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Heavy Metal Contamination in Commercialy Important Prawns and Shrimps Species Collected From Vile-Parle and Bandra Markets of Mumbai (West Coast) India

KEYWORDS: Prawn and shrimp, Heavy metals, Spectroscopy

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ABSTRACT *The Prawn and shrimp samples were collected from local markets of Vile –Parle and Bandra suburban areas of Mumbai city from June to December 2013. These prawn samples were dried in the laboratory and, the dried prawns were crushed into a fine powder by mortar and pestle and stored in amber colored bottles in vacuum desiccators. These samples were evaluated by Atomic Absorption spectrophotometer for the determination of the ten heavy metals namely Cu, Zn, Mn, Fe, Co, Cr, Ni, Pb, Cd, and Hg. In the present work, the mean values at minimum and maximum concentrations of copper, zinc, iron and chromium in the prawns and shrimp samples are found below the maximum specified acceptable concentration where as Mn, cobalt, nickel, lead, and cadmium these values were found above the maximum specified acceptable concentration as prescribed by WHO. The mean values of the minimum and maximum concentrations of mercury in the prawns and shrimp samples were not detected as these concentrations were either less than 0.001ppm or absent in all the species of prawns and shrimps.*

INTRODUCTION:

Coastal belts are highly populated and urbanized with industries. Marine food such as fish, prawn, crab and mussel are delicacies and form an important staple part of daily food. Pollution of aquatic environments with heavy metals has seriously increased worldwide attention and under certain environmental conditions, fish, Prawns and shrimps may concentrate large amounts of some metals from the water in their tissues. Heavy metals such as Cu, Zn, Mn, Fe, Co, Cr, Ni, Pb, Cd, and Hg are potentially harmful to most organisms even in very low concentrations and have been reported as hazardous environmental pollutants able to accumulate along the aquatic food chain with severe risk for animal and human health (Desi *et al.* 1998). Toxic heavy metal can cause dermatological diseases, skin cancer and internal cancers (liver, kidney, lung and bladder), cardiovascular disease, diabetes, and anaemia, as well as reproductive, developmental, immunological and neurological effects in the human body (Rose *et al.* 1992) and (Lukawski et al. 2005).

Hence it is necessary to monitor the concentration of these contaminants in prawns and shrimps so that a warning signals can be given to the society in case the concentration levels cross the threshold limits. The available literature reveals that the inshore water of the above creeks around Mumbai possesses elevated levels of contaminants and their consistent inputs have resulted their high build up a marine organism particularly fishes, prawns and shrimps. Hence it is expected that the sea food available around Mumbai may have elevated levels of pollutants. These contaminants if determined can lead to identify causes of disease or toxic effects which would be prevented in the population.

At present the population of Mumbai is severally suffering from lots of disorders particularly respiratory and digestive due to air and drinking waters. Most of these causes have been identified and remedial measures have been taken up. However, toxic effect due to metal contamination of fish, Prawns and shrimps, which is a main diet of majority of the population of Mumbai is not primarily addressed and completely neglected. In fact the relevant toxic effect may be already prevalent in the society and most probably they may become severe in due course of time. Hence, the stage has already reached to address the problem in detailed and to dig the thought under the problem.

It is therefore necessary to determine the extent of contaminants in prawns and shrimps as one of the major source of food so that the warning signals can be given to the society in case the threshold limits have reached. Even otherwise it becomes necessary to educate the society of the social evils of pollution. The study can also provide the information on possible causes of pollution. So that mitigation measures to minimize the pollution can be taken in time.

MATERIALS AND METHODS:

SAMPLE COLLECTION :

The Prawn samples of were collected from local markets of (Vile -Parle and Bandra) Mumbai city from June, 2013 to, December 2013. The Prawn samples, packed in propylene bags, were stored at – 20 ^{0}C in deep freezer in the Department of Zoology, S.S & L.S. Patkar College, Goregaon (West) Mumbai for further analysis.

SAMPLE DIGESTION:

Five replicates of samples containing 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 1 gm of dry weight samples and wait for 24 h, the samples were digested in Kjeldal flask. This mixture was digested by heating the flask in a heating mantel, at 100°C for 2 h, and 30 % hydrogen peroxide was added to it intermittently till a pale yellow-colored solution was obtained. The digestion flask was further heated gently until frothing subsided and the sample was then heated to dryness. The residue so obtained was left to cool for half an hour and dissolved in 30 ml of deionized water and the solution was filtered using Whatman filter paper No. 42. The digested sample was quantitatively transferred into 50 ml flask, and then diluted with distilled water up to the mark and stored in a polypropylene bottle. The above procedure was repeated for all the other samples. All above chemicals used were of analytical grade.

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PREPARATION OF STANDARD METAL ION SOLUTIONS:
Stock solutions (1µg / ml) of each of the metal ions were prepared using appropriate metal salt of AR grade quality in dilute hydrochloric acid. The working standards of these solutions were prepared by appropriate dilutions in distilled water.

INSTRUMENTATION:
The samples were analyzed on Inductively Coupled Plasma Atomic Emissions Spectroscopy (ICP-AES, Model ARCOS *from M/s. Spectro, Germany*) at the Sophisticated Analytical Instrument Facility (RSIC), Indian Institute Of Technology (IIT) Powai, Mumbai-400076, India.

CHEMICALS AND REAGENTS:
All the chemicals and reagents were procured from S.D. Fine Chemicals were of AR grade quality.

RESULTS AND DISCUSSIONS:

Table No. 1. Collection of prawn and shrimps from Vile -Parle market of Mumbai suburbans

S. No.	Name of the prawn/ Shrimp	Metal Ions									
		Cu	Zn	Mn	Fe	Co	Cr	Ni	Pb	Cd	Hg
1	Solenocera crassicornis	1.392	1.293	6.721	7.831	ND	0.148	2.127	4.196	ND	ND
2	Parapenaeopsis stylfera	1.275	5.982	7.921	7.272	0.014	0.442	2.112	2.294	ND	ND
3	Acetes indicus	0.987	1.283	8.085	6.589	ND	0.346	1.022	2.032	0.212	ND
4	Metapenaeus kutchensis	1.612	2.847	7.342	13.036	0.071	0.267	1.043	2.012	ND	ND
5	Metapenaeus brevicornis	0.908	1.873	8.876	8.188	0.018	0.154	1.011	1.087	0.110	ND
6	Parapenaeopsis hardwickii	1.543	2.732	7.012	7.652	ND	0.164	2.082	4.181	ND	ND
7	Microbrachium rosenbergii	2.328	4.087	6.087	2.251	ND	0.127	1.145	1.112	0.274	ND
8	Penaeus monodon	2.187	1.121	4.211	6.704	ND	0.108	1.018	1.132	0.113	ND
9	Penaeus japonicus	1.185	2.876	6.218	9.212	ND	0.128	1.078	3.067	0.239	ND
10	Penaeus semisulcatus	2.544	4.890	7.823	6.112	ND	0.111	1.068	2.029	0.103	ND

***Each value is the average of 5 determinations.**

Table No. 2. Collection of prawn and shrimps from Bandra market of Mumbai suburbans

S.No.	Name of the prawn/ Shrimp	Metal Ions									
		Cu	Zn	Mn	Fe	Co	Cr	Ni	Pb	Cd	Hg
1	Microbrachium rosenbergii	1.543	2.638	7.2	4.961	0.013	0.149	1.021	1.111	0.119	ND
2	Solenocera crassicornis	2.328	1.121	7.951	5.274	ND	0.175	0.021	3.139	0.033	ND
3	Metapenaeus Monoceros	2.187	1.693	6.823	3.175	ND	0.177	1.029	4.021	ND	ND
4	Metapenaeus affinis	1.124	1.873	6.125	4.223	0.017	0.184	0.077	2.043	0.752	ND
5	Parapenaeopsis hardwickii	1.11	3.39	7.215	8.473	ND	0.161	0.013	2.132	0.540	ND
6	Parapenaeopsis sculptilis	1.142	1.511	7.818	2.043	ND	0.141	1.011	1.033	ND	ND
7	Penaeus indicus	1.392	4.087	6.124	5.999	ND	0.051	0.034	1.036	0.033	ND
8	Penaeus monodon	1.124	3.428	3.342	2.621	0.012	0.011	1.034	3.135	ND	ND
9	Penaeus japonicus	1.124	1.217	4.985	5.941	0.017	0.048	0.057	2.039	0.026	ND
10	Penaeus semisulcatus	1.765	2.876	6.218	7.697	0.016	0.069	0.029	1.003	ND	ND

***Each value is the average of 5 determinations.**

COPPER (Cu)
Copper is an essential trace metal for all living organisms, and also required by crustacean species as an essential part of their oxygen-carrying pigment haemocynin Engel, 1981.

Excess accumulation of copper in hepatic cells causes liver diseases Walshe, (1984). Abnormal accumulation of copper in the tissues and blood is a point of similarity with genetic disease of man called Wilson's disease Jones & Hunt (1983) and Lee and Garvey (1998). Most absorbed copper is stored in liver and bone marrow where it is bound to metallothionein Sarkar et al. (1983), and acute exposure to copper results in nausea, vomiting, bloody diarrhea, hypertension, uremia and cardiovascular collapse Gossel & Bricker (1990).

In the present work, the values of the mean minimum and

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maximum concentrations of copper in the prawns and shrimp samples collected from Vile parle market are found to be 0.908 ppm in *Metapenaeus brevicornis* and 2.544 ppm in *Penaeus semisulcatus* and from Bandra market are found to be 1.11 ppm in *Parapenaeopsis hardwickii* and 2.328 ppm in *Solenocera crassicornis* respectively. These values were found below the specified Maximum acceptable concentration was found below the permissible limit as prescribed by (30 ppm) WHO (1989) and (10 ppm) by FAO maximum limits for prawn.

ZINC (Zn)

Zinc is called an "essential trace element" because a very small amount of zinc is necessary for human health Casarett & Doull's (1996). It is also used for asthma; diabetes; high blood pressure; acquired immunodeficiency syndrome (AIDS); Alzheimer's disease, Down syndrome, Hansen's disease, ulcerative colitis, peptic ulcers and promoting weight gain in people with eating disorders such as anorexia nervosa Casarett & Doull's (1996).

Both acute and chronic toxicity syndromes occur with large overdoses of zinc and the principal features are epigastric pain, diarrhea, nausea and vomiting. In addition to the gastrointestinal effects, the central nervous system may be affected, showing symptoms such as irritability, headache and lethargy (Hambidge et al., 1986).

In the present work, the values of the mean minimum and maximum concentrations of zinc in the prawns and shrimp samples collected from Vile parle market are found to be 1.121 ppm in *Penaeus monodon* and 4.890 ppm in *Penaeus semisulcatus* and from Bandra market are found to be 1.121 ppm in *Solenocera crassicornis* and 4.087 ppm in *Penaeus indicus* respectively. These values were found below the specified Maximum acceptable concentration WHO (1992) limits (1000 ppm).

MANGANESE (Mn)

Manganese is a mineral that is required in small amounts in the human body, in normal conditions, contains about 10 mg to 20mg of manganese, and it is present in enzymes like oxidoreductases, transferases, hydrolases, lyases, isomerases, and ligases (Oga, 2008; Goldhaber 2003) which are necessary for several biological functions.

High levels of manganese in human body can cause dermatitis, problems in the glucose metabolism and of proteins, mitochondria abnormalities, infertilities, bad formation of the bones, decrease of the serum cholesterol, and other diseases (ATSDR, 2000).

In the present work, the values of the mean minimum and maximum concentrations of Mn in the prawns and shrimp samples collected from Vile parle market are found to be 4.211 ppm in *Penaeus monodon* and 8.876 ppm in *Metapenaeus brevicornis* and from Bandra market are found to be 3.342 ppm in *Penaeus monodon* and 7.951 ppm in *Solenocera crassicornis* respectively. These values were found above the specified Maximum acceptable concentration (1 ppm) which was found above the permissible limit as prescribed by limits WHO (1989).

IRON (Fe)

The ingestion of large quantities of iron results in haemochromatosis a condition in which normal regulatory mechanisms do not operate effectively, leading to tissue damage as a result of the accumulation of iron. This condition rarely develops from simple dietary overloading Watt, and Merrill, (1963). Tissue damage has occurred, however, in association with excessive intake of iron from alcoholic beverages in some cases of alcoholism. Tissue damage has also resulted from prolonged consumption of acidic foodstuffs cooked in iron kitchenware Hopps (1972).

In the present work, the values of the mean minimum and maximum concentrations of iron in the prawns and shrimp samples collected from Vile parle market are found to be 2.251 ppm in *Microbrachium rosenbergii* and 13.036 ppm in *Metapenaeus kutchensis* and from Bandra market are found to be 2.043 ppm in *Parapenaeopsis sculptilis* and 8.473 ppm in *Parapenaeopsis hardwickii* respectively. These values were found below the specified Maximum acceptable concentration (100 ppm) limits by WHO 1989 for prawn.

COBALT (Co)

Cobalt is not often freely available in the environment, but when cobalt particles are not bound to soil or sediment particles the uptake by plants and animals is higher and accumulation in plants and animals may occur. Cobalt is used in many alloys (super alloys for parts in gas turbine aircraft engines, corrosion resistant alloys, high-speed steels, cemented carbides), in magnets and magnetic recording media, as catalysts for the petroleum and chemical industries, as drying agents for paints and inks. The radioactive isotopes, cobalt-60, is used in medical treatment and also to irradiate food, in order to preserve the food and protect the consumer. Cobalt is beneficial for humans because it is a part of vitamin B12, which is essential for human health. Cobalt is used to treat anaemia with pregnant women, because it stimulates the production of red blood cells. However, too high concentrations of cobalt may damage human health, mainly with people that work with cobalt. Health effects may also be caused by radiation of radioactive cobalt isotopes. This can cause sterility, hair loss, vomiting, bleeding, diarrhea, coma and even death.

In the present work, the values of the mean minimum and maximum concentrations of cobalt in the prawns and shrimp samples collected from Vile parle market are found to be 0.014 ppm in *Parapenaeopsis stylfera* and 0.071 ppm in *Metapenaeus kutchensis* and from Bandra market are found to be 0.012 ppm in *Penaeus monodon* and 0.017 ppm in *Metapenaeus affinis and Penaeus japonicus* respectively. These values were found above as compared with Arun Kumar K and Hema Achyuthan 2007.

CHROMIUM (Cr)

The particulates of chromium enter the aquatic medium through effluents discharged from tanneries, textiles, electroplating, mining, dyeing and printing industries (Mertz, 1992 ,1993; Burton et. al 1993; Burton, 1995). Chromium compounds have been found to be mutagenic and carcinogenic in a variety of test systems. Chromium is also a compound of biological interest, probably having a role in glucose and lipid metabolism as an essential nutrient. Death in acute chromium poisoning is usually due to uraemia. Chronic intoxication by inhalation or skin contact leads to incapacitating eczematous dermatitis, with oedema and ulceration (Lingard et. al 1979).

In the present work, the values of the mean minimum and maximum concentrations of chromium in the prawns and shrimp samples collected from Vile parle market are found to be 0.111 ppm in *Penaeus semisulcatus* and 0.442 ppm in *Parapenaeopsis stylfera* and from Bandra market are found to be 0.011 ppm in *Penaeus monodon* and 0. 184

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ppm in *Metapenaeus affinis and* respectively which was found below the permissible limit as prescribed by WHO (1989) (50 ppm) and by FAO(1 ppm) maximum limits for prawn.

NICKEL (Ni)

Nickel is called the depression and suicide metal as it is associated with these feelings and symptoms. It is a particularly deadly toxic metal Sunderan and Oskarsson, (1991).

Cocoa is one of the foodstuffs with higher than average natural nickel content. Small amount of nickel is needed by the body to produce red blood cells. However, excess amount can become toxic (Sunderan and Oskarsson 1991).

In the present work, the values of the mean minimum and maximum concentrations of nickel in the prawns and shrimp samples collected from Vile parle market are found to be 1.011 ppm in *Metapenaeus brevicornis* and 2.127 ppm in *Solenocera crassicornis* and from Bandra market are found to be 0.021 ppm in *Solenocera crassicornis* and 1.034 ppm in *Penaeus monodon* respectively.The upper maximum limits were found above the acceptable concentration 0.5ppm to 1.0 ppm by WHO (1989).

LEAD (Pb)

It is known as deadely and accumulative poison even when consumed in small quantaties and is capable of deadling nerve receptor in man Bodansky, and Latener, 1987. The main sources of lead pollution in the environment include effluents & emissions from industries, emissions from vehicles running on leaded petrol, the smoke and dust emissions of coal and gas-fired power stations, use of lead sheets by roofers as well as the use of paints and anti-rust agents. Contamination by lead of foodstuffs is caused by the soldered seams of cans and the soldered closures of condensed milk cans, the metal caps of wine bottles and, also by lead pipes used in drinking water systems Bodansky, and Latener, 1987.

From the public health point of view, lead toxicity reportedly causes renal tubular dysfunction indicated by proteinuria, aminoaciduria, glucosuria, hyperphosphaturia and impairment of sodium transport Goyer (1986) and Manahan (1992).

In the present work, the values of the mean minimum and maximum concentrations of lead in the prawns and shrimp samples collected from Vile parle market are found to be 1.087 ppm in *Metapenaeus brevicornis* and 4.196 ppm in *Solenocera crassicornis* and from Bandra market are found to be 1.003 ppm in *Penaeus semisulcatus* and 4.021 ppm in *Metapenaeus Monoceros* respectively. These values were found above the specified Maximum acceptable concentration as prescribed by WHO 1992 (0.5ppm).

CADMIUM (Cd)

Cadmium a highly toxic metal, is present throughout the environment and accumulates in liver and kidney of mammals through the food chain Barber, 1998. Cadmium may enter into the aquatic bodies through sewage sludge and with the run off from agricultural lands as it is one of the major components of phosphate fertilizers. Also, the major sources of contamination include electroplating, paper, PVC plastic, pigments and ceramic industries, battery, mining and smoldering units and many other modern industries Gupta, et al., 2003.

In the present work, the values of the mean minimum and maximum concentrations of cadmium in the prawns and shrimp samples collected from Vile parle market are found to be 0.103 ppm in *Penaeus semisulcatus* and 0.274 ppm in *Macrobrachium rosenbergii* and from Bandra market are found to be 0.026 ppm in *Penaeus japonicus* and 0.119 ppm in *Macrobrachium rosenbergii* respectively. These values were found above the specified Maximum acceptable concentration as prescribed by WHO (1984) 0.005 ppm.

MERCURY (Hg)

Mercury is extremely harmful, even a concentration of 0.03 ppm in drinking water is not permissible. Mercury enters natural water through industrial discharge where by bacterial action it is converted into very stable and water soluble methyl mercury ion. Mercury which is taken up by fish and through food chain enters higher animals and man. Most of the fish today have a mercury concentration of 0.02-0.2ppm which is now considered 'normal'. In polluted water its concentration may be even 1ppm. Consumption of such fish is hazardous, which was indeed the cause of death of over one thousand persons in the Minamata Island of Japan, due to what goes by name 'Minamata disease'. Mercury deactivates sulphur containing enzymes with active –SH groups, affects brain cells and central nervous system. Symptoms of mercury poisoning are physical and emotional disturbances, self-consciousness, timidity, embarrassment with insufficient reasoning, anxiety, indecision, lack of concentration, depression or despondency, resentment of criticism, irritability or excitability, a complete change of personality as of the Mad Hatter, a character depicted in the well-known " Alice in Wonderland" story (Banerjea 1995).

In the present work, the values of the mean minimum and maximum concentrations of mercury in the prawns and shrimp samples were not detected as these concentrations were either less than 0.001ppm or absent in all the species of prawns and shrimps.

CONCLUSION:

From the above results, in the case of metal contamination, Mn, cobalt, nickel, lead, and cadmium was found to be high in Prawn and shrimp samples collected from (Vile -Parle and Bandra) markets. It can be assumed that the sea from where the Prawn and shrimp were collected might be receiving outfalls from industrial waste and sewage from the city as it faces the open Arabian Sea. The levels of heavy metals such as copper, zinc, iron and chromium in Prawn and shrimp samples collected from (Vile -Parle and Bandra) markets were within permissible limits. These elemental toxicants may be transferred to man on consumption of Prawn and shrimp obtained from the market. These heavy metals transferred to man through the consumption of Prawn and shrimp, pose health hazards because of their cumulative effect in the body. Therefore, it was concluded that the Prawn and shrimp are not heavily burdened with metals, but a danger must be considered depending on the agricultural and industrial developments in this region. The Prawn and shrimp from Arabian Sea should be monitored periodically to avoid excessive intake of trace metals by human, and to monitor the pollution of aquatic environment. In view of these findings strict method of waste disposal control should be adopted to ensure the safety of the environment and safeguard our aquatic life.

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