EAS Journal of Nutrition and Food Sciences
Abbreviated Key Title: EAS J Nutr Food Sci
ISSN: 2663-1873 (Print) & ISSN: 2663-7308 (Online)
Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-2 | Issue-2 | Mar-Apr; 2020 | DOI: 10.36349/easjnfs.2020.v02i02.001

Research Article

Determination of Lead and Cadmium concentration in water used by food providers in Bahri Locality- Sudan

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Article History
Received: 24.03.2020
Accepted: 15.04.2020
Published: 21.04.2020

Journal homepage:
https://www.easpublisher.com/easjnfs

Quick Response Code

Abstract: This study was carried out to evaluate the level of two heavy metals (namely lead and cadmium) in water used by food providers in Bahri locality- Sudan. Sixty water samples were obtained from different restaurants and vended food providers, distributed over eight different areas in Bahri locality - Khartoum. A questionnaire was also designed to collect data regarding area, water source and the different purpose for using water. The concentration of the metals was analyzed using Atomic Absorbance Spectrophotometric method. The results obtained showed the presence of Cadmium (Cd) and Lead (Pb) in the water samples with different concentrations. The mean level of Cd in the examined sample was (0.015 ± 0.003 ppm) while the mean level of the lead was (0.21 ± 0.017 ppm) which exceeds the acceptable limit (0.01 ppm). Most of the food providers used one water source for all activities such as drinking, cooking food, washing utensils and hand washing. The higher concentration was found in samples obtained from the Industrial Area, and water stored in pial. Thus, determination of heavy metal levels in the main water systems should be evaluated on routine basis. Availing hygienic water sources and areas for street food providers should also be done by the appropriate authorities.

Keywords: Cadmium, Food Providers, Lead, Sudan, Water.

INTRODUCTION

Water is-by far - an important and vital solution for sustaining life. It covers about 71% of the Earth's surface and it is the main constituent of Earth's streams, lakes, oceans, and the fluids of most living organisms and it makes up the major part of living tissues (Mohammad, 2015). Also, it is a major component of all types of food and it greatly affects food texture and food processing techniques (Vaclavik and Christian, 2014., Mohammad, 2015, Mehtab, *et al.*, 2017).

Water may become contaminated by physical, chemical, biological, or radiological substances (EPA, 2017, Mehtab *et al.*, 2017). One of the important contaminants is the heavy metal pollution. These metals may originate from anthropogenic sources, such as: untreated domestic and industrial wastewater discharges, accidental chemical spills, direct soil waste dumping, and residues from some agricultural inputs, pesticides, metals, toxins produced by bacteria, and human or veterinary drugs (Salwa *et al.*, 2016., EPA, 2017., Mehtab *et al.*, 2017, Sergi *et al.*, 2017).

Human exposure to harmful metals may occur through various routes such as consumption of contaminated water or food, exposure to air-borne particles or using utensils prepared from materials that may lead to leakage of the minerals to the food (Ehsan, 2003., Samuel *et al.*, 2015., Salwa *et al.*, 2016, Georg, 2018).

One of the most common heavy metal that may be found in in drinking water is Lead (Pb) . It causes general metabolic poisoning and enzyme inhibition and has the ability to replace calcium in bone (Chaitali and Jayashree, 2013). Lead compounds may also cross the blood–brain barrier in adults, and thus adults may suffer from lead encephalopathy related to acute poisoning by organic lead compounds (Lars, 2003). High concentrations of lead in the body can cause death or permanent damage to the central nervous system, the brain, and kidney, hyperactivity, memory and concentration problems, high blood pressure, hearing problems, headaches, slowed growth, reproductive problems in men and women, digestive problems, muscle and joint pain (Bala *et al.*, 2014, Mahipal *et al.*, 2016).

Another important metal is Cadmium (Cd). It is toxic even in low concentrations and can accumulate in the body and ecosystems besides it has a long biological half-life in the human body ranging from 10 to 33 years. Long term exposures induce renal damage

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and affect liver function, damages or reduces mental and central nervous system function (Chaitali and Jayashree, 2013).

The lack of safe drinking water and water supply system in developing countries is a global concern. About 884 million people in the world still do not obtain their drinking water from approved resources, and almost all of these people are in developing regions (WHO/UNICEF, 2010).

In Sudan, people in some areas do not have an access to clean and safe water and sometimes they obtain the water directly from rivers or canal (waterway), or through purchasing from water vendors. During the period from 2004 to 2006 there was 476 deaths caused by diarrhea (Cholera) and 3753 cases of hepatitis E (Salwa *et al.*, 2016). A previous study in Sudan showed that water samples obtained from three different states (Khartoum, Nahr elnile and Sinnar) had significantly high level of lead compared to the standard acceptable level (Salwa *et al.*, 2016). Nowadays the number of people taking meals outside home is increasing and the number of food providers is also increasing in the country. Some of these providers are working in unhygienic environment and are thus considered as a source of food borne diseases. Some of these vendors have no definite source of water and they obtain the water needed for cooking and preparation of food, washing of utensils from nearby sources. This problem may be very serious in people working in industrial and traffic areas since several studies reported high levels of metals in such areas (Magdalena *et al.*, 2015.,Amrutha and Udayashankara, 2014, Khairuzzaman, *et al.*, 2014., Salwa *et al.*, 2016., Sergi *et al.*, 2017).

The aim of this study was to determine the level of Lead and Cadmium in water used by food providers for the different purposes Bahri locality - Sudan. Also their compliance with standard limits of heavy metals.

MATERIALS AND METHODS

Study area:

This study was carried out in Bahri locality. The study area extended from Shambat West to Al – Ingaz Street east, and from Bahri Central Station south to Al –Safyia north. Samples were obtained during October 2018. .

Data collection

A questionnaire was used for collection of data regarding: area, source of sample, uses of water and other relevant information. A total of 60 water samples were collected from different sources including restaurants, street vendors and transient food sellers. The restaurants were of two types: one type (class 1) was complying to the international restaurant standard requirements in construction and in type of food prepared and water source. The other type(class2) was the traditional restaurants that may prepare local or international meals but they have no standards for construction or water sources. Water samples were also obtained from the Street vendors or transient food sellers who do not have permanent place; no definite source of water, usually found in crowded areas such as markets, building sites, bus station and other similar places.

Water samples were obtained either directly from the tap, or other containers where it is being stored in such as pail, thermos, or barrel. Water samples were collected in clean containers, stored at 4^{o}C till transferred to the laboratory for analysis. The analysis for Cadmium (Cd) and Lead (Pb) was done using Atomic absorption spectrophotometric method (Brooks *et al.*, 1967).

The results were analyzed using One Sample t-test, and ANOVA tests for the association between Cd and Pb level and other factors.

RESULTS

Water samples collected in this study were obtained from various geographical areas in Bahri locality as shown in Fig.1.

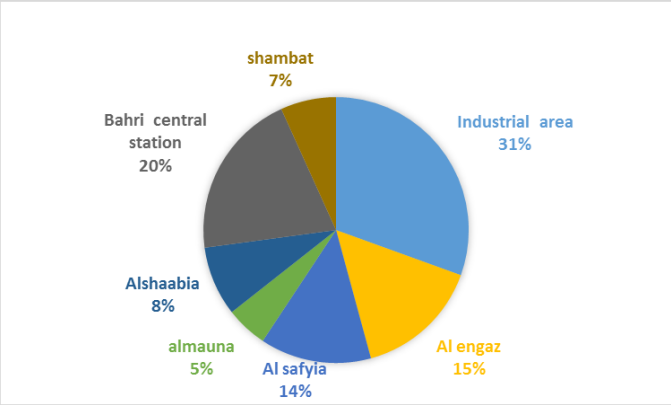

Fig. 1: Different areas from which the samples were obtained.

The water samples were obtained from different types of restaurants which were classified into class 1 representing (22%), class 2 (32%), in addition to street vendors (46%). All food providers (or restaurants) did not use filter for water except one restaurant. In some restaurants water was used directly from the tap (37%), while in other situations it may be was stored in different containers such as barrel (10%), pail (18%), and thermos (35%) and may be used throughout the day. It was found that water obtained from the same source was used for the different purposes such as drinking (38%), washing hands and utensils (20%),food preparation or for all purposes (42%).

Level of Lead and Cadmium:

The mean lead concentration in water samples was (0.21 ±0.0022 ppm), while the mean of cadmium concentration was (0.015 ±0.000389 ppm).

The level of Lead and Cadmium obtained from different areas, types of restaurants and storage containers are shown in (Figs: 2,3,4**).**

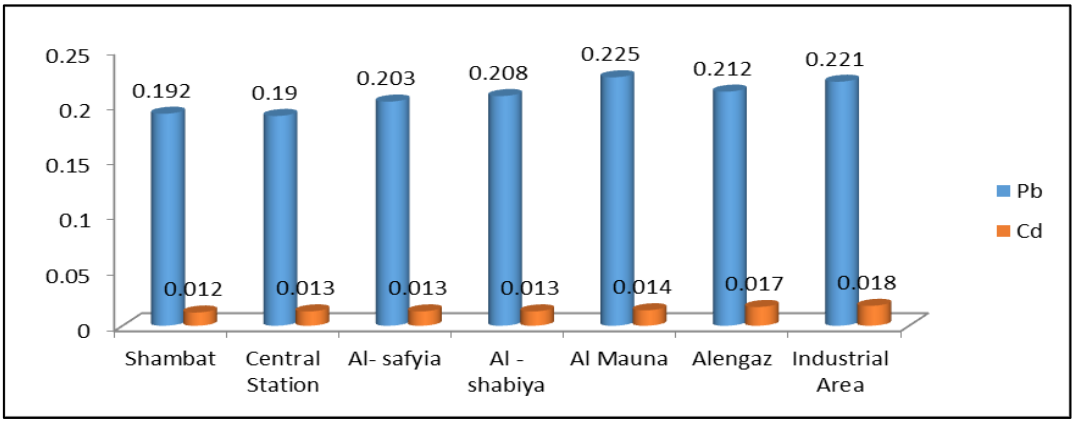

Fig.2: Level of Lead and Cadmium in different Areas

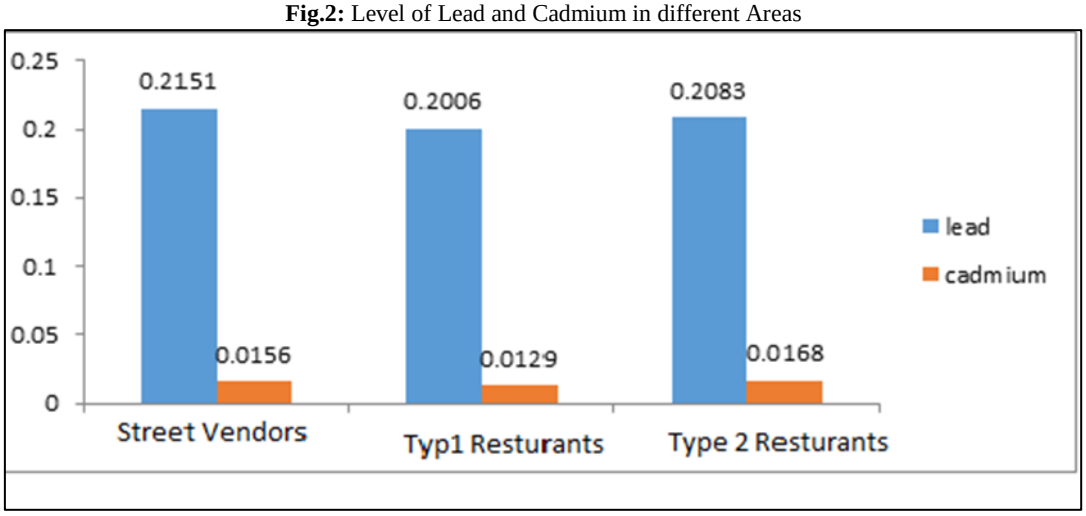

Fig.3: Level of Lead and Cadmium in water from different types of restaurants food vendors

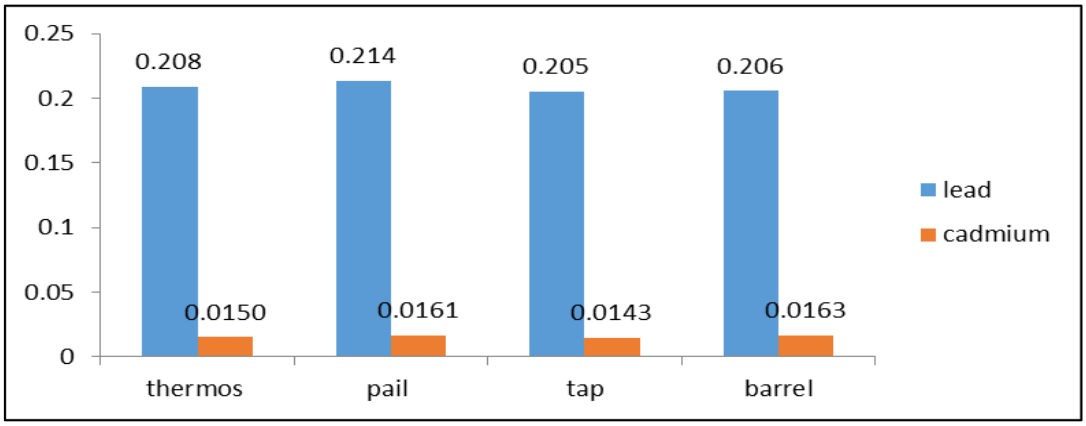

Fig.4: Level of Lead and Cadmium from different storage containers

Level of lead and cadmium compared with reference value:

The results showed a highly significant difference (p value = 0.000) between the mean of lead in the water samples (0.21 ppm) and the standard level of lead (0.01ppm) (EQSs,1997). Also there was a highly significant difference (p value = 0.000) between the mean of cadmium (0.015ppm) and standard mean of cadmium (0.01ppm) according to (EQSs,1997) with confidence interval 95%.

Association between level of Lead and Cadmium and different types of restaurants:

Using one-way ANOVA there was a highly significant difference (p- value = 0.000) between mean of lead and cadmium in class 1 and 2 restaurants and the street vendors with confidence interval 95%.The water used in class 1 restaurant was the best.

Association between Lead and Cadmium and different areas:

One-way ANOVA showed a highly significant difference (P- value = 0.000) between mean of Pb and Cd in Shambat, Bahri Central station, Al-Safyia, Al-Shabyia, Almauna, Alengaz street and in the Industrial Area. With confidant interval 95%.The lowest level of Cd was found in Shambat area while the lowest level of lead was found in Central station water.

Association between lead and Cadmium and storage containers:

ANOVA test showed no significant difference (P- value = 0.359) between mean level of lead in water stored in barrels, in water coming directly from taps, in water stored in thermos, and in water stored in pail. There was no significant difference (P- value = 0.102) between mean of cadmium in water stored in barrels, in water coming directly from taps, in water stored in thermos, and in water stored in pail, with confidant interval 95%.

The mean of Lead and Cadmium of tap water was significantly different from other sources, tap water having the lowest level of Pb and Cd.

DISCUSSION

The increased levels of heavy metal in water may have a negative impact on human health. Monitoring the levels of these metals in water used by the community, by food providers in restaurant and street vending foods is necessary to evaluate the hazards to which the people may be exposed to.

In this study, water used by restaurants and food providers was examined for determination of Cd and Pb levels. The study showed the presence of cadmium in the majority of the tested samples above acceptable limits (91.6 %) with a concentration ranging from (0.010 – 0.020 ppm), with a mean of (0 .015 $\pm$ 0.0004 ppm).

Regarding , Pb it was also detected in all tested samples (100%) and the level was above the acceptable limits, with a concentration ranging from (0.176 – 0.236 ppm) with a mean of (0.21 $\pm$ 0.002 ppm). When compared to the acceptable limit of 0.01ppm (EQSs,1997) both levels were above the limits.

Several studies showed similar results regarding Cd and Pb levels (Chaitali, *and Jayashree*, 2013, Bala *et al.,* 2014, Samuel *et al.,* 2015). The study carried by Ekhator *et al*. (2017) showed high levels of Pb in all samples of street food and the presence of Cd in 70% of the tested samples in Nigeria. Other studies showed lower levels (Omer, 2007., Olcay *et al.,* 2011).

According to a survey by the World Health Organization (WHO) in 1996, 74% of countries reported that street foods (defined as "ready-to-eat foods," processed or fresh, which are sold at stationary locations or hawked in streets and open places) contribute significantly to urban food supply. They are usually opposed to stores and licensed establishments (WHO,1996, Mwangi *et al.,* 2001). These foods are mostly cheap and they are also easily accessible by large number of consumers (WHO,1996., Ohiokpehai, 2003., Tinker, 2003., FAO, 2007). These Street vended food can be a health problem especially if they are contaminated with biological or chemical material. Contamination can arise from various sources such as preparation methods, poor packaging, vehicular exhaust emission, indiscriminate waste disposal, poor sanitation, industrial wastewater and emission and commercial activities (Ekhator *et al* ,2017). Heavy metals can eventually reach the food chain either through direct use of water already containing high levels. In the present study lead and cadmium were detected in the different water storage containers used by the food providers. A previous study carried by Baxter *et al.,* (2009) showed that minerals found in cooked food may originate from the water or utensils used for preparation of the food. The study also showed a significant relationship between the lead content of the tap water and the prepared food which suggests that the lead may leach into the food (Baxter *et al.,* (2009). Another study showed that cheese and meat had high levels of lead when prepared using lead- glazed ceramic (Magdalena *et al.*,2009). The study also showed an association between high level of lead in women's blood using lead- glazed ceramic utensils used for food preparation.

Some environmental factors have also been reported to play a role in the occurrence of metals in water or food. In this study the highest levels of Pb and Cd was found in industrial area. This may be due to the high emission of industrial waste in the environment. The study carried out by (Ehsan, 2003) showed high

levels of lead in food sold in Elsauge Alarbi area (central Khartoum) which is considered a very congested traffic area. In addition, the original water source may contain high levels of minerals. Fish and Water samples selected from three different areas in Sudan (Khartoum, Nahrelnile and Sinnar State) showed high levels of Cd and Pb (Salwa *et al.,* 2016) which may be a source of increased levels of metals in food if the water is used directly. Such problem may arise through the improper disposal of industrial wastes as sometimes it is directly released in the river or the main water systems eventually affecting the water and the aquatic system. Several studies previously also reported presence of high levels of cadmium, mercury arsenic and lead, in food and water in the country (Ehsan, 2003., Omer, 2007, Salwa *et al.,* 2016).

Thus, since safety of finger food is becoming a major concern as it is probably prepared and sold under unhygienic conditions, with limited access to safe water, sanitary services, or garbage disposal facilities and are considered as a significant contributor of foodborne diseases (Amrutha and Udayashankara, 2014). A new concept called "Street Food Safety Objective (SFSO)" has been recently introduced. To achieve the SFSO a well-planned program of good hygiene practices starting from the safety of the ingredient and raw materials entering the street food chain should be adopted. (Trafialek *et al.,* 2017).

CONCLUSION:

The findings of this study showed high levels of Cd and Pb in water used by the different food providers. The limits of Pb were above the maximum international acceptable limits. The levels were also high in the different water storage containers. The levels of the two minerals showed different levels between the different areas under study.

Recommendation:

Continuous monitoring of heavy metals in various water sources especially in highly polluted areas is very important. Awareness raising programs involving several partners such as local authorities, the food vendors, related government departments should be also put into action.

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