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Assessment of Selected Heavy Metals (Zn, Mn, Pb, Cd, Cr and Cu) in Different Species of *Acetes* Shrimp from Malacca, Johor and Terengganu, Peninsular Malaysia

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ABSTRACT

This study was conducted to evaluate selected heavy metals on four different species of *Acetes* shrimp, family Sergestidae namely *Acetes indicus, A. intermedius, A. vulgaris* and *A. serrulatus*. The study aimed to determine the concentrations of heavy metals namely Zn, Mn, Pb, Cd, Cr and Cu in the tissue of these shrimp in three different sites (Malacca, Terengganu and Johor) on the west and east coast of Peninsular Malaysia. Samples were collected and frizzed, dried and digest in the lab to determine the concentrations of heavy metals by Inductively Coupled Plasma- Mass Spectrometry (ICP-MS). Results showed that in general, the heavy metals concentrations in of *Acetes* shrimp species depend significantly upon the period of taking the samples, specie and location. The highest concentration level for Cr was 1.34±0.24 μg g^{-1} (dry weight) dw, Zn 46.34±11.10 μg g^{-1} d.wt. Cu 56.09±8.69 μg g^{-1} d.wt. were recorded in Terengganu on February 2011. There was no significant difference on concentration of chromium. Results showed concentration of Cd was 0.76±0.13 μg g^{-1} d.wt. . Whereas result recorded in Terengganu on April 2011 showed the highest concentration level for Pb of 0.59±0.13 μg g^{-1} d.wt. was in Johor on February 2011. The highest concentration level for Mn of 1.77±0.42 μg g^{-1} d.wt. was recorded in Johor on April 2011. Concentrations of heavy metals of *Acetes* shrimp collected from all study areas showed safe and permissible levels for the human consumption and public health.

Key words: *Acetes* shrimp, klebang besar, marang, mersing, sergestidae, estuarine push net

INTRODUCTION

Heavy metals can be transferred to the marine organisms through the intake of food, or from seawater directly. Metals are concentrated in some marine organisms more than in the surrounding environment. The process of biological enlargement occurs when a chemical rise in concentration in the bodies of organisms with progression trophic levels during the food chains. Marine fauna, in general, are affected from the accumulation of contaminants in the environment and therefore have expansively used in marine pollution monitoring programmes (UNEP, 1993; Uthe *et al*., 1991). So these marine fauna is subjected to the distribution of metals in the environment due to the rise of heavy metals naturally from the earth's crust (Khlifi and Hamza-Chaffai, 2010). Species of genus *Acetes* were locally known as udang geragau exists widely in the west coast of Peninsular Malaysia (Amin *et al*., 2009; Arshad *et al*., 2007). This shrimp live in the tropics and subtropics regions specifically on the coastline near river estuaries (Houlthuis, 1980).

This shrimp reside in subsistence fisheries, so its commercial importance in Peninsular Malaysia (Amin *et al.*, 2008). *Acetes* shrimp is an essential important source of protein for some of Asia's population and residents of East Africa (Omori, 1977; Xiao and Greenwood, 1993). The suggested shrimps play a big role in the food chain in coastal waters (Xiao and Greenwood, 1993). Heavy metals pollution in marine environment has long been recognized as a fundamental and major problem facing fishery industry (Balkas *et al.*, 1982). In the marine water, high concentrations of heavy metals can enter to the environment coastline as the result of human activities (Ringwood, 1991; Zabel, 1993). Mining and industrial wastes may create a potential source of heavy metal pollution in the marine environment (Gumgum *et al.*, 1994; Lee and Stuebing, 1990). Heavy metals were accumulate in the bodies of marine fauna and then transferred to human through the food chain (Giordano *et al.*, 1991; Luoma, 1983). So the impact of contamination of heavy metals of marine animals became very important and a lot of attention has to be given from the health safety organizations. This is a fact because marine fauna is an important source of protein (Davies and Russell, 1988; Madany *et al.*, 1996; Sadiq *et al.*, 1995). According to Szefer *et al.* (1990), knowledge of the distribution of heavy metals in isolated tissues of marine organisms is useful to identify specific organs that may be affected. Different factors including environmental, physiological and genetic may affect distribution of heavy metals in different tissues of marine fauna. Some researchers have reported recently that some heavy metals, taken up primarily by some tissues of marine fauna, are transported translocated) to other tissues (Francesconi *et al.*, 1993; Pourang and Amini, 2001). In humans, some of heavy metals can cause several physiological and harmful health effects (Landis and Yu, 1999). Human exposure to different levels of heavy metals from the water, air and food directly (Zyadah and Abdel-Baky, 2000). One of the major contributors to the pollution of the environment with trace metals is the manufacturing sector in Malaysia. Also industries involving in metal finishing processes such as drilling operations in electroplating and clean up of metal components has been determined as the major sources of waste containing of high concentration of heavy metals (Rahman and Surif, 1993). Many studies explained some of high traces of metals in the west coast of Peninsular Malaysia (Sivalingam and Bhaskaran, 1980; Liong, 1986; Ismail, 1993; Din and Jamaliah, 1994; Chua *et al.*, 1997; Abdullah *et al*; 1999; Yap *et al.*, 2004). There is growing concern about pollution of heavy metals and residents are demanding more clean environment (European Commission, 2006; Figueroa, 2008). The objective of this study is to determine the concentration of heavy metals in the body of some sergestid shrimp in west and east coast Peninsular Malaysia.

MATERIALS AND METHODS

The fresh samples of *Acetes* shrimp were collected by estuarine push net from three different sites. These sites namely Klebang Besar in (Malacca state) which is situated at N 02°13 00. 09 and E 102° 11 29.01, Marang in (Terengganu state) which is situated at N 5°12 04 88 and E 103°13 01.65, Mersing in (Johor state) which is situated at N 2°25 47.45 and E 103°51 00.72 as shown in the Fig. 1. The samples were collected at the same time during the study period.

Sample collection: The samples were taken from the local fisherman and immediately preserved in ice box and returned back to laboratory to preserve in -20°C in the freezer until digestion and analysis. Each individual of *Acetes* shrimp were observed and identified using digital microscope Keyence (VHX-500).

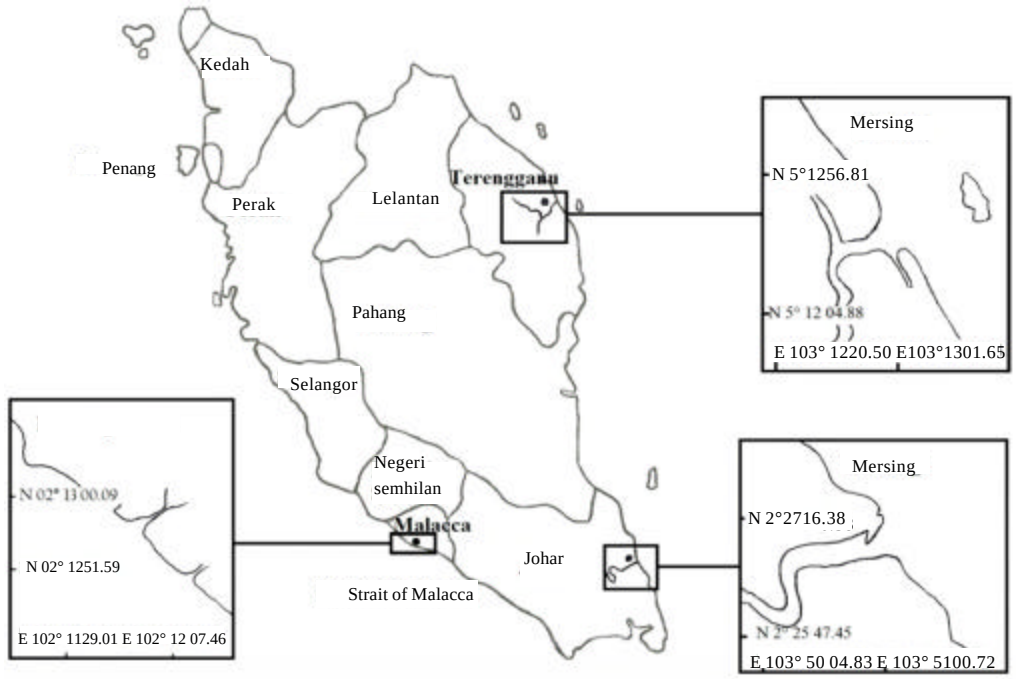

Fig. 1: Geographical location of the sample area in Malacca (Klebang Besar), in Terengganu (Marang) and in Johor (Mersing) on the coastal waters of Peninsular Malaysia

Samples analysis: Ten replicates of samples containing eight shrimps in a Petri dish were dried using oven at 80°C for 2 days to get the Dry Weight (dw). For digestion process, 1 mL of concentrated nitric acid 70% was added to the dry weight samples and wait for 24 hours. The samples were digested in dry block heater at 100 °C for 2 h, left to cool for half an h. Then 0.4 mL hydrogen peroxide was added to the mixture and samples were return to the dry block heater for 1 h at 100°C. Then take it out to cool for half an hour, 25 mL of de ionized water was added to dilute the samples. Consternation of Zinc (Zn), manganese (Mn), lead (Pb), cadmium (Cd), chromium (Cr) and copper (Cu) were determine of each sample using inductively coupled plasma-Mass Spectrometry (ICP-MS model Elan 9000 Perkin Elmer ICP-MS, USA). The data were presented in $\mu g\ g^{-1}$ of sample Dry Weight (d.wt.).

Statistical analysis: Statistical analysis were done using a computer program IBM SPSS statistics version 20 ,T test and One way ANOVA and the significance readings were recorded at $p<0.05$ levels.

RESULTS AND DISCUSSION

Results obtained show that concentrations of heavy metals are differences depend on species, seasons and study areas (Table 1). The levels of Zn, Mn, Pb, Cd, Cr and Cu in study areas (Malacca, Terengganu and Johor) revealed another of Pb<Cd<Cr<Mn<Zn<Cu. The metal concentration in *Acetes* sp. ranged from 0.04 to 0.76 $\mu g\ g^{-1}$ d.wt. for Cd, 0.07 to 0.59 $\mu g\ g^{-1}$ d.wt. for Pb, 0.59 to 1.34 $\mu g\ g^{-1}$ d.wt. for Cr, 29.18 to 46.34 $\mu g\ g^{-1}$ d.wt. for Zn, 0.89 to 1.77 $\mu g\ g^{-1}$ d.wt. for Mn and 39.37 to 56.09 $\mu g\ g^{-1}$ d.wt. for Cu. The highest concentration of cadmium of 0.76 $\mu g\ g^{-1}$ was collected in April at the state of Terengganu from *Acetes intermedius*. The highest

Table 1: Heavy metals concentration (μg g^{-1} dry wt) in *Acetes* sp. at study areas during the period of study February and April 2011

	February			April			
Metal	Malacca *indicus* sp.	Terengganu *Indicus* sp.	Johor *serrulatus* sp.	Malacca *indicus* sp.	Terengganu *intermedius* sp.	Johor *Vulgaris* sp.	Limited level
Cd	0.04±0.01[a]	0.55±0.08[b]	0.31±0.06[c]	0.06±0.01[a]	0.76±0.13[d]	0.15±0.02[e]	5 μg/g[1]
Pb	0.07±0.01[a]	0.28±0.04[b]	0.59±0.13[c]	0.10±0.02[a]	0.11±0.02[a]	0.15±0.02[a]	2 μg/g[2]
Cr	0.95±0.14[a]	1.34±0.24[a]	0.91±0.11[a]	1.10±0.42[a]	1.08±0.13[a]	1.25±0.27[a]	50 μg /g[2]
Zn	30.57±3.77[a]	46.34±11.10[b]	36±3.28[a]	30.89±4.75[a]	29.18±1.80[a]	33.05±4.03[a]	100 μg /g[2]
Mn	1.14±0.16[a]	1.01±0.24[a]	1.69±0.24[b]	0.89±0.16[c]	1.22±0.08[d]	1.77±0.42[e]	5.4 μg /g[3]
Cu	40.25±5.79[a]	56.09±8.69[b]	50.64±2.35[b]	39.37±5.29[a]	46.82±4.15[c]	45.59±6.76[c]	150 μg /g[4]

Values are Mean±SD, Values with different letter within row are significantly different at $p<0.05$, [1]MFR (1985), [2]WHO (1989), [3]FAO/WHO (1984) and [4]ABIA (1991)

concentration of lead of 0.59 μg g^{-1} was collected in February at the state of Johor from *Acetes serrulatus*. The highest concentration of chromium of 1.34 μg g^{-1} was recorded in February at Terengganu state of *Acetes indicus*. Whereas the highest concentration of zinc recorded of 46.43 μg g^{-1} was in February of *Acetes indicus* at state of Terengganu. The highest concentration of manganese was 1.77 μg g^{-1} which was recorded in *Acetes vulgaris* in April at state of Johor. The highest concentration of copper in *Acetes indicus* was 56.09 μg g^{-1}, detected in February at state of Terengganu. Moreover, Cr, Zn and Cu levels in *Acetes indicus* were more than all other shrimps in the present study. Pb levels in *Acetes serrulatus* and Mn levels in *Acetes vulgaris* were more than all the other species. Cd levels in *Acetes intermedius* were recorded the highest among all the rest of *Acetes species*. In general, the results showed that the concentrations of heavy metals in the east coast of Peninsular Malaysia were more than in the west coast. However, the concentrations of heavy metals were higher in the month of February, especially lead, chromium, zinc and copper, while the manganese and cadmium were higher in April as shown in Table 1. In the study areas, most of the highest concentrations of chromium, zinc, copper and cadmium of 1.34, 46.34, 56.09 and 0.76 μg g^{-1} (d.wt.), respectively were recorded in Terengganu state in February. While the highest concentration of lead and manganese of 0.59, 1.77 μg g^{-1} d.wt. respectively were recorded in Johor state in February and April. While there is no high concentrations were recorded in the state of Malacca during the study period. *Acetes indicus* was recorded the highest concentration among the other species of the metals chromium, zinc and copper. Whereas the highest concentrations of cadmium, lead and manganese were recorded in *A. intermedius*, *A. serrulatus* and *A. vulgaris,* respectively. In comparison with the required limits set by MFR, 1985 for Cd (5 μg/g wet weight ww), all the obtained mean values (μg g^{-1} d.wt.) of this metal were lower than the permissible limits. The heavy metal levels in present results were also lower than the recommended limits set by the WHO 1989. Concentrations of Pb, Zn and Cr were 2-100 and 50 μg g^{-1} d.wt. , respectively. Whereas concentration of Mn showed lower levels than the permissible limit of 5.4 μg g^{-1} d.wt. set by FAO/WHO 1984. The results determine the concentration of Cu was also lower levels than the required limit of 150 μg g^{-1} d.wt. set by Brazilian Ministry of Health (ABIA, 1991) as shown in the Table 1. In comparison of these results with the results of the previous regional studies showed that the concentrations of heavy metal of current results are the lower except of the copper which recorded the highest concentration. The present results showed that the highest concentration of cadmium, lead, zinc and copper were 0.76, 0.59, 46.34, 56.09 μg g^{-1}, respectively. Three studies conducted by Ruangwises and Ruangwises (1998); Wong *et al.* (2000) and

Table 2: A comparison of recorded concentration μg g^{-1} of cadmium, lead, chromium, zinc, manganese and copper from three different regional studies with present study

Location	WB	Cd	Pb	Cr	Zn	Mn	Cu	References
Regional studies								
The Gulf of Thailand	Dry	0.17-3.25	0.19-3.75	----------	24.9-213	----------	2.94-15	Ruangwises and Ruangwises (1998)
Tolo Harbour,Hong Kong	Dry	0.45-1.44	2.02-4.36	----------	90.0-135	----------	6.02-24	Wong *et al.* (2000, 2001)
Fish cultured sites at Hong Kong waters	Dry	0.31-0.87	4.34-25.9	----------	96.7-201	----------	19.0-20.1	
Malacca, Johor and Terengganu in Malaysia	Dry	0.04-0.76	0.07-0.59	0.59 _ 1.34	29.18-46.34	0.89-1.77	39.37-56.09	This study

WB: Weight basis

Wong *et al.* (2001) showed concentrations of cadmium, lead, zinc and copper of 3.25,1.44, 0.87 and 15 μg g^{-1}, 3.75, 4.36, 25.9 and 24 μg g^{-1} , 213, 135, 201 and 20.1 μg g^{-1}, respectively as shown in the Table 2.

However, the level of copper is still below the permissible limits set by FAO/WHO (1984). The previous regional studies did not include analysis of manganese and the chromium that were determined by this study of results of 1.77, 1.34 μg g^{-1}, respectively.

CONCLUSION

This study shows that all concentrations of heavy metals in different species of *Acetes* shrimp are still below the allowable limits set by FAO/WHO (1984). MFR (1985), Brazilian Ministry of Health ABIA (1991) and FAO/WHO (1984), WHO (1989). The higher levels of these heavy metals were recorded in the east coast. There were no correlations between the concentration levels of heavy metals and all different species of *Acetes* shrimp.

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