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Short Communication

ESSENTIAL HEAVY METAL CONCENTRATIONS (Zn, Fe, Cu, Mg AND Mn) IN MUSCLE TISSUE OF GREEN TIGER SHRIMP, *PENAEUS SEMISULCATUS*, WITH DIFFERENT SIZE CLASSES

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ABSTRACT

The present study was conducted to determine the concentrations of heavy metals Zn, Fe, Cu, Mg and Mn in muscle tissue of the two weight classes of green tiger shrimp, *Penaeus semisulcatus* including the shrimps with a mean weight of 11.70-25.50 g (n=75) (first class) and 50-101.40 g (n=19) (second class). Shrimp samples (n=94) were collected from coastal waters of Bahrekan, Khuzestan province, Iran during October, 2015. A flame atomic absorption spectrophotometer was used to measure the heavy metal concentrations in muscle tissue of shrimps. Based on obtained results, the average concentrations of 7.75±0.12, 1.29±0.19, 3.02±0.04, 0.10±0.05 and 0.57±0.05 mg/kg.wet.weight were found respectively for Zn, Fe, Cu, Mg and Mn in shrimps of first weight class. For shrimps of second weight class, the average concentrations of Zn, Fe, Cu, Mg and Mn were 7.68±0.04, 1.17±0.03, 2.96±0.06, 0.11±0.02 and 0.52±0.06 mg/kg.wet.weight respectively. There were no significant differences in concentrations of measured heavy metals between two weight classes of green tiger shrimps. In conclusion, the concentration of all measured heavy metals in the present study was in the range of international standards recorded for these metals.

Keywords: heavy metal, weight class, Bahrekan coast, green tiger shrimp.

INTRODUCTION

The heavy metals have been introduced as major contaminants of coastal waters and sea throughout the world. In general, the heavy metals have a high half-life and undegredable nature and disturb the aquatic ecosystems through accumulation in organism tissues and entrance and subsequent movement throughout the food chain in aquatic environments (Naser, 2013). The heavy metal almost are released into aquatic environments through the runoff of industrial (petrochemical contaminants), agricultural (pesticides), mineral and home wastes, drainage of landfills, oil transportation, shipping and porting activities, chemical erosion of the crust of the earth and thus the entrance of atmospheric sediments (França *et al*., 2005). By definition, the so-called essential metals are defined as a group of metals that biological needs to them are little in organisms. In other word, just little concentrations of essential metals could ensure the health of organism and higher concentrations have toxic effects (Javaheri Baboli and Velayatzadeh, 2013). The final destination of metals depends on physiological aspects of organism and whether it is necessary for the organism or not (Chang *et al*., 2015). The study of the heavy metals in aquatic environments could be conducted with assessment of their concentrations in water, sediments and the body of aquatic organisms.

Crustaceans including shrimps and crabs have been used successfully as biological monitoring tools to evaluate the biological impacts of contaminants in aquatic environments. In this regard, the marine crustaceans, shrimps and crabs could use as bioindicators for a simple evaluation of sea environments in terms of metal pollutions (Javaheri Baboli and Velayatzadeh, 2013). The accumulation and biomagnifications of toxic heavy metals throughout the sea food chain could threat human health as final consumer. Usually, the muscle tissues of sea animals are consumed by human. Thus, the knowledge on the muscular, heavy metal content of sea edible animals is essential to maintain health and hygiene of human (Külcü *et al*., 2014). Several studies have been carried out to evaluate the heavy metal concentrations in shrimps (Al-Mohanna and Subrahmanyam, 2001; Pourang and Amini, 2001; Pourang *et al*., 2005; Javaheri Baboli and Velayatzadeh, 2013). The main aims of the present study were: (a) evaluation of metal concentrations (Zn, Fe, Cu, Mg and Mn) in muscle tissue of the two weight classes (11.7-25.5 g (first class) and 50-101.4 g (second class)) of green tiger shrimp, *Penaeus semisulcatus* and (b) determination of weight-dependent differences of heavy metals between two weight classes.

MATERIALS AND METHODS

94 green tiger shrimps were purchased from local fisherman of Hendijan, coast of Bahrekan region, Khuzestan Province, Iran (*longitude*: 49°.42´.300˝- 49°.46´.246˝- E; latitude: 30°.03´.140˝- 30°.05´.520˝N) on October, 2015. Then, shrimp samples were transported to the lab by a polystyrene box containing crushed ice. In the lab, after Biometry, shrimps were divided into the two different weight classes including first class: 50-101.40 g (n=19) and second class: 11.70-25.50 g (n=75) and then were dissected to separate exoskeleton from muscle.

To measure the heavy metal concentrations of muscle tissue of shrimps, chemical digestion of samples with nitric acid and hydrogen peroxide (H_2O_2) was conducted as described by Mirabi *et al*. (2015). To this end, at first, the tissue samples were squeezed by a meat grinder and then the chemical digestion done. In this regard, 2 g of each sample was transferred into a digestion flask containing 10 ml of 65 % nitric acid and then placed on a hot plate at 130°C to evaporate the whole nitric acid. After that, the flask cooled in room temperature and then 2 ml 30% H_2O_2 was added to flask. After 30 min, flask content filtered by a filter paper and then diluted with distilled water. After dilution, metals concentrations were measured using a flame atomic absorption spectrophotometer with a wavelength range of 213.9–285.2 nm (Thermo M5, USA) (Mirabi *et al*., 2015).

In the present study, the data collection was carried out in according to a completely random design. The SPSS software (version 20) was used for data analysis. The data normality was investigated by Kolmogorov–Smirnov test. The independent samples *t*-test was employed to compare the means of heavy metals among two weight classes of green tiger shrimps at $P<0.05$.

RESULTS

According to obtained results, the mean muscular concentration of heavy metals were: Zn: 7.75±0.12 mg/kg.wet.weight (for first weight class) and 7.68±0.04 (for second weight class) (Fig 1); Fe: 1.29±0.19 mg/kg.wet.weight (for first weight class) and 1.17±0.03 (for second weight class) (Fig 2); Cu: 3.02±0.04 mg/kg.wet.weight (for first weight class) and 2.96±0.06 (for second weight class) (Fig 3); Mg: 0.10±0.05 mg/kg.wet.weight (for first weight class) and 0.11±0.02 (for second weight class) (Fig 4); Mn: 0.57±0.05 mg/kg.wet.weight (for first weight class) and 0.52±0.06 (for second weight class) (Fig 5). Also, there were no significant differences between two weight classes in terms of muscular content of Zn (Fig 1, $P>0.05$), Fe (Fig 2, $P>0.05$), Cu (Fig 3, $P>0.05$), Mg (Fig 4, $P>0.05$) and Mn (Fig 5, $P>0.05$).

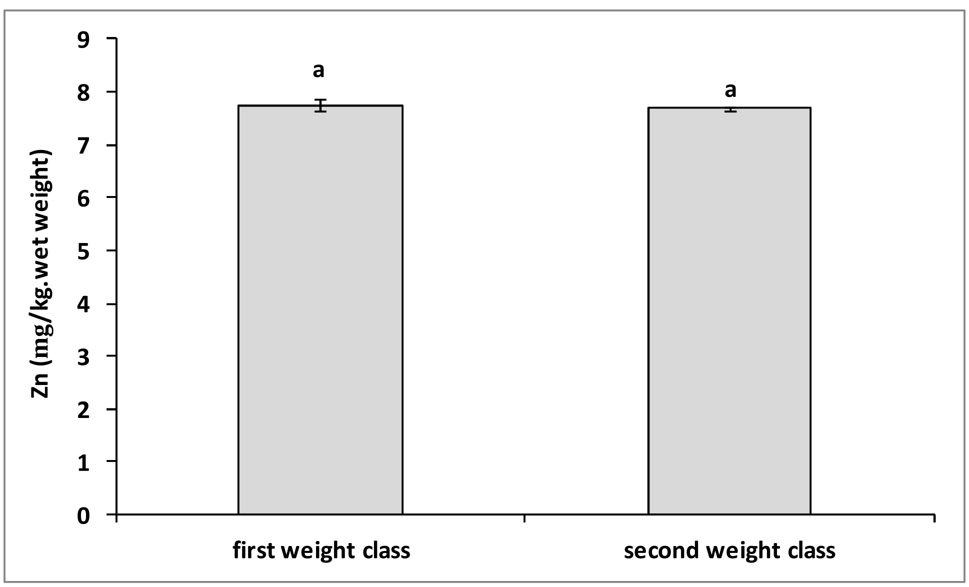

Fig 1. The comparison of Zn levels between in two weight classes of green tiger shrimp, *Penaeus semisulcatus* captured from Bahrekan coast. Bars (Mean ± SD) with the same letter are not significantly different (p>0.05).

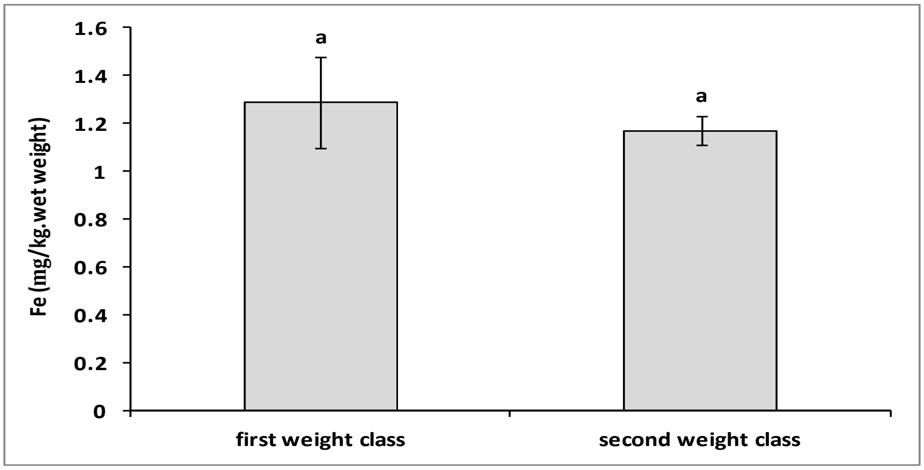

Fig 2. The comparison of Fe levels between in two weight classes of green tiger shrimp, *Penaeus semisulcatus* captured from Bahrekan coast. Bars (Mean ± SD) with the same letter are not significantly different (p>0.05).

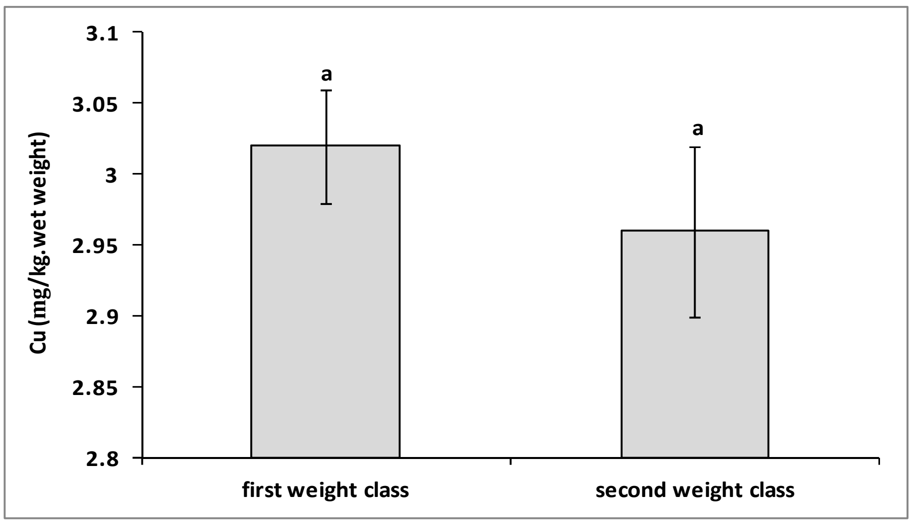

Fig 3. The comparison of Cu levels between in two weight classes of green tiger shrimp, *Penaeus semisulcatus* captured from Bahrekan coast. Bars (Mean ± SD) with the same letter are not significantly different (p>0.05).

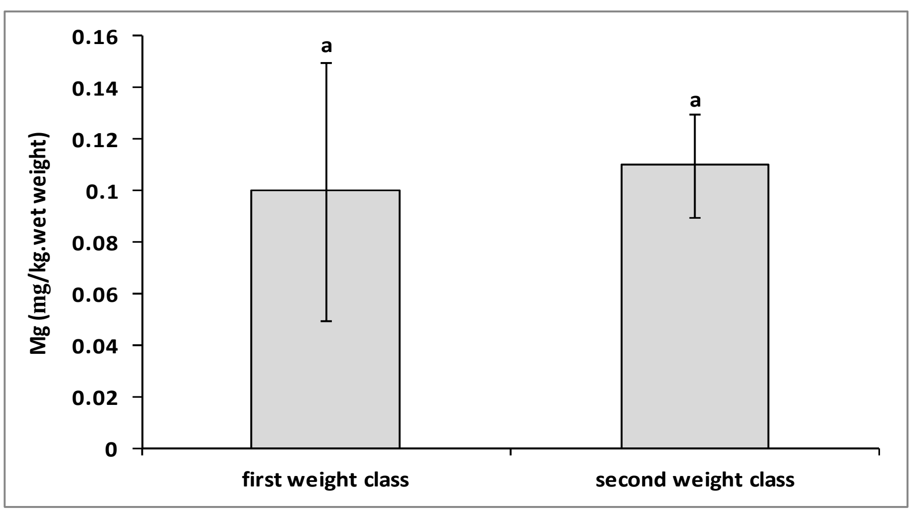

Fig 4. The comparison of Mg levels between in two weight classes of green tiger shrimp, *Penaeus semisulcatus* captured from Bahrekan coast. Bars (Mean ± SD) with the same letter are not significantly different (p>0.05).

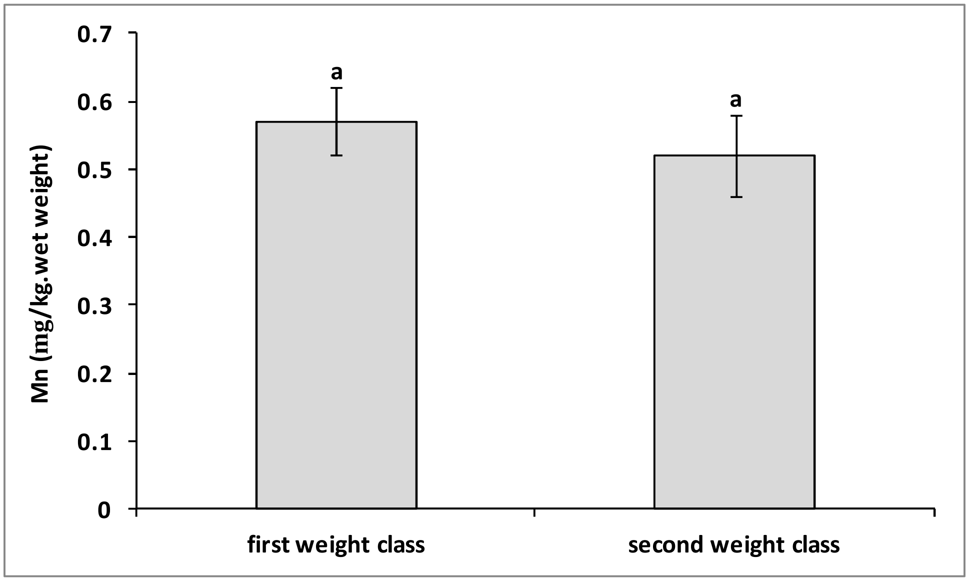

Fig 5. The comparison of Mn levels between in two weight classes of green tiger shrimp, *Penaeus semisulcatus* captured from Bahrekan coast. Bars (Mean ± SD) with the same letter are not significantly different (p>0.05).

DISCUSSION

The results of the present study showed a muscular concentration of 7.75±0.12 mg/kg. wet. weight Zn for first weight class and 7.68±0.04 mg/kg. wet. weight Zn for second weight class of tiger shrimps which were less than standards of Food and Agriculture Organization of the United Nations (FAO) for Zn i.e. 1000 ppm/wet. weight (El Gendy *et al*., 2015). Many studies have reported Zn contents in the muscle of shrimp species, including *Penaeus merguiensis* (40.20 µg/g.dry.weight; Pourang and Amini, 2001), *Metapenaeus affinis* (46.05 µg/g.dry.weight; Pourang and Amini, 2001), *Portunus pelagicus* (206 ppm/dry.weight; Al-Mohanna and Subrahmanyam, 2001) and *penaeus semisulcatus* (8.977 µg/g. wet weight; Pourang *et al*., 2005). The main sources of Zn pollution are the wastes of agricultural activities such as pesticides ,food industry and also the industries involved in the production of paintand anti-corrosion materials (El Gendy *et al*., 2015). Zn is an essential metal in biological systems which it plays an important role in RNA and DNA synthesis and cell division (Soliman, 2015). In our study, the values of Cu in muscle were 3.02±0.04 and 2.96±0.06 mg/kg.wet weight for first weight class and second weight class of tiger shrimps respectively. These values were less than the standards of World Health Organization (WHO) (30 ppm/wet weight) for Cu (El Gendy *et al*., 2015). There are several reports on Cu concentrations in muscle tissue of penaeidae including *Penaeus semisulcatus* (3.418 µg/g.wet weight; Pourang *et al*., 2005), *Fenneropenaeus merguiensis* (1.26 µg/g.dry.weight; Javaheri Baboli and Velayatzadeh, 2013). Cu contamination of aquatic environments occurs usually through use of anti-corrosions on ship hulls and also runoff of municipal and industrial activities such as mining, metallurgy and the production of chemical dyes and algaecides (El Gendy *et al*., 2015). Cu and Zn are of essential metals and have important role in cellular metabolism and survival of the most animals including crabs (as a blue-blooded aquatic animal). Therefore, the high levels of these metals may be due to the more essentiality of them for crabs (Javaheri Baboli and Velayatzadeh, 2013). In the present study, the muscular concentrations of Fe were 1.29±0.19 and 1.17±0.03 mg/kg. wet weight for first and second weight class of tiger shrimps respectively. These concentrations were lower than those reported by WHO (100 mg/kg.wet weight) (Olgunoğlu, 2015). There are many reports regarding muscular concentrations of Fe in penaeidae. For example, *Penaeus merguiensis* (17.77 µg/g. dry weight; Pourang and Amini, 2001), *Metapenaeus affinis* (22.15 µg/g.dry weight; Pourang and Amini, 2001) and *Fenneropenaeus merguiensis* (15.13 µg/g.dry weight (Javaheri Baboli and Velayatzadeh, 2013). In organisms, Fe as a part of hemoglobin is involved in electron and oxygen transportation. Also, Fe is a key element in many enzymatic systems of organisms (Javaheri Baboli and Velayatzadeh, 2013). In our study, the concentrations of 0.57±0.05 (for first weight class) and 0.52±0.06 mg/kg.wet.weight (for second weight class) Mn were found in muscle tissue of tiger shrimps. These concentrations were less than those recommended by WHO (1 mg/kg.wet.weight; Olgunoğlu, 2015). According to existing studies, various Mn concentrations have been reported in muscle tissue of shrimp species. In this regard, the Mn concentrations of 0.95

ppm/dry.weight and 0.1 µg/g.dry.weight were reported for *Portunus pelagicus* (Al-Mohanna and Subrahmanyam, 2001) and *Fenneropenaeu merguiensis* (Javaheri Baboli and Velayatzadeh, 2013) respectively. Human requirements to Mn is little (10-20 mg) in normal condition. Mn acts as a co-enzyme for important enzymes, oxidoreductase, transferase, hydrolase, lyase, ligase and isomerase (Zodape, 2015). In our study, Mg concentrations muscle of tiger shrimps were 0.10±0.05 mg/kg.wet.weight (for first weight class) and 0.11±0.02 (for second weight class). These concentrations were lower than those reported by Javaheri Baboli and Velayatzadeh (2013) in *Fenneropenaeu merguiensis* (321.33 µg/g.dry.weight). With regards to our results, the order of heavy metal accumulation in muscle tissue of tiger shrimp was Mg>Fe>Cu>Zn>Mn. Javaheri Baboli and Velayatzadeh (2013) have reported the order of Mg>Fe>Cu>Zn>Mn in the muscle of *Fenneropenaeus merguiensis*. Also, the order of Mn>Zn<Fe was found in the muscle of *Penaeus semisulcatus* (Heidarieh *et al*., 2013). In general, the concentration of accumulated heavy metals depends on external (such as: soluble metals, physicochemical properties, metal interactions, sediment, food and etc.) and internal (such as: individual differences, body size, growth stage, sex and etc.) cues (Olgunoğlu, 2013). The results of the present study showed lower concentrations of essential metals, Cu, Fe, Zn, Mn and Mg in muscle of tiger shrimps compared to standards limits. Also, there were no significant differences between first and second weight classes of tiger shrimps. The reported Zn concentrations in our study was similar that reported by Soliman (2015). In the studies of Rainbow (1990 and 1996), the size of crabs had no impact on concentrations of heavy metals, Cu, Fe and Zn, indicating a physiological acclimation to essential metals and thus maintenance of them in stable concentrations.

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REFERENCES

Al-Mohanna, S.Y. and M.N.V. Subrahmanyam (2001). Flux of heavy metal accumulation in various organs of the intertidal marine blue crab, *Portunus pelagicus* (L.) from the Kuwait coast after the Gulf War. Environ. Int., 27(4):321–326.

Chang, E.S. and M. Thiel (2015). Physiology. The Natural history of the Crustacea, Oxf. Univ .Press., 4:1-512

El Gendy, A., S. Al Farrajand and M. El Hedeny (2015). Heavy Metal Concentrations in Tissues of the Shrimp *Penaeus semisulcatus* (De Haan, 1844) From Jazan, Southern Red Sea Coast of Saudi Arabia. Pakistan. J. Zool., 47(3): 671-677.

França, S., C. Vinagre, I. Caçador and N.C. Henrique (2005). Heavy metal concentrations in sediment, benthic invertebrates and fish in three salt marsh areas subjected to different pollution loads in the Tagus Estuary (Portugal). Baseline / Mar .Pollut. Bull., 50:998–1003.

Heidarieh, M., M. Ghannadi Maragheh, M. Azizi Shamami, M. Behgar, F. Ziaeiand and Z. Akbari (2013). Evaluate of heavy metal concentration in shrimp (*Penaeus semisulcatus*) and crab (*Portunus pelagicus*) with INAA method. J. Springer Plus., 2:1-5

Javaheri Baboli, M. and M. Velayatzadeh (2013). Determination of heavy metals and trace elements in the muscles of marine shrimp, *Fenneropenaeus merguiensis* from Persian Gulf, Iran. J. Anim. Plant. Sci., 23(3): 786–791.

Külcü, A.M., D. Ayas, A.R. Köşker and K. Yatkin (2014). The Investigation of Metal and Mineral Levels of Some Marine Species from the Northeastern Mediterranean Sea. J. Mar. Biol. Oceanogr., 3:2

Mirabi, A., Z. Dalirandeh And A. Shokuhi Rad (2015). Preparation of modified magnetic nanoparticles as a sorbent for the preconcentration and determination of cadmium ions in food and environmental water samples prior to flame atomic absorption spectrometry. J. Magn. Magn. Mater., 381:138–144.

Naser, H.A. (2013). Assessment and management of heavy metal pollution in the marine environment of the Arabian Gulf: A review. Mar. Pollut. Bull., 72 :6–13.

Olgunoğlu, M.P. (2013). Heavy metal Contents in Muscle Tissue of Three Deep-Seawater Mediterranean Shrimp Species (*Plesionika martia*, *Plesionka edwardsii*, *Aristeus antennatus*). Pol. J. Environ. Stud., 24: 103-107.

Pourang, N., J.H. Dennis and H. Ghourchian (2005). Distribution of heavy metals in *Penaeus semisulcatus* from Persian Gulf and possible role of metallothionein in their redistribution during storage. Environ. Monit. Asses., 100: 71–88.

Pourang, N. and G. Amini (2001). Distribution of trace elements in tissues of two shrimp species from Persian Gulf and effects of storage temperature on elements transportation. J. Water. Air. Soil. Pollut ., 129: 229–243.

Rainbow, P.S. (1990). Heavy metal levels in marine invertebrates. In: Furness, R.W., Rainbow, P.S. (Eds.), Heavy Metals in the Marine Environment. CRC Press, Inc., Boca Raton ., 67–79.

Rainbow, P.S. (1996). Heavy metals in aquatic invertebrates. In: Beyer, W.N., Heinz, G.H., Redmon-Norwood, A.M. (Eds.), Environmental Contaminants in Wildlife: Interpreting Tissue Concentrations. Lewis Publishers, Boca Raton., 405–425.

Soliman, I. (2006). A Study of Heavy Metals Pollution in Some Aquatic Organisms in Suez Canal in Port-Said Harbour. J. Appli. Sci. Res., 2(10):657-663.

Zodape, G.V. (2014). Heavy Metal Contamination in Commercially Important Prawns and Shrimps Species Collected From Vile-Parle and Bandra Markets of Mumbai (West Coast) India. Indian. J. Appli. Res. Zool., 4(8): 670- 674.