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Comparative study of the heavy metal concentration of the various parts of *phractocephalus hemioliopterus* (catfish) and *trachurus trachurus* (horsefish)

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Abstract
The concentration of heavy metals (Cu, Cd, Cr, Ni, Mn and Zn) in the head, muscle and tail of *phractocephalus hemioliopterus* (catfish) and *trachurus trachurus* (horsefish) were determined. Sample preparation was done using the modified American Public Health Association (APHA) method while the heavy metal concentration was determined using the Atomic Absorption Spectrophotometer. Values of heavy metals in mg/g obtained were as follows, Cd:0.0000-0.0138mg/g, Cr:0.0000-0.0188mg/g, Ni: 0.0000-0.0114, Mn:0.0214-0.1300mg/g, Zn:0.0199-0.1227mg/g with Cu being conspicuously absence in all parts of the fish species examined. Comparatively with the WHO stipulated limits all the elements fell below these limits except Mn which was a bit higher than the permissible limit although do not pose any health challenges to consumers given its status as an essential element by researches.

1. Introduction

Heavy metals are natural trace components of the aquatic environment, but their level have increased due to industrial, agricultural and mining activities. As a result, aquatic animals are exposed to elevated levels of heavy metals. The levels of metals in the upper members of the food web like fish can reach values many times higher than those found in aquatic environment or in sediments. Some of these metals are toxic to living organisms even at low concentrations whereas others are biologically essential and become toxic at relatively high concentrations at an instance or with overtime accumulation. Depending on their concentration they may exert beneficial or harmful effects on plant, animal and human life or even enzymes preventing them from their normal functions (Forstener, 1981; Duruibe *et al.*, 2007). At high concentrations (lethal toxicity) they can lead to death of the organisms. At relatively lower concentration, organism may suffer from various kinds of adverse effect and still survives. Histological changes may occur in digestive tubular tracks, gill or epithelial tissues.

Symptoms due to interference with the organism's neurological systems may also be observed such as changes in enzymal or hormonal activities resulting in weakness of organisms, changes in growth or reproduction rate, susceptibility to parasitic pathogens or diseases may occur. Due to their toxicity and accumulation in biota, determination of the levels of heavy metals in commercial fish species have received considerable attention in different countries in the region and around the World, hence this study was undertaken to investigate the current heavy metal contamination in edible tissue (muscle), head and tail of *phractocephalus hemioliopterus* (catfish) and *trachurus trachurus* (horsefish) sold in Nigeria's open markets with a view to ensuring the safety of the food supply and minimizing the potential hazardous effect on human health if any.

2. Materials and Methods

2.1. Sample Collection

Fresh fishes measuring within 24-30cm in length were purchased from Eke Awka Market , in Awka Anambra State, Nigeria. The Catfish is a locally cultivated breed while the Horse fish is an imported breed.

2.2. Sample preparation

The fish samples were thoroughly washed with de-ionized water to remove traces of any particulate matter and the required parts cut using dissecting materials. The various parts were pulverized to ensure homogeneity of the samples before sampling. All reagents used were of standard analytical grade from BDH and all solutions also prepared using standard analytical reagent grade chemicals. Sequel to the heavy metal determination, the pulverized fish samples were digested using the modified APHA method.

2.3. Sample Digestion

0.5g of the homogenized sample parts individually were weighed into a 100ml conical flask followed by the addition of 10ml 50% nitric acid and H_2O_2 each respectively. The mixture was then heated continuously at 130°C with the aid of a heating mantle for 20minutes during which 10ml of 50% nitric acid and H_2O_2 were intermittently added to ensure that the solution do not dry up. The heating process was continued until a clear solution was obtained.

5ml of saturated ammonium oxalate solution was added and the solution filtered using whatmann filter paper. The entire solution was made up to the 100ml mark of a volumetric flask and kept for metal analysis using Atomic Absorption Spectrophotometer (Varian AA 240).

2.3.1. Principles of Atomic Absorption Spectrophotometer

Atomic Absorption is a physical process involving the absorption of light of a specific wavelength unique to an element by the atoms of the elements. The key feature is the production of free, ground state atoms from the sample which pass through the light beam from the hallow cathode lamb. For many conditions the absorption of radiation follows Beer's law:

$A = abc$,

where,

A = absorbance,

a = the absorptivity,

b = path length of absorption

c= concentration of the absorbing species

Beer's law shows a relation between absorption and concentration of analyte, so calibration of the instrument is needed (Bruice, 2011).

3. Results and Discussion

The data obtained for heavy metals composition in analyzed fishes parts are presented in Table 1

Table 1. *Heavy metal composition of the fishes parts*

		Elements					
Fish Parts	**Fish Specie**	**Cu**	**Cd**	**Cr**	**Ni**	**Mn**	**Zn**
Head	Cat	0.0000	0.0080	0.0000	0.0105	0.1300	0.1227
	Horse	0.0000	0.0086	0.0000	0.0237	0.1112	0.0513
Muscle	Cat	0.0000	0.0000	0.0000	0.0077	0.0770	0.0199
	Horse	0.0000	0.0064	0.0188	0.0114	0.0962	0.0497
Tail	Cat	0.0000	0.0066	0.0000	0.0000	0.1152	0.0668
	Horse	0.0000	0.0138	0.0162	0.0000	0.0214	0.0631
WHO Standard		6.000	0.4000	0.3000	0.1200	0.0020	8.000

3.1. Copper

Copper is considered an essential constituent of metalloenzymes of living organisms and is required in haemoglobin synthesis and in the catalysis of metabolic reactions. It plays a crucial role in many biological enzymes that catalyze oxidation/reduction reactions. Its total absence in these fish parts would save high consumers of these fish species health challenges that could result from the accumulation of this element among which is free radical formation and chromosomal aberrations (StoutHart, 1996).

3.2. Cadmium

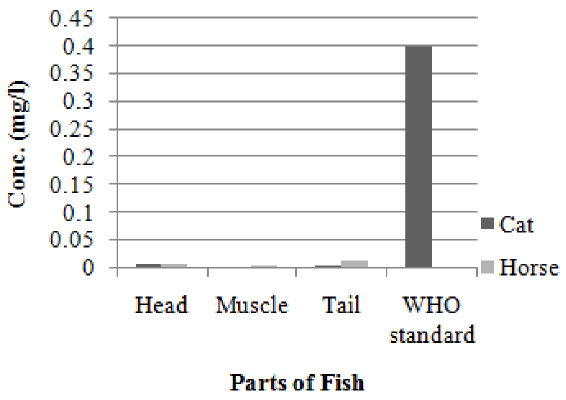

Fig 1. *Cadmium concentration (mg/l) in the various fish parts.*

Cadmium is a non-essential, highly toxic and eco-toxic metal. The occupational levels of Cd exposure prove to be a risk factor for chronic lung disease and testicular degeneration. Cd could originate from water, sediments and food and may accumulate in the human body inducing kidney dysfunction, skeletal damage and reproductive deficiency (WHO/FAO, 2004).

The WHO (1989) recommended a maximum permissible limit of 0.4mg/g for Cadmium with the concentration of Cd in the fish sample ranging between 0.0000-0.0138mg/g, it has shown that they are below the stipulated limit. Cd was conspicuously absent from the muscles of the catfish as a result would not pose any threat to the consumers of these fishes with regards to the associated health hazards that could result from the accumulation of this element. Odomelan (2005) reported a value Cd of 0.3mg/g while Ishaq et al., (2005) reported 0.18mg/g and 0.1988mg/g in *C.garipinus* and *T.Zilli* respectively from River Benue.

3.3. Chromium

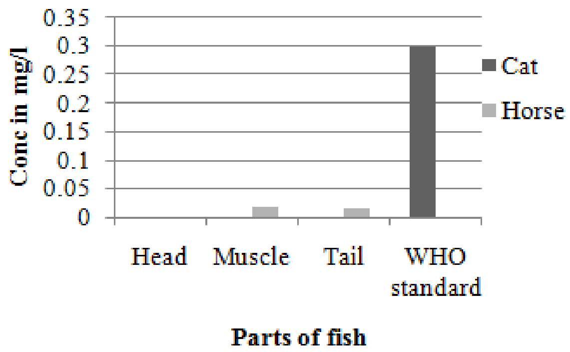

Fig 2. *Chromium concentration (mg/l) in the various fish parts.*

Chromium in insulin plays an important part in passing dissolved proteins from the blood to the cells in an efficient manner, hence the concentration of Cr which ranged between 0.0000-0.018mg/g in different parts of the fishes against the stipulated limit of 0.3mg/g shows the agreement of the results with the standard and its positive contribution to the vital role of the insulin in the part of fish such as the muscle (0.0188mg/g) wherein it was detected.

Chromium concentrations of 0.02-1.122mg/g was reported by Obasohon (2007) from an investigation of *parachama obscura* from Ogha River in Benin City while Nwani et al., (2010) reported Cr concentration of 0.238mg/g in *C.nigrodigidato* from fresh water ecosystem at Afikpo all showing different variations from the WHO stipulated limit in accordance with our observation.

3.4. Nickel

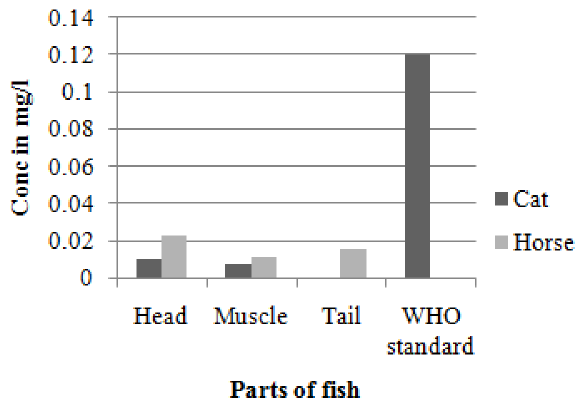

Fig 3. *Nickel concentration (mg/l) in the various fish parts.*

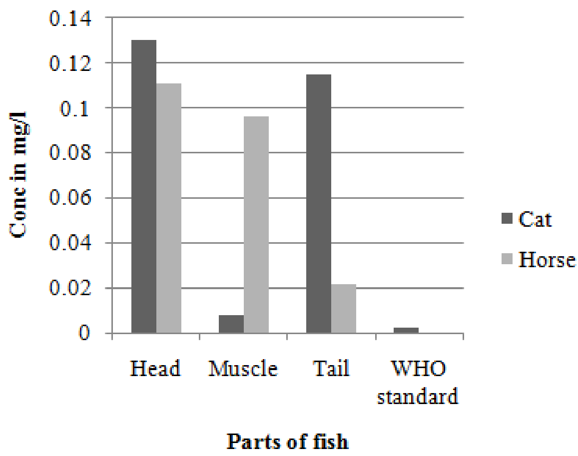

Fig 4. *Magnessium concentration (mg/l) in the various fish parts.*

Nickel although in very trace amount is considered essential as it serves as an activator of some enzymes (Momtaz, 2002). Higher levels however could cause respiratory problems or even cancer (April, 1990). Nickel concentration from our results ranged between 0.0000-0.0237mg/g which is below the stipulated standard of 0.12mg/g. Conspicously absent was Ni in the tail part of the two fish species. Idodo-umeh (2002) reported a Nickel concentration of between 0.32-0.71mg/g which is higher than that of our findings showing better adherence to limits by our fish samples viz a viz its higher safety level.

3.5. Manganesse

Manganesse levels with values ranging between 0.0214-0.1300mg/g although higher than the stipulated limits of

0.002mg/g does not pose any health risks as has been classified by Momtaz (2002) as an essential element which is present in all living organisms.

3.6. Zinc

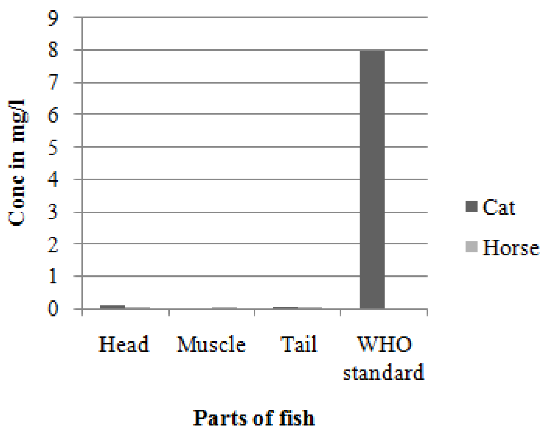

Fig 5. *Zinc concentration (mg/l) in the various fish parts.*

Zinc is an essential element but at high concentrations, it can be toxic to fishes causing mortality, growth retardation and reproductive impairment. Toxicity due to excessive intake of zinc has been reported to cause electrolytic imbalance, anemia and lethargy (Prasad, 1984). The concentration of Zn in the head, muscle and tail parts of these two fish species ranged between 0.0199-0.1227mg/g which fell highly below the WHO permissible limit of 8mg/g.

4. Conclusion

Heavy metals accumulate in different tissues of cat and horse fishes with different magnitudes. Generally, based on the parts under examination, the level of accumulation shows that Tail < Muscle < Head while based on species, the catfish has proven to accumulate more heavy metals than the horse fish. Summarily, based on the results of the analysis conducted, the level of the heavy metals determined fell below the WHO stipulated standard indicating safety for consumers of these fish species.

Recommendations

Continuous monitoring of fish species sold in the market should be encouraged to help in the prevention of heavy metal toxicity in man as a result of bioaccumulation in fishes with a view to ensuring the safety of these seafood for human consumption.

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