Assessing copper bioaccumulation in edible bivalves sold in Lucena market, Quezon province, Philippines

Glenn L. Sia Su a *, Jan Erika S. Basilio a , Elaine Loreen C. Villanueva a , Maria Lilith L. Sia Su b , Elena M. Ragragio a , Gliceria Ramos c and Michael Ajero d

a Biology Department, University of the Philippines-Manila, Philippines
b College of Medicine, University of the Philippines-Manila, Philippines
c Biology Department, De La Salle University-Manila, Philippines
d Chemistry Department, De La Salle University-Manila, Philippines

*Corresponding author: siasug@gmail.com; Phone: +63-25265861

Abstract

This study assessed the copper bioaccumulation in shells and soft tissues of edible marine bivalves obtained from a public market in Quezon Province. The collection of the marine bivalves from the public market was carried out for three consecutive months from September to November 2012. Bivalves’ shells and soft tissues were acid-digested and examined for copper bioaccumulation. Results showed that copper concentrations were present in both soft tissues and shells of the bivalves. Significant differences in the copper concentrations among species, shells, and soft tissues and in the months of collection (p < 0.05) were evident. A direct relationship between the copper concentrations in the soft tissues and that of their shell exists (r² = 0.42; p < 0.05). All soft tissues of the edible bivalves examined were within the permissible limits, making the bivalves safe for consumption. Continuous monitoring on the heavy metal accumulation in foodstuff is necessary to safeguard the general populace’s health and well-being.

Keywords: shellfish, heavy metal, bioaccumulation, food

Received: 14th January 2015; Revised: 28th February; Accepted: 15th March; © IJCS New Liberty Group 2015

Introduction

Heavy metals remain to be one of the forefront issues hounding the general populace, especially that heavy metals continuously enter our environmental systems. Heavy metals released in the environment may be contributed by natural and anthropogenic processes. The concern heightens when these metals persist in our environment and end up in trophic relationships where they are being accumulated within the animal tissues. These heavy metals are known to be nonbiodegradable (Katsiki and Florou, 2006) and, when taken up by organisms through bioaccumulation, are known to be nonreversible (Einollahi Peer et al., 2010). Copper is a trace metal that is essential to life (Lauenstein et al., 2002), but the consumption of copper in high concentrations can bring about detrimental effects to the organism (Naigaga and Kaiser, 2006) and to those who consume such foodstuff. Copper, being an important trace mineral, is likewise known to persist in the environment, transfer across the trophic relationships, and end up bioaccumulating in animal tissues. Aquatic organisms, particularly shellfish, are those organisms commonly affected, especially when these heavy metals enter marine ecosystems through natural and
anthropogenic means. Shellfish, being a common foodstuff sold in markets, are a widely consumed commodity by Filipinos. Filipinos are fond of eating shellfish, because it is recognized to be a good source of meat, macronutrients, and micronutrients. However, shellfish are not just known as an important source of nourishment but are likewise recognized as a good biomonitor of our environment (Maanan, 2008).

The current concern nowadays lies on assessing the potential risks that these metals may have to human health. It is always important to determine the bioaccumulation capacity and monitor the metals in the animal’s tissue, especially in the edible ones sold in market systems. This study does not aim to determine the areas of contamination where these edible shellfish were obtained, but this study aims to conduct a comprehensive survey of the edible shellfish being sold in the market systems and subsequently monitor the heavy metal content of the shellfish species sold in markets. Results of this study are vital, as they provide valuable information on the safety of foodstuff available in the market systems and provide means of raising people’s awareness gearing toward safeguarding public health’s from the possible effects of contaminants like heavy metal exposures.

Materials and Methods

All the edible shellfish obtained for three consecutive months from September to November 2012 were obtained from a selected market located at the Southern Luzon, Philippines. This market is situated on the north and northeast by the Municipality of Pagbilao, on the south and southeast by the Tayabas Bay, on the southwest by the Municipality of Sariaya, and on the northwest by the Municipality of Tayabas. Lucena City is at the southeastern part of Quezon Province and is approximately 137 km southeast of Metro Manila. Edible bivalves of about 0.5-1 kg are being sold in the market. All the available shellfish sold in the market at the time of collection were obtained and were stored under 4°C and immediately brought in the laboratory. In the laboratory, the samples were washed, measured for their shell length (mm) and shell width (mm) using a Vernier caliper and weighed (g) using a top loading balance. The shellfish’s soft tissues were separated from their shells following the methods of Fang et al. (2001). Both shell and soft edible tissues were processed for metal analysis. All shell and soft tissues were ash, and the wet digestion method was used in the analysis for total copper concentrations following the standard procedures of FAO (1976) prior to using the Shimadzu AA-6300 atomic absorption spectrophotometer (Shimadzu Scientific Instruments, Inc., Kyoto, Japan). Appropriate controls and standards and calibration curves were prepared for the total copper variable tested in the shellfish examined.

Results of the shellfish examined for total copper were analyzed for significant differences on the copper concentrations of the shellfish sold in the market among the species examined and among the months of collection using the analysis of variance. The test indicating $p < 0.05$ could be a reason to indicate that the difference between the species and the months of collection was significant. A post hoc test using the Tukey’s test was performed to compare whether significant differences were observed. The shell’s copper concentrations and the soft edible tissues copper concentrations were assessed for skewness and kurtosis tests to determine whether the distribution of the data deviated from the distribution of the normal curve prior to performing the correlation test.
using the Pearson’s correlation. All the statistical analyses in this study were performed using the IBM SPSS software, subsequently their results were presented here.

Table 1. Shellfish species obtained from a market over the duration of the study

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
<th>Local name</th>
<th>Location obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Perna viridis</em></td>
<td>Asian green mussel</td>
<td>Tahong</td>
<td>Cavite</td>
</tr>
<tr>
<td><em>Katelysia hiantina</em></td>
<td>Hiant venus</td>
<td>Halaan</td>
<td>Quezon Province</td>
</tr>
<tr>
<td><em>Anadara cornea</em></td>
<td>Corneous ark</td>
<td>Sishi</td>
<td>Quezon Province</td>
</tr>
<tr>
<td><em>Polymesoda erosa</em></td>
<td>Mangrove clam</td>
<td>Gapalan</td>
<td>Quezon Province</td>
</tr>
<tr>
<td><em>Pharella sp.</em></td>
<td>Bamboo shell</td>
<td>Bamboo shell</td>
<td>Quezon Province</td>
</tr>
<tr>
<td><em>Crassostrea iredalei</em></td>
<td>Slipper cupped oyster</td>
<td>Talaba</td>
<td>Quezon Province</td>
</tr>
</tbody>
</table>

Table 2. Mean ± SD total copper concentrations of the shellfish species soft tissues and shell

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Mean ± SD Total Copper Concentrations (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shell</td>
</tr>
<tr>
<td><em>Perna viridis</em></td>
<td>0.0337 ± 0.0142</td>
</tr>
<tr>
<td><em>Katelysia hiantina</em></td>
<td>0.0271 ± 0.0225</td>
</tr>
<tr>
<td><em>Anadara cornea</em></td>
<td>0.0319 ± 0.0260</td>
</tr>
<tr>
<td><em>Polymesoda erosa</em></td>
<td>0.0499 ± 0.0289</td>
</tr>
<tr>
<td><em>Pharella sp.</em></td>
<td>0.0867 ± 0.0371</td>
</tr>
<tr>
<td><em>Crassostrea iredalei</em></td>
<td>0.0352 ± 0.0047</td>
</tr>
</tbody>
</table>

Fig. 1. Comparative assessment of the total copper concentrations of the shellfish species examined

Fig. 2. Relationship of the total copper concentrations of the shellfish species shell and soft tissues

www.currentsciencejournal.info
Results and Discussion

A total of six edible shellfish species were obtained from the market over the duration of the study. As the shellfish were purchased, vendors were interviewed to determine the local names and the location where the shellfish were collected. Table 1 shows the listing of the shellfish species, their local names, and the location where they were collected. Not all shellfish species were represented in the months of collection. The common shellfish species available all throughout the collection were *Perna viridis*, *Katelysia hiantina* and *Anadara cornea*. The total copper concentrations of the shellfish species edible soft tissues and shells are shown in Table 2. Figure 1 shows the comparison of the total copper concentrations in the shell and soft tissues assessed on the shellfish species examined per month of collection. High total copper concentrations were evident in both the shell and soft tissues of the *Pharella* sp. in the month of September. *Crassostrea iredalei* showed higher total copper concentrations in the soft tissues, but the *Pharella* sp. had a higher total copper concentration in the shell for the month of November. Significant differences in the total copper concentrations were evident in the shell and soft tissues of the shellfish species examined over the course of the study \( P < 0.05 \). Despite the differences in the total copper concentrations evident in the soft tissues of the shellfish species examined, the soft tissues of the shellfish were way below the maximum acceptable load of 0.5 mg copper/kg body weight/day (World Health Organization, 1967). Our result has shown that the total copper concentration in the shell is significantly correlated with the total copper concentration in the soft tissues of the shellfish species examined as shown (Fig. 2). The direct relationship between the shell and the soft tissues of the shellfish species examined indicates that as the total copper concentration in the shell increases, the total copper concentration in the soft tissues likewise increases.

This was a cross-sectional study, and its scope is limited in assessing the total copper concentrations in the shells and soft tissues of shellfish species obtained from the markets during the periods of investigation. The most important result in this study is the baseline documentation of the total copper concentrations in the shellfish species and on the assessment of whether these shellfish are considered safe for food consumption. All the shellfish species examined during the periods of investigation showed copper concentrations that were below the maximum acceptable load of copper in shellfish per day. Higher copper concentrations were evident in the soft tissues as compared to the shells of the shellfish species examined. Other studies (Perez-Lopez et al., 2003; Einollahi Peer et al., 2010) corroborated with our result, presenting that higher copper concentrations were evident in the soft tissues of the shellfish as compared to those of its shells. This result may be likely because copper is an essential metal utilized to make hemocyanin, serving as a respiratory pigment for these organisms (Caussy et al., 2003). The utilization of this metal may suggest that the metal is conserved within the soft tissues of the organism. Likewise, total copper has concentrated in the shell of the shellfish species examined.

A study (Cravo et al., 2004) has indicated that the copper may be sequestered in the shell as a part of the organism’s uptake of the metal. Higher copper concentrations evident in the soft tissue than in the shell are supported by a study of Yap et al. (2003), where they
indicated that initially the metals are distributed in the soft tissues before they get sequestered into the shells of the organism. All of the shellfish species examined showed varied total copper concentrations in both their shells and soft tissues. The total copper concentrations in the shellfish species examined showed variations in the periods of investigation. The variation in the total copper concentrations in the shellfish species examined was also observed in the periods of investigation, as this may be influenced by the different biological activities of the organism (Perez-Lopez et al., 2003). Likewise, the variation in the total copper concentrations accumulated within the organism may also be indicated by the different capacities of the organism to accumulate the metal and the differences in the affinities of the metal to the binding sites of the metallothioneins in the soft tissues of the organisms, hence affecting the metal concentrations found in the shellfish species examined (Vierengo et al., 1985). A study (Perez-Lopez et al., 2003) has indicated that the variations in the metal concentrations of the shellfish species may also be influenced by the capability of the species to regulate the metals in their bodies.

**Conclusion**

This study assessed the total copper concentrations of the shellfish species obtained from a market for three consecutive months of collection. All the shellfish species showed varied total copper concentrations in their soft tissues and shell. The soft tissues had higher total copper concentrations compared to the shell of the shellfish species examined. A direct correlation exists between the metal accumulations of the organism’s shell to that of its soft tissues. All the total copper concentrations in the soft tissues of the shellfish species examined were way below the permissible limits, indicating that the shellfish are safe for food consumption. Continuous monitoring of the edible shellfish sold in markets should be conducted to continuously safeguard the general public’s health and well-being from the potential tragedies that heavy metals may pose.

**References**


