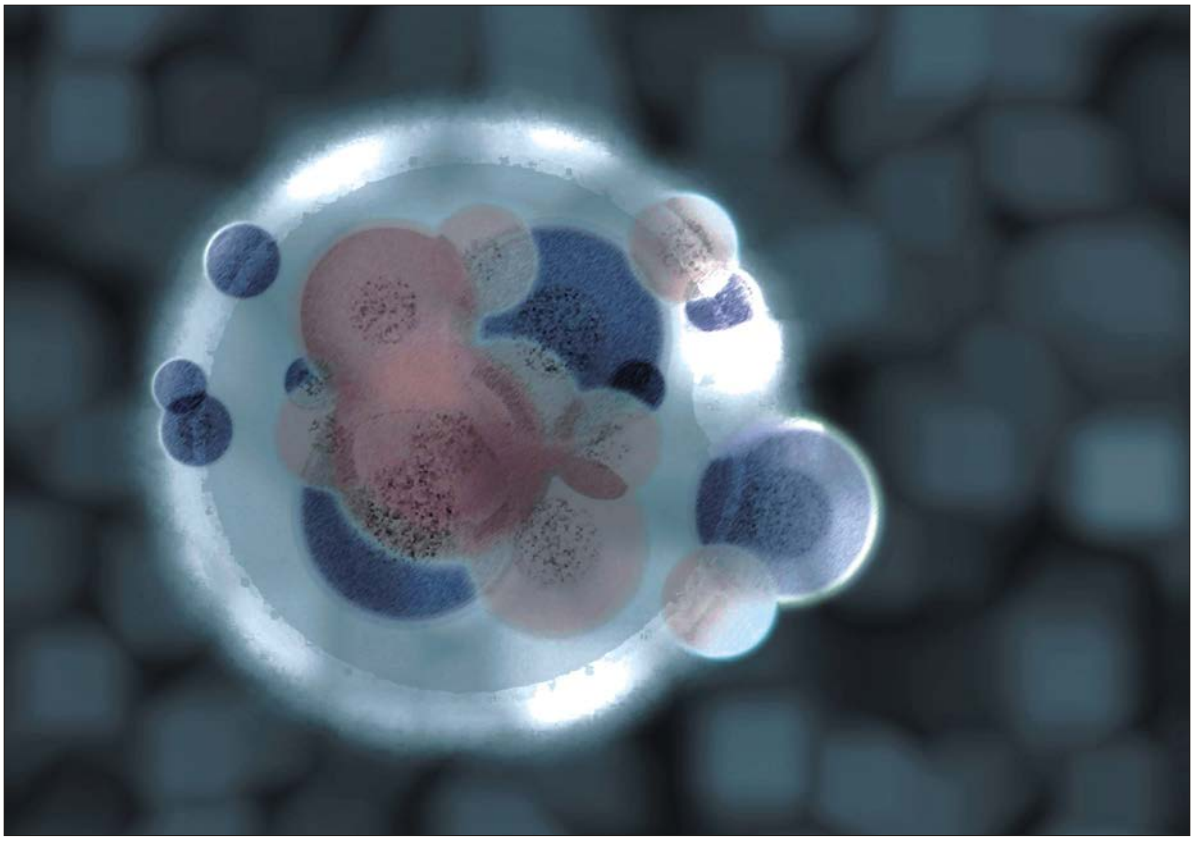

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Evaluation of Selected Heavy Metals (Zn, Cd, Pb and Mn) in Shrimp (*Acetes indicus*) from Malacca and Kedah, Peninsular Malaysia

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Abstract: Environmental pollution has become a source of concern and inconvenience to the world, the study was conducted to evaluate some selected heavy metals on *Acetes* shrimp. The present research project was undertaken to determine heavy metal (Zn, Cd, Pb and Mn) in the tissue of shrimp (*Acetes indicus*) in two different sites (Malacca and Kedah) on the west coast of Peninsular Malaysia. Samples were collected in this study during the months August, September, October and November and determine the concentrations of heavy metals zinc, lead, cadmium and manganese by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). The results show that in general, the highest heavy metals concentrations were detected in samples taken from Malacca than Kedah. The heavy metal concentration in this shrimp varied significantly depending upon the months and sample station from where the shrimp was collected. In Malacca, the highest concentration level of Zn was detected in the *Acetes* shrimp (45.79±2.54 μg g^{-1} dry weight) in October 2010 followed by that of Kedah reported in September (45.08±2.93 μg g^{-1}). The highest concentration level of Cd was detected in *Acetes* at Malacca 0.83±0.64 μg g^{-1} in September, whereas it was 0.21±0.04 μg g^{-1} in November at Kedah while the highest concentration level of Pb was recorded in Malacca which was 1.29±0.85 μg g^{-1} in September while it was 0.55±0.12 μg g^{-1} in October at Kedah. The highest concentration level of Mn was detected in *A. indicus* in Malacca recorded 6.95±1.19 μg g^{-1} in August while it was 6.10±1.01 μg g^{-1} in November at Kedah. However, the concentrations of heavy metals in *Acetes indicus* collected from Malacca and Kedah were within the permissible levels and are safe for the human consumption and public health.

Key words: *Acetes indicus*, estuarine push net, Klebang Besar, Tanjung Dawai, coastal waters

INTRODUCTION

Acetes inhabit coastal and estuarine waters in tropical, subtropical and temperate parts of the world and from an important organism's component of coastal zooplankton communities (Young and Wadley, 1979; Chaitiamvong, 1980; Grabe and Lees, 1992; Omori, 1975; Holthuis, 1980). *Acetes* shrimp in different species range from 10-40 mm in the total length, economically, nutritionally very important in Asian and east African waters (Omori, 1977; Xiao and Greenwood, 1993). Shrimp of *Acetes indicus* is mainly used in subsistence fisheries and consequently, commercially very important in Malaysia (Amin *et al*., 2008). *Acetes* shrimp provides a main source of protein for some residents in Asia and East Africa. The fishing season coincides with the teeming season in the place where the *Acetes* shrimp fishery is accomplished. The teeming behavior of *Acetes* is described in relation to the wind direction. Heavy metal pollution of the marine environment for a long time ago recognized as serious environment as a concern (Balkas *et al*., 1982). In the marine environment, pollutants probably accumulate in marine organisms and consequently transferred to human during the food chain. And so on, it has become increasingly important for Identification and assessment levels of heavy metals in marine organisms because of safety and nutritional conditions. This is true especially on marine organisms edible because it was probably a source of protein (Madany *et al*., 1996; Sadiq *et al*., 1995; Giordano *et al*., 1991). Heavy metals are very toxic because as ions or compound form, they are in water where the marine organisms live and may be easily absorbed into the sea organisms and relate to enzymes and structural proteins. In humans, some of heavy metals can cause several of physiological and health effects (Landis and Yu, 1999).

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Human exposure to different levels of trace metals directly from the air, water and food (Zyadah and Abdel-Baky, 2000). Major contributor to the pollution of the environment with heavy metals is the manufacturing sector in Malaysia and described using the industry metal finishing involving under drilling operations such as electroplating and clean up the metal components for various industries have been identified as the main source of waste containing a high concentration of heavy metals (Rahman and Surif, 1993). There are many studies that describes some of high heavy metals in the west coast of Malaysia (Sivalingam and Bhaskaran, 1980; Liong, 1986; Ismail, 1993; Din and Jamaliah, 1994; Abdullah *et al*., 1999; Yap *et al*., 2004; Chua *et al*., 1997), both from natural geological processes and human activities industries and human waste; this is of great interest of public health, since the metals were easily accumulated in the soft tissues of some organisms (Ismail *et al*., 1999). However, from this side the toxic metal excessive consumption of metal-contaminated seafood causing toxicity to humans. Heavy metals are inorganic chemicals, never decompose, cannot be metabolized and will not turn into harmless substances (Kromhout *et al*., 1985) exposure to high doses of heavy metals like Zn, Pb and Cu are caused Parkinson's disease (Gorell *et al*., 1997). The aim of this study was to evaluate the concentration of heavy metals in the body of the shrimp Acetes index in the west coast of Malacca and Kedah Peninsular Malaysia.

MATERIAL AND METHODS

The fresh samples of *A. indicus* were collected from estuarine push net from two different sites namely Tanjung Dawai, Kedah which is situated at (N 5°40 47. 00, E 100° 21 53. 25) and Klebang Besar, Malacca which is situated at (N 02°13 00. 09 and E 102°11 29.01) as shown in the Fig. 1. The samples were collected at the same time during the study period, beginning from August to November 2010.

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 until analysis. Each individual of *A. indicus* was observed and identified using digital microscope Keyence (VHX-500). Heavy metals analyzed were zinc (Zn), lead (Pb), cadmium (Cd) and manganese (Mn).

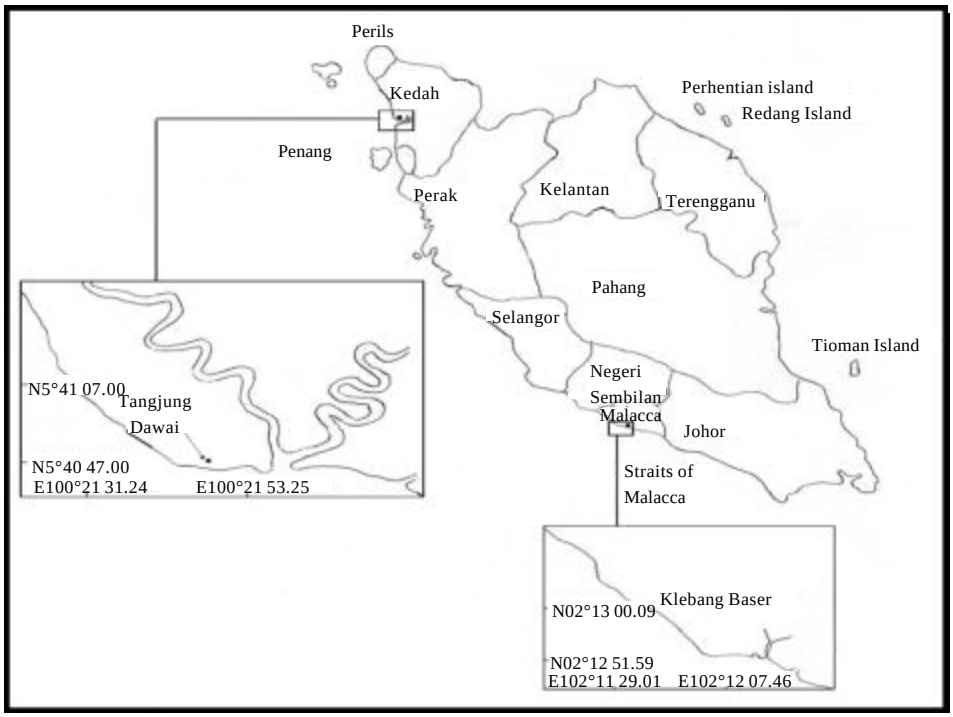

Fig. 1: Geographical location of the sample area in Kedah (Tanjung Dawai) and in Malacca (Klebang Besar) on the coastal waters of Peninsular Malaysia

Sample analysis: Ten replicates of samples containing eight shrimps in a Petri dish were oven dried at 80°C for 2 days to get the dry weight (DW). For digestion, 1 mL of concentrated nitric acid 70% was added to the dry weight samples and wait for 24 h, the samples were digested in dry block heater at 100°C for 2 h, Left to cool for half an hour, then 0.4 mL hydrogen peroxide was added to the mixture and return the samples 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 were analyzed using, Inductively Coupled Plasma-Mass Spectrometry (ICP-MS model Elan 9000 Perkin Elmer ICP-MS, USA) to determine the heavy metals concentration, the operational parameter settings used in ELAN 9000 Perkin Elmer. The data were presented in μg g^{-1} of sample dry weight (DW).

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

RESULTS AND DISCUSSION

High concentrations of some heavy metals in the Malacca state more than Kedah state, the metal concentrations in the *Acetes indicus* ranged from 34.25 to 45.79 μg g^{-1} DW for Zn, 0.02 to 0.83 μg g^{-1} DW for Cd, 0.17 to 1.29 μg g^{-1} DW for Pb, 2.61 to 6.10 μg g^{-1} DW for Mn. The levels of Cd, Pb, Mn and Zn in the both sites revealed another of Cd<Pb<Mn<Zn at the period of study as shown in the Table 1 and 2. However, the highest concentration of Zn was recorded in Malacca which was 45.79 μg g^{-1} in October 2010 while the lowest concentration was recorded in November which was 40.69 μg g^{-1}, whereas, the highest concentration of Mn was recorded in Malacca which was 6.95 μg g^{-1} in August while the lowest concentration was 2.61 μg g^{-1} in November while Cd and Pb levels were observed as the highest concentrations in *Acetes* collected from Malacca which were 0.83 and 1.29 μg g^{-1}, respectively in September while the lowest concentration were recorded in Malacca which were 0.07 and 0.17 μg g^{-1}, respectively in November, as shown in Table 1. In Kedah, the highest concentration of Zn was recorded in September which was 45.08 μg g^{-1} while the lowest concentration was recorded in November which was 34.25 μg g^{-1}, whereas, the highest concentration of Cd was recorded in Kedah which was 0.21 μg g^{-1} in November, whereas, the lowest concentration was 0.02 μg g^{-1} in October. The highest concentration of Pb was recorded the highest concentration in October which was 0.55 μg g^{-1}, in Kedah while the lowest concentration was recorded in August and it was 0.25 μg g^{-1}, whereas, the concentration of Mn in Kedah recorded the highest level in November which was 6.10 μg g^{-1} while the lowest concentration of Mn which was 5.87 μg g^{-1} recorded in October as shown in Table 2. Huge ships were moored on along of Malacca Straits is one of the reasons for increase some of heavy metals concentration. Human activities on land passed down through the rivers to the sea have an impact on the variation in high and low concentrations of selected metals in this study at different months. All these concentrations obtained through this study were under the allowable levels set by different countries and some of international organization. In comparison with the permissible limits set by MFR (1985) for Zn (500 μg g^{-1} DW), Cd (5 μg g^{-1} DW) and Pb (10 μg g^{-1} DW), all the mean values (μg g^{-1} DW) of these metals in present results in Malacca and Kedah were lower than the limits. The heavy metal levels in this study were also lower than the recommended guidelines for Zn, Cd, Pb and Mn set by Brazilian Ministry of Health (ABIA, 1991), Australian Legal Requirements (NHMRC, 1987), World Health Organization (WHO, 1989). Except for some concentrations of Mn which were higher than the permissible limits set by the Food and Agriculture Organization Of The United Nations (FAO/WHO, 1984) which was (5.4 μg g^{-1} DW) whereas, in the present result ranged from (2.61-6.95 μg g^{-1} DW) in Malacca and (5.87-6.10 μg g^{-1} DW) in Kedah as shown in the Table 3.

Table 1: Heavy metal concentration in shrimp (*Acetes indicus*) in Malacca during the period of study

	Conc. (μg g^{-1} dry wt.)			
Metal	August	September	October	November
Zn	42.68±5.42^{a}	44.34±2.02^{a}	45.79±2.54^{a}	40.69±1.48^{b}
Cd	0.23±0.11^{a}	0.83±0.64^{b}	0.09±0.02^{c}	0.07±0.01^{c}
Pb	0.34±0.11^{a}	1.29±0.85^{b}	0.38±0.08^{a}	0.17±0.01^{d}
Mn	6.95±1.19^{a}	4.02±0.49^{b}	4.64±0.55^{b}	2.61±0.24^{c}

Values are Mean±SD, Values with different letter within row are significantly different

Table 2: Heavy metal concentration in shrimp (*Acetes indicus*) in Kedah during the period of study

	Conc. (μg g^{-1} dry wt.)			
Metal	August	September	October	November
Zn	44.48±4.17^{a}	45.08±2.93^{a}	39.70±1.97^{b}	34.25±2.20^{c}
Cd	0.04±0.02^{a}	0.14±0.07^{b}	0.02±0.01^{a}	0.21±0.04^{c}
Pb	0.25±0.05^{a}	0.26±0.07^{a}	0.55±0.12^{b}	0.29±0.04^{a}
Mn	6.87±0.68^{a}	5.90±1.28^{a}	5.87±0.75^{a}	6.10±1.01^{b}

Values are Mean±SD, Values with different letter within row are significantly different

Table 3: Guidelines on heavy metals for food safety set by different countries and some of International organizations

		Conc. ($\mu g\ g^{-1}$)			
Location	WB	Zn	Cd	Pb	Mn
Permissible limits set by MFR (1985)	Dry	500	5	10	-
Maximum permissible levels established by Brazilian Ministry of Health (ABIA, 1991)	Dry	250	5	10	-
Australian Legal Requirements (NHMRC, 1987)	Dry	750	10	-	-
World Health Organization) (WHO, 1989)	Dry	100	1	2	-
FAO/WHO (1984)	Dry	-	-	-	5.4
Heavy metal levels of *A. indicus* (present study)					
Malacca	Dry	40.69-45.79	0.07-0.83	0.17-1.29	2.61-6.95
Kedah	Dry	34.25-45.08	0.02-0.21	0.25-0.55	5.87-6.10

WB: Weight basis, -: No data

Table 4: A comparison of reported concentration $\mu g\ g^{-1}$ of zinc, cadmium, lead and manganese in *Acetes indicus* with other marine organisms from previous regional studies and other studies done in Malaysia with the present results

		Conc. ($\mu g\ g^{-1}$)				
Location	WB	Zn	Cd	Pb	Mn	References
The study of previous regional Southeast coast of India	Dry	60.4-94.1	1.59-4.40	2.48-6.92	-	Senthilnathan *et al.* (1998)
Coastal waters of Hong Kong Malaysia	Dry	89.0-164	0.29-1.43	7.50-60.50	-	Phillips (1985)
Penang Malaysia	Dry	76	BDL	7	-	Sivalingam and Bhaskaran (1980)
Peninsular Malaysia (9 sites)	Dry	75.1-129	0.68-1.25	2.51-8.76	-	Yap *et al.* (2004)
Malacca and Kedah Malaysia (2 sites)	Dry	34.25-45.79	0.02-0.83	0.17-1.29	2.61-6.95	This study

BDL: Below detection limit, WB: Weight basis, -: No data

In comparison, the present results were less than all the results of the previous regional studies conducted by Senthilnathan *et al.* (1998) in the Southeast of India, another study conducted by Phillips (1985) in coastal waters of Hong Kong and the other study was done in Malaysia as shown in the Table 4. The present results shows that the highest concentration of zinc was 45.79 $\mu g\ g^{-1}$ while it was 129 $\mu g\ g^{-1}$ in the study were conducted by Yap *et al.* (2004) in other sites in Malaysia, 76 $\mu g\ g^{-1}$ in the study were conducted by Sivalingam and Bhaskaran (1980) in Penang while the high concentrations of cadmium in the present results 0.83 $\mu g\ g^{-1}$ and it was in the other studies conducted on the coast of Malaysia 1.25 $\mu g\ g^{-1}$ by Yap *et al.* (2004). The highest concentration of lead in present results was 1.29 $\mu g\ g^{-1}$ whereas, the highest concentration of this metal in the results conducted by (Yap *et al.*, 2004) were 8.76 $\mu g\ g^{-1}$ while it was 7 $\mu g\ g^{-1}$ in the study conducted by Sivalingam and Bhaskaran (1980) in Penang while these studies did not include the manganese, whereas, the highest concentration of manganese in this present results was 6.95 $\mu g\ g^{-1}$.

CONCLUSION

This study shows that the concentration of heavy metals in shrimp (*Acetes indicus*) is still below the allowable limits proposed by different countries and some of international organizations in the both sites (Malacca and Kedah), the higher level of these heavy metals were recorded in Malacca.

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