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Levels of Four Heavy Metals in Two Fish Species Collected from Aldubaseen Area in Khartoum State, Sudan

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Abstract

Cr, Fe, Hg and Ni concentrations were determined in gills, muscles and bones of two fish species *Oreochromis niloticus* and *Clarias lazera* collected from Aldubaseen bridge area along the White Nile in Khartoum State. The concentrations of the metals were carried out using Flame Atomic Absorption Spectrophotometer Generally results showed that both fish species accumulated Fe at higher levels than Cr, Hg and Ni in the three tested tissues. The general pattern of accumulation of heavy metals in *O. niloticus* showed Fe > Cr > Hg > Ni while accumulation in *C. lazera* was Fe > Cr > Ni > Hg in three tested tissues of both fish species .Results also showed that accumulation of heavy metals differed in the different tissues. *O. niloticus* showed a significantly different ($p < 0.05$) pattern of accumulation as follows: muscles > gills > bones for the four heavy metals. In *C. lazera* although not significantly different ($p > 0.05$) the pattern was gills > muscles > bones for the four heavy metals. It was concluded that levels of heavy metals determined in this study were well below the maximum limits for fish consumption proposed by FAO\WHO [1].

Keywords: *Heavy Metals; Oreochromis niloticus; Clarias lazera; White Nile; Sudan*

Introduction

The continuous introduction of contaminants into a natural environment causes instability and disorder that may harm the ecosystem. Heavy metals which are continuously discharged into water bodies are considered one of these contaminants. Fish are often at the top of the aquatic food chain and many concentrate large amount of heavy metals [2,3]. Fish absorbs metal directly from contaminated water or indirectly from feeding on living organisms of the contaminated water [4]. Kalfakakon and Akrida-Demertai [5] working on the effect of heavy metals in fish, reported that heavy metals exhibited bio-accumulation from water to fish. They demonstrated that metal concentrations in fish are higher than in water, which indicates the bio-accumulation. Farombi., *et al*. [6] stated that heavy metals have a destructive effects on the ecological balance. This study was conducted to assess the levels of some heavy metals in the soft tissues of two commercial fish of the River Nile to investigate whether the fish have elevated concentrations of these heavy metals in their tissues that could render them dangerous for human consumption.

Materials and Methods

Sample Collection

A total number of 10 fish species were collected from Eldubaseen Bridge area at the White Nile. Fish were first identified by species, then the total length (cm) and body wet weight (g) of each specimen was measured. The species used were The Nile Tilapia (*Oreochromis niloticus*) and the Cat fish (*Clarias lazera*).

Fish handling and processing

Before chemical analysis, the fish were dissected. All of the tools used for dissecting flesh sampling were made of stainless steel to avoid contamination with metal residues. The gills muscles and bones were taken out and homogenized once at a time. Each tissue was oven- dried to a constant weight at 60°C [7]. The samples were ground into powder using a porcelain pestle and mortar. Powder samples were then kept in an air –tight plastic containers till used for analysis.

Digestion of the Samples

About 2g of each of the powdered samples were weighed and placed into high temperature resistant crucibles. Weighed samples were then ashed in a muffle furnace at 550°C. Following ashing each sample was acid digested using 10 ml of 5 N Hydrochloric acid, digestion occurred over 20 minutes on a hot plate at 80°C. Samples were then filtered and transferred to 50 ml conical flasks. The flasks were then filled to a volume of 50ml using distilled water .These prepared solutions were used for the Atomic Absorption Spectrometry analysis according to the method described by Pearson [8] to measure Cr, Fe, Hg and Ni concentrations in the gills ,muscles and bones of the two selected fish species.

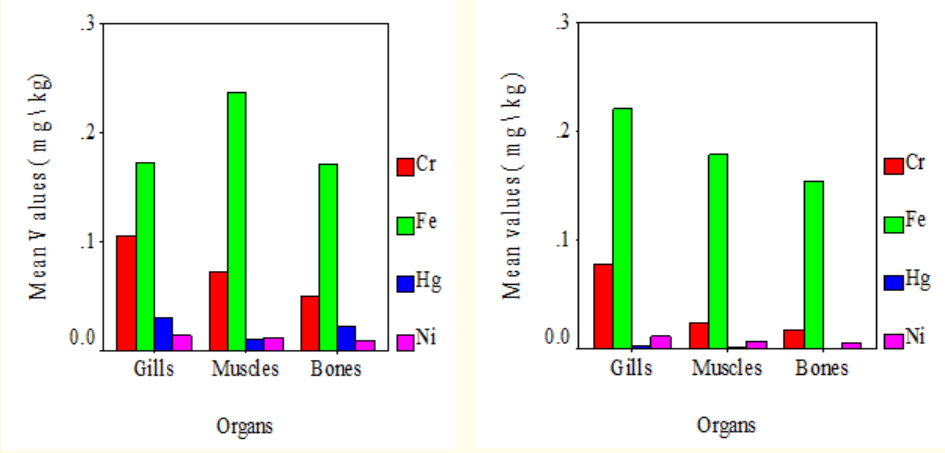
Statistical Analysis

Results of the heavy metal analyses were subjected to a one-way Analysis of variance (ANOVA) to test for significant differences ($p < 0.05$) in the concentrations of the heavy metals in the different tissues of the two fish species.

Results

Metal concentrations in different organs of the two fish species:

The concentrations of Cr, Fe, Hg and Ni in the muscles, bones and gills of the two fish species collected from The White Nile, Eldubaseen Bridge area were determined .Results revealed that Fe concentrations were highest in *C. lazera* and *O. niloticus* fish species giving 0.22 mg/kg and 0.172 mg/kg respectively .Nickel was lowest in *O. niloticus* while Hg showed lowest concentrations in *C. lazera* as shown in figure 1 (a and b).



(a) **(b)**

Figure 1: *Mean concentration of Chromium (Cr), Iron (Fe), Mercury (Hg) and Nickel (Ni) in gills ,muscles and bones of (a) O. niloticus (b) C. lazera .*

In *O. niloticus* the pattern of Cr and Ni concentrations in the different organs were as follows: gills > muscles > bones while Fe pattern was muscles > gills > bones and Hg pattern was gills >bones>muscles Figure (1a). On the other hand the pattern of Cr, Fe, Hg and Ni concentrations in the different organs of *C. lazera* were as follows: gills > muscles > bones Figure (1b).

Metal concentrations in edible muscles of the two fish species:

Calculation of the average concentrations of Cr, Fe, Hg and Ni in the muscles of the two fish species gave the following results: Cr: 0.048 ± 0.01, Fe: 0.208 ± 0.015, Hg: 0.0062 ± 0.001, Ni: 0.0046 ± 0.0015. This leads to the following ranking: Fe > Cr > Ni > Hg .The metal levels in the fish muscles of *O. niloticus* and *C. lazera* yield a similar ranking.

In this study the detected levels of heavy metals in the fish flesh were compared with the international permissible levels FAO (1984) Table (1 and 2).

Heavy metal	Muscles (mg/kg)	Permissible level (mg/kg)
Cr	0.0723 ± 0.0040	0.5
Fe	0.2367 ± 0.0298	0.8
Hg	0.0107 ± 0.0015	0.5
Ni	0.00113 ± 0.002	70 - 80

Table 1: *Comparison of Cr, Fe, Hg and Ni in mg/ kg dry wt. (mean ± standard deviation) in muscles of O. niloticus collected from Aldubaseen bridge area, Khartoum state with international levels.*

Heavy Metal	Muscles	Permissible level
Cr	0.0233 ± 0.0068	0.5 mg/kg
Fe	0.2367 ± 0.0298	0.8 mg/kg
Hg	0.0107 ± 0.0015	0.5 mg/kg
Ni	0.00113 ± 0.002	70 – 80 mg/kg

Table 2: *Comparison of Cr, Fe, Hg and Ni in mg/ kg dry wt. (mean ± standard deviation) in muscles of C. lazera collected from Aldubaseen bridge area, Khartoum state with international levels.*

Discussion

This study investigated Chromium (Cr), Iron (Fe), Mercury (Hg) and Nickel (Ni) concentrations in gills, muscles and bones of two commercially important fish species from Aldubassen Bridge area in Khartoum state. The Nile Tilapia *O. niloticus* and the cat fish *C. lazera* were selected because they are the most commonly consumed fish in Khartoum state .This investigation showed that different fish species contained different concentrations of a certain metal in their different organs. In agreement with these findings Kalay., *et al*. [9], reported that different fish species accumulate metals in their tissue in significantly different values. Canli and Atli [10], reported that levels of heavy metals in fish vary in various species. This can be attributed to factors such as metal concentration, age, size, physiological status, habitat preferences, feeding behavior of the different fish species.

In general among the three studied organs in the two fish species the gills accumulated the highest concentrations of all studied heavy metals. This finding agreed with that of Al-Weher [11] working with Cd, Cu and Zn. Fish are exposed to waterborne heavy metal fractions when taking in considerable amount of water in the process of respiration and osmoregulation. Therefore gills serve as the important route of heavy metal exposure from surrounding water. The large surface area of gills further facilitates the adsorption of heavy metals onto the surface of gills during respiration [12].

Fish muscle is the edible part of fish and frequently employed in assessing health risks in relation to fish consumptions. The concentrations of Cr, Fe, Hg and Ni in fish muscle tissues examined in this study were well situated within the permissible limits of FAO\WHO [1]. Results showed that in the different parts of fish, the concentration of heavy metals ranked as follows: Fe > Cr > Ni > Hg in *O. niloticus* and *C. lazera.* Similar results was observed by Abdulali., *et al* [13]. It was concluded that the edible muscles of both fish species showed levels of heavy metals well below the maximum limits for fish consumption proposed by FAO\ WHO [1]. Accumulation of heavy metals in the different organs specially muscles and bones may be considered as an important warning signal for bioaccumulation in fish and possible health problems with human consumption .It was recommended that monitoring of heavy metals level in commercial fish is a must and precaution measures and effective legislations need to be taken in order to prevent future heavy metal pollution in the Nile.

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