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Determination of Some Heavy Metal Concentrations in Razor Clam (*Solen brevis*) from Tanjung Lumpur Coastal Waters, Pahang, Malaysia

[1]B.Y. Kamaruzzaman, [1]M.S. Zahir, [1]B. Akbar John, [1]A. Siti Waznah,
[1]K.C.A. Jalal, [1]S. Shahbudin, [2]S.M. Al-Barwani and [2]J.S. Goddard
[1]Institute of Oceanography and Maritime Studies,
International Islamic University Malaysia, 25200 Kuantan, Pahang, Malaysia
[2]Department of Marine Science and Fisheries, Sultan Qaboos University,
P.O. Box 34, Al-Khod 123, Sultanate of Oman

Abstract: An effort to analyze selected heavy metal accumulation by the razor clam (*Solen brevis*) from Tanjung Lumpur was conducted on January to April 2010. A total of fifty individuals of Razor clam *Solen brevis* were sampled and metals such as Iron (Fe), Zinc (Zn), Copper (Cu), Manganase (Mn), Lead (Pb) and Cadmium (Cd) Concentrations were determined using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Among the metals Fe occurred in elevated concentration in the soft tissue of razor clam followed by Zn. Cd was found to be in least concentration in the sample. Mean concentration of Fe, Zn, Mn, Cu, Cd and Pb in the soft tissue were 415.2±56.52, 87.74±11.85, 18.71±2.10, 8.64±1.75, 0.67±0.29 and 1.61±0.45 $\mu g\ g^{-1}$ dw, respectively indicating that the bioaccumulation of essential metals in the soft tissue was greater than the non essential heavy metals. Metal accumulation in the soft tissue of razor clam followed Fe > Zn > Mn > Cu > Pb > Cd order in present study. The observed concentration of acute toxicity of metals in *Solen brevis* (Family: Solenidae) from Tanjung Lumpur Coastal waters was lower than the permissible limit recommended by National and international standards proved that this species could be utilized for human consumption.

Key words: Heavy metal, ICP-MS, tanjung lumpur, bioaccumulation, acute toxicity

INTRODUCTION

Heavy metals pollution has been a hot issue in environmental studies for many years. Even though, metals occur naturally in the environment but due to the anthropogenic inputs which originate from various human activities the concentrations have been rising. Heavy metals tend to accumulate in the food chain and eventually will be consumed by organisms (Connell *et al*., 1999; Franca *et al*., 2005). These impacts of anthropogenic activities on marine environments can be determined by measuring various chemical markers such as heavy metals in the water, biota and sediments (Audry *et al*., 2006; Tuncel *et al*., 2007). It was also observed that, among the pollutants found in coastal and estuarine sediment, heavy metals are the most persistent because they cannot be destroyed or broken down by natural or biological processes. Aquatic organisms living in polluted ecosystem often bioconcentrate these metals into their tissues, it has been argued widely that these organisms can be used as biomonitors indicating the bioavailability of contaminants and the degree of pollutant (Luten *et al*., 1986; Schuhmacher and Domingo, 1996).

Bivalve mollusks are well–known to accumulate heavy metals and have been widely used as bioindicator heavy metal pollution in an aquatic environment (Lau *et al*., 1998). Filter feeding bivalves are capable to accumulate heavy metals in their body parts from surrounding environment and numerous studies were attributed for this purpose. Many studies have shown that intertidal mollusks can be good biomonitoring organisms (Ismail, 2006). Their sessile natures, mode of feeding, ability to accumulate contaminants from the environment and availability for human consumption were reported as the criteria for bivalves to act as indicators (Phillips, 1976a, b). Among them Razor clams (*Solen* sp.) are soft bottom dwelling infaunal marine bivalves with more or less narrow and long shells, with gaps at both ends. There is very little documented information available about the metal contents in Razor clam (*Solen brevis*) which are locally known as ambal despite the popularity as a source of seafood item

Corresponding Author: B.Y. Kamaruzzaman, Institute of Oceanography and Maritime Studies,
International Islamic University Malaysia, 25200 Kuantan, Pahang, Malaysia

(Kanakaraju *et al*., 2008a). Thus, this study was undertaken to determine the amounts of selected heavy metals (Cd, Cu, Pb, Zn, Fe and Mn) in the soft tissues of razor clam at Tanjung Lumpur coastal area of Kuantan, Pahang.

MATERIALS AND METHODS

Sampling location: The study area is located at Kuantan estuary adjacent to Tanjung Lumpur mangrove area (Fig. 1). It is a traditional fishing village located along the mouth of the Kuantan estuary. This study area lies between longitude 103°19'13.09" E to 103°21'02.79" E and latitude 03°48'46.34" N to 03°47'34.82" N.

Sample collection and preparation: A total of 50 *Solen brevis* (Shell length 5-8 cm) were collected randomly by hand picking during lowest low tide time from January and April 2010 at sandy beaches of Tanjung Lumpur, Kuantan Pahang to examine essential and Non essential heavy metal accumulation in the soft tissue part. Collected mussels were placed in sterile plastic bags and iced prior to laboratory analysis. The samples were brought to the Institute of Oceanography and Maritime studies (INOCEM) lab and cleansed to remove the mud or any attached particles and then washed with double distilled water. Soft tissue (edible portion) from the shells were excised with a plastic knife and wrapped with aluminum foil and dried in oven at 65°C for 72 h.

Tissue digestion procedure: Acid digestion method was performed to digest the samples which involved heating of 0.5 g of dried tissues of razor clam in Teflon beaker with mixed concentrated acids (Hydrogen Peroxide (H_2O_2), Nitric acid (HNO_3), hydrochloric acid (HCl)) and sulphuric acid (H_2SO_4) in the ratio of 1:1 (Kamaruzzaman *et al*., 2007). After the digestion process hundred times dilution was performed using Mili-Q water then the samples were analyzed using Inductively Coupled Plasma Spectrophotometer (ICP-MS). The values of the heavy metal concentrations in the tissues were calculated based on dry weights as this discounts the variability due to inner parts differences in the moisture content of organisms. The precision assessed by replicate analyses was within ±3%. The analytical procedures for the razor clam were checked with the Standard Reference Material (SRM) for Oyster Tissue 1566b. The recoveries of all the metals were between 95-105% (Table 1). One-way Analysis of Variance (ANOVA) statistical test was performed to check the significance of p-value. The determined concentration of various heavy metals were compared with previous study on the heavy metal

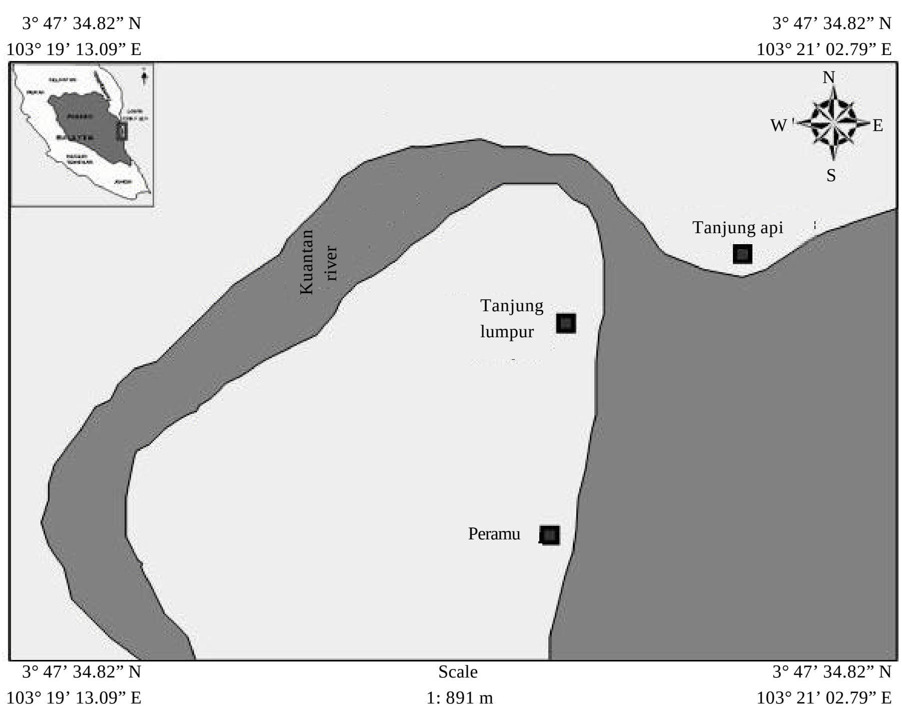

Fig. 1: Location of the study area showing sampling site at Tanjung Lumpur Coastal area, Pahang

Table 1: Percentage recovery test for Standard Reference Material (SRM) oyster tissue 1566b

Metals	Certified value	Analyzed value	Percentage of recovery (%)
Mn	18.500±0.2	17.89±0.36	96.70
Fe	205.800±6.8	207.60±0.13	100.87
Cu	71.600±1.6	69.50±0.59	97.07
Zn	1424.000±46	1392.00±6.36	97.75
Cd	2.480±0.08	2.610±0.11	105.24
Pb	0.308±0.009	0.318±0.18	103.25

Table 2: Comparison of analyzed heavy metal concentrations (μg g^{-1} dry weight) in the soft tissue of Razor clam (*Solen brevis*) in the present study with similar studies on *Solen regularis* and the permissible limits set by Food and Agriculture Organization/World Health Organization (FAO/WHO) and Malaysian Food Regulation (MFR, 1985)

		Kanakaraju *et al.* (2008a)			
Elements	Present study Tanjung Lumpur	Moyan	Serpan	FAO (WHO, 1982)	MFR (1985)
	(μg g^{-1})				
Fe	415.2±56.52	307.3±38.3	540.0±26.7	-	-
Zn	87.74±11.85	-	-	200-500	100
Mn	18.71±2.10	67.3±9.52	48.9±13.4	-	-
Cu	8.64±1.75	5.2±0.85	6.5±1.33	50-150	30
Pb	1.61±0.45	-	-	5-30	2
Cd	0.67±0.29	0.5±0.23	0.68±0.41	10	1

accumulation in the soft tissues of *Solen regularis* collected from Sabah, Malaysia (Kanakaraju *et al*., 2008b).

RESULTS

The concentration of analyzed metals (Fe, Zn, Mn, Cu, Pb and Cd) in the soft tissues of *Solen brevis* revealed that, Iron (Fe) concentration in the edible soft tissues of razor clam collected from study area (Tanjung Lumpur coastal area, Kuantan) was higher than the other metals with the mean concentration of 415.2±56.52 μg g^{-1} followed by Zinc (Zn) with mean concentration of 87.74±11.85 μg g^{-1}. Mean concentration of Manganese (Mn) and Copper (Cu) in the soft tissue was 18.71±2.10 and 8.64±1.75 μg g^{-1}, respectively. Lead (Pb) and Cadmium (Cd) were accumulated in lower concentration in the soft edible tissue of *Solen brevis* with the mean concentration range of 1.61±0.45 and 0.67±0.29 μg g^{-1}, respectively. Present observation also revealed that the bioaccumulation level of essential metals is greater than the non-essential metals in the soft tissue of the organism. The order of metal accumulation in the soft tissue of *S. brevis* collected from Tanjung Lumpur coastal area, Kuantan was Fe > Zn > Mn > Cu > Pb > Cd in this present study (Table 2).

It was also observed that Fe, Cd accumulation in the soft tissue of razor clam collected from Tanjung Lumpur coastal area was lower than the razor clam samples from Serpan, Sabah but higher than Moyan, Sabah samples. Mn concentration in the soft tissue of razor clam in the present study was lower than the concentration of Mn from the Sabah samples but Cu concentration was comparatively elevated in the razor clams in the present study when compared with both Moyan and Sepan samples.

DISCUSSION

The knowledge of heavy metal concentrations in native species is very important with respect to nature management, human consumption of these species and to determine the most useful biomonitor species and the most polluted area. So, the present study examined the concentrations of Fe, Zn, Mn, Cu, Pb and Cd in the soft tissue of razor clam collected from Tanjung Lumpur coastal area. It is also to be noted that there are various factors influencing the metals accumulation in bivalves. Among them metal bioavailability, season of sampling, size of the sample, hydrodynamics of the environment and reproductive cycle of selected organism are having direct influences on the metal accumulation in to the different body tissues (Otchere, 2003; Kamaruzzaman *et al*., 2008b). The elevated concentration of Fe in the soft tissue of razor clam compared to the other metals in the present study might be due to the major role played by this essential metal in maintaining the proper physiological functions of the organism. This observation was well corresponded with the previous study by Kanakaraju *et al*. (2008a) who postulated that Fe plays an important role as an essential element in all living systems from invertebrates to human, hence they tend to accumulate high concentration of Fe from the surrounding environment. The high concentration of Fe in the razor clam might also be due to the abundance of this element in substrate/ sediment. Furthermore, this occurrence also indices the natural capacity to regulate and accumulate elevated concentration of Fe in bivalves (Kanakaraju *et al*., 2008b).

Even though the Zn concentration was higher in the soft tissues of razor clam when compared with other metals (except Fe), their accumulation produces no risk to

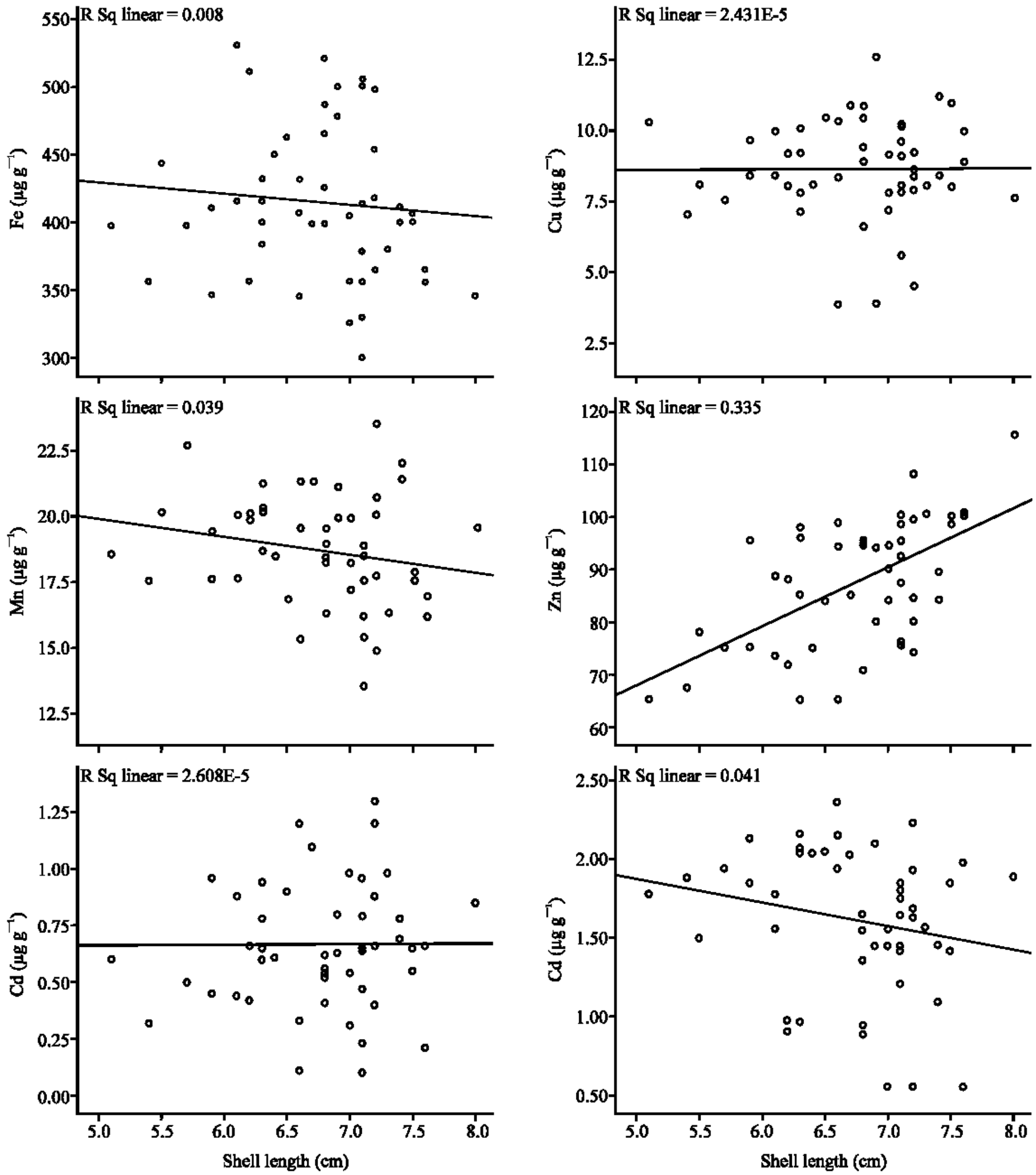

Fig. 2: Linear regression analysis shows relationship between shell length (cm) and the amount of accumulation in the soft tissue of razor clam (µg g^{-1} dw) collected from Tanjung Lumpur coastal waters

the aquatic organisms. Similar observation was reported by Kamaruzzaman *et al*. (2008a) in Asian green mussel *Perna viridis* indicating higher accumulation of Zn concentration in the soft tissue compared to other toxic metals studied. It was also observed that it plays a major role in the biosynthesis of nucleic acids, DNA and RNA polymerases production and thus involved in the healing processes of tissues in the body through various enzymatic reactions (Bodsworth, 1994).

The observed low concentration of Mn in the soft tissue of razor clam collected from Tanjung Lumpur coastal area compared with the earlier studies clearly showed that the sources of Mn in the study area was relatively limited. On the other hand, Cu accumulation in the samples from the present study was comparatively higher than the samples from other sampling locations indicating the source of Cu in Tanjung Lumpur coastal area was relatively higher than the other sampling sites.

This observation might also be due to the physiologic condition of the razor clams that is influenced by the existing environmental factors which in-turn accelerates the Cu accumulation in faster rate.

In contrast, Cd is not an essential element for plants, animals and human beings (Kamaruzzaman *et al.*, 2010; Merian, 1990). Generally, the occurrence of Cd in the marine environment is rare. Therefore, the impact of Cd on the environment is considerably small. As a result, this study shows Cd as the least abundant metal in razor clam. It was reported that normally bivalves do not regulate Cd, but they usually accumulate this element (Kamaruzzaman *et al.*, 2008a; Li *et al.*, 2006). Hence, razor clam might not be able to regulate Cd in their body. It was also observed that Pb accumulation in the soft tissue was also under permissible limit indicating the Tanjung Lumpur coastal area is not polluted by lethal heavy metals such as Cd and Pb. Linear regression analysis showed the shell length had no influence on the amount of heavy metal accumulation by the razor clam for all the selected metals (except for Zn) and it was also observed that razor clam with the shell length range between 6.5-7.5 cm accumulates more amount of heavy metals (Fig. 2).

Metals concentrations obtained in this study were compared with the international standards for metals in mollusks/shellfish compiled by Food and Agricultural Organization (FAO) of United Nation and Malaysian Food Regulation as shown in Table 2. The obtained results showed that, all metals were accumulated in lower concentration in the soft tissue than their respective Maximum Permissible Limits (MPL). In comparison with previous study done by Kanakaraju *et al.* (2008a), present study confirm relatively higher concentration of Cu and Zn, whereas, Mn, Fe, Cd and Pb occur in slightly lower concentrations in the soft tissue of *Solen brevis*.

CONCLUSION

Present study revealed that the concentration of heavy metals such as Fe, Zn and Mn in the soft tissue of razor clam collected from Tanjung Lumpur coastal waters found to be high in the samples from other sampling locations and the least abundant element was Cd (Kanakaraju *et al.*, 2008b). The detected concentration of all the studied metals in the soft tissue was fall within the regulatory limits set by FAO and Malaysian Government. Thus, it can be concluded that the razor clam collected from Tanjung Lumpur can be classified as safe for human consumption. In addition, by using *Solen brevis* as a biomonitoring agent, the contamination of Mn, Fe, Cu, Zn, Cd and Pb in this study area was found not be serious since *Solen* sp. accumulates heavy metals in the soft tissues and constitutes one of the important food-chains in the coastal environment, this information is therefore useful in predicting metal contaminations in the coastal areas.

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