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Detection of Concentrations of Some Heavy Metals in Two Fresh Water Fish Species at WdiHalfa Fisheries, Sudan

Nadia Eldirdiry Omer Karoum[1*], Siham Elias Suliman[2] and Mohamed Abdelsalam Abdalla[2]

1. Federal Ministry of Animal Resources, Department f Fisheries
2. Department of Preventive Medicine and Public Health, College of Veterinary Medicine, Sudan University of Science and Technology

***Corresponding Author:** Email mohamedkarar1998@hotmail.com

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Abstract

This study was undertaken to evaluate the detection of heavy metals in the fish lead (pb),cadmium (Cd)and chromium (Cr) in Two Spp of fish (*Oreochromis nilotica*) Bulti Spp and (*Labeo niloticus*) Dabsa Spp in Nuba lake Wadi Halfa Northern State , as well as to correlate the detected elements with their respective concentrations with weight and length of the two fish Spp In Winter .10 samples *Orechromis niloticus* (Bulti spp) and other 10 samples of *Labeo niloticu (Dabsa Spp.)* were collected from the Nubian lake in Northern state in December 2016 in (Winter) and were analyzed to measure the concentrations (mg/Kg DW) Cadmium (Cd), Chromium (Cr) by atomic absorption spectrometry 210 / 211VG Atomic Absorption Spectrophotometer [3]Sudan Academy of Sciences (SAS), National Center for research. . The measured concentration of heavy metals in the present study was in order of, Cd, Cr and Pb The ranges of the measured concentrations Cd (mg/kg) in the10 samples of *Oreochromis niloticus* (Bulti Spp) samples were 0.065,0.057,0.035,0.032,0.017,0.056,0.021,0.045,0.062and0.066 for the Cr were 0.115,0.085,0.050,0.055,0.075,0.035,0.175,0.465,0.072and0.055 for Pb were 0.0315,0.130,0.175,0.165,0.160,0.150,0.375,0.485,0.195 and0.235 and for the Lbeo niloticus was as follows Cd 0.021,0.055,0.0285,0.058, ,0.076, 0.054,0.046,0.049,0.067 and 0.056 for the(Cr) were 0.260,0.075,0.080,0.095, ,0.065,0.095,0.220,0.072,0.090 and 0.070 and for Pb were 0.205,0.105, ,0.185,0.550,0.290,0.210,0.205,0.075,0.245and 0.160 which are all less than the permissible range . The mean concentrations of, Cd, Cr,and Pb observed in the present study in Bulti were 0.0456,0.1152 and 0.2385 mg/kg respectively and for Dabsa were 0.0767,0.1122 and 0.2233 respectively Therefore, the study results revealed that the Nubian lake at Wadi halfa Northern state quality might be considered as not polluted with the these heavy metal.

Keywords: Heavy metals; Nubian lake, Concentration, Correlation

Introduction

Heavy metals are considered the most important form of pollution of the aquatic environment because of their toxicity and accumulation by marine organisms (Malik, 2014). The concentration of heavy metals in the fish from the River water has shown that the metal concentration found in the fish samples were higher than the range of maximum acceptable limits as per WHO. The various industrial outlets which drain into the river is a probable source of the heavy metals in the rivers, leading to severe deleterious effect on humans, fish and plants (Sen *et al.*, 2011). Various national and international agencies have determined the recommended range of heavy metals permissible to human health (Singh *et al.*,

2014).Heavy metals are individual metals and metal compounds that can impact human health. Three common heavy metals are discussed in this brief cadmium, chromium and lead. These are all naturally occurring substances which are often present in the environment at low levels. In larger amounts, they can be dangerous. After decades of rapid urbanization, population growth and industrialization, developing countries are now home to many of the world's most critical air, water and solid waste problems. Early studies have identified the rise in the pollution of particular heavy metals in freshwater systems around the world, particularly in rivers. The pollution has mainly been caused by industrial processes and industrial waste, typically from rubber and oil palm mills (Tariq *et al*., 1996). Heavy metals are intrinsic, natural constituents of our environment and the term "heavy metals" refers to any metallic elements that have relatively high density and are toxic or poisonous even at low concentration(lentech, 2004) Moreover they are also known as trace elements because they occur in minute concentrations in biological systems. Sediments may become contaminated by the accumulation of heavy metals through various sources such as disposal of high metal wastes, land application of fertilizers, animal manures, sewage sludge, pesticides, wastewater irrigation(Khan,2008; Zhang, 2010) . The agricultural drainage water containing pesticides and fertilizers and effluents of industrial activities and runoff in addition to sewage effluents enter into the water bodies and sediment with huge quantities of inorganic anions and heavy metals(EDCG, 2002) .The heavy metal contamination of aquatic ecosystems above the natural background load has drawn the attention of many researchers. Heavy metals may accumulate in aquatic species, enter the food chain and cause serious harm to human health when the contamination content and exposure are significant (Goyer, 1997) (Papagiannis *et al*., 2004) (Türkmen *et al*., 2005) (Fernandes *et al*., 2007). . The accumulation of heavy metals in fish is an important issue because many fish species are consumed as a source of protein by a large section of the population, especially those who live near rivers. The low saturated fat and sufficient omega fatty acids in fish are also important in supporting good human health. Fish, in comparison with invertebrates, are more sensitive to many toxicants and are a convenient test subject for indication of ecosystem health(Adams and Ryon, 1994;Zaki *et al*., 2014). Heavy metals are produced from a variety of natural and anthropogenic sources .(Bauvais *et al*., 2015) In aquatic environments, heavy metal pollution results from direct atmospheric deposition, geologic weathering or through the discharge of agricultural, municipal, residential or industrial waste products, also via waste water treatment plants (WWTPs), (Demirak *et al*,2006; Maier *etal*., 2014;Dhanakumar *et al*.,2015). Essential metals include Fe, Cu, Zn and manganese (Mn), whereas non-essential metals are Hg, Pb, nickel (Ni) and Cd (Türkmen *et al*., 2005). High concentrations of heavy metals affect the growth and development of fish during early life stages such as hatching, larval development and juvenile growth because they were more sensitive during these stages than during mature stages. Evidently, fish form the link for the transfer of toxic heavy metals from water to humans (Ashraf *et al.*, 2010). The harmful effect of trace elements when consumed above the recommended limit can be toxic (acute, chronic or sub-chronic), and heavy metals can be neurotoxic, carcinogenic, mutagenic or teratogenic. _ Fishes are considered to be most significant biomonitors in aquatic systems for the estimation of metal pollution level (Rashed, 2001; Authman *et al*., 2008) they offer several specific advantages in describing the natural characteristics of aquatic systems and in assessing changes to habitats In addition, fish are located at the

end of the aquatic food chain and may accumulate metals (Lamas *et al*.,2007). The objective of this study was to detect the concentrations of some heavy metals in some fresh water fish.

Materials and Methods

Site Description:

Sudan is located in the northeastern part of Africa . The lake Nubian in Wdi Halfa northern state with length 180Km 15Km width and 20 -40 meter depth, the River Nile basin which flows up, passing through Wadi Halfa in north Sudan up to the Mediterranean Sea. The lake has been used by the local people for domestic use, transportation, and small scale fishing .

Sample Collection Aand Fish Tissue Preparation

10 fishes of Bulti Spp. And 10 fishes of Dabsa Spp. were collected from the Nubian lake in Wadi Halfa in the northern state in December 2016 (Winter season in Sudan) in plastic bags and were taken to Suba veterinary research central laboratory . Muscle tissue of fish (dorsal muscle) was used in this study because it is the major target tissue for metal storage and is the most edible part of the fish. Fish tissues were cut and oven dried at 110°C to a constant weight (Tüzen ,2003).

Typical Analytical Procedure

Sample Preparation:

Twenty five grams of wet tissue were weighed (5 g dry weight) into crucible; samples were dried at 135 °C for 2 hr and obtained a dry weight. Then it was transferred to a cool muffle furnace and slowly temperature was raised to 450 °C-500 °C overnight ash samples were removed, let cool to room temperature, cautiously 2 mL HNO3were added and swirled. Evaporated carefully just to dryness on warm hot plate or steam bath. Then transferred to cold furnace, temp was raised slowly to 450 °C- 500 °C and held at this temperature for 1 hour. Crucible was removed and cooled. HNO3 treatment was repeated, to obtain clean, practically carbon-free ash (Somers, 1968; Childs and Gaffke, 1974; Capar, 1977). Ten ml of 1N HCl was added and ash was dissolved by heating cautiously on a hot plate. Then was transferred to a 25-mL volumetric flask and HCl was the mixture added as necessary. It was cooled and diluted to volume (AAS,1994;Umit and Mustafa, 2008**)**.

Statistical Analysis

All analysis was determined at significance levels of $p<0.05$. When necessary, data were $\log_{10}$ (x+1) transformed to normalize the distributions. All statistical analyses were computed using Statistical Package for Social Sciences (SPSS) version 16.0.

Results

Three common heavy metals were measured cadmium (Cd) was ranged between 0.017-0.066 , chromium (Cr) ranged between 0.035-0.465 and lead(Pb) between 0.130-0.485 mg/kg in (Bulti fish) and that for Dabsa Spp.the cadmium (Cd) was ranged between 0.021-0.285 , chromium (Cr) ranged between 0.065-0.260 and lead(Pb) between 0.075-550 mg/kg Table (1).

Table (1) Heavy Metal (mg/kg) in *Orechromis niloticus and Labeo niloticusb* **from Nubian lake Wadi Halfa in North State.**

Bulti	Cd(mg/kg)	Cr(mg/kg)	Pb(mg/kg)	Dabsa	Cd(mg/kg)	Cr(mg/kg)	Pb(mg/kg)
1	0.065	0.115	0.315	1	0.021	0.260	0.205
2	0.057	0.085	0.130	2	0.055	0.075	0.105
3	0.035	0.050	0.175	3	0.285	0.080	0.185
4	0.032	0.055	0.165	4	0.058	0.095	0.550
5	0.017	0.075	0.160	5	0.076	0.065	0.290
6	0.056	0.035	0.150	6	0.054	0.095	0.210
7	0.021	0.175	0.375	7	0.046	0.220	0.205

8	0.045	0.465	0.485	8	0.049	0.072	0.075
9	0.062	0.072	0.195	9	0.067	0.090	0.245
10	0.066	0.055	0.235	10	0.056	0.070	0.160
Range	0.017-0.066	0.035-0.465	0.130-0.485		0.021-0.285	0.065-0.260	0.075-550
Mean conc	0.0456	0.1152	0.2385		0.0767	0.1122	0.2230

The length of Bulti fish ranged between 7.2 – 11 cm and that of Dabsa fish ranged between 10.9-13.4 Cm this have no any significant statistic difference (P> 0.05) in accumulation of three tested heavy metal in the two Spp. of the fish. Whereas the weight of Bulti 160 – 498 grams and that of Dabsa fish 273- 458 grams showed no significant statistic difference (P>0.05) among the three tested heavy metal in fish (Table 2)

Halfa :Orechromis niloticus (Bulti Spp)

No	Length cm	Weight gm
1-	11	430
2-	11	330
3-	10.8	325
4-	11	428
5-	10.9	410
6-	10.8	498
7-	11	319
8-	10.3	400
9-	8.8	230
10-	7.2	160

Halfa Dabsa

***Labeo niloticus* (Dabsa Spp)**

No	Length cm	Weight gm
1-	12.0	448
2-	11.5	396
3-	12.0	335
4-	12.0	325
5-	11.5	253
6-	13.2	440
7-	13.4	478
8-	11.5	312
9-	10.9	310
10-	11.0	300

Discussion

The concentration level of Cd, Cr, Pb of 10 Bulti fish and 10 Dabsa fish in different samples which are shown in table 1 are found less than the permissible concentration levels of Cd Cr and Pb and they were ranging over following intervals: Cd: (0.011-0.019) mg/Kg, Cr: (0.022-0.046) mg/Kg, Pb: (0.014-0.068) mg/Kg. In food, the allowed amounts of heavy metals (HMs) vary from country to country and are based both on the WHO recommendations and local requirements. According to Lithuanian Standards of

Hygiene (LSH, 2001; Yarsan and Yipel, 2013) the maximum tolerable limit (MTL) of Pb in fish meat is 0.4 mg/kg which is the same as the value adopted by the European Commission for Pb in marine fish muscle (ECDG, 2000), while FAO set a limit of 0.5mg/kg (FAO, 1983). The guideline limit set for Cd by FAO (1983) is 0.05mg/kg for fish, the concentration range from this study is less than the recommended one. WHO (1993) has set a maximum limit of 0.05 mg/l of Cr in drinking water. An estimate of the daily intake was ranging from 0.025 to 0.2 mg/day (Codex, 1995). Since no standard/ guidelines were set for Cr, the stable oxidation state in biological samples, thus Cr found in this study may not be above the recommended daily intake. The muscle concentration of non-essential element Pb in all fish samples was below the detection limit. Turkish Food Codex (Anonymous, 2008) and Commission Regulation (EC) (Anonymous, 2006) indicate that maximum level is 0.30 mg/kg wet wt. for Pb. Cd concentration was, however, well below the proposed maximum in the food safety regulations (MAFF, 1995). Fish tissue used in this study is from one species which is *Orechromis niloticus* (Bulti fish). The obtained results showed also the correlation between the heavy metals depending on the weight and length of the fish samples which were shown in table2 which also showed no significant result. The levels of heavy metal accumulation in fish depend on the growth rate, metabolism, feeding pattern and ecological requirements fish species (Yilmaz *et al*., 2010). Other factors are the differences in life history patterns among species including trophic levels and geographical distribution of life stages, which influence their exposure to heavy metals (Allen-Gil and Martynov, 1995). In conclusion, the total mean heavy metal concentration of all fish species in this study revealed an order of Pb, Cr and Cd. Therefore, the results in this study demonstrated that fish species caught in the White Nile River were not contaminated with heavy metals. Although the concentrations of heavy metals in the fish were not detected, the potential for metal toxicity danger may appear in the future depending upon the extent of industrial and domestic wastewater influx and human activities in the adjacent areas to Nile. To develop a healthy freshwater fishing industry and to prevent heavy metal risks to human health in the River, the water standards and concentrations of heavy metals in the water column and fish should be monitored regularly. Type of heavy metals and characteristics of rivers in Sudan should be highly considered in selection of different types of fishes including Red Sea fish for heavy metals analysis.

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الكشف عن تركيزات بعض المعادن الثقيلة في نوعين من أسماك المياالا العذبة في مصايد وادي حلفا. السودان

نادية الدرديري عمر كروم[1] سهام الياس سليمان[2] محمد عبدالسلام عبدالله[2]

1/ وزارة الثروة الحيوانية الفدرالية , قسم الاسماك

2و 3/. قسم الطب الوقائي و الصحة العامة , كلية الطب البيطر , جامعة السودان للعلوم و التكنولوجيا

المستخلص

أجريت هذه الدراسة لتقييم الكشف عن المعادن الثقيلة الرصاص) والكادميوم والكروم في اثنين من اجناس الأسماك Oreochromic nilotica (اسماك البلطي) و Labeo niloticus (اسماك الدبسة) جمعت من بحيرة النوبة وادي حلفا الولاية الشمالية ، وكذلك لربط العناصر المكتشفة بتركيزات كل منها مع وزن وطول السمكتين في فصل الشتاء .عشرة عينات تم جمعها من Orechromis niloticus(سمك البلطي) و 10 عينات أخرى من Labeo niloticu (سمك الدبسة) من بحيرة النوبة في الولاية الشمالية في ديسمبر 2016 في (شتاء) وتم تحليلها لقياس تركيز (mg / Kg DW) كادميوم (Cd) ، كروم (Cr) و الرصاص (Pb) بواسطة مطياف الامتصاص الذري 210 / VG211 الامتصاص الذري الطيفي في المركز الوطني للبحوث . كان التركيز المقاس للمعادن الثقيلة في الدراسة الحالية بترتيب Cd و Cr و Pb. وكانت نطاقات التركيزات المقاسة Cd (mg / kg) في 10 من عينات Orichromis niloticus (سمك البلطي) كانت 0.065.0.057.0.035 ، 0.032،0.017،0.056،0.021،0.045،062،066 و 0،066 للـ CRكانت and0550.035،0.175،0.465،0.072،0.115،0.085،0.050،0.055،0.075 لـ Pb كانت 0.0315،0.130،0.175،0.160 ، 0.150،0.375،0.485،095 و 0.235 وللبيليو النيلي كان على النحو التالي 0،001،055،028،028،05 دينار بحريني ، و 0.076 ، 0.076 ، 0.054،046،0،049،067 ، و 0.056 لـ

(كر) 0.095،0.080 و 0.090،0.072،0.220،0.095،0.065 و 0.070 و Pb كانت 0.105،0.205 و 0.245،0.075،0.205،0.210،0.290،0.290،0.290،0.550،0.185 و 0.160 وكلها أقل من النطاق المسموح به. كانت التركيزات المتوسطة لكل من Cd و Cr و Pb التي لوحظت في الدراسة الحالية في Bulti هي 1152،0.0456 و 0.2385 ملغم / كغم على التوالي ، وبالنسبة لـ Dabsa كانت 1122،0.0767 و 0.2233 على التوالي لذلك ، كشفت نتائج الدراسة أن بحيرة النوبية في وادي حلفا الولاية الشمالية تعتبر غير ملوثة بهذه المعادن الثقيلة.