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Determination of Cadmium and Lead in Sewage Sludge from the Middle Region (Misrata, Msallata and Tarhünah Cities) of Libya

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***Abstract*—**The concentrations of cadmium and lead in sewage sludge samples were determined by Atomic Absorption Spectrometric Method. Samples of sewage sludge were obtained from three sewage treatment plants localised in Middle Region of Libya (Misrata, Msallata and Tarhünah cities).

The results shows that, the mean levels of Cadmium for all regions are ranges from 81 to 123.4 ppm and these values are higher than the limitations for the international standard which are not registered more than 50 ppm (dry weight) in USA, Egypt and the EU countries. While, the lead concentrations are ranged from 8.0 to 189.2 ppm and all values are within the standard limits which graduated between (275–613) ppm.

***Keywords*—**Cadmium, Lead, Sewage, Spectrometry.

I. Introduction

THE utilisation of sewage sludges, a by-product of wastewater treatment, is a serious problem of many sewage-treatment plants. New methods of utilization are urgently searched for because of growing amounts of the product [1]. The sewage sludge contains a variety of pollutants, such as biodegradable organic matter, heavy metals and pathogens, and the arbitrary discharge of the sludge would bring heavy pollution to the environment [2].

Treatment and disposal of the wastewater sludges become a major environmental problem since more intensive treatment methods should be applied to the sludge than wastewater itself. Sludge disposal methods currently in use are landfill, incineration, ocean dumping and agriculture land application. Among these, the land application is the most attractively employed method since dewatered sludge can serve as a valuable resource of fertilizer or soil conditioner which facilitates nutrient transport and increases water retention [3], [4].

However, before agriculture application of the dewatered sewage sludge, it is necessary to give full consideration on the levels and kinds of priority pollutants such as PCBs and pathogens, a critical step in the decontamination of the dewatered sludge is to remove toxic heavy metals since heavy metals are not degradable biologically and physicochemically and thus, once released into the soil environment, they have high potential to deteriorate soil quality and groundwater supply and hence human health and safety [5].

Total heavy metal concentration is an important indicator for their potential risks on the environment. However, the chemical speciation of heavy metals involves different fractions, and each fraction has dissimilar potential impact on the environment. Thus, the specific chemical speciation of heavy metals is another key factor in determining their eco-toxicity [6], [7].

Cadmium and Cd compounds are, compared to other heavy metals, relatively soluble and are therefore generally more mobile and bio-available. Thus the risk of bio-accumulation of Cd, which is toxic to both plant and animal life, must be seriously considered. Increases in soil Cd contents due to Cd in soil amendment products result in an increased uptake by plants and, in view of the danger of the chronic accumulation of Cd in the human body it is important to limit the daily intake through the diet, since even slightly elevated Cd concentrations in food can have significant long term effects [8], [9].

Lead is a toxic heavy metal that appears in the environment mainly due to industrial processes. Lead pollution is one of the most serious environmental problems because of their stability in contaminated sites and the complexity of the mechanism for biological toxicity [10]. A relatively low content of lead has a negative effect on the heart, blood vessels, kidneys, liver, and respiratory system [11]-[13].

Among different techniques, flame atomic absorption spectrometry (FAAS) is the most frequently used and the popular one. FAAS technique is classified as a single-elemental method and requires long time for analysis of several elements in a sample.

The objective of the research was to determine cadmium and lead content in sludge samples collected from Misrata, Msallata and Tarhünah treatment plant by using atomic absorption spectrometric method.

II. Materials and Methods

A. Collection of Samples

Sludge sample were collected from the municipal wastewater treatment plant in Misrata, Msallata and Tarhünah cities located in middle region of Libya as in Fig. 1, and stored in bottles made of borosilicate glass hard rubber or plastic. The samples were collected during six months, May, June, July, August, September and October.

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B. Reagents

Reagents used in this study were of the highest available quality i.e. analytical grade. All solutions and dilutions were prepared in bidistilled water.

Fig. 1 The location of municipal wastewater treatment plants

C. Preparation of Samples

0.5 gram of dry sample were weighed in conical flask, 5 ml conc. nitric acid were added and covered with watch glass, and the mixture were heated on hot plate to near-dryness after which it was allowed to cool prior to the addition of 5 ml conc. nitric acid and 10 ml conc. sulfuric acid, evaporate until dense white fumes were evolve. Successive 10 ml conc. nitric acid were added until the solution became a clear, then the acid was evaporated to deem complete. After cooling, 50 ml of distilled water was added to the digestate and heat to almost boiling, which after allowing the insoluble matter to settle, was then filtered and transferred to a 100 ml volumetric flask 100 ml, finally the conical flask was rinsed with distilled water, which was added to the content of the volumetric flask, which allowed to cooling, prior to making the volume up to the mark with distilled water.

D. Equipment

Cd and Pb were determined by using atomic absorption spectrometry (AAS) with a GBC 932 Avanta Ver. 1. 33 (Austria).

II. Results and Discussion

The content of cadmium and lead in the sludge collected during six months, May, June, July, August, September and October from the municipal wastewater treatment plant in Misrata, Msallata and Tarhünah cities are listed in Table I.

A. Atomic Absorption Spectrometric (AAS) Determination of Cadmium

The concentration of Cd ions in all sludge samples under consideration using AAS are shown in Table I. It was found that, the level of Cd ions in all samples is ranged from 81.2-153.4 ppm. The results of cadmium in three plants are described as:

1. Misrata Plant

In the present study, the concentrations of cadmium in sludge samples were collected from the municipal wastewater treatment plant in Misrata city ranged from 89.8 to 123.4 ppm. The highest concentration of Cd (123.4ppm) was determined in the sludge sample during May month, followed by August month and the lowest was determined during September month (89.8ppm) and the cadmium content increases in the following order: September < July < June < October < August < May as in Fig. 2.

TABLE I
Cadmium and Lead Content (MG/KG) of Sludge Sample from Misrata, Msallata and Tarhünah Plants

Sample Number	Month	Area	Metals mg/kg (ppm)	
			Cd	Pb
1	may	Misrata	123.4	93.6
2	june		99.0	52.6
3	july		95.4	25.4
4	august		115.8	42.2
5	september		89.8	29.6
6	october		102.6	8.0
7	may	Msallata	107.2	41.4
8	june		89.0	33.0
9	july		87.2	13.0
10	august		81.2	60.0
11	september		103.4	39.0
12	october		123.4	55.6
13	may	Tarhünah	91.8	189.2
14	june		153.4	132.2
15	july		127.6	117.4
16	august		116.8	81.0
17	september		106.8	39.4
18	october		109.8	42.9

2. Msallata Plant

The concentrations of Cd in sludge samples are ranged from 81.2 to 123.4 ppm, which collected from the municipal wastewater treatment plant in Msallata city. The minimum and maximum concentrations of cadmium were found during August month and October month respectively and the content of cadmium decrease in the following sequence: October > May > September > June > July > August as in Fig. 2.

3. Tarhünah Plant

All the sludge samples were collected from municipal wastewater treatment plant in Tarhünah city showed the concentration of cadmium between 91.8 and 153.4 ppm.

The cadmium content of sludge samples has a maximum value of 153.4 ppm during June month and a minimum value of 91.8 ppm during May month; the lead content increase in the following order: May < September < October < August < July < June as in Fig. 2.

Generally, the average concentrations of cadmium in all sludge samples collected from Misrata, Msallata and Tarhünah plants are 106.91 ppm. The study showed that, The highest concentration of was found in sludge samples is 153.4 ppm from Tarhünah plant during June month, while Msallata plant during August month has the lower concentration it reached

(81.2 ppm). All these values are above the USA, Egypt and the EU countries recommended maximum values for dry sludge (50 ppm).

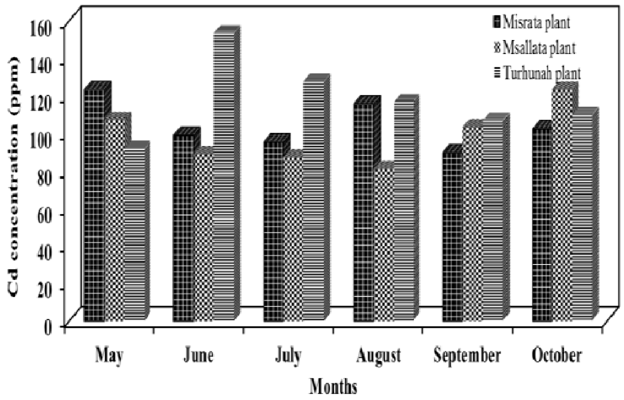

Fig. 2 Cadmium concentrations in different sludge samples during months collected from Misrata, Msallata and Tarhünah cities

B. Atomic Absorption Spectrometric (AAS) Determination of Lead

Lead concentration in all sludge samples under consideration using AAS are shown in Table I. It was found that, the content of Pb ions in all samples is ranged from 8.0 – 189.2 mg/kg. The results of lead in three plants are described as:

1. Misrata Plant

The concentrations of Pb in sludge samples are ranged from 8.0 to 93.6 ppm, which collected from the municipal wastewater treatment plant in Misrata city. The minimum and maximum concentrations of lead were found during October month and May month respectively and the content of lead decrease in the following sequence: October > July > September > August > June > May as in Fig. 3.

2. Msallata Plant

All the sludge samples were collected from municipal wastewater treatment plant in Msallata city showed the concentration of lead between 13.0 and 60.0 ppm. The lead content of sludge samples has a maximum value of 60.0 ppm during August month and a minimum value of 13.0 ppm during July month; the lead content increase in the following order: July < June < September < May < October < August as in Fig. 3.

3. Tarhünah Plant

In the present study, the concentrations of lead in sludge sample were collected from the municipal wastewater treatment plant in Tarhünah city ranged from 39.4 to 189.2 ppm. The highest concentration of Pb (189.2 ppm) was determined in the sludge sample during May month, followed by June month and the lowest was determined during September month (39.4 ppm) and the lead content increase in the following order September < October < August < July < June < May as in Fig. 3.

The forgoing results showed that, the average lead concentrations in all sludge samples collected from Misrata, Msallata and Tarhünah plants are 60.86 ppm. The study showed that, The highest concentration of lead was found in sludge samples is 189.2 ppm from Tarhünah plant during May month, while Misrata plant during October month has the lower concentration it reached (8.0 ppm). All these values are within the USA and the EU countries standard limits which graduated between 562-613 ppm and it is nearly to the Egyptian values (275 ppm).

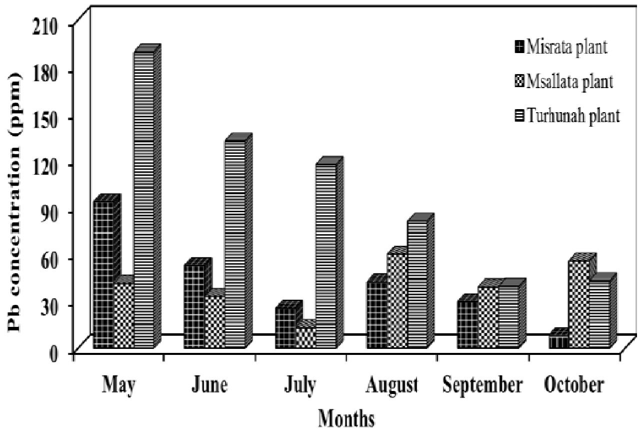

Fig. 3 Lead concentrations in different sludge samples during months collected from Misrata, Msallata and Tarhünah cities

III. Conclusion

Municipal sludge collected from three sewage treatment plants at middle region of Libya (Misrata, Msallata and Tarhünah cities) are rich with cadmium and lead metal. The average concentrations of Cd in all samples exceeded the allowable values while the average lead concentrations were below the permissible values in the national application standard.

Generally the sludge from Misrata, Msallata and Tarhünah treatment plants would not be suitable for agricultural use because of their high cadmium contents.

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