipal Wastewater Treatment Plant in the city of Łowicz in the years 2005–2006. The compost was produced from municipal sewage sludge (70 %) and sawdust (30 %). Samples for compost analyses were collected 3 times a year. A representative sample was obtained by adding together and mixing thoroughly 10 individual samples collected in one go from different spots selected on the study prism. Test samples of approximately 1 kg were taken for further laboratory analyses.

The laboratory compost samples were dried with the use of a forced air drier at the temperature 105 °C and then ground. The following features were evaluated:

- reaction – with the use of potentiometric method,
- dry mass content – with the use of gravimetric method,
- organic matter content – after thermal decrepitation at 600 °C,
- the total nitrogen content – with the use of Kjeldahl method.

After wet mineralization in the mixture of nitric(V), chloric(VII) and sulphuric(VI) acids, there were determined:

- the total content of phosphorus – with the use of spectrophotometric method,
- the content of calcium, magnesium and heavy metals (lead, cadmium, nickel, zinc, copper and chromium) – with the use of the AAS method.

Chemical analyses were carried out according to the common methods of agricultural chemistry [11].

Results and discussion

The results of chemical analyses showed high contents of organic matter and nitrogen in examined compost (Table 1). Thus, a possibility of the use of this material for plant fertilization was shown. At the same time, the results of compost analyses on parasites and bacteria carried out by the District Centre of Sanitary and Epidemiologic Surveillance in the city of Skierniewice, did not show either pathological bacteria from the genus *Salmonella* or alive eggs of intestine parasite species, such as *Ascaris* sp., *Trichuris* sp. and *Toxocara* sp. This confirmed usefulness of analysed compost for natural utilization [12].

Table 1

Chemical properties of sewage sludge compost from the Municipal Wastewater Plant
in the city of Lowicz

Timing of sample collection	pH	d.m. [%]	Organic matter [% d.m.]	Organic C	Total N	P	Ca	Mg	C:N
April 2005	5.8	46.7	66.2	384.0	26.4	17.1	32.5	5.3	14.5
August 2005	5.6	43.5	66.5	385.7	25.4	11.4	35.5	4.5	15.2
November 2005	5.9	34.3	72.1	418.2	23.1	10.9	29.6	4.8	18.1
April 2006	6.3	45.0	63.6	368.9	27.7	12.1	31.8	4.6	13.3
August 2006	6.5	47.3	58.4	338.7	26.6	13.6	36.8	5.3	12.7
November 2006	6.2	43.2	61.3	355.6	25.9	11.8	32.3	4.7	13.7
Average	—	43.3	64.7	375.2	25.9	12.8	33.1	4.9	14.6
LSD _{0.05}	not significant								

Investigated sewage sludge compost showed reaction from neutral to weak acidic (pH 5.6–6.5) as well as relatively high contents of calcium (33.08 g Ca · kg⁻¹ d.m.) and magnesium (4.87 g Mg · kg⁻¹ d.m.), which can be considered as advantageous because in Poland, a great quantity of acidic and very acidic soils has been observed [13].

The content of nitrogen and organic carbon as well as C:N ratio have an effect on the possibility of agricultural use of sewage sludge compost. The total N in investigated compost was from 23.1 to 27.7 g · kg⁻¹ d.m., and the content of organic C ranged from 338.7 to 418.2 g · kg⁻¹ d.m. (Table 1). These amounts are similar to those observed by other authors in pre-compost sewage sludge [5, 8]. The C:N ratio in investigated compost ranged from 12.7:1 to 18.1:1 (Table 1). Czekala [14] reported a high range of C:N ratio in sewage sludge examined in the region of Wielkopolska (from 5.3:1.0 to 21.9:1.0). C:N ratio of sewage sludge indicates a rate of its decomposition in soil. Therefore, this parameter should be taken into account during evaluation of sewage sludge for fertilizer purposes, in view of the fact that C:N ratio is crucial for the use of nitrogen by plants [15].

The total phosphorus in composted sewage sludge was on average 12.82 g · kg⁻¹ d.m. When compared with observations by other authors, our end results indicated the total phosphorus in compost obtained from municipal sewage sludge were two fold lower than that reported by Izewska [5]. On the other hand, the content of phosphorus observed in this study was similar to the average content of this element in sewage sludge (raw and composted) tested in the region of Wielkopolska [14].

Sewage sludge and compost produced from it contain various amounts of heavy metals, such as lead, cadmium, nickel, zinc, copper and chromium, which can exclude this material as useful for agricultural purposes. The content of all heavy metals in sewage sludge compost analysed in this study was relatively low (Table 2) and did not exceed the levels permitted by the Regulation of the Minister of Environment on application of sewage sludge in agriculture [12].

Table 2

The content of heavy metals in sewage sludge from the Municipal Wastewater Plant in the city of Lowicz

Timing of sample collection	Pb	Cd	Zn	Cu	Cr	Ni
	[mg · kg ⁻¹ d.m.]					
April 2005	43.0	0.50	1064.0	201.0	63.8	16.1
August 2005	36.1	1.36	1014.0	312.0	57.0	16.5
November 2005	49.1	0.50	1046.0	283.0	62.3	13.8
April 2006	29.5	0.50	845.0	218.0	42.4	16.1
August 2006	33.4	1.26	1084.0	235.0	47.9	18.9
November 2006	41.8	0.50	968.0	310.0	46.6	14.4
Average	38.8	0.77	1003.5	259.8	53.3	16.0
Level permitted by law [12]	500	10	2500	800	500	100
LSD _{0.05}	not significant					

The maximum possible application rate for agricultural use of the analysed compost was calculated based on the obtained results on content of heavy metals and the levels granted in the Regulation of the Minister of Environment [12] (Table 3).

Table 3

The average content of heavy metals in sewage sludge compost and the maximum compost rate to use in agriculture

Heavy metal	Maximum annual rate of heavy metal* [g · ha ⁻¹]	Heavy metal content in sewage sludge [mg · kg ⁻¹ d.m.]	Maximum annual rate of compost [mg d.m. · ha ⁻¹]
Lead (Pb)	1000	38.82	25.8
Cadmium (Cd)	20	0.77	26.0
Nickel (Ni)	200	15.97	12.5
Zinc (Zn)	5000	1003.50	5.0
Copper (Cu)	1600	259.83	6.2
Chromium (Cr)	1000	53.33	18.8

* Regulation by the Minister of Environment [12].

The calculated results showed zinc as the element which is the most limiting factor for the possibility of agricultural use of tested sewage sludge compost. Based on the content of this element in analysed compost it was calculated that the maximum annual rate of this compost dry mass which can be applied in agriculture cannot exceed 5.0 Mg · ha⁻¹ per year (Table 3), which is equivalent to 11.5 Mg per ha⁻¹ · year⁻¹ of fresh mass.

Conclusions

1. Compost produced from sewage sludge and sawdust by the Municipal Wastewater Plant in the city of Lowicz indicated neutral to acidic reaction and the high content of

nitrogen, phosphorus and calcium in organic matter. At the same time, the levels of heavy metals did not exceed the norms for agricultural use of such compost. Therefore, this waste material can be used for plant fertilization in field cultivation.

2. The use of analysed compost for soil fertilization can influence maintenance, yet improvement of organic matter content in soil which is harmony with the new soil directive elaborated by the EU.

3. The maximum application rate of analysed compost calculated taking into account the results obtained and the heavy metals levels granted in the Regulation of the Minister of Environment, is restricted by the content of zinc and it amounts to approximately 5 Mg of dry mass per ha annually, being equivalent to 11.5 Mg of fresh mass.

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OCENA MOŻLIWOŚCI ROLNICZEGO ZAGOSPODAROWANIA KOMPOSTU Z OSADU ŚCIEKOWEGO Z MIEJSKIEJ OCZYSZCZALNI ŚCIEKÓW W ŁOWICZU

Katedra Nauk o Środowisku Glebowym
Szkoła Główna Gospodarstwa Wiejskiego w Warszawie

Abstrakt: Dokonano oceny składu chemicznego pod kątem możliwości rolniczego wykorzystania kompostu z komunalnego osadu ściekowego.

Na podstawie przeprowadzonych badań stwierdzono, że badany kompost charakteryzuje się odczynem słabo kwaśnym do obojętnego oraz dużą zawartością substancji organicznej, azotu i wapnia. Jednocześnie zawartość metali ciężkich nie przekracza norm umożliwiających rolnicze wykorzystanie tego kompostu. W związku z tym odpad ten może być wykorzystywany do nawożenia roślin w uprawie polowej. Maksymalna dopuszczalna dawka tego kompostu, obliczona zgodnie z ilością podaną w Rozporządzeniu Ministra Środowiska i zawartością metali ciężkich w badanym kompoście, jest limitowana przez cynk i wynosi około 5,0 Mg suchej masy na ha rocznie, co odpowiada dawce 11,5 Mg świeżej masy.

Słowa kluczowe: kompost, osad ściekowy, składniki nawozowe, metale ciężkie, nawożenie