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Assessment of health risk on metal accumulation from consumption of *Corbicula fluminea*

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Abstract. Indicators of environmental quality encompass a number of environmental aspects such as water, soil and biotic life. As an example, the fundamental human needs is access to clean food sources. Nowadays, metals pollution has become a great concern as it could lead to a bad effect on a human's health. In this study, heavy metals concentration in *Corbicula fluminea* is a clam that is frequently consumed by the local people in the state of Kelantan. In this study, metal concentration in *Corbicula fluminea* were determined and the possible human health effects were evaluated by using the Target Hazard Quotients (THQ. Five heavy metals were determined which are cadmium, arsenic, lead, copper, and zinc. The samples were collected from Tumpat, Kelantan whereby the study area was surrounded by agricultural activities and housing settlement. The sample went through a wet digestion process before being analysed by the Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). The limit of heavy metals concentrations in aquatic species for consumption has been set for human health by Food and Agriculture Organization (FAO). Accumulation of heavy metals in the species were found to be high for cadmium. Furthermore, in risk and safety assessment, both arsenic and lead had very low level of metal concentration in the species. Based on the result obtained, cadmium exceeded the permissible limit set by the FAO, whereas, the calculated THQ was below one, which indicated means there was a least chance of carcinogenic effects to human's health.

1. Introduction

Trace of heavy metals in aquatic ecosystem is causing a serious environmental concern because of their toxicity and deleterious effects to aquatic organism. Heavy metals are non-biodegradable and thus they are persistent in the water and create complex environmental problem involving ecotoxicology, hydrogeochemistry, biology and ecology. They can easily enter the aquatic ecosystem through small drainage channels, river inputs and atmospheric depositions [1, 2]. These metals can enter the aquatic life through respiration process and diet, which incorporate the uptake of metal within their tissues. Although, organisms require some trace elements for their metabolism but excessive number of metals can give adverse effects at toxic concentrations [3].

Bivalves are good biomonitors of metal pollution in aquatic environments because they are in contact with the water column and sediment, which are known to accumulate contaminants, sentinel species, easy to handle, low-cost strategy and tolerant to water pollution [3]. Among the bioindicator sentinel species, which are exposed in cages (in-situ), filter-feeding bivalves, and in particular the Asian clam *Corbicula fluminea (C. fluminea)*, are regularly used [4]. Because of the rapid responses to environmental changes, *C. fluminea* had been proposed as an excellent bioindicator for environmental assessment [5, 6]. *C. fluminea* is a bivalve mollusks and is a sedimentary filter feeder characterized by very high capability to bioaccumulate chemical substances dissolved in the water [7], or bound to suspended particles [6]. For over three decades, research on *C. fluminea* has been expanding and developed as a water pollution biomonitoring. Morphological observations and changes in biochemical indexes of *C. fluminea* are being rapidly updated with the development of histological analyses and molecular biology in recent years [6]. Therefore, this study aims to demonstrate the capability of *C. fluminea* in providing information about the degree of metal pollution in the aquatic system and to evaluate the possible human health issues by using the target hazard quotient (THQ).

2. Materials and Methods

2.1. Study area

The research site was located at Kampung Jal Besar, Tumpat, Kelantan, in the north-eastern part of Peninsular Malaysia with the coordinate 6°07'59.5"N 102°09'07.9"E. The sampling area was located near the paddy fields, which was surrounded by housing settlements and a few small restaurants owned by the local people. Due to the location of the sampling sites, which is near to the paddy fields, it is believed that the metal pollution in the river is introduced due to run-off of fertilizers, pesticides and chemical substances used in the agriculture activity.

2.2. Sample collection and preprocessing

The *C. fluminea* were donated by the local people of Kampung Laut, Tumpat, Kelantan. The samples were taken four times in two months. After separating the species and sand, the specimens (10 samples) were kept in the sampling polyethylene bag in the icebox and brought to the lab in a day to sustain their freshness before ongoing the digestion and analysis processes. At the lab, the total length and weight were recorded before the dissection process. Then, the soft tissues of the samples were taken out and washed with deionized water before dried in the oven at 110 ºC for overnight to obtain a constant weight. Finally, the dried samples were grounded to improve homogeneity and was kept in a desiccator for further use.

2.3. Analysis procedure

Nitric acid, sulphuric acid and hydrogen peroxide solutions were purchased from Merck and were of analytical grade. The wet digestion method was performed according to analytical methods for Inductively Coupled Pasma-Mass Sectrometry (ICP-MS). Approximately 5.0 g of dry weight samples were placed in a 50 ml beaker containing HNO_3 H_2SO_4 with a volume of 5 ml each. Then, the beaker was heated at 60 ºC for 30 mins. The beaker was first cooled down before adding 10 ml of HNO_3 and heated again slowly until reaching 120 °C. After 30 mins, temperature was increased to 150 °C for another half an hour. The beaker was removed when the samples turned black. The samples were then allowed to cool before adding H_2O_2 until the sample colour is clear. Finally, the content of the beaker was diluted to the mark of a 50 ml volumetric flask before transferred into centrifugal tubes for ICP-MS analysis.

2.4. Statistical analyses

The significant differences between the studied elements were analysed using statistical analysis made by SAS®JMP® version 9 software package and Microsoft Excel 2010. Then, the target hazard (THQ) was calculated using Equation 1 as described by [8]. This estimation provides an indication of human health risk due to contaminant exposure [9].

$$\text{THQ} : EDI/RfD \qquad (1)$$

3. Results and Discussion

The potential of metal variability with size variation in *C. fluminea* was analysed. The morphometric data of *C. fluminea* and the mean concentrations of metals obtained in their soft tissue are shown in Table 1. Although the samples were different in sizes, no significant differences were noted in the metal concentration effect in the samples [10, 11].

Based on the findings, *C. fluminea* contained higher concentrations of cadmium (Cd). This concentration has exceeded the maximum permissible level for Cd (>0.05 mg/kg) as stated in the guideline of Food and Agriculture Organization (FAO) 1983. The high concentration of Cd could be due to the fertilizer, pesticides or herbicides applied to the paddy fields surrounding the study area, whereby agriculture is one of the main activities [12]. A previous study also showed that *C. fluminea* had a high bioaccumulation capacity to Cd. This finding indicated that Cd can be the best and valuable biological indicator [6] for *C. fluminea*. Moreover, Cd is persistent and poisonous to humans [13]. Thus, its accumulation in *C. fluminea* can threaten the nearby sampling sites community.

Table 1. Biometric parameters and metal concentration in *C. fluminea.*

Biometric parameter	
Length (cm)	2.23 ± 0.3
Weight (g)	2.50 ± 0.8
Metal concentration (mg/kg)	
Cd	0.08 ± 0.01
As	0.05 ± 0.01
Pb	0.02 ± 0.00
Cu	-
Zn	-

- not detected

C. fluminea showed significant differences ($p < 0.005$) in metal accumulation rates due to excretion, regulation and storage mechanisms [17]. The concentration of arsenic (As) and lead (Pb) in this study were reported to be below the permissible level according to the FAO 1983 with both values less than 1.0 mg/kg. Meanwhile, copper (Cu) and zinc (Zn) were not detected in the samples as these are essential elements that are needed in aquatic life metabolism. As for Pb, Cd and As, they are not needed in the biological systems [10] and the accumulation of these metals can be harmful to people if their level exceeded the guideline from FAO. Based on Table 1, the distribution of metal concentration in *C. fluminea* followed the order of: Cd > As > Pb > Cu, Zn.

By calculating THQ, the risk of non-carcinogenic health risks related to *C. fluminea* consumption were determined (Table 2). If the level of THQ is below 1, there will be no apparent risk. But, if the THQ >1, it is likely to cause adverse health effect [15].

Table 2. Target Hazard Quotient of metal ingestion *C. fluminea.*

	THQ
Cd	0.15
As	0.36
Pb	0.01
Cu	-
Zn	-

- not indicated

From the observation, all the THQ values calculated were lower than 1 which mean that the metal evaluated in the soft tissue of *C. fluminea* from the studied sites did not harm the consumers. Moreover, the exposure to these metals were considered not significant due to THQ value below than 1. It is noteworthy that the Cd concentration in this study exceeded the maximum permissible level. Thus, it is recommended to control the intake of *C. fluminea* in order to lessen any harmful health effects.

4. Conclusions

This study showed that the risk of consumption corresponding to their exposure might be related to their high tolerability. The findings from this study revealed the variation of metal accumulation in *C. fluminea* following the order of: Cd > As > Pb > Cu, Zn. The preliminary risk assessment study, suggested that risks posed by the metal via consumption of *C. fluminea* were within the tolerable regions. The concentration of Cd was found higher than other metals which suggested that Cd was more highly absorbed for biological function. Even though the THQ level in this study is very low, but consumers should take extra precaution in controlling the amount of *C. fluminea* in their dietary to avoid any unwanted health effects.

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References

[1] Anandkumar A, Nagarajan R, Prabakaran K, Bing C H, Rajaram R, Li J and Du Daolin 2019 Bioaccumulation of trace metals in the Coastal Borneo (Malaysia) and health risk assessment *Marine Pollution Bulletin* **145** 56-66.

[2] Vu C T, Lin C, Shern C C, Yeh G and Tran H T 2017 Contamination, ecological risk and source apportionment of heavy metals in sediments and water of a contaminated river in Taiwan *Ecol. Indc.* **82** 32-42.

[3] Bonnail E, Sarmiento A M, DelValls T A, Nieto J M and Riba I 2016 Assessment of metal contamination, bioavailability, toxicity and bioaccumulation in extreme metallic environment (Iberian Pyrite Belt) using *Corbicula fluminea Science of the Total Environment* **544** 1031-1044.

[4] Pereto C, Coynel A, Lerat_Hardy A, Gourves P Y, Schafer J and Baudrimont M 2020 *Corbicula fluminea* : A sentinel species for urban rare earth element origin *Science of the Total Environment* **732** 13852.

[5] Arini A, Daffe G, Gonzalez P, Feurtet-Mazel A and Baudrimont M 2014 What are the outcomes of an industrial remediation on a metal-impacted hydrosystem? A 2-year field biomonitoring of the filter-feeding bivalvle *Corbicula fluminea Chemosphere* **108** 214-224.

[6] Guo X and Feng C 2018 Biological toxicity response of asian clam (*Corbicula fluminea*) to pollutants in surface water and sediment *Science of the Total Environment* **631-632** 56-70.

[7] Dos Santos K C and Martinez C B R 2014 Genotoxic and biochemical effects of atrazine and roundup, alone and in combination, on the asian clam *Corbicula fluminea Ecotoxicol. Environ. Saf* **100** 7-14.

[8] Waheed S, Malik R N and Jahan S 2013 *Environ Toxicol. Pharmacol* **36** 579-87.

[9] Idris N S U, Rosman M A, Mohamed Ghani N, Jamain E R, Mukri I and Abdul Halim N S 2021 Levels of trace metals in edible fish species of Permanent Forest Reserve (PFR), Merapoh, Pahang: A threat to batek tribe *IOP Conf. Series: Earth and Environmental Science* **756**.

[10] Idris N S U, Md Zain S, Low K H, Kamaruddin A K and Md Salleh K 2016 Evaluation of heavy metal concentrations in wild and cultivated *Hemibagrus* sp. using principal component analysis *Malaysian Journal of Analytical Science* **20(3)** 517-524.

[11] Anno G H, Young R W, Bloom R M and Mercier J R 2003 Pose response relationship for acute ionizing radiation lethality *Health Physics* **84** 565-575.

[12] Wang Y, Qiu Q, Xin G, Yang Z, Zheng J, Ye Z and Li S 2013 Heavy Metal contamination in a

vulnerable mangrove swamp in South China *Environmental Monitoring and Assessment* **185(7)** 5775-5787.

[13] Idris N S U, Low K H, Koki I B, Kamaruddin A F, Salleh K M and Zain S M 2017 *Hemibagrus* sp. as a potential bioindicator of hazardous metal pollution in Selangor River *Environ. Monitoring Assess*. **189** 220.

[14] Adel M, Conti G O, Dadar M, Mahjoub M, Copat C and Ferrante M 2016 Heavy metal concentrations in edible muscle of whitecheek shark, *Carcharhinus dussumieri* from the Persian Gulf: A food safety issue *Food Chemical Toxicology* **97** 135-40.

[15] Wei Y, Zhang J, Zhang D, Tu T and Luo L 2014 Metal concentrations in various fish organs in different fish species from Poyang Lake, China *Ecotoxicology and Environmental Safety* **105** 182-188.