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SELECTED HEAVY METALS CONCENTRATION IN EDIBLE TISSUE OF THE MUD CRAB, GENUS *Scylla* FROM SETIU WETLANDS, TERENGGANU

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Abstract: This study was carried out to determine the level of selected heavy metals (Cu, Zn, Pb and Cd) in edible tissue in mud crab, genus *Scylla* collected along Setiu Wetland, Terengganu. In this study, Inductively Coupled Plasma Mass Spectrometry (ICP-MS) was used to determine the concentration of heavy metals in mud crabs after digested in closed Teflon bomb with suprapur nitric acid. The average concentration for Cu, Zn, Pb and Cd were 89 µg/g, 137 µg/g, 0.22 µg/g and 0.25 µg/g dry weights respectively. Zinc, Pb and Cd were well correlated with the mud crab size where the metals concentration increasing with the size. This study also revealed that Cu and Zn concentration in the edible tissues most of the samples were also higher if directly compared to the maximum permitted level, 100 µg/g for Cu and 150 µg/g for Zn set by Malaysia Food Regulation. However, the edible tissues that people consumed do not exceed the Provisional Tolerable Weekly Intake (PTWI) value set by FAO/WHO. As a conclusion, the mud crabs from Setiu wetlands are still safe to be consumed and did not give any adverse health risk effect to local communities.

Keywords: Heavy metals, mud crab, edible tissue, Setiu wetlands, human safety.

Introduction

Mud crab, genus *Scylla* is a giant mud crabs that are mostly found in the Indo-Pacific region and around the Indian Ocean to East Africa. They commonly can be found in sheltered waters in estuaries and mangrove area where the mud flats present. Mud crab origin from the family Portunidae, order Decapoda and class Crustacea (Hassan *et al.,* 2011). Mud crab is one of the seafood product that high in protein and this organisms mainly collected traditionally form the natural ecosystem. Currently, the request of the mud crab is increasing nowadays due to the increases demand in human consumption. In Southeast Asian countries, mud crab is one of the most important fishery commodities (Kamaruzzaman *et al.,* 2012).

Mud crab is potentially to accumulate the heavy metal as they are well known as a deposit feeder in aquatic environment (Suprapti *et al.,* 2012). High levels of toxic heavy metal can accumulate in their whole body which is biomagnified through food chain compare to fish due to their feeding behaviour and long-term contact with the bottom sediments (Attar *et al.,* 1992). Since the mud crab can accumulate high contaminations form surrounding environment, these species are suitable to be used as an indicator for environmental pollution (Achudume *et al.,* 2010).

Heavy metals play a vital role in some biochemical mechanisms in living aquatic organisms and crucial element for live to have a proper growth, development and physiology (Shanker, 2008). Heavy metals are still increasing in our environment and their contribution through occupational or environmental exposure in the general population was largely ignored for long (Mudipalli, 2008). However, these heavy metals will turn toxic to the living organisms if the concentration are higher as needed by the organisms. High heavy metals concentration will degrade the biochemical processes and cause adverse health effects on living organisms include human beings (Mudgal *et al.,* 2010) and continuous exposure to these heavy metals will increase the morbidity and mortality in the human being (Adal, 2013).

Materials and Methods

A total of 100 mud crabs (Figure 1) consist of various sizes (weight from 50.6 to 530 g, length from 79.5 to 130 mm) were caught randomly by using crab traps set along the Setiu Wetlands (Figure 2). The samples were collected on the next day and were brought back to laboratory and preserved in freezer at -20 ^{o}C before further analysis.

Figure 1: Mud crab, genus *Scylla*

In the laboratory, weight and size measurement of all collected mud crabs were recorded. Before analysis, crab samples were washed with running distilled water to get rid off from the foreign particle like sand and mud. The crab samples were dissected in laminar flow bench by using a pair of seramic knifes and Teflon forceps. The dissected samples were replicated and transferred to petri dishes and were dried in an oven at 60 °C until they have a constant weight. After totally dried, mortar and pestle were used to homogenize dried samples.

A total of 0.05 g of dried samples was weighed and digested with Suprapur nitric acid (HNO3) in a closed Teflon bomb digester (Ong *et al.,* 2014; Ong *et al.,* 2015). The blank without sample and standard reference material, Dolt Fish liver SRM1946 were processed simultaneously with the samples. The teflon beaker was covered and placed in a stainless steel bomb, which was then sealed with a screw closure to avoid any acid leakage and placed in the oven for 6 hours at 150 ºC. After that, the samples were cooled into room temperature and transferred in a centrifuge tube and diluted with Mili Q water until 10 mL. The values of heavy metals in mud crab samples were measured by using Inductively Coupled Plasma Mass Spectrometry (ICPMS) (Kamaruzzaman *et al.,* 2008; Ong *et al.,* 2013).

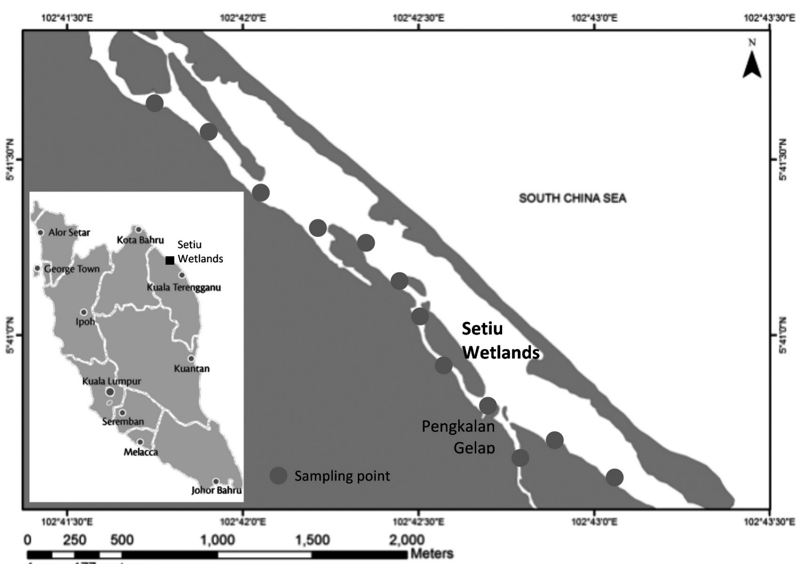

Figure 2: Sampling location at Setiu Wetlands, Terengganu

Results and Discussion

Recovery test have been conducted by analysing the SRM1946 Dolt Fish liver in order to measure the precision and accuracy of analytical method used in this study. The result obtained as shown in Table 1 with values ranged from 93-103%, which indicated a good and acceptable recovery analysis.

Generally, the concentration of Zn and Cu were higher in edible tissue parts of mud crab compared to Pb and Cd (Figure 3). This is because Cu and Zn are essential trace metals that needed in crabs metabolism activities (Kamaruzzaman *et al.,* 2012) and uptake through water and food surrounding them. High concentration of Zn in edible tissue compare to other heavy metals might due to the Zn acts as an important role as a precursor in most enzymatic activities. So, it is worth to state that the concentration of Zn have great tendency to accumulate in all crab's body including the edible tissue (Kamaruzzaman *et al.,* 2012). On the other hand, Zn is important for normal growth and the development in crustaceans and cause high concentration of Zn accumulated in crabs' hepatopancreas.

Figure 4 shows the correlation graphs between Cu, Zn, Pb and Cd and the size of mud crabs collected from Setiu Wetlands. From these graphs, Zn, Pb and Cd show a positive correlation while Cu shows negative correlation with the size. Positive value of correlation means that heavy metals are directly proportional to the length of mud crabs. Conversely, the negative value of correlation means that heavy metals are inversely proportional against the length of mud crabs. Based on the Pearson correlation indicator, Zn shows moderate correlation relationship while Pb and Cd show weakly related with the size of mud crabs.

Some researchers have investigated and documented the relationship between concentration of heavy metals in different tissues of crabs and the biological characteristics especially sex and body length (Pourang *et al.,* 2005). From their findings, besides the crab size, the level of heavy metals that accumulated

Table 1: Recovery of elemental concentration (µg/g) by SRM1946 Dolt Fish Liver chemical analysis

Heavy Metals	Certified Value (µg/g)	Measure Value (µg/g)	Recovery (%)
Cu	31.2±1.1	30.8±0.9	98.7
Zn	116±6.0	112±7.2	96.5
Pb	0.16±0.04	0.15±0.02	93.7
Cd	24.3±0.8	25.1±1.1	103

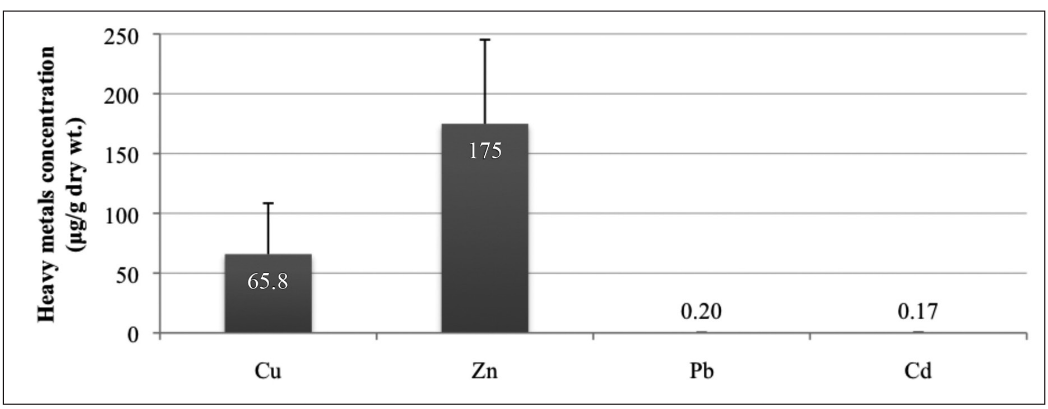

Figure 3: Average concentration of Cu, Zn, Pb and Cd in mud crabs collected

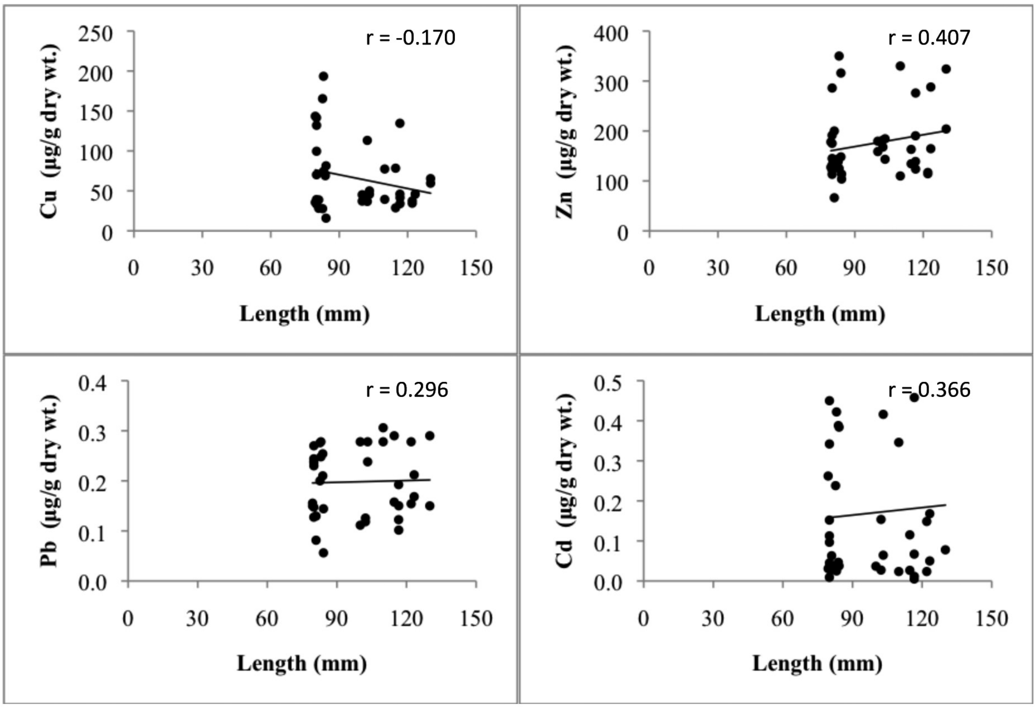

Figure 4: Correlation between heavy metals concentration and size of mud crabs

in their organs also depends on feeding habits (Romeo *et al.,* 1999), ecological needs metabalisms (Poovachiranon, 1991, Linde *et al.,* 1998) and their living habitats (Canli & Atli, 2003). Some studies also found that the metals accumulation in tissues are affected by other factors such season, physical and chemical status of water surrounding their habitat (Mitra *et al.,* 2012).

Crustaceans organism such as crab force to accumulate metals in initially available form to bind with metabolites in the receiving cell, and then transported elsewhere in the body through haemolymph where these metals play an important role in the metabolism of the crab (Marsden *et al.,* 2004). These crabs will detoxify or excrete the newly intake metals to prevent getting toxic from the metals. If the detoxification and excretion process are more effective than the rate of metals uptake, the crustaceans will survive and do not have toxic effects from metals that they obtained (Rainbow & Black, 2002).

The co-association between heavy metals studied were also calculated and shown in Table 2. From the table, the correlation value of Cu-Zn, Cu-Pb are >0.1, show a very negligible relationship between those heavy metals and indicate that the source of metals may come from different source. Meanwhile, moderate correlation was shown in Cu-Cd, Zn-Cd and Zn-Pb which is >0.4, indicate that probably due to

Table 2: Values of *r* for correlation between metals studied

Metals	Cu	Zn	Cd	Pb
Zn	0.154			
Cd	0.474	0.709		
Pb	0.299	0.578	0.724	

Table 3: The estimation Malaysian weekly dietary intake of metals from crab samples collected from Setiu Wetlands in one week

	Zn	Cu	Pb	Cd
Edible tissue (this study) mg/kg	66.4-350	15.9-193	0.06-0.31	0.005-0.408
PTWI ((mg/kg bw)/week)	7	3.5	0.025	0.007
PTWI (mg/week) for a 63 kg adult	441	220.5	1.575	0.441
Max consumption (kg/week)	1.26	1.14	5.15	1.08

the similarities of the source of metals into the mud crabs body (Nyangababo *et al.,* 2005).

Consumer such as human consume some heavy metals into their body accidently and these heavy metals will give adverse human health risk if the concentration exceed certain safety values (Ong *et al.,* 2014; Ong *et al.,* 2015). Therefore, Provisional Tolerable Weekly Intake (PTWI) was introduced by FAO/WHO to estimate the risk of toxicity may cause by heavy metals intake (Ngassapa *et al.,* 2010) toward human via consumption of the organism. Table 3 shows the estimated of Malaysian weekly dietary intake of metals by assumming eating 1 kg of seafood a week per human capita (WWF, 2013). According to Malaysian Adults Nutritional Survey (MANS) that conducted by Malaysia Ministry of Health in 2003, the average body weight of Malaysia adult (18-59 years old) is 62.65 kg. Therefore, 63 kg of body weight were used in the calculation of PTWI in this study.

From our findings, the maximum consumption to avoid these selected metals poisoning of these mud crab edible tissue was 1.08 kg per week. Using Cd as an example, this estimation was calculate base on the PTWI value for a 63 kg adult (0.007 mg/kg per week x 63kg = 0.441 mg/week). The maximum value of Cd concentration in the edible tissue, 0.408 mg/kg were used to calculate the maximum consumption (0.441 mg/week/0.408 mg/kg = 1.08 kg/week) that allowed according to the PTWI value set by FAO/WHO. From this estimation, those consumers who take the crab edible tissue from Setiu wetlands as a meal according to the standard (1 kg/week) are safe from these selected metals poisoning.

Conclusion

The concentrations of Zn, Cu, Pb and Cd in mud crabs were comparatively higher than the previous study from other regions in Malaysia. The concentration of Cu that accumulates in muscle part is higher than maximum permitted level. However, other heavy metals, Zn, Pb and Cd concentrations were lower compared to the maximum permitted level. Besides, the concentration of Zn, Pb and Cd were directly proportional to the length of mud crabs while inversely proportional from Cu. This might due to the feeding habits and ecological needs metabolisms of adult and young mud crabs. For assessment toward the risk to local communities, the concentration of Zn, Cu, Pb and Cd were below the Provisional Tolerable Weekly Intake (PTWI) value that set by FAO/WHO. The mud crabs in Setiu Wetland area still safe to be consumed since the concentration of heavy metals in consumable part is lower the PTWI.

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