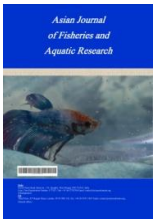

Asian Journal of Fisheries and Aquatic Research

7(4): 15-21, 2020; Article no.AJFAR.58075
ISSN: 2582-3760

Determination of Lead and Cadmium Levels in Water and Fish Muscle in Elshajara Area, Khartoum State-Sudan

Moatez Mohammed Elhassan Mhmoud[1] and Hind A. Elnasri[2*]

[1]Fish and Aquatic Research Centre, Ministry of Animal Resources, Khartoum, Sudan.
[2]College of Veterinary Medicine, University of Bahri, Sudan.

Authors' contributions

This work was carried out in collaboration between both authors. Author MMEM designed the study, performed the practical part including collection of sample and supervising the laboratory analysis. Author HAE did over all supervision of the study and writing of the manuscript. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJFAR/2020/v7i430125
Editor(s):
(1) Dr. Bruno Fiorelini Pereira, Federal University of West of Bahia, Brazil.
(2) Dr. Vijai Krishna Das, Kamla Nehru Institute of Physical and Social Sciences, India.
(3) Dr. Forcep Rio Indaryanto, University of Sultan Ageng Tritayasa, Indonesia.
Reviewers:
(1) Ajayi Olusina Tunde, Federal College of Animal Health and Production Technology, Nigeria.
(2) Boucherit Ahmed, University of Blida, Algeria.
Complete Peer review History: http://www.sdiarticle4.com/review-history/58075

Original Research Article

Received 09 May 2020
Accepted 14 July 2020
Published 20 July 2020

ABSTRACT

This study aimed to investigate the levels of lead (Pb) and Cadmium (Cd) in water and fish muscle obtained from Elshajara area - Khartoum - Sudan. This area is located near one of the important factories in the country and is also an important fishing site.

A total of 60 samples (30 water and 30 fish muscles) were obtained from 3 different sites in the targeted area. The levels of Pb and Cd were measured using Atomic Absorption Spectrometry.

The overall mean level of Pb and Cd in water samples were 0.148±0.0104 µg/l and 0.014±0.002 µg/l, respectively. Regarding the fish samples, the levels of Pb and Cd were 0.28480±0.018 µg/kg and 0.027±0.004, respectively. The levels were below WHO acceptable limits.

The level Pb and Cd in water and fish obtained from area B were the highest because this site is closest to the factory effluent site and thus the high levels.

**Corresponding author: Email: hindnasri2017@gmail.com;*

Adopting proper water disposal systems for factories and other industrial facilities is necessary to avoid contamination of the ecosystem. This may in the long run affect the human health through consumption of food contaminated with such metals.

Keywords: Lead; cadmium; fish muscle; water; Sudan.

1. INTRODUCTION

Fish is considered as one of the most important sources of nutrients, especially protein, in many countries. Proteins and lipids are the major components whereas carbohydrates are detected at very limited levels [1]. Chemical composition of fish varies according to age, sex, environment and season.

Fish are exposed to contamination from different sources. Among these contaminants are the heavy metals. Minerals are needed for the normal metabolism of the fish and are usually taken up from water, food or sediment [2-6].

Heavy metals are known for their bioaccumulation ability in the aquatic ecosystems [7,8]. They are not removed from aquatic environment and thus can accumulate in particular substances and sediments; so their toxicity may be a serious problem to the human consumers via the food chain through consumption of fish and other sea foods–since they can accumulate these toxic substances within their tissues [9,10]. High concentration of minerals in fish muscle might be due to the close contact with the sources of these toxic metals in solution form, since fish use water soluble oxygen by filtering massive quantity of water through the gills and can thus lead to the bioaccumulation in the tissues [11].

It has thus been recommended that the monitoring of water, sediment and biota may provide a coherent status of the water bodies within individual river basins. Among the elements recommended for monitoring by WFD Framework Directive and its Daughter Directives are Cd, Pb, Hg, Ni, As, Cu, Cr and Zn [12].

Among the various metals found in water or fish are Lead (Pb) and Cadmium Cd). They are regarded as toxic for human because they have the ability to accumulate in the body causing adverse effect in blood, central nervous system, kidneys, reproductive and immune system [13].

In Sudan, contamination of river water is becoming a serious problem [14,15]. With the increase in human activities such as increase in the use of pesticides and fertilizers near river banks, improper disposal of factories' effluents with minimum preliminary treatment into the water is becoming an important threat for contamination of the Nile River– the main river in the country- and hence the ecosystem at large.

This study aimed to determine the levels of Pb and Cd in water and fish samples obtained from Elshajara area, Khartoum- Sudan. This area is known to be a main fishing area and it is located near one of the important factories in the country.

2. MATERIALS AND METHODS

2.1 Study Area

Water and fish samples were obtained from Elshajara area. It is located at White Nile river extending from Aldubaseen Bridge to Fish Researches Center (N 32°28ˈ43" Ë 40ˈ15°30).

This area is known to have one of the important factories located in the area besides, it is an important fishing site. The study area was divided into 3 areas: Area A, the area between Aldubaseen Bridge and the effluent of the factory. Area B, across this effluent area and, Area C, which is the area following the effluent area (Picture 1).

2.2 Collection of Samples

A total of 60 samples were collected from targeted area, 30 samples of water and 30 samples of fish muscles. Mainly two species are found Nile Tilapia and Catfish. Ten samples of water and fish were obtained from each site. They were collected from middle of river in clean plastic bottles and transported directly to Central Laboratory of Veterinary Research-Soba for mineral analysis.

Picture 1. The study area

2.3 Analysis of Minerals

Cadmium and Lead concentrations in all samples were determined using Atomic Absorption Spectroscopy (novAA350) [16].

2.4 Statistical Analysis

One-sample t-test was used to test the difference between the levels of heavy metals in samples and the standard level. Also, the results were subjected to one-way Analysis of Variance (ANOVA) to test the difference in the concentrations of heavy metals between the different samples and the area.

3. RESULTS

3.1 Concentrations of Pb and Cd in Water Samples

The overall mean of Pb concentrations were 0.148±0.0104 µg/l and 0.285±0.018 µg/kg in water and fish samples, respectively. The mean concentration of Pb in fish samples was significantly higher ($p>0.05$) than its' concentration in water samples. The average concentration of Pb in water samples were 0.143±0.0075 µg/l, 0.158±0.0064 µg/l, 0.140±0.0064 µg/l for sites A, B, and C, respectively (Fig. 1). The results showed a significant difference between the concentration of lead in water in site B ($p=.000$) compared to sites A and C. No significant difference was found between sites A and C.

With respect to Cd, the mean concentration in water samples was 0.014±0.002 µg/l, while the mean concentration in fish samples was 0.027±0.004 µg/kg.

The concentrations of Cd were 0.011±0.0019 µg/l, 0.017±0.0015 µg/l, 0.013±0.0015 µg/l for sites A, B and C, respectively (Fig. 1). The concentration of Cd in water samples obtained from site B was significantly higher ($p=.00$) than its' concentrations in other sites.

3.2 Concentration of Pb and Cd in Fish Samples

The concentrations of lead in fish tissues from the different sites were 0.284±0.010

µg/kg, 0.294±0.020 µg/kg, 0.277±0.010 µg/kg for sites A, B, and C, respectively (Fig. 2). There were no significant differences in the concentrations of lead in fish samples among the three different sites.

The concentrations of Cd in fish samples from the different sites were 0.027±0.003 µg/kg, 0.029±0.004 µg/kg and 0.025±0.003 µg/kg for sites A, B and C, respectively. There was a significant difference between Cd level in site B and the other sites. No significant difference was found between sites A and C.

4. DISCUSSION

This study aimed to investigate the levels of Pb and Cd concentrations in water and fish tissues obtained from Elshajara area. The results showed that all obtained samples (water and fish muscles) from different sites contained lead and cadmium with different concentrations.

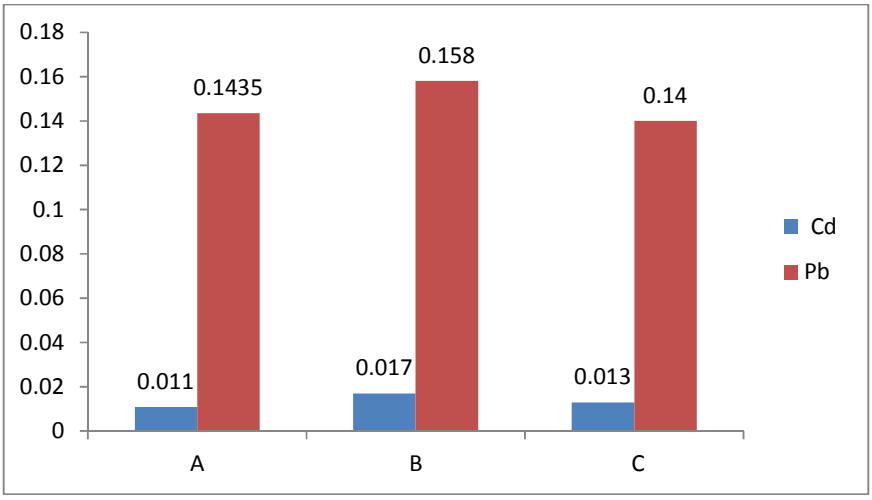

Fig. 1. Concentrations of Pb (µg/l) and Cd (µg/l)in water from different sites

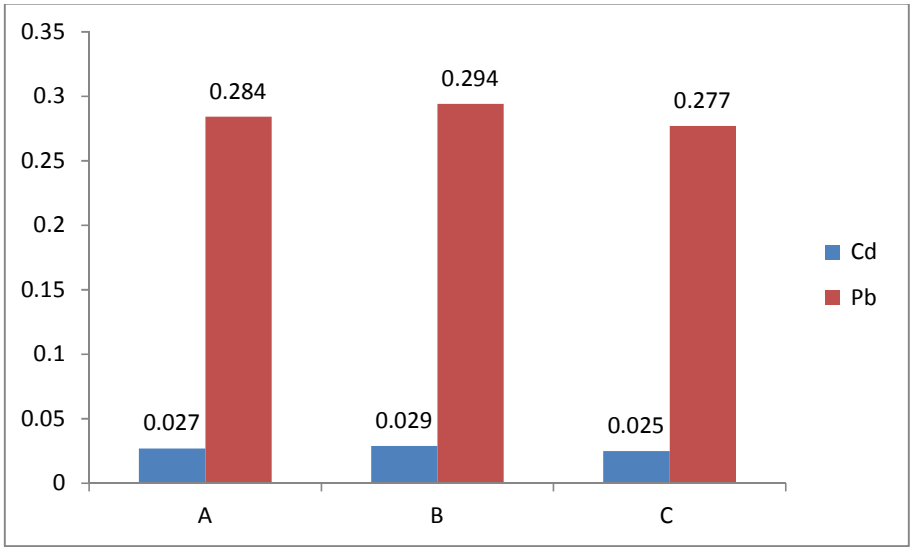

Fig. 2. Concentrations of Pb (µg/kg) and Cd (µg/kg) in fish from different sites

The mean of lead concentration in water samples was significantly higher than the permissible level of 0.01 µg/l determined by EQS [17]. The concentration of lead in site B was the highest among the three areas. The change in color and bad smell of water was also observed in these samples. This is probably because this site is the closest to the factory and nearest to the sewage discharge area. This result agrees with high concentration of lead reported in Eljabal dam and Eluzuzab area in Sudan [14-18].

The mean concentration of lead in fish tissue was 0.285±0.018 µg/kg. This concentration was below the permissible limit of 2 µg/kg determined by WHO [19] albeit that, it was higher than the permissible limit of 0.1 µg/kg which was determined by EQS [17]. These results are lower compared to previous studies carried out for detection of Pb in fish from different areas in Lagos lagoon and in *C. gariepinus* from Ogun River [20,21]. The results in this study were found to be higher than the results reported in fish from Atlantic Sea [22].

A previous study showed that Pb in fish tissue is being positively correlated with total Pb concentration in water, thus, the quality of water affects the quality of sediments and also have influence on the aquatic organisms [12]. Also, a previous study showed higher levels of Pb in *C. Soborna* fish species which was above the acceptable limits for human consumption [23]. Lead maybe a ubiquitous pollutant that may originate from discharge of commercial effluents, fish processing plants, steel and paper mills, cement factories, paint and dye producing plants, soap and detergent factories [23].

The results of this study showed that the level of Cd in water (0.014±0.002 µg/l) was higher than the allowable level that is determined by EQS [17]. While its' concentration in fish (0.027±0.004 µg/kg) was below the permissible level determined by WHO [19]. The concentration of Cd in fish obtained from site B also had the highest concentration same as the water sample obtained from the same site. Previous studies reported low levels of Cd in fish [24,25]. A previous study carried in Nigeria showed the presence of Cd, Cr, Pb, Zn in water, fish, soil and different kinds of edible vegetables from waste water irrigated farms [26]. The high levels of Cd and Cr concentrations may be due to textile industries close to water, which discharge their effluents into surrounding rivers without proper treatment and may also be as a result of the application of excess fertilizers by farmers. Many factories are located in Khartoum Industrial areas and the waste is usually passed into the White Nile, through sewage bonds and can thus be considered an additional source of water pollution. An earlier study reported the increased level of Cd and Pb in fish species and water samples around coastline and cities [27].

One of the serious problems is the continuous use of waste water with high metal concentration to irrigate farms which may later affect the environment including soil, vegetables, fish and water [28] and hence affect the human health.

5. CONCLUSION

This study revealed the high levels of lead and cadmium in water at Elshajara area which were above the permissible limits. The level of Pb in fish tissues was higher than the allowable limit according to EQS levels. The existence of cadmium and lead with high concentrations reflects the water pollution in the area due to the industrial activity. This may be considered as a threat for the ecosystem which may affect the human health.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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