Evaluation of heavy metals in tissue of Tympanotonus fuscatus sold in some markets in port harcourt metropolis, Nigeria

Abstract

Tympanotonus fuscatus is found in mangrove swamps of the coastal region of the Niger Delta Nigeria. It is a source of protein, Hence it is used in the preparation of delicacies. This study evaluated the level of heavy metals in tissues of Tympanotonus fuscatus sold in some markets in Port Harcourt, Rivers state, Nigeria. Triplicate samples of Tympanotonus fuscatus was purchased from seven different markets within Port Harcourt metropolis. The samples were digested and analyzed using a Flame atomic absorption spectrometer. Results showed that the concentration of the heavy metals ranged from 0.76–1.56mg/kg (nickel), 22.36–29.28mg/kg (zinc), 185.07–921.49mg/kg (iron), 0.05–0.56mg/kg (lead), 80.96–102.62 mg/kg (cobalt) and 19.04–69.45 mg/kg (manganese). Moisture and organic matter contents ranged from 78.88–85.87% and 86.06–92.23% respectively. Analysis of variance showed that there is significant difference (P<0.05) in most of the locations for each of the parameters. The variation that exists could be due to differences in the pollution load of the aquatic habitats from where the samples were harvested. Based on permissible limit, the heavy metals concentration were within allowable limit for fish-food specified by Food and Agricultural Organization/World Health Organization, Median International Standard and European Union except for iron, manganese and copper. The high level of iron, manganese and copper suggests potential health effects.

Keywords: aquatic pollution, environmental health, fish food, heavy metals, Tympanotonus fuscatus

Introduction

Several invertebrate species are found in aquatic ecosystem in the Niger Delta. In addition, Niger Delta is home of several fish species including shelled and fin fish. Some of the common shell fish found in the region is univalve gastropods that belong to the Mollusca phyla. Periwinkles are a typical example of shelled fish which is found predominantly in the littoral region of the marine and estuarine habitats having mangrove plants. Periwinkles predominantly belong to three genus including Tympanotonus, Pachymelania and Mercenaria. Of the three genera, species of periwinkle that belong to the Tympanotonus and Pachymelania genera are predominant in the Niger Delta region of Nigeria. As such, the two predominant species of periwinkle are found in fresh and salt water interphase (brackish water) habitat and benthos of the Niger Delta. But the two species are phenotypically different. For instance, Pachymelania aurita has sharp spines (which depend on the age of the species) and broader aperture, while the species Tympanotonus fuscatus has turreted, granular and spiny shells with tapering ends.

Specifically, Tympanotonus fuscatus concentrate under the roots and decaying red mangrove trees and small collection of water during low tide. Hence, their population depends on their quest for food and shelter. The flesh of Tympanotonus fuscatus is used in the preparation of delicacies in the Niger Delta region. While the shell is used for construction works especially in coastal communities close to the mangroves. Being a source of food to several families, there is the need to assess the level of undesirable substances in their tissues due to level of environmental pollution in the aquatic ecosystems. According to Okuo et al., the environment where food-based aquatic Mollusca are harvested from gives reasons to worry.

According to Ogamba et al., Izah & Angaye, the intensity of environmental contaminants has increased. This is probably due to industrialization, population growth, urbanization without adequate management and planning strategy. Pollution emanates from several human activities and to a lesser extent natural effects such as weathering. Pollution often emanates from the activities of oil and gas industries, which tend to spread fast and wide when in aquatic environment. Agricultural activities (use of pesticides and agrochemicals), marketing, food processing, municipal solid wastes and effluents resulting from several chemical industries are other sources of environmental pollution. During rainfall, the constituent of these wastes streams could be washed off or leached into nearby pools of water and/or surface waters, where it could affect the biota in such aquatic ecosystem.

Wastes are major source of environmental heavy metals pollution. This happens when the wastes are improperly discharged. According to Obasi et al., condemned batteries and bathroom effluents are possible source of water pollution. Okuo et al., reported that the mining, dumping of dangerous military wastes and carcasses of old...
damaged vehicles are some of the sources of heavy metal pollution on soil. This heavy metals have the tendency to bioaccumulate and become very toxic especially when their concentrations exceed the allowable limit in such environment.

Heavy metals have adverse environmental and public health importance. Typically, heavy metals are grouped into essential (elements required at certain concentrations for maintenance of life) and non-essential (not required by the body even at low concentrations). When the concentration of essential heavy metals such as iron, copper, zinc, manganese etc exceeds the recommended limit, it could be deleterious to the body just as the non-essential heavy metals such as arsenic, lead, cadmium and mercury. As such, most heavy metals are toxicants that could induce multiple organ damage. For instance, lead has the tendency to interfere with several enzymatic functions and physiological processes in the human body thereby affecting the nervous, reproductive, cellular and cardiac systems. The effects of several heavy metals to the different tissues and organs have been previously described by Izah et al.

Due to the ability of Tympanotonus fuscatus to bioaccumulate toxicants such as heavy metals in their environment and its role in human nutrition, several studies have been carried out on the heavy metals concentration in Tympanotonus fuscatus from several locations in the Niger Delta. Some of these studies were carried out in Qua Iboe River Basin, Ibena, Akwa Ibom State, Elechi Creek, Rivers state, Warri River, Delta state, In Eagle Island River, Rivers State, Nenbe in Nenbe Local Government Area and Lobia in Southern Ijaw Local Government Area of Bayelsa, Oron River in Idia-oro, Oron Local Government area of Akwa-Ibom State, Itu River in Ikot-Udobia in North-western part of Akwa-Ibom state and Abuloma River, Port-Harcourt, Rivers state, Egbokodo River, Warri, Delta state.

The Tympanotonus fuscatus sold in some major markets are obtained from different sources and variation exists in pollution level of their different habitats. There is the need to assess the level of heavy metals in aquatic food proteins sold in our local markets. Therefore, this study focused on the heavy metals in tissues of Tympanotonus fuscatus sold in some markets in Port Harcourt metropolis, Nigeria.

**Materials and methods**

**Sample collection, preparation and analysis**

Triplicate tissue samples of Tympanotonus fuscatus were purchased from seven markets within the Port Harcourt metropolis, Rivers state, Nigeria. The fish samples were transported to the laboratory in an ice chest. The samples were washed using sterile water and there after dried in oven at 105°C for 6 hours. The samples were blended to powder, dry-ashed in a muffle furnace at 450°C. Some of the samples were digested using 5 ml of 10% nitric (sp. gr 1.42) and 5ml of 10% hydrochloric acid (sp. gr 1.19) which was added separately. The respective solutions of ash were transferred into 100 ml pyrex beakers with about 20ml distilled water washings and covered with ribbed watch glasses before being heated at 95°C on a hot plate until the mixture was concentrated to about 10ml. The concentrated ash solution was allowed to cool at room temperature. The content was filtered and quantitatively transferred into a 50ml volumetric flask before being diluted to mark with distilled water. The ash solutions were analyzed using Flame Atomic Absorption Spectrometer (GBC Avanta PM A6600). The instrument was calibrated prior to sample aspiration with a series of prepared standard solutions of the respective metals of interest. The metals were analyzed at varying wavelengths of 213.9 nm, 324.70nm, 232.00nm, 248.3nm, 279.5nm, 357.90nm, 228.8nm, 217.00nm and 240.70nm for zinc, copper, nickel, iron, manganese, chromium, cadmium, lead and cobalt respectively. The moisture and organic matter content of the samples were gravimetrically analyzed as previously described by Horsfall et al.

**Statistical analysis**

SPSS software version 20 was used to carry out the statistical analysis. Data were expressed as mean±standard deviation. A one-way analysis of variance was carried out at P=0.05, and Waller-Duncan multiple range test statistics was used to determine the source of the observed difference. Spearman rho correlation matrix was used to show relationship among the various parameters under study.

**Results and discussion**

Table 1 presents moisture content, organic matter content and heavy metal levels in tissue of Tympanotonus fuscatus sold in some markets within the Port Harcourt metropolis, Nigeria. The spearman rho correlation matrix of parameters under study is presented in Table 2. Among the heavy metals studied, chromium, cobalt and cadmium were not detected. The findings of this study is contrary to the earlier findings of Otitoju and Otitoju that reported cadmium in the range of 0.11–0.27mg/kg, but comparable to the result of chromium i.e. <0.001mg/kg (not detected). Furthermore, the reported cadmium and chromium level of this study is also contrary to the previous findings of Ijeomah et al.

The concentration of heavy metals depicted the following trends: nickel ranged from 0.76–1.56 mg/kg, being significantly different (P<0.05) in most of the markets. Nickel showed positive significant correlation with lead (r=0.604, P<0.01) and manganese (r=0.488, P<0.05), and negatively correlated with organic matter (r=0.631, P<0.01). Zinc concentration ranged from 22.36–29.28mg/kg. There was no significant difference (P>0.05) among the various markets of study. Zinc showed positive significant relationship with moisture (r=0.463, P<0.05) and organic matter (r=0.482, P<0.05). Iron concentration ranged from 185.07–921.49mg/kg. There was significant variation (P<0.05) among the samples from the various markets. Iron showed positive significant correlation with manganese (r=0.579, P<0.01). Lead concentrations ranged from 0.05–0.56mg/kg, being significantly different (P<0.05) among the various markets. Lead showed positive significant relationship with iron (r=0.544) and manganese (r=0.524), and negatively correlated with moisture (r=0.487) and organic matter (r=0.491) at P<0.01. Copper and manganese concentration in the tissues of Tympanotonus fuscatus within the study area ranged from 80.96–102.62mg/kg and 19.04–69.45mg/kg respectively. Basically, there was significant difference (P<0.05) among the various markets for each of the metals. Moisture and organic matter content of the tissues of Tympanotonus fuscatus within the study area ranged from 78.88–85.87% and 86.06–92.23% respectively. Typically, there was significant difference (P<0.05) among the various markets for both parameters. Moisture showed positive significant relationship with organic matter (r=0.709, P<0.01). The positive correlation between moisture and organic matter content is an indication that both parameters are from similar source. The significant positive relationship which zinc depicted with moisture and organic matter is an indication that the moisture plays an essential role in the bio-concentration of zinc by Tympanotonus fuscatus in their habitats.

The variation in the heavy metals, organic matter and moisture
content of *Tympanotonus fuscatus* sold in some major markets within the Port Harcourt metropolis could be due to differences in their source and pollution levels across their different habitats. Typically, pollution in aquatic ecosystems which is majorly caused by anthropogenic activities, which is a threat to biota species of the aquatic ecosystem. Pollution is caused as a result of chemical pollutants from industrial, domestic and agricultural wastes. This waste occurs in different dimensions. For instance, agricultural wastes resulting from the use of pesticides and other agrochemicals in fields close to aquatic ecosystem end up in the available surface waters. Obasi et al., reported that the disposal of condemned car batteries, metals and metal components into surface water, leaching of metals from garbage and solid wastes, effluents from bathroom is another possible source of surface water pollution. Furthermore, pier toilet system is also used in many coastal communities in the Niger Delta. In addition, municipal wastes, market wastes are also deposited in close-by surface waters. *Tympanotonus fuscatus* is found in intertidal areas and estuarine characterized by mangroves such as *Rhizophora racemosa*, *R. mangle*, *Avicennia Africana*, *Nypafruticans*, *Laguncularia racemosa*, etc. In the Niger Delta, the mangroves are also a home of several oil and gas installations. Ijeomah et al., reported that Oil spillage has been implicated as the major cause of environmental pollution in oil producing areas in Nigeria. Therefore, pollution associated with oil and gas activities in addition to pollution caused by wastes discharged into the aquatic ecosystem could be another source of heavy metals in the tissues. Because *Tympanotonus fuscatus* inhabits in the detritus rich mud substratum in quiet water it has the tendency to absorb toxicants from its environment (i.e. water and sediment). Obasi et al., reported that the presence of heavy metals in *Tympanotonus fuscatus* could be due to their ability to bioaccumulate within the food chain.

Based on the recommended limits for fish-food, lead, cadmium in this study is within European Union limit. In addition to lead and cadmium, chromium and zinc was also found within median international standard previously recommended by authors and FAO/WHO reference limit. Iron, manganese, copper was higher than WHO allowable limit. Furthermore, copper was higher than Median International Standard, FAO/WHO. Cobalt was not detected in the fish food while nickel concentration is quite insignificant to cause major harmful effect on consumers.

The result of the heavy metals depicted the following order: chromium<cadmium =cobalt<lead<nickel<zinc < manganese<copper<iron. The higher concentration in iron, copper, manganese and zinc in the tissues of *Tympanotonus fuscatus* followed a similar trend to Ijeomah et al. The authors reported that non-vertebrate fauna species such as *Tympanotonus fuscatus* have high affinity for iron, zinc, manganese and copper intake. As such, this may be associated to the role these essential heavy metals play in the organisms. Most of these essential heavy metals play essential role for enzymatic, physiological and metabolic processes, replacement of cells and activation of low immune system. Further reported that in iron, copper, manganese and zinc are cofactors for a larger number of enzymes. However, Excessive intake of these metals could constitute health risks. The pathological effects of heavy metals under study have been previously reported by Izah et al., Izah & Angaye, Aigberua & Tarawou.

**Table 1** Moisture content, Heavy metal and organic matter content in tissue of *Tympanotonus fuscatus* sold in some markets within Port Harcourt metropolis, Nigeria

<table>
<thead>
<tr>
<th>Markets</th>
<th>Nickel, (mg/kg)</th>
<th>Copper, (mg/kg)</th>
<th>Zinc, (mg/kg)</th>
<th>Lead, (mg/kg)</th>
<th>Iron, (mg/kg)</th>
<th>Manganese, (mg/kg)</th>
<th>Moisture (%)</th>
<th>Organic Matter (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eneka</td>
<td>0.76±0.03a</td>
<td>93.77±0.57c</td>
<td>26.45±1.16ab</td>
<td>0.09±0.0a</td>
<td>409.49±2.07d</td>
<td>25.17±1.74ab</td>
<td>85.16±0.01c</td>
<td>90.40±0.23d</td>
</tr>
<tr>
<td>Oil mill</td>
<td>1.11±0.06ab</td>
<td>89.73±1.17bc</td>
<td>26.66±0.85ab</td>
<td>0.07±0.0a</td>
<td>292.56±3.81c</td>
<td>59.12±4.17</td>
<td>85.87±0.01e</td>
<td>88.53±0.26c</td>
</tr>
<tr>
<td>Rumuodai</td>
<td>1.47±0.23b</td>
<td>81.43±0.73a</td>
<td>27.02±1.14ab</td>
<td>0.15±0.0b</td>
<td>507.70±3.86f</td>
<td>31.48±0.57b</td>
<td>83.03±0.02b</td>
<td>78.97±0.08b</td>
</tr>
<tr>
<td>Rumuokwurushi</td>
<td>1.56±0.26b</td>
<td>80.96±1.14a</td>
<td>25.53±1.81ab</td>
<td>0.56±0.0c</td>
<td>447.36±3.80c</td>
<td>69.45±2.70e</td>
<td>85.67±0.04d</td>
<td>88.15±0.09c</td>
</tr>
<tr>
<td>Slaughter</td>
<td>1.48±0.23b</td>
<td>93.74±2.10c</td>
<td>22.36±1.29a</td>
<td>0.19±0.0b</td>
<td>220.58±4.05b</td>
<td>23.80±1.69ab</td>
<td>78.88±0.07a</td>
<td>86.06±0.03a</td>
</tr>
<tr>
<td>Elimgbu/Tank</td>
<td>0.82±0.06a</td>
<td>86.27±1.08b</td>
<td>27.67±1.51b</td>
<td>0.05±0.0a</td>
<td>185.07±2.91a</td>
<td>19.04±0.69a</td>
<td>85.87±0.04e</td>
<td>92.98±0.26f</td>
</tr>
<tr>
<td>Woji Market</td>
<td>1.13±0.08ab</td>
<td>102.62±0.95d</td>
<td>29.28±1.42b</td>
<td>0.18±0.0b</td>
<td>921.49±14.47g</td>
<td>41.23±1.86c</td>
<td>85.68±0.05d</td>
<td>92.23±0.13e</td>
</tr>
</tbody>
</table>

Each value is expressed as mean±standard error (n=3). Different alphabets along the column indicate significant difference (P<0.05) according to Duncan statistics.

Citation: Aigberua AO, Izah SC. Evaluation of heavy metals in tissue of *Tympanotonus fuscatus* sold in some markets in port harcourt metropolis, Nigeria. MOL Toxical. 2018;4(5):334-338. DOI: 10.15406/moljt.2018.04.00123
Table 2 Spearman rho correlation parameters under study

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Nickel</th>
<th>Copper</th>
<th>Zinc</th>
<th>Lead</th>
<th>Iron</th>
<th>Manganese</th>
<th>Moisture</th>
<th>Organic matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nickel</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>-3.44</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>-2.87</td>
<td>1.33</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>.604**</td>
<td>-.047</td>
<td>-.167</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>.283</td>
<td>.087</td>
<td>.381</td>
<td>.544*</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>.488*</td>
<td>-.203</td>
<td>.173</td>
<td>.524*</td>
<td>.579**</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moisture</td>
<td>-.358</td>
<td>-.053</td>
<td>.463*</td>
<td>-.487*</td>
<td>-.198</td>
<td>.220</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>OM</td>
<td>-.631**</td>
<td>.296</td>
<td>.482*</td>
<td>-.491*</td>
<td>-.045</td>
<td>-.192</td>
<td>.709**</td>
<td>1.000</td>
</tr>
</tbody>
</table>

**.Correlation is significant at the 0.01 level (2-tailed).
*.Correlation is significant at the 0.05 level (2-tailed).
N=21, n=3

Conclusion

The study investigated the level of some selected heavy metals in tissues of Tympanotonus fuscatus sold in some markets within the Port Harcourt Metropolis, Rivers state, Nigeria. The study found that cobalt, cadmium and chromium were below detection limit of the instrument. While the levels of iron, manganese and cobalt exceeded the World Health Organization permissible limit for fish food. Therefore, caution should be exercised in the consumption of Tympanotonus fuscatus. Furthermore, surveillance should be carried out by Federal Environmental Protection Agency with regard to different categories of municipal and industrial wastes that are discharged into the environment in addition to wastes from oil and gas activities.

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None.

Conflict of interest

The authors there are not conflict of interest.

References


