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Occurrence of heavy metals levels in water and inhabitants of Iraqi marshes

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Abstract

One hundred- eight of water samples have been collected from six stations in Al-Hammar marshes in the period between 18th till 24th of Aug in 2007. In addition ninety-seven of blood samples and one hundred-twenty samples of stool have been collected from marsh's inhabitants who are living and using the marsh water. The heavy metals (lead, chromium, and cadmium) have been detected in the collected water and samples. Detection results of heavy metals levels in marsh water were mentioned that 85% of water samples contained lead concentrations more than the maximum acceptance levels (MAL) which are determined by World Health Organization (WHO), while all of samples contained chromium and cadmium in high levels more than MALs. On the other hand, results of heavy metals determination in blood samples showed similar results of heavy metals in water; 59% of the samples contained lead levels more than the Maximum Permitted Level (MPL) which was determined by WHO. In addition all the blood samples viewed chromium and cadmium levels higher than their MPLs.

Key words: *Heavy metals, Iraqi marshes, Lead, Chromium, Cadmium.*

Introduction

Water is one of the most important parts of life on Earth, it is one of our most important natural resources, and it covers over than 70 % of its surface and only 3% of this percentage is fresh water, only one third of fresh water is liquid and the other part occurs as frozen fresh water. [(1) (2)] Because of water is the number one natural resource that all life depends on here on Earth. Its pollution represents a serious global problem due to its effects on the living organisms, it accounts for the deaths of more than 14,000 people daily, and nearly 2 billion people drink contaminated water that can be harmful to their health. [(3) (4)] Heavy metals have long been recognized as serious pollutants of the aquatic environment due to their impairment in metabolic, physiologic, structural, and all other systems when present in high concentrations in the milieu. [(5) (6)] The problem appears when living organism is exposed to high levels of these elements because they cannot eliminate these entire amounts and there is a part of these excess amounts that will accumulate inside specific organs in a serious process which is called bioaccumulation. [(7)] Lead, chromium, and cadmium were chosen in this study to determine their levels due to previous studies referred to their high levels in the Iraqi marshes, as well as their toxic effects on human which may ranging from subtle symptoms to serious diseases, for instance, they have increasing blood pursue and headache, till it reach to their carcinogenic effects. [(8) (9)] Generally, heavy metals could affect organisms directly by accumulating in their body or indirectly by transferring

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to the next level of the food chain, one of the most serious results of their persistence is biological amplification through the food chain. [10]

Materials and methods

Sample locations

Surface water were collected from six stations in Al-Hammar marshes, all these stations located in Dhi-Qar provinces, and covered a big area of the marshes, starting from Al-Eslah till the beginning of Al-Chebayesh. The locations of these stations were determined by geographical positions of the studied sites technique (GPS) in table 1, while figure 1 shows the study stations in A l-Hammar marshes map.

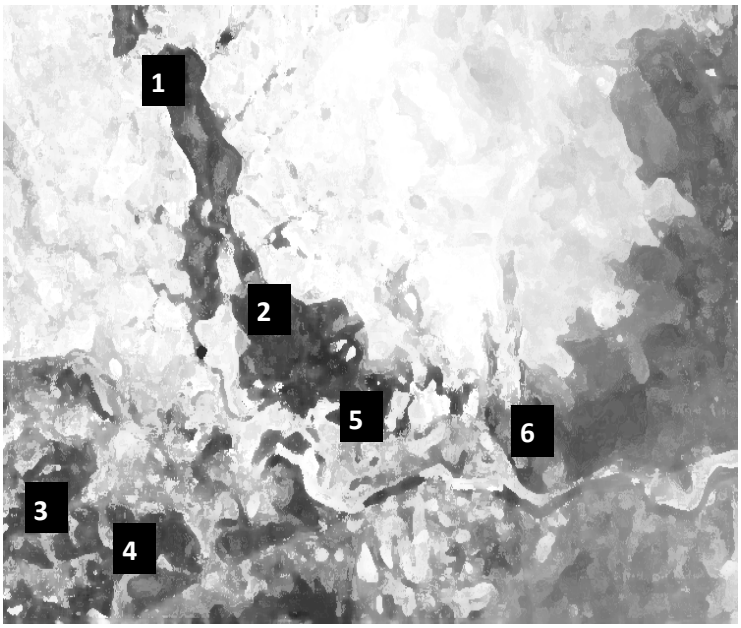

Figure 1: The location of the studied stations.

Table 1: The Geographical positions of the studied sites (GPS).

No.	Station	Longitude			Latitude		
1	**Al-Eslah**	31°	16'	54"	46°	61'	0.1"
2	**Al-Fohood**	30°	97'	76"	46°	71'	29"
3	**Al-Mrawih**	30°	94'	99"	46°	72'	34"
4	**Near Al-Chebayesh**	30°	96'	66"	46°	92'	74"
5	**Al-Tar**	30°	91'	29"	46°	65'	15"
6	**Al-Kermashia**	30°	86'	71"	46°	55'	79"

Samples collection.

One hundred-eight samples of water were collected from six stations in the Iraqi marshes (eighteen samples from each station). Water samples were collected in 1 litre containers (30 - 50 cm depth). [11] In addition, ninety-seven of blood samples were collected from marsh's inhabitants who are living and dealing or using marsh water, the blood samples collected in sterilized plan tubes, and then immediate centrifuge happened, after that the plasma was transferred to another sterilized plan tube.

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The collection happened during the period from the 18th to the 24th of August -2007 and starting from the beginning of Al-Eslah till Al-Kermashia area

Detection levels of the heavy metals.

Levels of some heavy metals (lead, chromium, and cadmium) were determined in both water and blood samples. Flame atomic absorption was used to detect the metals levels in water samples, while flameless atomic absorption was used to detect them in blood samples. (12)

Results and discussion

Determination of heavy metals levels in marsh water.

The results of the detected heavy metals levels in all collected samples of marsh water showed high levels of the studied heavy metals comparing with the maximal acceptance levels (MAL) which determined by world health organization (WHO) as shown in table 2. It's clear to see that among all the water samples numbers which were collected, lead levels were arranged from 0.022 up to 0.04 ppm with average equal to 0.031 ppm. On the other hand, the results illustrated that the chromium levels were recorded as the highest levels of the detected metals in marshes, its maximum, minimum, and the average values were 0.27, 0.11, and 0.173 ppm respectively.

The minimum levels in the results were recorded of cadmium levels; their maximum value was 0.03, their minimum value was 0.013, and the average of all its levels was 0.022 ppm, table 2 shows the maximum, minimum, and the average values of the determinate metals in the water samples as well as MAL of WHO.

Table 2: Heavy metals values in water samples (13)

No.	Metals	Max.	Min.	Mean	MAL
1	Lead	0.04	0.022	0.031	< 0.01
2	Chromium	0.27	0.11	0.173	$\ll 0.05$
3	Cadmium	0.028	0.013	0.022	< 0.003

The sampling period was in the 1st week of August, this period determinate according to results of many previous studies which indicated to the increasing of heavy metal concentrations in summer months comparing with their in spring months. (14) (15) (16) (17) Al-Haidarey and Al-Kinzawi analyzed this phenomenon (increasing and decreasing of heavy metals concentrations in summer and spring respectively) due to many reasons such as the increase of the evaporation in summer, degradations of organic matter (after the death of a lot of organisms in hot months), and the decrease of productivity (living uptake) processes, instead, they mentioned decreasing of their levels in spring as a result of the uptake of dissolved chemicals and nutrients which occurs during the growth season (spring). (18) (19) Because the absence of water purification and desalination systems in all the Iraqi marshes area, as well as difficult access to safe drinking water, the people were using the marshes water as a drinking water till now, figure 2 shows the comparison of results between heavy metals values in Iraqi marshes and their MAL according to WHO.

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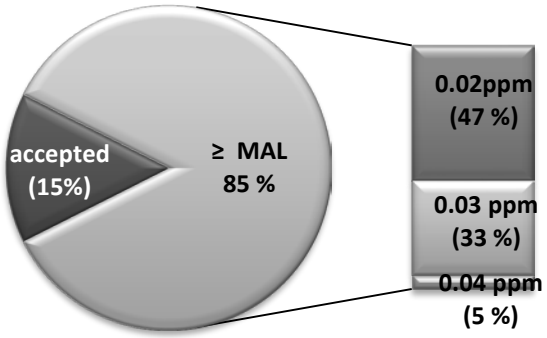
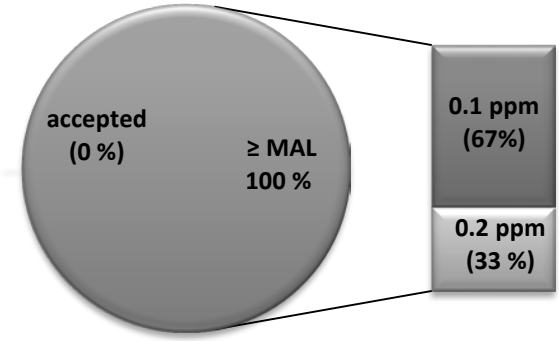
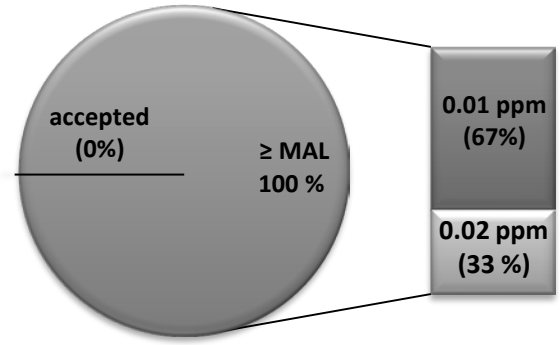
Comparing of heavy metals levels determined values in Iraqi marshes with their MALs reflects the huge pollution values of all the currently heavy metals in the marshes. These results came along with others which were carried by Al-Haidarey indicating that all lead, chromium, and cadmium levels where higher than MALs in Iraqi marshes, [19] while it disagree with other results carried by Al-Malikey in tl [20]



A: Lead level in water



B: cadmium level in water



C: Chromium level in water

Figure 2: the comparing of estimated of the heavy metals levels in water samples with MAL.

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Water pollution became one of the more important problems in the entire world due to its increase by time; heavy metals represented the most important pollutants in the aquatic environment due to their effects on all living organisms including human as well as their ability to accumulate in bioaccumulation phenomenon. Increasing of heavy metals in the entire world may come by many reasons including untreated sewages and waste water which were thrown in river or other water bodies, in addition to other natural sources. [21] [22] Increased population in the last few decades have caused a dramatic increase in the demand for river water, as well as significant deteriorations in water quality throughout the world. [19]

There are two ways of heavy metals entrance into the aquatic environments of southern Iraqi marshes; natural and anthropogenic ways. [23] Natural ways include storm dust fall, erosion or crustal weathering and decomposition of the biota in the water, without mention to other ways such as lava and volcanic projectiles or acid rain. [19] On the other hand, anthropogenic ways can be assembled by untreated domestic and industrial sewage which were discharging to the Tigris and Euphrates Rivers then reaching to southern marshes or by discharging directly into marshes, [20] the wars that happened in that area also served as a source of heavy metals due to using the extensive burning, heavy bombing and shelling, and widespread use of chemical weapons. [19] In addition to all these reasons, it is possible to believe that metals in the study area were derived mainly from the igneous mineral deposits in the Iraq-Iran Mountain range. [24] One of the most important point in the present study results represented by the high recorded results of chromium arithmetic mean in marsh water which reached to (0.173 ppm or 173 ppb), this can be considered as the most hazardous point above all these results since the hazardous level of chromium determined by EPA as which is 100 ppb. [25]

Varol *et al*., reported the absence of any heavy metal pollution in Tigris in Diyarbakir; the biggest city and the largest urban settlement in the Tigris Basin in Turkey, those results showed that the average values of lead, chromium, and cadmium concentrations were 0.02, 0.05, and 0.02 ppm respectively. i.e. all water samples were mostly below or close to MAL. From all these results it is clear that all of heavy metals pollutions were starting after Turkish area. [13]

Al-Juboury recorded a slight pollution of lead and chromium metals in the up regime of Tigris in the north of Iraq, he suggested that the clay and heavy minerals may form an important source for the natural pollution by the heavy metals in the recent sediments of the Tigris River, as well as most of the pollution came from the wastewater contributed to the river. [26] Limited factories number in the Iraqi southern marsh regions and the surrounding areas indicate a lack of industrial sources of these metals, another interesting study in the southern marshes carried by Al-Malikey can support this idea, her results showed that there wasn't any heavy metals pollution in the air of that area, that indicate the absence of any industrial waste in that area. [20]

Determination of some heavy metals levels in blood samples.

Levels of the three selected heavy metals (lead, chromium, and cadmium) in blood of a random group of Iraqi marshes inhabitants were determined to evaluate their concentrations into human

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body , as well as to looking for any relationship between their concentration in marsh water and the inhabitants blood.

Table 3 illustrates briefly the results of the maximum, minimum, and geometric mean values of estimated heavy metals levels in blood samples which were taken from people who were living in the marsh, in addition to the maximum permitted levels (MPL) of these metals in blood according to WHO. Comparing with MPL of heavy metals in blood, it's clear to see that most of blood heavy metals levels were above these values.

In the case of lead levels, the results in table 3 show that the lead levels were starting from 0.011 ppm up to 0.281 ppm with mean value equal to 0.119 ppm. According to these results, it's clear to see that the mean of the blood levels were higher than MPL which was 0.1 ppm. Figure 3 shows the comparison of the MPL of lead by WHO with the estimated blood levels of lead. Many organisms like american academy of pediatrics (AAP) defined lead poisoning as blood lead levels higher than 10 µgldL (0.1 ppm). [28] [29] According to that definition, around 58% of the tested people in the present study are undergoing lead poisoning.

Table 3: Heavy metals levels in blood samples *(ppm)* [27]

No.	Metals	Max.	Min.	Mean	MPL
1	**Lead**	**0.281**	**0.011**	**0.119**	**< 0.1**
2	**Chromium**	**0.073**	**0.006**	**0.029**	**< 0.006**
3	**Cadmium**	**0.049**	**0.008**	**0.023**	**< 0.007**

In its Third national report on human exposure to environmental chemicals, control disease centers (CDC), recognized that blood lead levels below that are dangerous to children's health and have been associated with lower intelligence, as well as other symptoms of nervous system dysfunction. [30] [31] [32] [33] In addition to all, Funmilayo indicated that lead may impair development and have harmful health effects even at level low than 0.1 ppm, and he mentioned that there is no known safe exposure. [34] On other hand, chromium results showed extreme contaminated case represented by no presence to chromium acceptance level in any of the blood samples, the levels in these samples were ranging from 0.006 – 0.073 ppm, and the geometric mean where more than four times comparing with MPL which is less than 0.005 ppm, while Wood *et al*., reported that the safe level of blood chromium supposed to be less than 40 nmol/L (around 0.002 ppm), [35] figure 3 shows the comparing of estimated of chromium levels of the collected blood samples and MPL.

Many previous studies referred to the medical important of chromium poising due to its effects on public health, starting from simple syndrome such as , redness, itching and swelling and passing throw kidney and liver disorders till it reaches to lung, and kidney cancer. [36] In the case of cadmium level in blood, the level started from 0.007 till reaching to 0.216, with 0.119 ppm as a mean value of all their results. Results showed that the geometric mean was more than permitted levels 5 µg/g (0.005 ppm) as to be shown in table 3, and none of the samples contain cadmium concentration in the range of MPL as shown in figure 3. CDC consider that the cadmium blood level of 5 µg/l (0.005 ppm) or higher hazardous, another search showed the cadmium concentrations in some blood samples

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of a group of people (that lives in the area near by the power plants which contaminated by outflow from the coal processing industry) reached to 6 ppb and recorded these results as a cadmium concentration. [37] Other study reported that blood cadmium levels in a range of 25-50 µg/L (0.25-0.5 ppm) correlated with many serious symptoms such as renal damage or disorders, in addition to fatal cases by cadmium poisoning which may occur later. [38] [39]

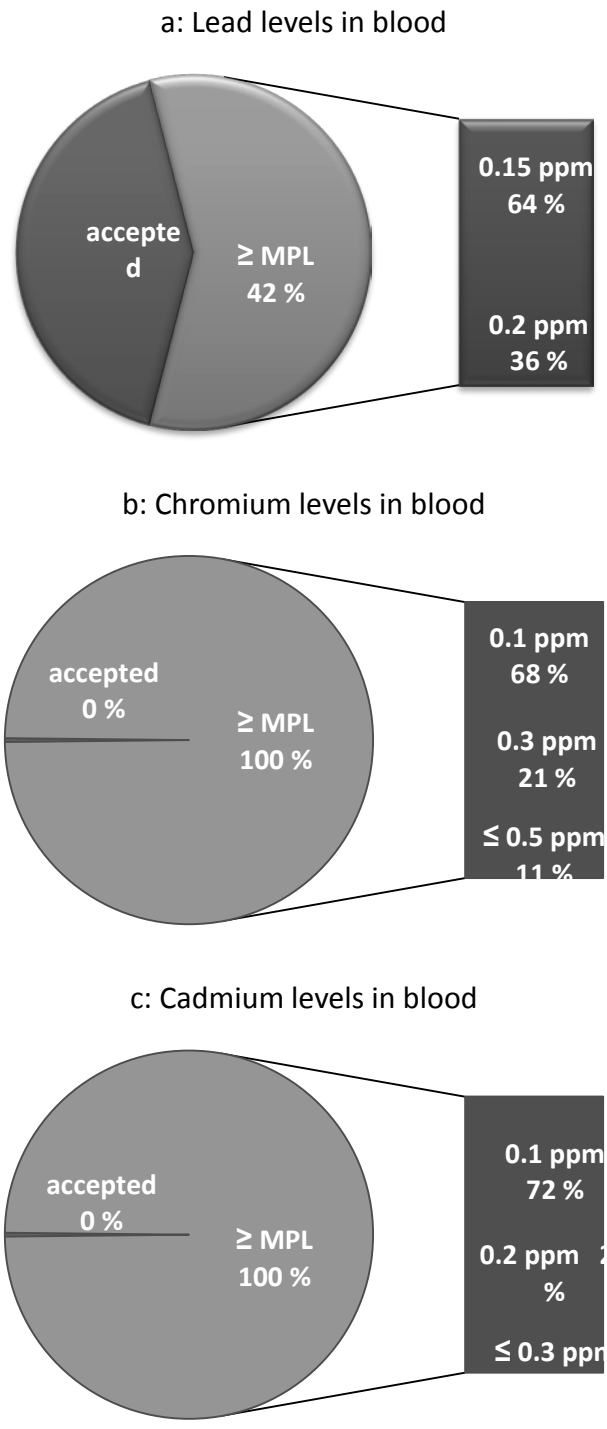

Figure 3: the comparing of estimated of heavy metals levels in the blood samples and MPL

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Generally, all lead, chromium and cadmium estimated results show high levels in blood of the collected samples, and – except few samples which contained normal lead levels – all the samples contained metals levels excess than maximum permitted levels. The reported results of metals blood levels reflect the huge pollution in that area.

In an attempt to compare the concentration of heavy metals in both water of Iraqi marshes and blood samples of marsh inhabitants, it is obvious to see the similarity between concentration of these metals in both samples (higher concentration than MAL and MPL). In more details, results showed that both water and stool samples contained high level concentration of lead in their samples, (85%) of water samples and (58%) of stool samples were above the acceptable levels of lead. As well both water and blood samples contained chromium and cadmium concentrations higher than the acceptable levels in there.

It is quite pleasant to reach a conclusion those human beings inhabitants of southern Iraqi marshes have got contaminated from the marsh water based on the fact that the same or similar levels of concentrations of heavy metals have been recorded in both marsh water and blood samples in the present study.

This assumption is also based on the fact that the Iraqi marshes habitants were using the contaminated water for drinking till now, as well to drinking source for their animals, and to water their plant, these high levels of the heavy metals inside their bodies is a result of the bioaccumulation of metals which enter them majority by marsh water. The critical point during any dealing with heavy metals is the bioaccumulation; the metals ability to accumulate inside living organisms into a specific organs. [(40)] Accumulation ultimately causes toxic effects on humans by affecting food quality of crops, animal products, as well as drinking water quality, with more consideration to food chain. [(37)]

Villanueva *et al*., mentioned that the increasing of heavy metals inside the human fluids mostly occurred by ingestion (drinking or eating) or inhalation (breathing). [(42)] previous study done by Al-Malikey showed that there is no air pollution of marshes area by any kind of heavy metals, this result as well as the current investigation represents also a good base to conclude the absence of air pollution effects on heavy metals levels in blood and therefore major cause of the high levels of these metals inside human body was their total dependent on the marsh water. [(20)]

In brief, heavy metal contamination in the environment has become a serious problem due to the increase in the addition of these metals to the environment. Natural sources as well as the anthropogenic sources account for this contamination, which has become a threat to public health. Heavy metals are being released to the environment. [(43)] Contamination of the aquatic environment by toxic metal ions is a serious pollution problem. Due to the fact that, unlike organic pollutants, chemical or biological processes can't degrade toxic metal ions. To remediate the aquatic environment, the toxic metal ions should be concentrated in a form that can be extracted conveniently, possible f use or at least for proper disposal. Natural resources including plants and microorganisms ar ensively explored to combat metal ion pollution. [(44)]

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