Concentrations of Cd, Pb, Cu and Zn in Gastropods Available in Major Markets of Kota Kinabalu, Sabah

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Abstract—Gastropods are more susceptible to heavy metal accumulation through food intake and absorption from the environment and sometimes impose health hazard to consumers. Thus, this study was investigated the concentration of cadmium (Cd), Lead (Pb), Copper (Cu) and Zinc (Zn) in two edible gastropods species Cerithidea quadrata and Nerita lineate. These fresh gastropods were bought from four markets around Kota Kinabalu. The fresh gastropods soft tissues were dissected to two different part, muscle (edible part) and digestive caecum (non edible part). Wet digestion method has been carried out using nitric acid (69\%) and detected with Inductively Couple Plasma-Optical Emission Spectrometry (ICP-OES). The metal concentrations were in range of 0.120 – 0.65 mg/kg for Cd, 0.098 – 0.54 mg/kg for Pb, 15.92 – 102.77 mg/kg for Cu and 69.17 – 176.43 mg/kg for Zn respectively. These concentrations were found significantly correlated with body parts and size of the gastropods. There was a significant difference of metal concentration between different body part of the gastropods. Surprisingly, some of the heavy metals concentrations were exceeded the permissible level by Malaysia Food Regulation, 1985 and Food & Agriculture Organization.

Keywords— Gastropods, heavy metal, Cerithidea quadrata, Nerita lineate.

I. INTRODUCTION

Heavy metals in very small amounts are necessary to support life. However in larger amounts they become toxic to biological systems. Generally it enters the aquatic environment through natural process such as atmospheric deposition, erosion of geological matrix and anthropogenic activities [1]. Therefore monitoring heavy metal pollution in aquatic environment and biological species has drawn great concern. Aquatic organism such as mollusks accumulate organic and metallic pollutants at concentrations several orders of magnitude above those concentration in the environment [2],[3]. These create anxiety on how safe is the gastropods to the consumers.

Department of Fisheries Malaysia (2005) [4] has indicted that there are about 18 species of marine gastropods in Malaysian coastal area. However, as economic growth rapidly, this leads to the increment in the production and usage of toxic chemicals. Eventually, the coastlines become a sink for agricultural, industrial, and domestic wastes. Thus, more biomonitoring studies have been done using gastropods in Malaysia.

Gastropods species such as Nerita lineate, Telescopium telescopium, Pomacea insularum, Thais aculeate and Faunus ater are some of common species in Peninsular Malaysia that have been associated with metal accumulation and contamination in aquatic system [2],[3],[5], [6], [7]. It is known that gastropods have the ability to accumulate heavy metals to elevated levels in their different parts which are much higher than the concentration of metal in ambient environment.

They are sedentary or less mobile than fishes, makes them more susceptible to accumulate contaminants effectively than the environment. They also exhibit low or undetectable enzyme activities which metabolize pollutants [8]. Moreover, some of the gastropods are important seafood or source of protein. Thus, studying them has significant human health implications.

Still there is lack of studies of heavy metals concentration in gastropods that have been done in West Malaysia, Sabah. Therefore, the present study aimed to investigate the heavy metals concentration (Cd, Pb, Cu and Zn) in the soft tissues of two very popular gastropods species among consumers in Kota Kinabalu, Sabah. Then the concentrations were compared with the permissible level by Food Regulation Malaysia, 1985 [9] and Food and Agriculture Organization (FAO) [10].
II. MATERIALS AND METHODS

The fresh gastropods of *Cerithidea quadrata* and *Nerita lineate* (local nama ‘siput sedut’ and ‘siput gayung’) were bought from four main markets in Kota Kinabalu. The two species were selected as they are common and the most popular gastropods among community in Kota Kinabalu, Sabah.

The location of the gastropods where they were collected by the fisherman was also recorded. Hundred and fifty customers were interviewed briefly and fill in a questionnaire covers demographic information and data on nutritional habits. The interviews included on the preferable gastropods, amount, frequency of consumption, gastropods preparation methods and weeks of consumption.

The samples were secured in clean plastic bags, kept on ice while being transported back to the laboratory for analysis. The gastropod size was measured and the soft tissues were removed from its shells using a hammer. The soft tissues then dissected to two parts; edible (muscle and foot) and non edible (digestive caecum).

Wet digestion method has been carried out using nitric acid (Analar gred, BHD 69%) and detected with Inductively Couple Plasma-Optical Emission Spectrometry (ICP-OES). In order to avoid possible contamination, all glassware and equipment used were acid washed. The percentage of recoveries of the heavy metal analyses was acceptable at 85 – 110%.

III. RESULTS AND DISCUSSION

Various metals present in any aquatic environment either through natural geochemical processes or anthropogenic activities. These metals would be uptake by aquatic organism and accumulate in their tissues. Results in this present study for the concentrations of metals in the two species are shown in Table 1. The concentration of metals in both gastropods tissues has the following order Zn> Cu> Cd>Pb.

Generally, Cd, Cu and Zn concentration can be traced in both species with the highest concentration were found in the digestive caecum (DI) of *C. quadrata* from Tanjung Dumpil. Metal concentration in the soft tissues showed considerable ranges values for individual species even between different species from the same habitat. There are significant higher Cd, Pb, Cu and Zn concentration in *C. quadrata* as compared to *N. lineate* even from the same area in Kota Marudu (Kruskal-Wallis, p<0.05).

However, differences in metal concentrations in the soft tissues between *C. quadrata* from Tanjung Dumpil and Kota Marudu were not statistically significant. This suggested that same species have a same mode of life and feeding and same uptake rate of metal concentration even from different area [11], [12]. Still the metal concentration in the gastropods habitat should not be excluded entirely as it also depends on geographical factors, contamination source, anthropogenic activities and weather in that area [6], [8], [13]. A. H. Bu-Olayan and B. V. Thomas, 2001[12] shows that *C. scabridum* accumulate more heavy metal during summer compare to winter season in Kuwait.

The Spearman-rho correlation (r=0.9223; p<0.05) analysis shows that Cu and Zn concentration are increased with the size of the gastropods. This depends on the accumulation strategy adopted by each species for each metal. Based on the study by Rainbow, 1995 [13] rates of uptake and excretion of metals are affected by features of the biology of the organism, including the permeability of the external surface, the nature of the food, and the efficiency of the osmoregulatory system present.

There are significant differences between metal concentration in non-edible and edible part of the gastropod (Kruskal-Wallis, p<0.05). This is because different parts have different functions in metabolism and physiology. The digestive tract and intestines were found to have better ability as metals are easily binds with metallothionien in DC than in other part of the soft tissues [8]. Moreover, the digestive tract is the central metabolism and detoxification of heavy metals [15].

Figure 1 shows the comparison of metal concentration in muscle (M) and digestive caecum (DC) of gastropods with the standard permissible level by Malaysia Food Regulation (MFR), 1985 [9] and recommended by Food Agriculture Organization [10]. The concentrations of Cd, Pb and Cu in the muscle are lower than the standard. Metal concentration in the DC shows a different trend. Most of Cd, Pb, Cu and Zn concentrations are extremely higher in the DC compared to the muscle and exceed the permissible level by both standards. Zn concentrations are found extremely high in both parts of the gastropods based on FAO [10].

These concentration suggested that both gastropods species from Tanjung Dumpil and Kota Marudu may impose health hazards. Still, these metals are concentrated mostly in the DC which consider as non edible part and will be removed. The legislative limits for Cu and Zn in shellfish are 70.0µg/ g and 1000µg/ g wet weight in Australia [16] are much higher compared to MFR, 1985 [9] which is 30mg/kg and 100 mg/kg respectively.

<table>
<thead>
<tr>
<th>Species</th>
<th>Parts</th>
<th>Mean metal concentration (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>C. quadrata</em> (L1)</td>
<td>M</td>
<td>Cd</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.12±0.08</td>
</tr>
<tr>
<td></td>
<td>GI</td>
<td>1.27±0.65</td>
</tr>
<tr>
<td><em>C. quadrata</em> (L2)</td>
<td>M</td>
<td>0.18±0.01</td>
</tr>
<tr>
<td></td>
<td>GI</td>
<td>0.21±0.08</td>
</tr>
<tr>
<td><em>N. lineate</em> (L2)</td>
<td>M</td>
<td>0.14±0.02</td>
</tr>
<tr>
<td></td>
<td>GI</td>
<td>0.32±0.04</td>
</tr>
</tbody>
</table>

* bdl – below detection limit
* L1 – Tanjung Dumpil
* L2 – Kota Marudu

TABLE I
MEAN CONCENTRATIONS (MG/KG W.W.) AND STANDARD DEVIATIONS OF ANALYZED METALS (N= 30).

ANALYZED METALS (N=30).
Copper and Zn are essential elements and are not considered to be significant threats to human health [16]. They also have low mammalian toxicity and can be regulated by man [14], [15], [16]. Then again, all metal concentrations in edible parts (muscle) are lower than the permissible level by MFR, 1985. Meaning, the metal concentration in both gastropods are safe to be consumed. Simply by removing the DC from the gastropods before cooking and eating can minimize the health hazard from consuming the gastropods.

V. CONCLUSION

Even though the metal concentrations were above the permissible level set by Malaysia Food Regulation, 1985 and Food & Agriculture Organization, the potential health hazard of the gastropods still can be considered low. The high concentrations are mostly in the digestive caecum which is non-edible and can easily discard. Moreover, Cu and Zn are essential elements with low toxicity to humans. Still, further study is needed to investigate the concentration and sources of metals in the gastropods’ habitats. The simple survey analysis shows that some ethnicity in Kota Kinabalu may be at risk of exposure to high metal concentration in the gastropods as the gastropods were their main source of protein every day.

REFERENCES