

# Toxins in Gills and Flesh of *Synodontisorex* and *Bagrusfilamentosus*

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**Abstract** The concentrations of Cadmium (Cd), Chromium (Cr), Lead (Pb), Manganese (Mn) and Aluminium (Al) in water, sediments, gills and flesh of both *Synodontisorex* and *Bagrusfilamentosus* from River Jega in Kebbi State, Nigeria, were determined by atomic absorption spectrophotometer. The pattern of distribution of the heavy metals showed a preponderance of Cr and Mn over other metals in the organs of the two fish species as well as in the water and sediment samples. The highest concentration of Mn was in the sediment and lowest in water. The unexpectedly high concentration value obtained for Cr and Mn calls for medical alertness since it exceeded the WHO recommended acceptable limits for consumption. Al was not detected in the organs of fish species, water and sediment. Cd and Pb distribution in all the samples was lower than the WHO and USEPA recommended acceptable limits for consumption.

**Keywords** Heavy Metals, Water, Fishes, Sediment, Kebbi State, *Synodontisorex*, *Bagrusfilamentosus*

## 1. Introduction

Heavy metals pose a great concern to the Scientists as they cause environmental contamination by exhibiting behaviours consistent with those persistent toxic chemicals. The heavy metals cannot be degraded further, and their toxic effects can be long lasting, unlike the organic contaminants that decompose into other chemicals with time [1]. Heavy metals are known to have toxic effects even at low concentration, and their concentration in biota can be increased through bio-accumulations [2].

Many water bodies in Nigeria as revealed by studies are found to contain various levels of heavy metals pollutants [3, 4, 5, 6, 7]. Weathering process or mass activities such as agricultural and industrial waste disposal are the route through which these metals get in to the aquatic environment [8, 9]. Fish is often the last link in aquatic food chain therefore it is the need of time to determine its toxic metal concentration [10]. According to Abou-Arab [11] fish accumulate these heavy metals from the surrounding water and sediment. Many disease conditions in man are linked to the consumption of fishes contaminated with toxic metals [1]. Cadmium (Cd) and Lead (Pb) in any concentration can cause kidney damage, their symptoms of chronic toxicity include impaired kidney infection, poor reproductive capacity, hypertension etc. Chromium as Cr (vi) penetrates cell

membranes and can cause genotoxic effect and cancer [12, 13]. The main aim of this study were to determine the levels of Cadmium (Cd), Chromium (Cr), Lead (Pb), Magnesium (Mn) and Aluminium (Al) in different organs of fish species, water and sediment as well as their potential health effects on human.

## 2. The Fishes

### 2.1. *Synodontisorex*

Scientific Name: *Synodontisorex*; Etymology: *Synodontis*: From the Greek “syn” meaning together, and “odontos”, meaning tooth; in reference to the closely-spaced lower jaw teeth; Habitat: Africa: Chad, Niger, Nile, Volta basins and Bénoué River

Identification: All species in the genus *Synodontis* have a hardened head cap that has attached a process (humeral process) which is situated behind the gill opening and pointed towards the posterior. The dorsal fin and pectoral fins have a hardened first ray which is serrated. There is one pair of maxillary barbels, sometimes having membranes and occasionally branched. The two pairs of mandibular barbels are often branched and can have nodes attached. The cone-shaped teeth in the upper jaw are short. S-shaped and movable in the lower jaw. These fish produce audible sounds when disturbed rubbing the base of the pectoral spine against the pectoral girdle [14].

### 2.2. *Bagrusfilamentosus*

Scientific name: *Bagrusfilamentosus*

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**Etiology:**The generic name comes from the Mozarabicbagre, taken from the Greek pagros, meaning a fish (*Dentex* sp.). *Bagrus*: From 'bagre', a South American name for a catfish, but is only used for African and Asian species. **Habitat:** Africa: Niger River system.

**Identification:** A nocturnal feeder on cichlids on rocky shores, and occurs from the lower reaches of rivers to the deepest habitable parts of the lake. It also feeds on molluscs, crabs and zooplankton. **Identification:** Head about twice as long as broad, with smooth texture. Dorsal fins widely separated, Body Bronze/silver. Fins have a ruby colouration when reaching adulthood[15]



**Figure 1.** *SynodontisSorex*[14]



**Figure 2.** *Bagrusfilamentosus*[14,15]

### 3. Consumption of Fishesexposed to Heavy Metal

Heavy metals are classified as essential (if they play basic role as components of vital biochemical or enzymatic activities in human body e.g Fe, Mn, Mo, Cr, V, Zn) and as non-essential (if the metals are classified as with no biological, chemical and physiological importance in man. Deficiency or high concentrations of these metals may have detrimental effect on health. Once liberated into environment, man-made chemicals and products of heavy metals are taken up into the body via inhalation, ingestion and skin absorption. Heavy metals on exposure may not necessarily produce a state of toxicity in the body as they accumulate in the tissues over time until they reach toxic concentration[16]

Exposure to toxic metals is associated with many chronic diseases. As per available report, when metallic toxicant finds their way into the body, there are possible mechanisms through which they act. Some of which are:

(a) **Inhibition of Enzymatic Activities:** This is so because some metals such as Pb, Hg and Cd have affinity for sulphur

and therefore attack sulphur bonds in enzyme, thus immobilizing them. Other site of attack include the free amino (-NH<sub>2</sub>) and carboxyl (-COOH) groups in protein

(b) **Attacks on Cell Membrane and Receptor:** The heavy metals bind to cell membrane and receptor, thereby altering their structures. This affect transport and other inter or intra cellular processes in the body. Cd inhibits oxidative phosphorylation in the body

(c) **Interference with Metabolic Cations:** Heavy metals interfere with the metabolism of essential cations such as absorption, transportation, decomposition and storage. Cd follows the pathway of Zn and Cu metabolisms. Pb replaces Ca in bones

(d) **Action on the Artery:**Heavy metals can increase the acidity of the blood. The body draws Ca from the bones to help restore blood pH. Further to toxic metals set up conditions that lead to inflammation in arteries and tissues, causing more Ca to be drawn to the area as a buffer. The Ca, coats the inflamed area in the blood vessel but creating another by the hardening of the artery walls and its progressive blockage of the arteries. This leads to osteoporosis[16]

### 4. Materials and Methods

Sampling of water, fishes and sediments were conducted at the River side. Water and sediment samples were collected and preserved using Atuma and Egbroge method[18].

The fish species were collected from the fisher men at Jegariverand were put in plastic bags and refrigerated in the laboratory. Gills and muscular section were removed using a plastic knife and then dried in an oven of about 105±20<sup>0</sup>C for about 24 hours, after which were weighed prior to digestion, the dried gills and flesh of fish species were pounded and milled with a mortar and pestle until a powder was obtained[19]. They were then put in plastic containers and stored in desiccators until digestion. 10cm<sup>3</sup> conc. H<sub>2</sub>SO<sub>4</sub> and 5cm<sup>3</sup> conc. HNO<sub>3</sub> was added. The sample was digested in a fume cupboard until the solution volume was reduced to 2cm<sup>3</sup>. The digestion continued until the solution was colourless. This ensured the removal of all HNO<sub>3</sub>. The sample was allowed to cool, and 15cm<sup>3</sup> of distilled water was added with gentle swirling. 1M NaOH was added drop wise until a pink- brown or colourless solution was produced. The solution was filtered using a Whatman filter paper No. 42, followed by dilution to the mark in a 25cm<sup>3</sup> volumetric flask. The water and sediment were digested according to the method prescribed by Sreedevi et al.,[20]. Following the digestion, all samples were analyzed for Cd, Pb, Cr, Mn and Al.

### 5. Results and Discussion

The distribution of Cd and Pb in the gills and flesh of *Synodontissorex* and *Bagrus* fish species was generally low when compared to WHO and USEPA[12, 21] recommended levels Tables 1 and 2.

**Table 1.** Toxic metal distribution in *synodontisorex* fish organs

organs	Toxic metals Concentrations (ppm)				
	Cd	Cr	Pb	Mn	Al
Gills	0.005	0.514	0.022	0.362	ND
Flesh	0.004	0.466	0.010	0.384	ND

**Table 2.** Toxic metal distribution in *Bagrusfilamentosus* flesh and gills

organs	Toxic metals Concentrations (ppm)				
	Cd	Cr	Pb	Mn	Al
Gills	0.008	0.396	0.024	0.264	ND
Flesh	0.009	0.324	0.012	0.248	ND

Al is not detected in the organs of all the fish species. Which shows that the study area is unpolluted with these metals[7]? The concentration of Cr in all the fish species is higher in the gills than in the flesh, while the concentration of Mn in *synodontis* is higher in the flesh than the gills. The concentrations of Cr and Mn in all the fish species are higher than the permissible consumption limits[22]. Table 2 shows the concentration of Cr and Mn in gills higher than in flesh of *Bagrusfilamentosus* fish species. The specificity of concentrations of heavy metals is irrespective of the locality of fish capture and uptake route of the metals[23].

The distribution of the concentration of metals in both water and sediment was observed in this order Cr>Mn>Pb>Cd table 3. The result of this study shows that the concentration of metals in the sediment is higher than in water. Heavy metals entering an estuary in the solid form adhere to sediments whereas, the soluble form is precipitated to increase the sediment metal load and decrease the open water column concentration[24]. The concentration of Cr and Mn in sediment is higher than WHO standard as reported by Bhatia[25]. The presence of Cr in soaps and detergents used for washing and bathing in the River could be responsible for Cr highest level in sediment[26]. The Cr concentration level above WHO limit is a threat to human health as people were actually using the water from the River for drinking and domestic purposes. The high concentration of Mn in both water and sediment could be attributed to its presence in many types of rock[26]. It is above the permissible limits for drinking water.

**Table 3.** Toxic metal distribution in water bodies and sand samples

Sample ID	Toxic metals Concentrations (ppm)				
	Cd	Cr	Pb	Mn	Al
WB	0.000	0.199	0.011	0.124	ND
WM	0.002	0.187	0.013	0.105	ND
SB	0.008	0.587	0.016	0.412	ND
SM	0.001	0.595	0.007	0.401	ND

KEY: ND – Not detected, WB – Water from River bank, WM – Water from middle river, SB – Sand from River bank, SM – Sand from middle River

## 6. Conclusions

This study revealed that Cr and Mn levels in all the test samples were not only high but above the permissible limits as recommended by WHO. The bioaccumulation of these metals may pose great hazard to health of humans and animals that rely on the fish and water from River Jega. The concentrations of Cd and Pb in all the samples were however, low and below the standard limits. Al could not be detected in all the samples.

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