DETERMINATION OF SOME HEAVY METALS IN SOLID WASTE FROM HAEVY WATER TREATMENT STATION IN BAGHDAD

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ABSTRACT

Solid waste of heavy water treatment stations is used in agriculture as a fertilizer. This practice may transfer polluted chemicals to human food chain. In this research study, nine heavy metals (Pb, Co, Zn, Cu, Ni, Cr, Cd, As and Sb) were studied in solid waste from main waste water treatment station in Baghdad/Alrusafa city by using Atomic Absorption Spectrometry (AAS) technique. Eight samples were chosen carefully during the period of October 2016 to June 2017. The presented data showed that five of the studied metals have higher concentration as compared to others. The highly concentrated metals were [Pb (282.95), Zn (274.73), Cu (170.67), Ni (91.41), Co (29.45)], the concentration was measured in mg/kg. While [Cd (3.67), As (0.93), Sb (0.81), Cr (0.80)] showed lower concentration. The results showed that the total concentration of studied heavy metals was ranged between 1220.35 mg/kg in February to a low value of 562.63 mg/kg in October

Keywords: pollution, sewage waste, rustamyah, digestion

تقدير بعض العناصر الثقيلة في المخلفات الصلبة لمحطات معالجة المياه الثقيلة في بغداد

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المستخلص

المخلفات الصلبة لمحطات معالجة المياه الثقيلة تستخدم كأسمدة في الزراعة وهه الممارسة قد تنقل الملوثات الكيميائية الى السلسلة الغذائية للإنسان. في هذا البحث تسعة من المعادن الثقيلة هي (الرصاص والكوبلت والخارصين والنحاس والنيكل والكروم والكادميوم والزرنيخ والانتيمون) تمت دراستها في المخلفات الصلبة في محطة معالجة المياه الثقيلة الرئيسية في مدينة بغداد/الرصافة باستخدام تقنية مطيافية الامتصاص الذري. تم اختيار ثمانية نماذج بعناية خلال الفترة بين تشرين الاول 2016 لغاية ايار 2017. اظهرت النتائج المتحصلة إن خمسة من المعادن المدروسة ذات تراكيز عالية بالمقارنة مع الاخرى. المعادن ذات التراكيز العالية هي (الرصاص (282.95) والخارصين (274.73) والنحاس(170.67) والنيكل (91.41) والكوبلت (29.45)) قيست بوحدات ملغ/كغم، بينما (الكادميوم (3.67) والزرنيخ (0.93) والانتيمون (0.81 والكروم 0.80) اظهرت تراكيز اقل. النتائج اظهرت إن مجموع التراكيز للمعادن الثقيلة المدروسة تراوحت بين 1220.35 ملغ/كغم في شهر شباط واقل قيمة هي 562.63 ملغ/كغم في تشرين الاول.

كلمات دالة: تلوث، مخلفات صلبة، رستمية، هضم

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INTRODUCTION

Element that have specific gravity more than five times of that for water are called heavy metals (14). Heavy metal contamination in environment is predominant nowadays, so the importance of heavy metal pollution cannot be neglected. There are two sources of heavy metal pollution in soil, natural due to geology, and others related to human activities. The second sources is the major reason for increasing the concentrations of heavy metals to harmful level for both plant and animals. Activities such as fossil fuel burning, pesticides and fertilizer in agriculture, and sewage waste are some of these main sources of heavy metal pollution (18). Degradation of heavy metals is very low in water because of their low solubility, thus it tend to accumulate in soils and in plants (5). Heavy metals can enter the food chain when human beings consume either plants or animals (8). Increased soil pollution rates strongly affect the bioaccumulation potential of organic pollutants (16). Contamination of soil with heavy metals poses serious risks to humans and the ecosystem directly or indirectly through the food chain which is composed of man, plant, animal and soil, as well as affects the quality of groundwater, and thus causes plant poisoning and the validity of land for agricultural production (14). Fertilizers have been used by human being for a long time and this has affected the quality of agricultural soil (21). The plant needs a lot of macronutrients such as(N, P and K), as well as some elements such as (Ca, S, Mg, Cu, Fe, Mn, Mo and Zn) considered as micronutrient for plants, which are important for the healthy growth of the plant (13). Fertilizers containing (N, P, and K) also contain trace amounts of heavy metals (e.g., Cd and Pb) and their continued use increases their concentration in the soil (9). Heavy metals influence the plant growth due to change in biological and physiological process (17). Thus accumulation and migration of heavy metals in soil have ability to accumulate in the human body by food chain this poses a danger to human health (4). Nowadays, the influence of the heavy metals pollution in plants and soil becomes seriously increased (11). The heavy metals pose serious problem to the human body as they are not metabolized and keep accumulating, thus the constant exposure or frequent contamination of heavy metals in the food chain leads to high toxicity due to accumulation and it can cause chronic diseases (12). The use of wastewater and solid waste in agriculture dates back 400 years and is a common practice in many countries of the world (19). Wastewater irrigation accounts for 50% of the production of vegetables in urban areas (2). Farmers do not care about the quality of the water and solid sewage fertilizers and its impact on the environment and health. In spite of the low concentration of heavy metals, the continuation of irrigation by wastewater leads to accumulation of heavy metals in the agriculture soil. Heavy metals can exist as element ions within complex soil structures, some of these ions exist as separate entities or in ionic salts such as carbonate, phosphates or other salts, the element ions can pass by absorption on the inorganic salt surfaces. This increases the probability of element ions pollution. The other form of heavy metal ions bond with silicate, which is the largest concentration of heavy element in the soil, this form of silicate minerals does not cause a problem of heavy element pollution compared with other components because the transfer of metal ions is not allowed, thus it is less dangerous *than* other ionic salts (15). Plants absorb heavy metals and then pass to the human food chain directly or indirectly as animal feed (3). The toxicity of heavy metals are affected by several factors such as chemical form and its presence in the ecosystem (24). There are also other factors such as temperature and possible oxidation and reduction processes and the presence of cations and anions of other minerals and the pH, that can contribute to toxicity (22). The presence and accumulation of heavy metals in vegetables and fruits have been studied by researchers (23). In 2012 Satsananan and coworkers studied the presence of lead and cadmium in basil, ginger, turmeric, lemongrass, onion and coriander glory (20). There is an accumulation of some heavy metals in the soil of some areas of Baghdad compared to global values and in the following descending order (Fe> Ni> Pb> Co> Cd), this indicates the systematic absorption of heavy

elements in the soil (6). Plants have the ability to accumulate a trace concentrations of heavy metals continuously in plant tissues then appear in agricultural crops and finally to food chain of the human and animals (10).

MATERIALS AND METHODS

Atomic Absorption Spectroscopy (AAS) type (NOVE 3000) Germany made was used in this study, concentrated Nitric acid (HNO_3) 71% SDFCL company, Hydrochloric acid (HCl) PDH company, and deionized water.

Samples collectiom

100g of Eight solid waste samples from Al-Rustamyah sewage treatment plant in south of Baghdad city were collected between October 2016 to June 2017 to covered summer and winter seasons, samples were taken every month. Samples were collected in a plastic bags and transport to laboratory, drying in oven 100°C over night, grinding and sieving throw a mesh less than 100µm.

Sample digestion

1 gram of each sample was taken into an Erlenmeyer flask and then transferred into 100 ml Pyrex beaker. Then, 20 ml of Aqua Regia (1:3 HNO_3: HCl) was added to the sample for digestion. Digested sample was evaporated to near dryness at 100ºC on hot plate, then left to cool at room temperature. 15 ml of 5% HCl acid was added to resulted solution, then warmed using hot plate to dissolve any remaining salts. The sample was transferred to a 50 ml volumetric flask after cooling and the volume was completed by adding 5% HCl. The resulted solution was left about a day on a bench to settle the grain of sand, filtered by acidic filter paper (7). Finally, the sample was tested by Atomic Absorption Spectrophotometry.

RESULTS AND DISCUSSION

The results showed that there are two groups of heavy metals that were studied according to their concentrations, the first group includes five elements (Pb, Co, Zn, Cu and Ni), with high concentrations compared to the second group, which includes the remaining elements (Cr, Cd, As and Sb) as shown in Figure (1).

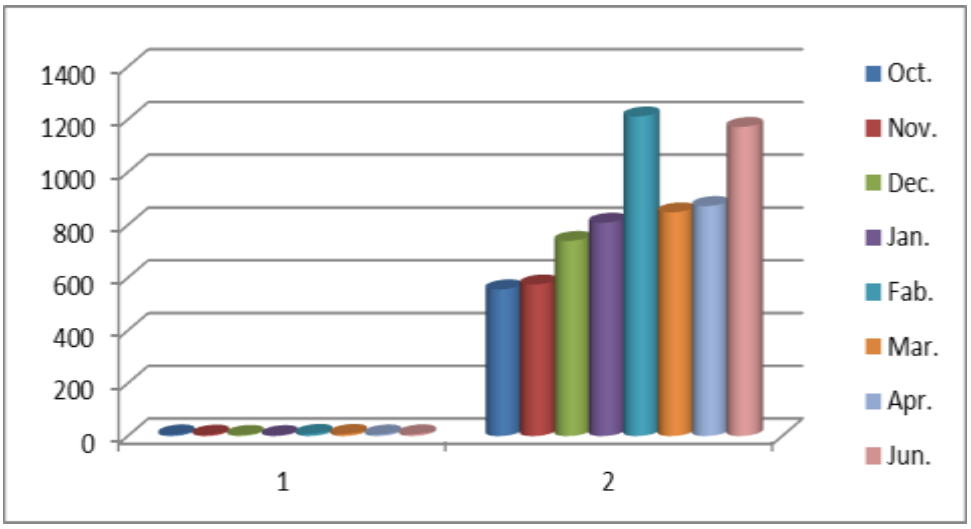

Fig. 1. Comparison of total concentration of two elements groups

In the first group, the lead was the highest concentration of 596.55 mg/kg in February and the lowest concentration of 122.31mg.kg^{-1} in April, average was 282.95 mg/kg for the eight months. This average is very high in the fertilizer used and this may cause increased concentration of lead in agricultural crops, while Cobalt showed the lowest concentration with average of 29.45 mg.kg^{-1}, Zinc was record average concentration of 274.73 mg.kg^{-1}, Copper showed 170.67 mg.kg^{-1} average and Nickel with 91.47 mg.kg^{-1}, generally high levels concentrations of these five heavy metals presence in samples are high as shown in table number (1), therefore we think it is dangerous to continue using these wastes as fertilizers in agriculture, especially because of high transition probability of these heavy metals to vegetables and fruits and then enter and accumulate in the human by food chain. Total concentrations for the five heavy metals record maximum value in February with 1211.84 mg.kg^{-1} this mean a very high concentration.

Table 1. Concentrations (mg.kg^{-1}) of Pb, Co, Zn, Cu and Ni

Date	Pb	Co	Zn	Cu	Ni	Total
Oct.	170.51	14.12	170.41	146.13	55.13	556.30
Nov.	132.73	26.23	303.90	104.93	7.04	574.83
Dec.	272.19	24.80	319.73	81.31	42.01	740.04
Jan.	343.87	23.73	174.20	172.60	94.62	809.02
Fab.	596.55	21.24	325.71	149.81	118.53	1211.84
Mar.	243.49	17.81	315.57	133.64	137.71	848.22
Apr.	122.31	54.90	282.73	305.45	106.82	872.21
Jun.	381.94	53.11	305.60	261.52	169.94	1172.11
Max.	596.55	54.00	325.71	305.45	169.94	
Min.	122.31	14.12	170.41	81.31	7.04	
Avrg.	282.95	29.45	274.73	170.67	91.47	
SD	157.91	15.63	64.53	76.65	53.68	

Figure 2 show comparison by concentrations of the elements in each studied months, lead record highest concentration October, January, February and June, while nickel record the lowest concentration in all studied months except November.

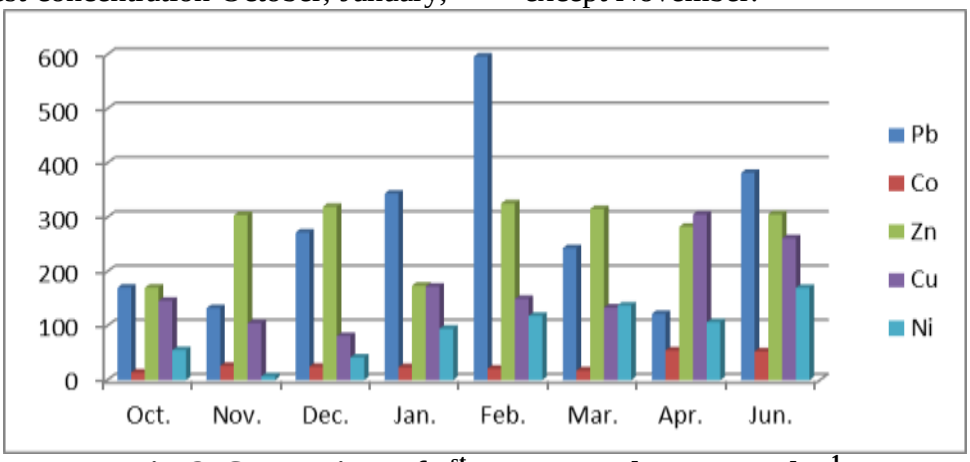

Fig. 2. Comparison of 1st group metals conc. mg.kg^{-1}

The second group of the studied heavy metals has showed lower levels compared with the first group as shown in table 2. Figure 3 showed higher concentration of cadmium with 6.7 mg.kg^{-1} in February, while chromium and antimony showed lower concentration in this group. Generally, these heavy metals are very dangerous to human life, especially Chromium and Arsenic.

Table 2. The total concentrations of Cr, Cd, As and Sb measured in (mg.kg^{-1})

Date	Cr	Cd	As	Sb	Total
Oct.	0.85	3.01	1.49	0.98	6.33
Nov.	0.59	3.03	1.39	0.64	5.65
Dec.	0.78	3.12	ND	0.71	4.61
Jan.	0.67	1.44	0.68	0.83	3.62
Fab.	0.89	6.07	0.79	0.76	8.51
Mar.	0.78	5.40	1.03	1.14	8.35
Apr.	1.02	3.13	1.12	1.02	6.29
Jun.	0.93	4.12	0.97	0.95	6.97
Max.	1.02	6.07	1.49	1.14	
Min.	0.59	1.44	ND	0.64	
Avrg.	0.80	3.67	0.93	0.81	
SD	0.14	1.48	0.47	0.17	

In Figure 3, cadmium was record highest concentration in all studied months, while other metals record low concentrations.

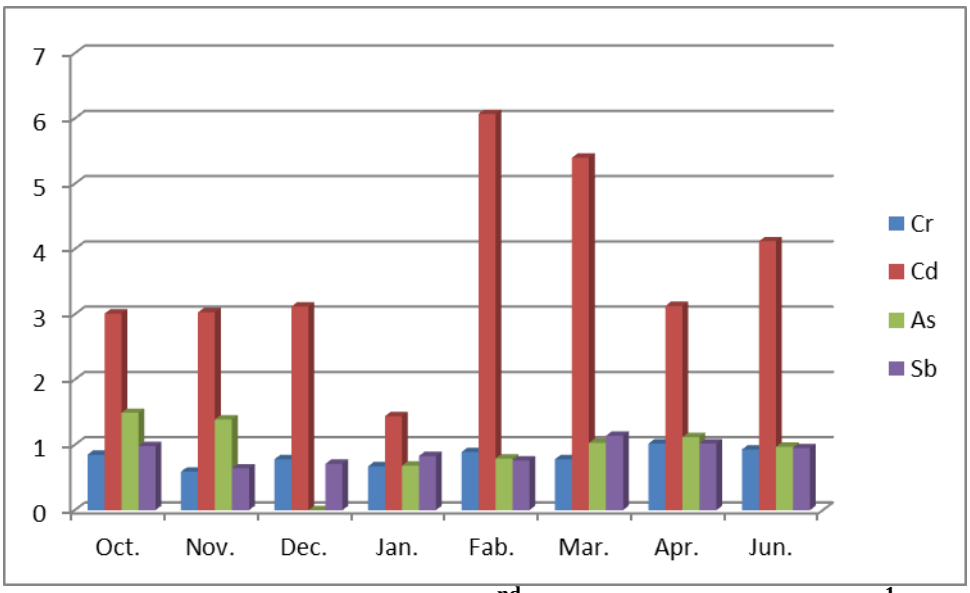

Fig. 3. column comparison of 2nd group metals conc. mg.kg-1

We recommend determination of heavy metals from solid waste and irrigation water of water treatment plants and follow the concentrations of heavy metals in agricultural crops and propose procedures to remove or reduce concentrations of heavy metals entering the food chain by these sources.

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