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Heavy Metal Composition of Tympanotonus Fuscatus Var. Radula Sold In Markets in Nasarawa State, Nigeria

Asemota[1]*, U.K., Obiekezie[2], S.O., Makut[2], M.D.,Fatokun[3], K.A. andOwuna[2], J.E.

1. Biotechnology Advanced Research Centre, Sheda Science and Technology Complex, Sheda, FCT Abuja, Nigeria.
2. Department of Microbiology, Faculty of Natural and Applied Science, Nasarawa State University, Keffi, Nasarawa State, Nigeria.
3. Chemistry Advanced Research Centre, Sheda Science and Technology Complex, Sheda, FCTAbuja, Nigeria.
**Corresponding Author: Asemota*

----------***ABSTRACT***----------

An investigation of the heavy metal levels in Tympanotonus fuscastus var radula sold in markets in Nasarawa State Nigeria was carried out.Tympanotonus fuscatus var. radula were bought from three sale locations in Keffi, Masaka and Orange markets and quantitative analysis of heavy metals was done using theAtomic Absorption Spectrophotometry. Theheavy metal analysis showed that heavy metal levels in the raw samples varied from 29.10–69.00mg/kg, 0.02–0.17mg/kg, 12.09–29.89mg/kg, below detection to 0.04mg/kg, 0.20–0.50mg/kg for nickel, cobalt, copper, chromium and lead respectively. Heavy metal levels in the boiled samples also varied from 18.40– 35.00mg/kg, 0.02–1.34mg/kg, 10.00–28.89mg/kg, below detection to 0.02 and 0.10–1.18mg/kg for nickel, cobalt, zinc, copper, chromium and lead respectively.There was no significant difference in the heavy metal values obtained from different markets. However, a significant difference ($p < 0.05$) was observed in the raw and boiled samples. This is attributed to the fact that boiling reduces the toxicity of metals as some of the metals escapes into the foaming leacheates that forms on during boiling. Thus, the presence of these heavy metals can be attributed to the discharge of natural, anthropogenic and industrial waste into the water bodies that serve as habitat to periwinkles. The levels of heavy metals in the periwinkle samples were within the tolerant levels in seafood as stipulated by regulatory agencies. Tympanotonusfuscatus var.radula periwinkles sold in markets in Nasarawa State, Nigeria are therefore safe for consumption. However, periodic and regular monitoring of the periwinkles brought to the market should be encouraged to avoid an accumulation which could be detrimental to the health of consumers.

KEYWORDS*: Heavy metals, periwinkles, spectrophotometry, market, Nigeria*

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I. INTRODUCTION

The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations (Ikejimba and Sakpa, 2014).The occurrence of heavy metals in water bodies, sediments and aquatic animals can be attributed to natural and anthropogenic activities in the environmentwhich includes the use of banned chemicals for fishing purposes by fishermen, oil spills, forest fires, gasflaring, ocean dumping as well as industrialand urbanization activities.Several authors have investigated the accumulation ofheavy metals in Tympanotonus fuscatus var. radula, notable among them are Davies et al. (2006)who studied the bioaccumulation of heavy metals in water, sediments and periwinkle Tympanotonus fuscatus var. radula from Elechi creek, Niger Delta. Andem et al (2013) studied the bioaccumulation of some heavy metals and hydrocarbon in the tissues of Tympanotonus fuscatus var.radula in the intertidal regions of Qua Iboe river basin in Akwa Ibom State. Fish and invertebrates have been used as bioindicators of water quality, this is attributed to the fact that they have relatively stable concentration compared with water analysis that indicates only short term conditions.Most of the waterbodies that serve as habitat to the periwinkles that are brought to markets for sale from Niger Delta serve as primary recipients of petroleum exploration and exploitation wastes, onshore and offshore industrial sewage, chemical contaminants,domestic and office wastes generated by multinational oil companies.

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The bioaccumulation of heavy metals in aquatic animals gives rise to mutations, change in tissue matter,biochemistry, behavior, reproduction and suppressgrowth in marine life as well as disease which can beharmful to humans. This consequently results in many human health conditions such as cancer, brain damage, kidney damage and behavioral problems (Obasahan and Eguavoen, 2008).Tympanotonus fuscatus var. radula serves as a source of high quality animal protein used in the preparation of many Nigerian delicacies especially in the Niger Delta region.

However, there is paucity of documented information on the periwinkles sold in markets in Nigeria and particularly markets in Nasarawa State. Nigeria. This research work is therefore a contribution to the baseline for the monitoring of heavy metals in Tympanotonus fuscatus var .radula sold in markets.

II. RESEARCH METHODOLOGY

Description of Study Area

Nasarawa State is located in the central part of Nigeria otherwise known as the middle belt with a population of 27, 137.81 km^2. It is bounded in the north by Kaduna State, in the west by Kogi State and Federal Capital Territory, Benue States and Plateau States in the East (NIMET., 2005). It has a total population of about 1, 863,275 people according to 2006 population census. It lies on latitude 7◦ 45^1 and 9◦25^1 N of the equator and between longitude 7◦ and 9◦ 37^1 E of the greenwich meridian (Agidi et al., 2018). Three markets in Nasarawa State were randomly selected. Keffi in Keffi Local Government Area (LGA); Masaka and Maraba Orange markets both in Karu LGA of Nasarawa State.

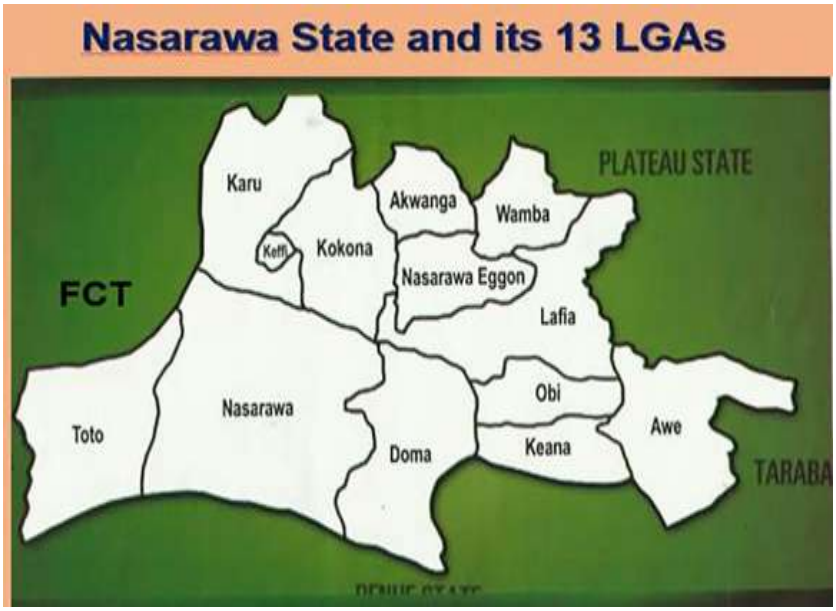

Figure1: Map of Nasarawa State Showing the Location of Keffi and Karu Local Government Area
Source: Local Government Development. Nasarawasaidadinkowa.com

Collection of Periwinkle Samples

Tympanotonusfuscatusvar.radulaperiwinkles with shells were bought from Soup ingredient sellers at three different sale locations each from Keffi, Masaka and Orange markets in Nasarawa State. The samples were collected in well labeled plastic containers.

Identification of Samples

The identification of the periwinkle samples were authenticated at Biotechnology Advanced Research Centre, Sheda Science and Technology Complex. Sheda. Abuja.

Preparation of Composite Samples

The periwinkle samples were separated into four groups:

Group1(Periwinkle Shells):- The periwinkles with shells were scrubbed, washed and rinsed to remove dirt and debris, the fleshwas extracted while empty shells were used for the analysis.

Group2(Periwinkle Samples without Shells;Flesh):- The periwinkle samples without shells were scrubbed and rinsed and the flesh extracted (Ogumgbele and Omowale, 2012). The meat was extracted using a specially fabricated needle. The flesh was used for the analysis.

Group 3(Boiled periwinkle shells):- Periwinkle samples in Group 1 were boiled at laboratory conditions of 100^{o}C for 5 minutes using a hot plate (Jenway, United Kingdom).

Group 4(Boiled Periwinkle samples without shells):- Periwinkle samples in Group 2 were boiled at laboratory conditions of 100^{o}C for 5 minutes using a hot plate (Model Jenway, United Kingdom).

Thereafter, Tympanotonusfuscatusvar. radulasamples were thoroughly washed with distilled water. The composite samples were dried in an oven at 70°C for 24 hours. The dried samples were ground into powder and kept dry in an air tight container for analysis.

Procedure for Heavy Metal Analysis

To isolate the heavy metals from the periwinkle samples, the organic matter content of the organisms was destroyed by wet digestion. One gram of each dried sample was digested with 20mL of 3M HNO3 for 3 hours while heating until a clear solution was obtained. Digested samples were filtered into 100mL volumetric flask, made up to mark with distilled water and then analyzed for chromium, lead, nickel, cobalt and copper using atomic absorption spectrophotometry (ice 3000 series, USA) as demonstrated by Ogundiran and Fasakin(2015).

Plate 1: Tympanotonus fuscatus var. radula with shells sold by soup ingredient sellers

Plate 2: Flesh of Tympanotonus fuscatus var. radula with its characteristic turquoise blue colour

Table 1: Mean Heavy Metal Analysis of Raw Tympanotonus fuscatus var. radula Sold in Markets in Nasarawa State, Nigeria (mg/kg)

Heavy metals	Nickel mg/kg	Cobalt mg/kg	Copper mg/kg	Chromium mg/kg	Lead mg/kg
Source					
Keffi shells	56.00^{a}±0.51	0.14^{a}±0.05	29.89^{a}±0.28	0.04^{a}±0.01	0.40^{a}±0.18
Keffi flesh	38.49^{b}±0.22	0.10^{b}±0.05	25.00^{a}±0.25	BDL	0.20^{b}±0.05
Masaka shells	65.00^{a}±0.53	0.16^{a}±0.11	29.00^{a}±0.19	0.02^{a}±0.01	0.50^{a}±0.26
Masaka flesh	40.54^{c}±0.51	0.02^{c}±0.18	29.00^{a}±0.19	BDL	0.45^{e}±0.12
Orange shells	69.00^{a}±0.56	1.17^{a}±0.13	12.09^{b}±0.13	0.02a±0.01	0.49^{a}±0.17
Orange flesh	29.10^{d}±0.45	0.12^{a}±0.05	24.00^{e}±0.24	BDL	0.32^{b}±0.41
Range	29.10-69.00	0.02-0.17	12.09-29.89	0.00-0.04	0.20-0.32
Standard deviation	1.23	1.82	0.71	0.02	0.44
*FAO, 1983	80.00	-	30.00	-	0.5

*Food and Agricultural Organization (1983) permissible heavy metal levels in Shellfish

Values are mean of triplicate determinations ± standard deviation.In each column, mean with a common supercript are not significantly different.

Table 2: Mean Heavy Metal Analysis of Boiled Tympanotonus fuscatus var. radula Sold in Markets in Nasarawa State, Nigeria (mg/kg)

Heavy metals	Nickel mg/kg	Cobalt mg/kg	Copper mg/kg	Chromium mg/kg	Lead mg/kg
Source					
Keffi shells	25.67^{a}±5.06	0.14^{a}±0.06	29.00^{a}±4.89	0.02^{a}±0.01	0.38^{a}±0.13
Keffi flesh	18.40^{b}±3.42	0.07^{b}±0.12	23.00^{a}±2.35	BDL	0.18^{b}±0.08
Masaka shells	1.34^{a}±0.78	1.34^{a}±0.71	28.89^{a}±4.14	0.01^{a}±0.01	0.11^{a}±0.21
Masaka flesh	23.74^{c}±0.46	0.02^{c}±0.11	28.00^{a}±4.08	BDL	0.14^{e}±0.13
Orange shells	30.56^{a}±6.08	1.16^{a}±0.17	10.00^{b}±0.15	BDL	0.10^{a}±0.05
Orange flesh	28.00^{d}±4.45	0.04^{a}±0.02	23.90^{e}±0.44	BDL	0.12^{b}±0.52
Range	1840-35.00	0.02-1.34	10.00-29.00	0.00-0.02	0.10-1.18
Standard Deviation	11.23	1.10	2.50	0.01	0.32
*FAO, 1983	80.00	-	30.00	-	0.5

*Food and Agricultural Organization (1983) permissible heavy metal levels in Shellfishes

Values are mean of triplicate determinations ± standard deviation.In each column, mean with a common supercript are not significantly different.

III. RESULTS AND DISCUSSION

Table 1 shows the mean heavy metal levels of raw Tympanotonus fuscatus var radula sold in markets in Nasarawa State. Cobalt was detected in the range 0.10–1.17mg/kg, chromium was detected in the range of 0.00–0.04mg/kg, Lead was detected in the range 0.20–5.00mg/kg, Nickel was detected in the range 21.10–69.00mg/kg while copper was in the range of 12.09 – 29.89mg/kg. Table 2 shows the mean heavy metal composition of boiled Tympanotonus fuscatus var. radula sold in markets in Nasarawa State. After subjection to heat at 100^{o} C for 5 minutes, the cobalt detected was in the range of 0.02–1.34mg/kg, nickel (18 40-35.00mg/kg), copper (10.00–28.00mg/kg), chromium (0.00–0.02mg/kg), lead (0.10–0.38mg/kg). Periwinkle shells bought from Orange market had the highest nickel and cobalt content. Davies et al (2006) reported the accumulation of cadmium, chromium, and lead in Tympanotonus fuscatus. Shell and soft tissue collected from four stations along Elechi creek, Niger Delta. In another study of heavy metal concentration in tissues of mud skipper (Poriophthalmus sp) a benthic feeder obtained from the Azuabie creek, Moslen and Mabeka(2016) found mean values of chromium, nickel and lead above limits in seafood as set by WHO (1985) and FAO (1983).and concluded that the accumulation of heavy metals in fish tissues above regulatory limits is an indication that mudskippers have ability to bio accumulate and biomagnify the metal pollutants without any physical signs of distress.

In this study, nickel detected is in the range of 29.00 – 69.10mg.kg in the raw samples and 18.40 – 35.00 in the boiled samples. This result disagrees with Onianwa et al.(2006) who recorded 3.80 mg/kg nickel content for periwinkles from Ibadan. Ogamba et al, 2016 reported a nickel content of 0.03-0.004mg/g for Tympanotonusfuacatusvar. radula. However, nickel content is below the 80mg/kg recommended permissible limit for consumption for humans. Lead is detected in the range of 0.20 – 0.50mg/kg in the raw samples and 0.10–0.38 in the boiled samples. The levels of lead in this study is lower than the 0.5mg/kg permissible limit as recommended by (FAO, 1983) and 1.0mg/kg as recommended by EC, (2001) for shellfishes. The copper content in the present study is in the range of 12.09 – 29.89mg/kg in the raw samples and 10.00–28.89mg/kg in the boiled samples. This does not agree with the report of Davies and Jamabo (2016) who reported a 2.15±0.43g/100g copper content for Tympanotonus fuscatus. FAO (1983) recommended permissible limit of copper in shellfishes as 30mg/kg. The copper content of periwinkles bought from markets in Nasarawa state does not exceed the permissible limit for human consumption. The chromium detected in this study was below detection level to 0.02mg/kg. Ogamba et al (2016) reported a 0.020 – 0.023 mg/kg chromium content for the same organism, he also reported that the shells of the organism had a higher accumulation of heavy metals than the soft tissues. Davies et al (2006) also detected a chromium in the soft tissues and shells of periwinkles from Elechi river, Niger Delta..

In the present study it is observed that boiling at 100^{o}C for five minutes reduced the heavy metal levels of the periwinkles. This could be due to the escape of some of the heavy metals into the leachates. Parboiling the periwinkles therefore reduces the risk of heavy metal contamination.

Statistical Analysis

Data were presented as mean standard deviation of triplicate determinations and probability tested at 95% level of significance ($P<0.05$). All statistical analyses were carried out using SPSS for windows version 21.0 statistical package (SPSS Incorporated. USA).

IV. CONCLUSION AND RECOMMENDATIONS

The detection of heavy metals in the flesh and shells of Tympanotonus fuscatus var. radula is an indication that they can be used as biomarkers in aquatic bodies. The low levels recorded is an indication that periwinkles sold in markets in Nasarawa State are suitable for human consumption and can also be used to supplement livestock feed.

Nevertheless, the indiscriminate discharge of effluents into waterbodies should be discouraged. There is need to emphasize the periodic monitoring of Tympanotonusfuscatus var.radula periwinkles brought to the market for sale to avoid the continuous accumulation and increase of the levels of heavy metals with time. The periwinkles should be properly processed before consumption.

Authors' Contributions

AUK conceived the research, participated in the sample collection, sample analysis and drafted the manuscript. FKA participated in the quantitative determination of heavy metals and also conducted the statistical analysis, OJE help in literature search and laboratory experiment, OSO and MMD supervised the laboratory analysis and reviewed the manuscript. All authors read and approved the final manuscript.

Conflict Of Interest

The authors declare no competing interests whatsoever.

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