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Level of concentrations of mercury and cadmium in *Batissa violacea* (Lamarck, 1818) collected along Cagayan River

Lenimfa P. Molina[*1], **Eunice S. Daluddung**[2], **Jhunrey C. Ordioso**[3]

Cagayan State University, Aparri Campus, Maura, Aparri, Cagayan, Philippines

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Abstract

Cagayan River is the natural habitat of the endemic *B. violacea* (Clam) and this is also cultured in the pond at Cagayan State University-Aparri. Clams are among the healthiest seafood; thus, it is one of the target commodities for post-harvest technology since there are only a few processing techniques employed for this particular resource. However, it is important to know if this commodity is safe to utilize. Since clams are benthic filter feeders, they are meaningful indicators of the bioavailability of toxic contamination. This study attempted to determine the level of heavy metals, particularly Mercury and Cadmium in clams samples using a Cold Vapor Atomic Absorption Spectrophotometer and UV-VIS Spectrophotometer, respectively. Results of the study revealed that the concentrations of heavy metals such as mercury and cadmium in the tissue of *B. violacea* collected in the wild and the pond was within the allowable limit set by US EPA, WHO, and FDA. However, continuous consumption may lead to serious health problems for consumers. The researchers recommend to the local government unit of Lallo to utilize the results of this study as a basis to protect the public from the possible adverse effect of continuous consumption of the *B. violacea*. To enhance the quality of the river, strict implementation of solid waste management must be enforced especially in communities near the river.

***Corresponding Author:** Lenimfa P. Molina ✉ molinalenimfa.csu@gmail.com

Introduction

Batissa violacea is an edible freshwater clam locally known as "cabibi". It is an endemic species of bivalves in Northern Cagayan, particularly at the Cagayan River which is the longest river in the Philippines. It is harvested from the natural growing area throughout the year and is currently collected from the ten barangays of Lallo Cagayan namely; Magapit, Sta Maria, San Lorenzo, Catayuan, Tucalana, Bagumbayan, Lafu, Fabrika, San Jose, and Maxingal, and in Barangay Batalla of the municipality of Camalanuigan.

"Cabibi" is sold in the market in its fresh state. Price ranges from 140-150 pesos per kilo if the supply is abundant and 170 to 180 pesos per kilo during the lean months (Molina *et al.*, 2021). This species of clam is edible and is one of the target commodities for post-harvest technology since there are only a few processing techniques employed for this particular resource. The development of value-added products from clams is imperative to increase economic returns from clam production. However, it is important to know if this commodity is safe to utilize. Since clams are benthic filter feeders, they are meaningful indicators of the bioavailability of toxic contamination (Luoma *et al.,* 1983) as cited by Pehaim, 2004. Metals occur naturally in the environment but due to anthropogenic activities, the level of concentration of these pollutants has been increasing with time, and there is a great tendency that these pollutants could affect the organisms, especially the filter feeders. Heavy metals effluence has been a hot topic in environmental studies. The amount of heavy metal content in clams poses a high risk to human health due to the continuous consumption of contaminated bivalves.

B. violacea is popular and easy to culture. There is no published information yet on the level of heavy metal content in this particular clam species. It was reported however by Aquilena, M. *et al.* (2011), in their undergraduate thesis report that some traces of heavy metals, particularly mercury have been found in some samples of clams they used in their research. No succeeding research studies have been undertaken to verify this report. Cabibi is utilized as food by the people in Lallo and nearby municipalities. It is served as a soup in their meals. Other forms of its utilization are simply sautéed and fried clams served as viand during lunch or dinner. It also serves as a means of livelihood to fisher folks who gather and market this clam. This study was, therefore, designed to generate information on the extent of the level of heavy metal in *Batissa violacea* and in the place where this species thrives.

Materials and methodology

Study Area

The study was carried out at Lallo River and Cagayan State University-Aparri Pond where clams are organically cultured.

Study Species

The Clam, *Batissa violacea* (Lamarck, 1806) is an economically and commercially important bivalve species in Northern Cagayan utilized mainly for its flesh and consumed either boiled or fried. It is a filter-feeding organism that is endemic species in the Cagayan River. Clam fishing represents a viable source of income and livelihood for the local people of Lallo Cagayan. Furthermore, it constitutes an important and cheap source of protein for the community. There is limited information on the safety of this clam for human consumption.

Collection and Processing of Samples

Clam samples were obtained from the two sampling sites (wild & pond) every month from the commissioned fishermen's catch and samples from the fishpond were collected randomly by handpicking. In the laboratory, the clam samples were cleaned to remove any debris and then washed with distilled water. The total weight of each individual was measured to the nearest 0.1 g, and the shell length of each clam was determined to the nearest 0.1 mm using a vernier caliper. The soft body parts of individuals were removed carefully dis-shelling the clams with a knife and then rinsed. All samples were put separately in preserving bottles with proper labeling and were used for analysis. The collected clam samples were brought to the laboratory for heavy metal analyses (Cadmium & Mercury).

Determination of Heavy Metal Content to Clam Samples Cadmium (Clam)

Digestion Process

Wet ashing method was performed to digest the clam samples. Before analysis, the clam samples were oven-dried at 100°C. About 0.5 g of the dried clam parts were placed in a 125ml Erlenmeyer flask and 25ml of distilled water. To this, 10ml of 1:2 mixtures of concentrated Nitric Acid (HNO_3) and Perchloric Acid ($HCLO_4$) were added. The sample was boiled using a magnetic stirrer until the solution was clear. The clear solution was transferred to a 50ml volumetric flask and the volume doubled with distilled water and mixed and then filtered using 12.5 mm Dia of filter paper. The concentration of Cadmium was determined using UV-VIS Spectrophotometer.

Test for Cadmium

Pipette 1.0ml of Reagent Cd-1 into a test tube. Add 10ml of the pretreated sample using a pipette and mix then add the reagent Cd-2 (0.20ml) and mix. One micro spoon of reagent Cd-3 was added and shaken vigorously until the reagent is completely dissolved. Leave to stand for 2 min (reaction time), then fill the sample into the cell and heavy metals were determined in the water samples using UV-VIS Spectrophotometer.

B. Mercury (Hg)

Clam samples were brought to the laboratory of the First Analytical Services and Technical Cooperative (F.A.S.T) at Makiling, Calamba, Laguna to check for the presence of mercury.

Results and discussion

Heavy Metals Concentration

Heavy metal is a collective term for metals of high atomic mass, particularly those transition metals such as lead, cadmium, and mercury that are toxic and cannot be processed by living organisms. The result of the level of concentration of heavy metals more particularly in mercury and cadmium in the tissues of clam and water samples where *B. violacea* was gathered is presented in Table 1.

Table 1. Test on Heavy Metal on Clam and Water Samples.

Parameter	Unit	Wild	Pond
Mercury	µg/g	<0.05**	<0.05**
Cadmium	mg/L	<0.05**	<0.05**

*Note: ** Reporting Limit*

The concentrations of mercury in the tissue of the *B. violacea* collected from their natural habitat and in Pond were below the International Human Consumption Advisory Limit of Total Mercury (THg) (0.5µg/g wet weight) set by WHO (2000). The recorded concentration in the tissues of the different clam sizes was 0.05µg/g for both *B. violacea* collected in the wild and in Pond. Thus, the analysis of mercury risk levels associated with the consumption of *B. violacea* by humans revealed that this species of Clam collected in the Cagayan River and cultured in Pond at Cagayan State University-Aparri campus were safe to eat as far as the THg is within the standard limit set by WHO (2000) is concerned. Likewise, the United States Environmental Protection Agency (US EPA, 1996) released a reference dose or guidelines for mercury in the diet: 0.1µg/kg/day which is lower than the standard set by WHO which is 0.47 µg/kg/day. However, WHO (2017) revealed that mercury exposure even in a small amount may cause serious health problems in the nervous, digestive, immune systems, lungs, kidneys, skin, and eyes. Furthermore, Obirikorang, *et al.* (2010) also suggested that even the low mercury concentrations in the tissues of the Clams can be lethal to heavy clam consumers. Montague (1998) also doubts the reference dose set by EPA, in which he concluded that making the mercury health standard more permissive is a dubious public health proposition. Furthermore, he also stated that the reference dose was just developed based on certain but questionable assumptions and this declaration of EPA on the safe and unsafe dosage of mercury to the human body is not advisable as a basis on the permissive level. During the year 1956 to 1974, mercury poisoning 10,000 people lived at Minamata Bay. Montague (1998), revealed that children can be poisoned by daily ingestion of fish polluted at only 0.11. Despite these complex issues, what is clear is that mercury is a highly toxic substance (Martinez-Finley & Aschner, 2014) that is not easily degraded by the human body thus continuous consumption of the contaminated clam may lead to more adverse effects on human health. Because of this much information that supports the effect of mercury even at a low level, this study suggests avoiding the consumption of these toxic clams collected in the area. It is therefore important to continuously monitor the mercury levels of *B. violacea* and a wider scale of mercury studies on the Cagayan River to further investigate the source of this mercury concentration detected in the Clam samples. Since this study did not observe any known point source of the Mercury in the two municipalities where *B. violacea* samples were collected. The result of this study is similar to the results of Otchere (2003) in his study on heavy metal concentrations in the tissues of bivalves from the three Lagoons in Ghana wherein no detection of a point source of the pollutants. Results of the study of Amisah *et al.* (2009) revealed that the variation of heavy metal accumulation in the whole tissues of the clams appears to be influenced largely by the reproductive stage of the organism. Furthermore, their study showed that during the spawning period the proteins and carbohydrates have high coherence for heavy metals. Thus, this study suggests conducting a study on the relationship of the spawning period to the level of accumulated heavy metals.

On the other hand, Cadmium is one of the most toxic elements which is a by-product of zinc production (Bernard, 2008). It was observed that there is no variation in the level of concentration of Cadmium (Cd) for both water and clam (at different sizes) samples collected in the wild and Pond of CSU-Aparri. The recorded concentrations of Cadmium for water and clam samples were 0.05mg/L and 0.05mg/g, respectively. This value of Cd is within the allowable standard limit set by the United States Environment Protection Agency (US-EPA) of Cd for foods which is 0.05ppm. The concentration of Cd in the water samples collected in the five stations in the wild falls under the Class D (DENR-EMB limit: 0.05) criterion of the water quality for toxic and other deleterious substances in freshwater. Thus, the water in the sampling stations is suitable for agriculture, irrigation, livestock watering, and industrial water supply (e.g., cooling). Despite the low level of Cadmium in the tissues of collected *B. violacea* in the wild and pond, it is still quite alarming since cadmium is non-essential and toxic to the human body. WHO (2017) also revealed that cadmium has a toxic effect on kidney, skeletal, and respiratory systems and is classified as a human carcinogen. Bernard (2008), also believed that cadmium is efficiently retained in the human body, which it accumulates throughout life which is also the same as mercury. Hence, this study strongly suggests that the continuous consumption of the Clam, *B. violacea* from these locations may cause serious health problems to the local consumers.

Conclusions

After conducting the study, the following conclusions were drawn:

1. The study revealed that the concentrations of heavy metals such as mercury and cadmium in the tissue of *B. violacea* collected in the wild and the pond was within the allowable limit set by US EPA, WHO, and FDA.

Recommendations

Considering the above findings, the following recommendations are made to help policymakers and other concerned agencies in decision-making as well as in crafting policies and mitigating measures.

1. The researchers recommend to the local government unit of Lallo, Cagayan to utilize the results of this study as a basis to protect the public from the possible adverse effect of continuous consumption of *B. violacea*.
2. Strict implementation of solid waste management must be enforced especially in communities near the river.
3. Urgent actions should be done by the concerned agencies to protect the health of the communities consuming this clam, especially pregnant women.
4. Regular monitoring of heavy metals in major rivers and tributaries draining into the river
5. Inventory and assessment of the potential source of the heavy metals in the Cagayan River particularly mercury and cadmium.

6. Regular monitoring of heavy metals in a clam and water samples at least twice a year (dry and wet seasons).

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