Original Article

Evaluation of Cadmium, Lead and Zinc Contents of Compost Produced in Babol Composting Plant (2012)

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Abstract

Background and purpose: The most important parameter is heavy metal contents in compost production technology. These heavy metals residue from substances like soap, detergents, cosmetics, packaging, leather and butteries are existed in municipal solid waste. The heavy metals can produce toxin for animal, human and plant. The aim of this research was study of produced compost quality based on heavy metals (Pb, Cd and Zn) in Babol compost plant in 2012.

Materials and Methods: The present research is a descriptive- cross sectional study in which was performed in six months. Total sample numbers (5 samples) were randomly provided from final compost of Babol plant and then after extraction and filtration, the concentration of heavy metals like cadmium, lead and zinc was measured by atomic absorption spectrophotometer PG-999.

Results: In analyzed samples the maximum, minimum and average of cadmium in the final compost were 7.25, 0.47 and 1.9 mg/kg. The maximum, minimum and mean of lead were 239.2, 31.9 and 67.1 mg/kg; in zinc were 972.7, 483.5 and 603.7 mg/kg respectively.

Conclusion: The concentration of heavy metals in Babol compost samples was under Iranian national and World Health Organization standards and could be used for different species of plants. However, the usability of compost depends on other parameters such as carbon to nitrogen and other components like glass, plastics and textiles.

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***Key words*:** Babol Compost Plant, Heavy Metals, Municipal Solid Waste, Compost

1. Introduction

The increasing generation of municipal solid wastes in throughout the world results many problems in field of the integrated solid wastes management (1,2). On the other hand, the rapid urbanization, the irregular increase in population and its following the more needs of food in the world cause the human to reinforce the soil with chemical fertilizer, municipal and industrial sewage sludge and pesticides contained heavy metals for the qualitative and quantitative improvement of agricultural products (3). The more than enough use of chemical fertilizer causes the entrance of heavy metals into food chain and human body (4). The gradual increase or the accumulation of heavy metals because of no degradation of them by microorganisms is the most important challenge at the present time (5). One of the most appropriate alternatives to use municipal solid wastes is compost technology. Composting is a stabilization process, which has been applied for different types of wastes (6). Compost has many appropriate effects on the soil properties, particularly in the soils that the organic matter content is low (7). The application of compost promotes some physical characteristics of soil, like porosity, bulk density, water-holding ability, buffering capacity and increases the cation exchange capacity (6, 8). Totally, compost application has a useful effect on the rhizosphere microorganisms and affects on the decrease of nematod population in plants (5). However, when big contents of compost are used, an inappropriate effect on the seed germination of plants may be occurring (8). Based on some investigations, the application of municipal solid wastes in agricultural regions can be useful for waste recovery (9, 10,11). But, agricultural using of MSW has some harmful potential effects on the environment cause to presence of pathogens and the different pollutants such as heavy metals and organic compounds. As well as, application of sewage sludge in the agricultural lands in the world, is one of the most important environmental concerns (12,13). Therefore, the potential risk factors should be considered for the safe use of compost for plants, animals and humans. These heavy metals residue from substances like soap, detergents, cosmetics, packaging, leather and butteries are existed in municipal solid waste (7, 14). Heavy metal poisoning causes serious damage to the kidneys, bones and nervous system in humans (7,9). Many countries, including America, Switzerland, Austria, Germany, France, Denmark, and the Netherlands have wide standards for the production and for different consumptions of compost (Table 1).

Table1. Standards associated with the use of compost (15, 16, 17)

Standards	Zn (mg/kg)	Pb (mg/kg)	Cadmium (mg/kg)
WHO	1200 -800	400-200	15-40
Ministry of Agriculture, Soil and Water Research Institute of Iran	Class A: 1400 Class B: 2800	Class A: 150 Class B: 300	Class A: 5 Class B: 10
Institute of Standards and Industrial Research of Iran	1300	200	10
Germany Standard	400	150	1.5
Switzerland standard	800	100	2

Torabian and et al, investigated the biological effect of compost in Iran and tested some of these conditioners. The results showed that the inert and outside materials and rocks in compost of all plants are less than the standard value (18). The quality of compost resulted from municipal solid waste of Tehran were compared with the standards of other countries in terms of metal concentrations. This comparison showed that the copper concentration in the case of non granular compost was higher than the standard concentration maximum of other countries and other metals were within these standards. Meanwhile, the lead was in the range of standard concentration minimum of other countries (19). The quality of compost generated from sewage sludge of south Isfahan waste water treatment plant as suspended solids (TSS), volatile suspended solids (VSS) and C/N ratio were determined (5). Also, quality of compost produced by Tehran and Khomein compost facilities has been compared. In this study, heavy metals contents like Pb and Cr in the final compost were 230 mg/kg, 70.2 mg/kg and 59.4 mg/kg and 19.8 mg/kg respectively (2). The effects of the generated compost from municipal solid wastes on the agricultural plants were been investigated (8). The latitude and longitude of Babol geographically are 36, 34', 15" and 52, 44', 20" north of Iran respectively. It also has an area of 1578.1 square kilometers. Babol compost factory was the first one utilized in the Northern provinces. Total household wastes are collected from the city and transported to the compost factory. In this factory the recyclable materials is separated and then the organic waste is fermented after crossing the riddle. Windrow method of composting is carried out. The amount of wastes produced in Babol is 200 tons per day. Babol municipality uses the produced compost in green space of city. Some amounts of compost as organic conditioner are purchased by farmers to boost the citrus trees (20). This study aimed to evaluate the concentration of heavy metals in the fertilizer of Babol compost plant in 2012.

2. Materials and Methods

This study is a descriptive-analytical. Random sampling was carried out on final composts generated by Babol compost plant during 6 months in 2012. Five Samples were transported to the laboratory in plastic bags. To remove the moisture of the

samples were immediately located at 105-103 ° C for 2 hours, then the samples were ground and passed through 30 mesh sieve. The Extracting was done by using the mixture of nitric acid, perchloric and sulfuric materials. 2 g compost sample was transferred to the 100 ml flask or 110 ml beaker by a sensitive balance. Then 30 ml of a mixture of acids and 4 seeds boiling stones were added. The contents of the flask were thoroughly mixed to wet compost particles completely. The mixture was placed overnight in vitro. The next day the samples were heated for 40 minutes at 170 ° C to remove most of acid nitric. The Extracting was done by using the mixture of nitric, perchloric and sulfuric acids. The temperature was gradually raised to reflux the rest of acid nitric. The contents of the flask gradually became dark during this procedure. When the distillation ended up, the temperature was increased up to acid perchloric boiling point ($205^{\circ C}$). Concentrated perchloric acid highly oxidized the residues of organic materials and provided white smoke. When the extract became colorless, digestion was continued for 1 hour. After cooling the sample, 20 ml of water and 2 ml of sodium nitrite (for sedimentation the particles) were added to beaker and were heated for 10 minutes. The contents of beaker were transferred to 50 ml Jujeh flask and bulked up and after mixing they were filtered by number 42 Watman paper (21). Then, the concentration of heavy metals in the filtered samples was determined by using Atomic Absorption Spectrophotometer PG, 990 Model Laboratory of Biochemistry of Babol University of Medical Sciences.

3. Results

According to the research objectives, the final compost of Babol compost plant was sampled and analyzed during the five stages and the results are presented in Table 2. According to the results of this study, the maximum, minimum and mean concentration of cadmium were 7.25, 0.47 and 1.9 mg/kg and in all cases was less than the amount proposed by the Iranian Institute of Standards and World Health Organization. Only in one case (1.96% of the samples), the concentration of cadmium exceeded the standards proposed by the Department of Agriculture for Class A.

Table 2. The Heavy metals concentration in the final compost of Babol compost plant

Sampling points	The mean and standard deviation Zinc	The mean and standard deviation Lead	The mean and standard deviation cadmium
1	615 ± 131.5	74 ±14.4	2.2 ± 2.3
2	579 ± 33.4	72 ± 60.2	2.9 ± 1.2
3	570.8 ± 37.9	68 ± 29.4	1.5 ± 0.5
4	614.5 ± 51.1	59 ± 20.8	1.4 ± 0.7
5	639.4 ± 24.3	62.6 ± 19.9	1.3 ± 0.3
Mean	603.7± 55.6	67.1± 28.9	1.9± 1

The results of maximum, minimum and mean of lead in the samples were 239.2, 11.8, and 67.1 mg/kg respectively. Comparison of the amount of lead in Babol compost with the WHO standard was according to these guidelines, while the maximum of lead concentration (in 2 cases) was over Ministry of Agriculture standards for Class A and standard Institute of Iran. The maximum, minimum and mean of zinc in the samples were 972.7, 483.5 and 603.7 mg/kg respectively. Comparison the zinc amount in Babol compost with the WHO, Ministry of Agriculture and Iran institute standards explained the conformity with these standards.

4. Discussion

The mean concentrations of heavy metals (Cadmium, lead, Zinc) in the analyzed compost samples were as follows in this study: Cadmium 1.9 mg/kg, lead 67.1 mg/kg, zinc 603.7 mg/kg. These amounts were according to Iran national standards and also below the WHO standard, But by the standards of some countries, in some instances cadmium levels exceeding the standard (standard in Germany 1.5 mg/kg) and the mean values with standard zinc 603 mg/kg (Germany standard: 400 mg/kg) is different (1.5 times the standard German). The concentrations of cadmium and lead in Babol compost was located in class 1 and zinc in class 2 according to standards associated with public health in the application of compost based on Ecology Department of Washington (16). In a study that was done in 2008 by Amouei and et al, the quality of produced compost from wastes of animals and rural household were separately analyzed. And the average concentrations of heavy metals such as cadmium, lead and zinc in samples of household wastes were 3 mg/kg, 16 mg/kg and 40 mg/kg respectively (20). The results indicated that the contamination of compost with heavy metals was considerably reduced by the separation of wastes at the source. Nine types of compost were analyzed. The results showed that the concentrations cadmium, zinc and lead in compost generated from food wastes were 0.4 mg/kg, 72 mg/kg and 625 mg/kg respectively. Results indicated that the concentrations of heavy metals in compost were minimal by the separation of wastes (21). Epstein and et al, analyzed the concentrations of heavy metals in two different composts produced from separated and unseparated municipal wastes. The results indicated that there were heavy metals in both types of composts but their amounts in separated wastes were less than those of unseparated wastes (14).

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