

Health Risk Assessment of Heavy Metals in Prawn *Penaeus merguensis* Collected in 2007 from Sri Serdang Market, Peninsular Malaysia

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Received: June 17, 2019; Published: July 24, 2019

DOI: 10.31080/ASNH.2019.03.0376

Abstract

Samples of prawn (*Penaeus merguensis*), were collected from a market in Serdang, Selangor, Peninsular Malaysia, in 2007. The prawns samples were dissected into five parts; soft tissue, carapace, periopods, pleopods and telson. The mean metal concentrations ($\mu\text{g/g}$ dry weight) in the soft tissues of the prawns were 89.2 for Fe, 13.6 for Cu, 55.5 for Zn, 0.01 for Cd and 0.01 for Ni. For the human health risk assessment, all values of target hazard quotient for the five metals in the adults of Malaysian population were found below 1.00. This showed that there was no non-carcinogenic risk of the five metals via the consumption of *P. merguensis* from the present study. Still, it is highly recommended that frequent monitoring of toxic chemicals besides heavy metals should be carried out for possible chemical contamination in this popular seafood in Malaysia.

Keywords: Heavy Metals; Health Risk Assessment; *Penaeus merguensis*

Introduction

The prawn *Penaeus merguensis* (Family: Penaeidae) were focused in the present study. They are natural dwellers of the coastal areas of Peninsular Malaysia and hold significant commercial values in the prawn farming industry since 1980s [1]. Therefore, the evaluation of human safety consumption of these prawns is of utmost importance.

Studies of heavy metals in the prawns have been reported in green tiger prawns (*P. semisulcatus*) from Turkey Kaya and Turkoglu [2], giant tiger prawns (*P. monodon*) from the Tanzanian coast [3,4], in *P. semisulcatus* from Khuzestan province, Iran [5], in *P. semisulcatus* caught from southern Red Sea coast of Saudi Arabia

[6], in Chinese shrimp *P. chinensis* [7], in *P. monodon* from Langat estuary of Peninsular Malaysia [8], and *P. monodon* from Tuaran and Likas of near Kota Kinabalu [9].

Marine shrimp species has long been used as a bioindicators for heavy metals pollution in numerous environmental monitoring studies [10,11]. However, the bioaccumulation of heavy metal in these organisms is influenced affected by many biological and environmental factors.

The objectives of this study are to: 1) investigate the concentrations of Cd, Cu, Fe, Ni and Zn in *P. merguensis* bought from a market in Sri Serdang, Selangor and; 2) to determine the target hazard quotients of heavy metals in the prawns bought from Sri Serdang market in comparison to cited data.

Materials and Methods

The prawn samples *P. merguensis* were bought from a market (pasar) in Sri Serdang, Selangor, Peninsular Malaysia, on the 5 April 2007. Twenty five individual of prawns were selected and dissected into several different parts: soft tissue, carapace, front legs (periopods), hind legs (pleopods) and telson. The ranges for the total wet weights, and body lengths were 6.65-9.32 g and 3.80-5.44cm, respectively.

All collected shrimp samples were kept frozen until dissection was carried out. The frozen samples were thawed at room temperature and later on, cleaned with double-distilled water (DDW). Determination of total soft tissue dry weight were conducted by drying individual whole STs at 60°C, for 72 hours until constant dry weight was achieved [12]. The prawn samples were placed onto aluminum foils dried at 105°C, for 72 hours until constant dry weight was achieved [12].

The dissected dried tissues (about 0.5g each) were weighed and digested in concentrated nitric acid (AnalaR grade, BDH 69%). Digestion were carried out by heating the nitric acid treated samples at 40°C for 1 hour and then raised to 140°C for at least 3 hours to achieve full digestion. After the digestion process was completed, the samples were topped up with DDW to 40 ml and before filtering them with Whatman No.1 (filter speed: medium) filter papers into acid washed plastic containers. The digested samples were then sent for Cd, Cu, Fe, Ni, and Zn determination by using the atomic absorption spectrophotometer (AAS) Perkin-Elmer Model 800.

All glassware and equipment used for this study were acid washed and procedural blanks were analyzed once for every five samples during analysis to ensure consistency in data collection. Standard solutions for all five metals were prepared and analyzed occasionally during the analysis for heavy metal recoveries. The heavy metal recoveries were being satisfactory with recoveries between 90-110%. The quality of the analytical procedures used for the prawn samples were verified by using CRM for Dogfish Liver (DOLT-3, National Research Council Canada). The recoveries for the CRMs were being satisfactory between 80-120%.

Human health risk assessment

The estimated daily intake is to calculate how much of prawns that be taken by an adult for one day. First, the dry weight (dw) basis was converted to wet weight (ww) by using the conversion factor (0.30) as follows:

Wet weight (WW) = metal concentration (MC) X conversion factor

The mean concentrations of the samples are needed for calculation of estimated daily intake of prawns. The estimated daily intake (EDI) ($\mu\text{g}/\text{kg}/\text{day}$) of prawns that contain levels of Cd, Cu, Fe, Ni, and Zn were measured by using a formula:

$$\text{EDI} = \text{MC} \times \text{CR} / (\text{BW})$$

MC represents the metal concentration ($\mu\text{g}/\text{g}$ wet weight) in the prawns. The body weight (BW; kg) for adults is 62 kg and consumption rate (CR; g/person/day) for cephalopod is 90g, following the report for Malaysian population [13].

The human health risk assessment of the heavy metal in the guava fruits was determined by the calculation of Target Hazard Quotient (THQ). If the THQ value is higher than 1.0, this means that the daily consumption of prawns would likely result in negative health effects during a lifetime in a human population [14]. The formula of THQ calculation was described as follow:

$$\text{THQ} = \text{EDI} / \text{RfD}$$

RfD represents the oral references dose ($\mu\text{g}/\text{kg}/\text{day}$). The reference doses used for Cd, Cu, Fe, Ni, and Zn are 1, 40, 700, 20 and 300, respectively, provided by the USEPA's regional screening level [15].

Results and Discussion

The mean concentrations of Fe, Cu, Zn, Cd and Ni in *P. merguensis* bought from market in Sri Serdang are presented in Table 1. The order of Fe and Zn levels are hind legs> front legs> telson> soft tissue> carapace, while carapace> front legs> telson> hind legs> soft tissue for Cd and Ni. Pourang, *et al.* [16] reported the highest level of Cd (0.790 $\mu\text{g}/\text{g}$ wet weight) was observed in exoskeleton (equivalent to carapace) of *P. semisulcatus*. The order of Cu levels are hind legs> front legs> telson> carapace> soft tissue. The mean metal

concentrations ($\mu\text{g/g}$ dry weight) in the soft tissues of the prawns were 89.2 for Fe, 13.6 for Cu, 55.5 for Zn, 0.01 for Cd and 0.01 for Ni. These metal ranges were also below the maximum permissible limits set by the Malaysian Food Regulation [17].

Table 1: Mean concentrations ($\mu\text{g/g}$ dry weight) of Fe, Cu, Zn, Cd and Ni in the prawn *Penaeus merguensis* from a market in Sri Serdang.

| | Fe | Cu | Zn | Cd | Ni |
|-------------|------|------|------|------|------|
| Soft tissue | 89.2 | 13.6 | 55.5 | 0.01 | 0.01 |
| Carapace | 42.9 | 18.0 | 25.1 | 1.71 | 8.09 |
| Front legs | 122 | 40.9 | 78.6 | 1.68 | 5.83 |
| Hind legs | 138 | 122 | 78.7 | 0.88 | 2.32 |
| Telson | 99.2 | 38.1 | 35.2 | 1.20 | 6.33 |

The concentrations of Cd, Cu, Fe, Ni and Zn of *P. merguensis*, from the present study and cited data from the literature are presented in Table 2. Overall, the five metal levels found from Sri Serdang market were lower or within the ranges as those reported in the literature (Table 2).

The values of EDI and THQ of Cd, Cu, Fe, Ni and Zn of *P. merguensis*, from the present study and cited data from the literature, are shown in Table 3. All values of THQ for the five metals in the adults of Malaysian population were found below 1.00. This shows that there was no non-carcinogenic risk of the five metals via the consumption of *P. merguensis* from the present study. Still, it is highly recommended that frequent monitoring of toxic chemicals besides heavy metals should be carried out for possible chemical contamination in the popular seafood in Malaysia.

Table 2: Concentrations ($\mu\text{g/g}$ dry weight) of Cd, Cu, Fe, Ni and Zn of *Penaeus merguensis*, from the present study and cited data from the literature. DW= Dry weight; WW= Wet weight.

Note: The $\mu\text{g/g}$ dry weights were converted by using conversion factors of 0.30, assuming the water content is 70%.

1= Anandkumar, *et al.* [18]; 2= Mitra, *et al.* [19]; 3= Alam [20].

| Sampling site | DW | | | | | WW | | | | |
|--------------------------------------|------|-------|-------|------|-------|-------|-------|-------|--------|--------|
| | Ni | Cu | Zn | Cd | Fe | Ni | Cu | Zn | Cd | Fe |
| Serdang market | 0.01 | 13.55 | 55.54 | 0.01 | 89.17 | 0.003 | 4.065 | 16.7 | 0.003 | 26.751 |
| Miri coast ¹ | 2.3 | 80.8 | 104 | 0.1 | NA | 0.69 | 24.24 | 31.2 | 0.03 | NA |
| Indian Sundarbans ² (min) | NA | 13 | 22 | 0.00 | NA | NA | 3.9 | 6.6 | 0.0003 | NA |
| Indian Sundarbans ² (max) | NA | 42 | 95 | 3.90 | NA | NA | 12.6 | 28.5 | 1.17 | NA |
| Kapar ³ | NA | 21.6 | 76.4 | 0.17 | NA | NA | 6.48 | 22.92 | 0.051 | NA |

Table 3: Values of estimated daily intake (EDI) and target hazard quotient (THQ) of Cd, Cu, Fe, Ni and Zn of *Penaeus merguensis*, from the present study and cited data from the literature.

Note: 1= Anandkumar, *et al.* [18]; 2= Mitra, *et al.* [19]; 3= Alam [20].

| Sampling site | EDI | | | | | THQ | | | | |
|--------------------------------------|-------|-------|------|--------|------|--------|-------|-------|-------|-------|
| | Ni | Cu | Zn | Cd | Fe | Ni | Cu | Zn | Cd | Fe |
| Serdang market | 0.004 | 5.90 | 24.1 | 0.004 | 38.8 | 0.0002 | 0.148 | 0.081 | 0.004 | 0.055 |
| Miri coast ¹ | 1.002 | 35.18 | 45.3 | 0.044 | NA | 0.050 | 0.880 | 0.151 | 0.044 | NA |
| Indian Sundarbans ² (min) | NA | 5.661 | 9.58 | 0.0004 | NA | NA | 0.142 | 0.032 | 0.000 | NA |
| Indian Sundarbans ² (max) | NA | 18.29 | 41.4 | 1.70 | NA | NA | 0.457 | 0.138 | 1.698 | NA |
| Kapar ³ | NA | 9.406 | 33.3 | 0.074 | NA | NA | 0.235 | 0.111 | 0.074 | NA |

Mokhtar, *et al.* [8] reported that the levels of Cd, Ni, Cu, Fe, and Zn in *P. monodon* were found to be lower than the recommended maximum level allowed in food, thus indicating that *P. monodon* from Bandar and Jugra aquaculture ponds were safe for human consumption. Based on samples collected from Iskenderun Bay, Yilmaz and Yilmaz [21] reported that the heavy metal concentrations, except for Cu, in male and female *P. semisulcatus*'s muscle were below the admissible limits. This metal elevation was assumed to be contributed by industrial pollution.

According to Frenet and Alliot [22], the role played by Cu in the production haemocyanin (an essential respiratory protein) could result in high Cu levels in the prawns, while Zn plays an important role in a variety of an essential respiratory protein and enzymatic processes.

Conclusions

From the data obtained in this study, prawns collected from a market in Sri Serdang are safe for human consumption. However, regular monitoring of heavy metal non-carcinogenic risks in this prawn and other species should be made to check for the possible human health risks.

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Volume 3 Issue 8 August 2019

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