j.Egypt.net.med.Assoc 76, no 3. 325 - 333 (2016)

# SOME HEAVY METALS RESIDUES IN CEUSTACEAN

By

**Ibrahim, M.A.A[1], Hamouda, A.A.T[1], and El - Mossalami, M.K[2]**

[1]Dept. of Food Hygiene and Control, Agri. Res. Center, Animal Health Res. Institute, Dokki, Giza

[2] Dept. of Food Hygiene and Control, Faculty. of Vet. Med., Cairo University

## ABSTRACT

In this study, a total of 100 samples of locally produced marketed crab (Callinectes Pallidus) and shrimp (Penaeus Natialis) 50 of each were collected from different fish markets and supermarkets in Giza Governorate, Egypt.The collected samples were analyzed for determination of lead, Cadmium, mercury and iron concentrations by using Atomic Absorption Spectrophotometry. Results revealed that, the mean concentration of Pb, Cd, Hg and Fe in muscle of crab flesh were 2.09, 0.15, ND and 16.06 ppm, respectively while in shrimp flesh were 0.89, 013, ND and 15.95 ppm, respectively. Also, results revealed that 100% of examined samples of crab and 38% of examined shrimp samples were contained Pb levels over the permissible limit according to **Egyptian standard 2360 (1993)**. While, the concentration of Cd was above the permissible limits according to **Egyptian standard 2360 (1993)** in all samples by 70% for both types. In addition, the Fe was above the permissible limit According to **WHO (1989)** in crab by 10% and 6% for shrimp flesh samples. Public health significance of the examined heavy metals, prevention measures and recommendations were discussed. Lead toxicity because central nervous system (neuropathy) and nephritis, Cadmium accumulates in liver and kidney causing kidney damage, Mercury can cross blood brain barrier and placenta cause neurological and teratogenic disorders, finally Iron cause organ failure and death occur.

**Key words:**

Crustacean, heavy metals, lead, cadmium, mercury, iron.

## INTRODUCTION

Fish, fish products and crustacean are widely consumed in many parts of the world by human because it has high protein content, low saturated fat and contain omega-3 fatty acids known to support good health. Owing to the great consumption of these fish and crustacean, the safety issues related to the possibility of heavy metals contamination are of great concern. Heavy metals still play an important role as pollutants affecting aquatic systems **(Mitra *et al.*,**

**2010)**.These metals, or some form of themare commonly found infood stuffs. The progressive and irreversible accumulation of these metals in various organs of marine organisms leads to metal related disease. Mercury (Hg), cadmium (Cd), lead (Pb) and arsenic considered as a major problem related to environmental pollution and are known because of their toxic, mutagenic and carcinogenic properties**(Belitz *et al.*,2001)**.Therefore.The presented study to throw light on the contamination levels of crustacean (crab and shrimp) by lead, cadmium, mercury and iron as well as their public health significance.

## MATERIAL AND METHODS

**Collection of samples:**

A total of 100 random samples of crab and shrimp (50 of each) were collected from fish markets and super markets from Giza Governorate. All samples were labeled then taken to the laboratory for analysis.

**Samples preparation (Greig *et al.*, 1982).**

A measured weight representative sample (three grams net weight) was taken from thoroughly homogenized edible tissues of each crustacean species then transferred into clean, acid washed screw-capped digestion tubes. All digestion tubes containing the representative samples were identified for examination.

**Digestion and analysis procedures:**

All samples were digested with pure analar concentrated nitric acid. 10 ml were added and thoroughly mixed then kept overnight at room temperature. The mixture was heated in a water bath at 65-70ºC for six hours. The mixture was cooled at room temperature then few drops of 30% hydrogen peroxide ($H_2O_2$) were added. After cooling 10 ml of deionized water were added to dilute the digesta then filtration and the clean filtrates were kept in screw capped tubes in a refrigerator. Atomic absorption spectrophotometer model (SENS) model 2015Argentina was used for quantitative determination of studied elements according to **Abdallah and Mostafa (1980); Welz and Melcher (1985); Medina *et al.* (1986) and Abdallah *et al.* (1993).**

**Quantitative determination of heavy metals:**

The concentration of lead, cadmium, mercury and iron (ppm) in each sample were calculated according to the following equation.

$C_1= (A_1/ A_2)\ C\ (D/W)$

Where:

$C_1$: heavy metal concentration in a sample (ppm net weight)
$A_1$: absorbance reading of sample solution.
$A_2$: absorbance reading of a standard solution.
C: concentration of heavy metal (μg/ml) of the standard solution.
D: dilution factor of a sample.
W: weight of a sample.

## RESULT AND DISCUSSION

**Table (1):** Lead residues (ppm) content in flesh of crab and shrimp samples (n=50 for each species).

| Samples | Minimum | Maximum | Mean ± SE | Samples exceed permissible limits (1.0ppm) * |
|---|---|---|---|---|
| **Crab** | **1.03** | **4.28** | **2.09 ± 0.06** | **50 (100%)** |
| **Shrimp** | **0.006** | **3.42** | **0.89 ± 0.095** | **19 (38%)** |

***According to ESS 2360 / (1993).**

Table (1) showed that, the Pb concentration (ppm) in crab was ranged from 1.03 ppm to 4.28 ppm with a mean level 2.09 ppm. Lower lead concentrations in crab than the present findings were reported by **Ahdy *et al.* (2007), Nasef *et al. i*n Egypt (2013) and Younis *et al.* (2015) in USA.** Nearly similar results of lead concentration in crab were detected by **Chitrarasu *et al* (2013)** in India**.** While very high lead level than the obtained results were recorded by **Botello (1996) Mexico** who found that pb was 12.13 ppm. Lead concentration in shrimp was ranged from 0.006 to 3.42 with mean value 0.89 ppm. From obtained results lead concentration exceeded the permissible limit (1.0 ppm) recommended by **ESS 2360 / (1993)** in 19 samples representing 38%. Lower lead concentrations in shrimp were reported by **Baboli and Velayotzdeh (2013)**. Nearly similar results were reported by **Abdel-Salam and Hamdi (2014).** Very high level of Pb in shrimp was detected by **Guhathakurta and Kaviraj (2000)** who found Pb concentration in shrimp flesh was 32.12 ppm in India. Presence of lead residues in crustacean may be attributed to contamination of aquatic environment with lead compounds. Moreover, excessive feeding by filtration result in high lead concentration in soft tissues. Lead concentration above the permissible limit represent an additional route of lead exposures and act as a serious health hazard for human especially children. Central nervous system is the target lead toxicity. Where characteristics of Pb toxicity are nephritis, neuropathy, rheumatic findings and anemia **(Goldfrank *et al.,* 1990).**

**Table (2):** Cadmium residues (ppm) content in flesh of crab and shrimp of examined samples (n=50 for each species).

| Samples | Minimum | Maximum | Mean $\pm$ SE | Samples exceed permissible limits (0.1ppm) * |
|---|---|---|---|---|
| **Crab** | **0.12** | **0.52** | **0.15 $\pm$ 0.009** | **35 (70%)** |
| **Shrimp** | **0.026** | **0.50** | **0.13 $\pm$ 0.01** | **35 (70%)** |

*** According to ESS 2360 / (1993).**

Table (2) showed that, the Cd concentration (ppm) in crab was ranged from 0.12 ppm to 0.52 ppm with a mean level 0.15 ppm. Lower Cd concentration in crab than the present findings were reported by **Ghorab and Khebbeb (2012) and Nasef *et al.* (2013).** Nearly similar results were recorded by **Abd El-Massih (1994).**While, very high level of Cd in crab was reported by **Chritrarasu *et al.* (2013)** who found that Cd concentration was 2.5 ppm. High level of Cd in crab reported by **Umunnakwe and Ogamba (2013).** In examined shrimp samples, the Cd concentration was ranged from 0.026 to 0.50 with mean level 0.13 ppm. From the obtained data lower Cd concentration in shrimp were reported by **Madany *et al.* (1996), Tabinda *et al.* (2010) and Ogundiran and Fasakin (2015).** Nearly similar finding of Cd in shrimp samples were recorded by **Baboli in Mexico and Velayatzadeh (2013)** who found that, the concentration of Cd was 0.175 ppm. High level of Cd in examined shrimp was recorded by **Bin Mokhtar *et al.* (2009).** From the obtained results in (Table 2) showed that Cd concentration exceeded the permissible limit (0.1 ppm) recommended by According to **ESS 2360/(1993)** in 35 samples representing 70% of examined shrimp samples. Presence of cadmium residues in examined samples may be attributed to contamination of aquatic environment with Cd compounds like cadmium waste stream from the industries mainly ends up in soil and uptake through food. Soils that are acidified enhance Cd uptake by plants. In aquatic ecosystem Cd can bioaccumulate in mussels, oysters, shrimp, lobsters and fish **(Umunnakwe and Ogamba, 2013).** Also, **Mitra *et al.* (2010)** added that, the main source of Cd in Aquatic environment was electroplating, manufacturing of Cd alloys and of pigments and plastic stabilizers, production of Nickel- Cadmium batteries and Wielding. In addition, crustacean containing cadmium concentration above the permissible limit may have a critical impact on public health. Cd accumulates mainly in liver and kidney included kidney damage **(Goyer, 1996).**

**Table (3):** Mercury residues (ppm) in flesh of crab and shrimp examined samples (n=50 for each species).

| Samples | Minimum | Maximum | Mean $\pm$ SE | Samples exceed permissible limits (0.5ppm)* |
|---|---|---|---|---|
| **Crab** | **Not detected** | **Not detected** | **Not detected** | **0 (0%)** |
| **Shrimp** | **Not detected** | **Not detected** | **Not detected** | **0 (0%)** |

***According to WHO (1989).**

The obtained data in (Table 3) revealed that Hg was not detected in any examined crustacean's samples. The obtained results showed that, the Hg concentration not exceeded the permissible limit (0.5 ppm) recommended by **WHO (1989)** standard from any examined samples of crab and shrimp. In contrast to our results, **Gawish (1998) and Ahdy *et al.* (2007)** reported Hg concentration 0.72 and 0.13 ppm, respectively. For shrimp, **Biney and Ameyibor (1992), Madany *et al.* (1996) and Baboli and Velayazadeh (2013)** found different concentration of Hg in examined shrimp samples. Nearly similar results were recorded by **Younis *et al.* (2015)** who failed to detected Hg in samples collected from Jeddah, Red sea, Kingdom Saudi Arabia. Mercury is non-essential trace metal, present in organic and inorganic forms **(Chen *et al.*, 2002).** Organic Hg compounds liberate their Hg slowly into tissues and cause degenerative changes in brain and peripheral nerves and in kidney. Also, Hg can cross the blood-brain barrier and placenta caused neurological and teratogenic disorders **(Marsh *et al.*, 1981).**

**Table (4):** Iron residues (ppm) in flesh of crab and shrimp of examined samples (n=50 for each species).

| Samples | Minimum | Maximum | Mean $\pm$ SE | Samples exceed permissible limits (50 ppm)* |
|---|---|---|---|---|
| **Crab** | **4.01** | **57.07** | **16.06 $\pm$ 2.04** | **5 (10%)** |
| **Shrimp** | **4.15** | **56.95** | **15.95 $\pm$ 1.09** | **3 (6%)** |

***According to WHO (1989).**

Table (4) showed that, the Fe concentration (ppm) in crab was ranged from 4.01 to 57.05 with a mean value 16.06 ppm and showed also that Fe concentration exceeded the permissible limit (50 ppm) recommended by **WHO (1989)** standard in 5 samples, representing 10 % of examined samples. Lower Fe concentration in crab than our result was reported by **Ahdy *et al.* (2007)**. Nearly similar results obtained by **Hosseini *et al.* (2012)**. High value of Fe residues in crab was reported by **Olowu *et al.* (2015).** Also, Fe residues in shrimp (ppm) were ranged from 4.15 to 56.95 with mean value 15.95 ppm. Fe concentration exceed the permissible limit (50 ppm) recommended by **WHO (1989)** in 3 samples representing 6%. Lower Fe concentration than the present findings were reported by **Ahdy *et al.* (2007)**. Very low level of Fe residues was reported by **Tabina *et al.* (2010).** Similar results of Fe concentration were reported by **Pournag and Amini (2001)**. High Fe residual content were reported by **Paez-Osuna and Tron-Mayen (1995) and Abdel-Salam and Hamdi (2014)**. Iron has very different function in the body. It serves as a carrier of oxygen to the tissues from the lungs by red blood cell hemoglobin, as transport medium for important enzyme systems in various tissues **(Camara *et al.,* 2005).** Moreover, **Bothwell and Charlton (1982)** found that there are two situations in which people were at risk of excessive storage of Fe in the body if they consume an excess iron. One was in people with refractory anemia associated with chronic bone marrow failure, such as that occurs in thalassemia. The other was in people who had another disorder of iron metabolism know as haemochromatosis. In both cases, iron overload can occur with accumulation of the metal in organs such as liver, pancreas and heart. Organ failure and death can occur.

## CONCLUSION AND RECOMMENDATION

It can be concluded from present investigation that analysis of crab and shrimp samples indicates contamination of these samples with heavy metals. Lead and cadmium were found with higher concentration exceed the permissible limit.

In order to protect human health from the hazardous effect of these chemical in crustaceans, the following recommendations should be applied:

1- A regular and representative monitoring of toxic metals in crustaceans in fish market and supermarkets are recommended.

2- Further reduction in the levels of environmental contaminants emanating from power plants and other industrial emission and effluent discharge are highly needed to reduce contaminant in puts into the aquatic environment to protect aquatic life and consumers.

## REFERENCES


**Abdallah, A.M. and Mostafa,M.A. (1980):**A flame molecular emission method for the determination of strontium in fresh waters. Annali dichimica by Societa Chimica Italibana, 70: 1 - 8.

**Abdallah, A.M., El-Dafrawy, M.M., Nazar, N. and El-Shamy, M. (1993):** Elimination of the interfering of transition metals in the hydride generation atomic absorption spectrometric determination of tin. J. Atomic Absorption Spectrophotometer, 8: 759.

**Abd El-Massih, S.G. (1994):** Microbial and chemical pollution of shellfish at their growing areas. Ph.D. Thesis, Fac. Vet. Med. Alex. Univ.

**Abdel-Salam,A.H.and Hamdi, A.S. (2014):** Heavy metals monitoring using commercially important crustaceans and mallusks collected from Egyptian and Saudia Arabia Costs. Animal and Veterinary Science, 2 (3):49-61.

**Ahdy, H.H.H.; Abdallah, A.M.A. and Tayel, F.T. (2007):** Assessment of heavy metals and non-essential content of some edible and soft tissues. Egyptian journal of Aquatic Research, 33 (1):85-87.

**Baboli, J. and Velayatzadeh, M. (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.

**Belitz,H.D.;Grosch,W.and Schieberle, P. (2001):** Lehrbuch der Lebensmittelchemie. Berlin:Springer, ISBN 3-540 - 41096 15.

**Bin-Mokhtar, M.; Aris, A.Z.; Munusamy, V. and Praveena, S.M. (2009):** Assessment level of heavy metals in *Penaeus monodon* and *Oreochromis* Spp. in selected aquaculture ponds of high densities development area. Eur. J. Sci. Res., 30: 348-360.

**Biney, C.A. and Ameyibor, E. (1992):** Trace metal concentrations in the pink shrimp Penaeus notialis, from the coast of Ghana. Journal of Water Air Soil Pollution, 63:273-279.

**Botello, V.A. (1996):** Hidrocarburos tóxicos en cuerpos acuáticos y su bioacumulación. Informe Final presentado a Petróleos Mexicanos. Instituto de Ciencias del Mar y Limnología, UNAM (Eds.), México.

**Bothwell, T.H., and Charlton,R.W. (1982):** A general approach to the problems of iron deficiency and iron overload in the population at large. Semin. Hematol, 19:54 - 62.

**Camara, F.; Amaro,M.A.; Barbera, R. and Clemente, G. (2005):** Bio accessibility of minerals in school meals: comparison between dialysis and solubility methods. Food Chemistry, 92: 481- 489.

**Chen, M.H.; Shih, C.C.; Chou, C.L. and Chou, L.S. (2002):** Mercury, organic-mercury and selenium in small cetaceans in Taiwanese waters. Marine Pollution Bulletin, 45: 237-245.

**Chitrarasu, P.; Jawahar Ali, A. and Babuthangadurai, T. (2013):** Study on the bioaccumulation of heavy metals in commercially valuable and edible marine species of Ennore creek, South India, Int. J. Pharm. Bio. Sci.; 4 (2): 1063-1069.

**ESS 2360 (1993) :** Egyptian specification standard for max residue limits for heavy metals in food and fish, PP.S, Egyptian Organization for standardization and quality control, Cairo, Egypt.

**Gawish, M.M. (1998):** Studies on some heavy metals in some marine organisms. M.Sc. Thesis, Fac. Agriculture, Mansoura Univ.

**Ghorab I. and Khebbeb M. (2012):** Assessment of heavy metal concentrations (Lead, Cadmium and Zinc) in three Crustacean species fished for in two regions of eastern Algeria. Annals of Biological Research, 3 (6):2838 - 2842

**Goldfrank,L.R.; Osborn, H. and Hartnett, L.(1990):** Lead. In: Goldfrank, L.R.; Flomentbaum, N.E.; Lewin, N.A.; Weisman, R.S. and Howland, M.A. (Eds.): Goldfrank's Toxicological Emergencies. 4th edition. pp. 627-637. Prentice-Hall International Inc. New Jersey, USA.

**Goyer, R.A. (1996):** Mechanism of lead and cadmium nephrotoxicity. Toxical Lett, 46: 153-162.

**Greig, R.A.; Sawyer, T.K.; Lewis, E.J. and Galasso, M.E. (1982):** A study of metal concentrations in relation to gill color and pathology in the rock crab. Archives of Environmental Contamination and Toxicology, 11:539 -597.

**Guhathakurta, H. and Kaviraj, A. (2000):** Heavy metal concentration in water, sediment, shrimp (Penaeus monodon) and mullet (Liza parsia ) in some brackish water ponds of Sunderban, India. Marine Pollution Bulltein, 40 (11): 914-920.

**Hosseini, M.; Bastami, A.A.; Khoei, J.K.; Songhori, E.J. and Najafzadeh, M. (2012):** Concentrations of Heavy Metals in Selected Tissues of Blue Swimming Crab, Portunus pelagicus (Linnaeus, 1758) and Sediments from Persian Gulf. World Applied Sciences Journal, 19 (10): 1398-1405.

**Madany, I.M., Wahab, A.A.A. and Z. Al-Alawi (1996):** Trace metals vconcentrations in marine organisms from the coastal areas of Bahrain, Arabian Gulf. Journal of Water Air Soil Pollution, 91: 233-248.

**Marsh, D.O.; Myers, G.J.; Clarkson, T.W.; Amin-zaki, L.; Tkriti, S.; Majeed, M.A. and Dabbagh, A.R. (1981):** Dose-response relationship for human fetal exposure to methylmercury. Clinical toxicology, 18:1311-1318.

**Medina, J.; Hernadez, F.; Pastor, A. and Beforull, J.B. (1986):**Determination of mercury, cadmium, chromium and lead in marine organisms by flameless atomic absorption spectrophotometery. Marine Poll. Bull., 17: 41- 44.

**Mitra, A.; Mondal, K. and Banerjee, K. (2010):** Concentration of Heavy Metals in Fish Juveniles of Gangetic Delta of West Bengal, India. Journal of Fisheries and Hydrobiology, 5 (1): 21-26.

**Nasef, M.E.A.; Marouf, H.A.; Dorah, E.H.I. and Abo-Samra, R.G. (2013):** Comparison of lead, cadmium and zinc concentration in locally produced salted fish, smoked herring and shellfish at Damietta Governorate, Mansoura. Vet. Med. J., xv(1):147-160.

**Ogundiran, M.B. and Fasakin, S.A. (2015):** Assessment of heavy metals and crude protein content of molluscs and crustaceans from two selected cities in Nigeria. African Journal of Food, Agriculture, Nutrition and Development, 15 (3):10099-10117.

**Olowu, R.A.; Jimoh, A.A.; Onwordi, C.T.; Onipede, O.J.; Ogunnaike, B.A. and Amosu, A.O. (2015):** Potential Toxic Metals Concentrations in Different Aquatic Lives Harvested from Lagos Island and Epe Lagoons. World Environment, 5 (2): 80-89

**Paez-Osuna F. and Ruiz-Fernandez, A.C. (1995):** Comparative bioaccumulation of trace metals in Penaeus stylirostris in estuarine and coastal environments. Estuaries, Coastal Shelf Science, 40:35 - 44.

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

**Tabinda, A.B.; Hussain, M.; Ahmed, I. And Yasar, A.(2010):** Accumulation of Toxic and Essential Trace Metals in Fish and Prawns from Keti Bunder Thatta District, Sindh. Pakistan J. Zool., 42: 631-638.

**Umunnakwe, J.E. and Ogamba, A.S. (2013):** Bioaccumulation of heavy metals in crabs at Bundu-Ama community, Port Harcourt." Journal of Environmental and Earth Science, 3 (14): 11-21.

**Welz, B. and Melcher, M. (1985):** Decomposition of Marine Biological Tissues for Determination of Arsenic, Selenium, and Mercury Using Hydride-Generation and Cold-Vapor Atomic Absorption Spectrometries. Anal. Chem., 57 (2):427-431.

**WHO "World Health Organization" (1989):** Guidelines for the safe use of wastewater and excreta in agriculture and aquaculture. Measures for public health protection. London School of Hygiene and Tropical Medicine, UK. Pp 187.

**Younis, A.M.; Amin, H. F.; Alkaladi, A. and Mosleh, Y.Y.I. (2015):** Bioaccumulation of Heavy Metals in Fish, Squids and Crustaceans from the Red Sea, Jeddah Coast, Saudi Arabia. Z66.