COMPOSTING OF URBAN SLUDGE BY MIXING WITH PLANT RESIDUES

COMPOSTAREA NĂMOLURILOR URBANE PRIN AMESTECAREA CU RESTURI VEGETALE

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Abstract. *Sludge arising from municipal treatment plants is a valuable source of trace elements and N, P, K for plants, while improving physical and chemical properties of soil. The purpose of this study was to evaluate the possibility of composting biodegradable waste through anaerobic digestion mixed with plant residues. The results showed the suitability of applying the composting process from a chemical point of view. The study highlights the environmental impact of compost derived from sewage mixed with vegetable scraps that leads to improved resource utilization, conservation and reduction of pollutants.*
Keywords: organic fertilizer, anaerobic digestion, aerobic composting

Rezumat: *Nămolurile de la stațiile de epurare municipale constituie o sursă valoroasă de oligoelemente şi de N, P, K pentru plante, totodată contribuind şi la îmbunătățirea proprietăților fizice şi chimice ale solului. Scopul acestui studiu a fost de a evalua posibilitatea de compostare a deşeurilor biodegradabile, prin digestie anaerobă amestecat cu reziduuri de plante. Rezultatele au aratat sustenabilitatea aplicării procesul de compostare din punct de vedere chimic. Studiul subliniază impactul asupra mediului prin utilizarea compostului rezultat din canalizare amestecat cu resturi vegetale, care duce la îmbunătățirea resurselor de utilizare, conservare şi de reducere a poluanților.*
Cuvinte cheie: fertilizare organică, digestie anaerobă , compostare aerobă

INTRODUCTION

In accordance with European Council Directive on the landfill of waste (European Council Directive, 1999), Member States are required to reduce gradually the amount of biodegradable municipal waste.

Currently, the major methods of waste management are: a) recycling (recovery) of product materials having been used by consumers, b) a composting process aerobic biological degradation of biodegradable organic matter, c) wastewater-a process of treating raw sewage that produces a non-toxic liquid effluent is discharged to rivers or sea, and a semi-product (sludge), which is used to change soil properties, d) burning a combustion process designed to recover energy and reduce the amount of waste that must be eliminated (Domingo et al., 2009).

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Biodegradable waste is not suitable for incineration because of their high water content and creates problems when put in landfills (emanation of gas and leachates (Befa, T. 2002). A promising solution to use biological waste is municipal sewage sludge fermentation. Distribution of treated sludge improves soil agrochemical characteristics.

Should be noted that sludge can contain organic pollutants, inorganic and biological, commercial and industrial establishments and add or compounds formed during the various water treatments (Dominica Del Mundo Dacera et al., 2009).

The purpose was to estimate, harness and label waste compost made from municipal waste mixed with vegetable waste, by studying chemical parameters.

MATERIAL AND METHODS

The fermented sludge samples (obtained by mesophilic anaerobic fermentation at 320 C) and composting (biodegradable vegetable waste resulting from the mixture, represented by leaves, grass, straw 30% residual sludge - sludge mixed with primary sludge fermented biological anaerobic and dehydrated in 70%) were taken and analyzed in the Laboratory Institute of Technology INCD ECOIND Bucharest. The analytical methods used were the standard in Romania. During the experimental periods (28.06.2010-06.07.2010 - fermentation and 08.07.2010-03.09.2010 - for composting) were analyzed fermented and composted sludge properties in accordance with rules laid down in Goverment Decision 708/2005-the use of the sludge of wastewater treatment plants in agriculture as fertilizer.

Compost from the effluent treatment plant was used as fertilizer, as previously sterilized and stabilized by anaerobic fermentation process.

Quality indicators used to assess anaerobic digestion process and to determine the efficiency of composting determination were determined separately for the samples of sludge and compost.

For samples of sludge were used to determine the pH, moisture, volatile matter, ammonium (NH4 +), total Kjeldahl nitrogen (NTK), total phosphorus (P total), sodium (Na), potassium (K), calcium (Ca 2 +), magnesium (Mg 2 +), total iron (Fe total), manganese (Mn), lead (Pb), cadmium (Cd), total chromium (total Cr), copper (Cu), nickel (Ni), zinc (Zn), mercury (Hg), and, compost samples were monitored by following indicators: pH, total organic carbon (TOC), total nitrogen (N total), total phosphorus (P total), the ratio carbon / nitrogen (C / N), sodium (Na), calcium (Ca2 +), magnesium (Mg 2 +), lead (Pb), cadmium (Cd), total chromium (Cr total), copper (Cu), nickel (Ni), zinc (Zn), cobalt (Co).

For analysis of fermented sludge from 28.06.2010 - 07.06.2010 have been taken equal instantaneous samples every 8 hours.

- pH was determined according to ISO 10390-99 with a pH meter.
- Humidity (amount of water determined by the difference between the mass of the sludge before and after drying at 105 o C) was determined in the oven according to EN 12880/2002.

- Dry matter (mass of sludge remaining after evaporation and drying at 105o C) was determined the oven, under ISO 11465-98.

- Volatile substance (amount of dry mass of sludge that is released as volatile as its calcination at 550oC) was determined in the furnace, according to EN 12879/2002.

- Heavy metals (Pb, Cd, Cu, Ni, Zn) were determined according to ISO 8288-01 with atomic absorption spectrophotometer.

- Total nitrogen determined by Kjeldahl method according to ISO 11261-00 take it 0.5 g dry sludge at 105 0 C which is transferred into a digestion tube and aims to determine nitrogen in the form of organic compounds found in sludge fermented by mineralization of the sample with concentrated sulfuric acid in the presence of catalyst and then subjected to alkaline distillation, ammonia released is absorbed in a boric acid solution and titrated with sulfuric acid.

- Total phosphorus was determined according to STAS 7184/14-79. Method for determination of phosphorus in sludge is fermented dry sludge sample in an oven at 1050C until constant mass which is then mineralized by dry or wet to convert various forms of phosphorus in orthophosphate. Orthophosphate ion is converted fosfomolibdenic complex is reduced with ascorbic acid to a blue complex. Absorbance of the blue complex formed is proportional to the concentration of phosphorus and measured photometrically by the spectrometer.

Of dry compost sample in drying oven at 750 C and ground through a sieve with pore size of 2 mm, measurements were made on pH, total N and heavy metals:

- pH was determined using a pH meter of compost aqueous extract prepared by mixing compost with distilled water at a rate of 1/10. The suspension was separated by centrifugation and the supernatant filtered through filter paper was analized. pH close to neutral and the final report C / N gives full mature compost, strengthening agronomic quality compost produced from municipal waste by anaerobic fermentation process.

- Total N was determined using a distillation apparatus by the Kjeldahl method.

- Heavy metals were determined by inductively coupled plasma spectrometer with optical emission (ICP-OES).

RESULTS AND DISCUSSION

The results obtained on the physico-chemical properties of fermented sludge obtained from the Waste water municipal treatment plant Pitesti and compost made from urban waste organic sludge mixed with vegetable waste (leaves, grass, straw) are presented in tables 1 and 2.

Table1

Physical-chemical properties of fermented sludge

Crt. no.	Indicator	Value
1.	pH	7,23
2.	Humidity %	93,46
3.	Volatile substance % from d.m.	51,7
4.	NH_4^+ mg/kg d.m.	924
5.	NTK mg/kg d.m.	22316
6.	P total mg/kg d.m.	1027
7.	Na mg/kg d.m.	2896

8.	K mg/kg d.m.	3814
9.	Ca mg/kg d.m.	12263
10.	Fe total mg/kg d.m.	12392
11.	Mn mg/kg d.m.	2213
12.	Pb mg/kg d.m.	98,1
13.	Cd mg/kg d.m.	6,2
14.	Cr total mg/kg d.m.	67,5
15.	Cu mg/kg d.m.	146,7
16.	Ni mg/kg d.m.	72,8
17.	Zn mg/kg d.m.	1408,6

Content of heavy metal ions from the fermented sludge falls into the maximum concentration limits established by Order 708/2004 on environmental protection and especially when we use sewage sludge in agriculture: Cd = 6.2 mg / kg DM concentration maximum accepted from of 10 mg / kg DM, with = 146.7 mg / kg DM concentration maximum accepted from of 500 mg / kg DM, Ni = 72.8 mg / kg DM concentration maximum accepted from of 100 mg / kg DM, Pb = 98.1 mg / kg DM concentration maximum accepted from of 300 mg / kg DM, Zn = 1408.6 mg / kg DM concentration maximum accepted from of de2000 mg / kg DM, Cr = 67.5 mg / kg DM concentration maximum accepted from of 500 mg / kg DM

Table 2

Chemical composition of the final compost produced from municipal sewage sludge

Crt. no.	Parameter	Unit of measurement	Value
1.	pH		7,33
2.	TOC	% from d.m.	21,14
3.	N_T	% from d.m.	1,73
4.	C/N	% from d.m.	12,21
5.	P_T	% from d.m.	0,25
6.	Ca	% from d.m.	0,07
7.	Mg	% from d.m.	0,65
8.	Na	% from d.m.	0,22
9.	Cu	mg/kg d.m.	84,1
10.	Zn	mg/kg d.m.	358,2
11.	Co	mg/kg d.m.	12,6
12.	Pb	mg/kg d.m.	128,1
13.	Ni	mg/kg d.m.	53,4
14.	Cr	mg/kg d.m.	19,4
15.	Cr total	mg/kg d.m.	324
16.	Cd	mg/kg d.w.	2,0

By anaerobic digestion there is a reduction in the proportion of organic matter content of 45-55%. We can consider that the pH value, due to its almost neutral (7.33) reflects its maturation, unlike the imature compost that has an acidic pH and makes the material product - compost made from municipal sewage sludge - have a potential character inhibitor of the movement of heavy metals in soil and their uptake by plants.

In composted sludge heavy metal concentration is reduced by following three percentages:

- Cd to 6.2 mg / kg DM in fermented sludge reached in compost to 2.0 mg/kg DM, so is reduced by 66.66%;
- Ni at 72.8 mg / kg DM in fermented sludge reached in compost to 53.4 mg/kg DM, reduced by 26.64%;
- With the 146 mg / kg DM in fermented sludge reached in compost 84.1 mg/kg DM, reduced by 42.39%;
- Pb from 98.1 mg / kg DM in fermented sludge reached in compost 128.1 mg/kg DM, so 30.58% increase in compost
- From 1408.6 mg Zn / kg DM in fermented sludge reached in compost 358.2 mg/kg DM, reduced by 74.57%;
- From 67.5 mg Cr / kg DM in fermented sludge reached in compost to 19.4 mg/kg DM, reduced by 71.25%.

CONCLUSIONS

1. Anaerobic digestion of sludge leads to a removal of the organic matter of 50%. Sludge treated by anaerobic digestion and composted with vegetable residues enables subsequent use as agricultural fertilizers.
2. C / N ratio of 12.21% is a possible recommendation of compost as organic biofertilizers.
3. Since heavy metals in sludge treatment plants are among the decisive factors for use in making compost, compost as fertilizer recommendation is possible in crops without soil pollution risk crops.
4. The content of heavy metals (Cr, Zn, Cd, Cu, Pb) of compost examined falls within the legal limits allowed and are therefore appropriate in terms of environmental protection in order to give an eco-label.
5. The finished compost provides an accurate picture of anaerobic digestion efficiency and quality of final product (compost), increasin the agronomic quality of compost made from municipal waste by anaerobic fermentation process.
6. The data presented are part of a comprehensive study aimed at applying sludge under anaerobic fermentation of compost as flower species.

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