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Original Research Paper

Metal Contamination in Commercially Important Prawn and Shrimp Species Collected from Malad Market of Mumbai Suburb of India

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ABSTRACT

The prawn and shrimp samples were collected from local markets of Malad suburban areas of Mumbai city from June to December 2012. These prawn and shrimp samples were dried in the laboratory and crushed into a fine powder by mortar and pestle and stored in amber coloured bottles in vacuum desiccators. These samples were evaluated by Inductively Coupled Plasma Atomic Emissions Spectroscopy for determination of the 10 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 were found below the maximum specified acceptable concentration whereas manganese, cobalt, nickel, lead and cadmium 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 either less than 0.001ppm or absent in all the species.

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 metals can cause dermatological diseases, skin cancer and internal cancers (liver, kidney, lung, bladder), cardiovascular disease, diabetes and anaemia, as well as reproductive, developmental, immunological and neurological effects in human body (Rose et al. 1992, Lukawski et al. 2005).

Hence, it is necessary to monitor the concentration of these contaminants in prawns and shrimps so that a warning signal 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 in their high buildup in marine organisms 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 diseases or toxic effects, which would be prevented in the population.

The toxic effects due to metal contamination of fish, prawns and shrimps, which is a main diet of majority of the population of Mumbai, are not primarily addressed and completely neglected. 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 been 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 were collected from local markets of Mumbai city from June, 2012 to December 2012. The prawn samples, packed in propylene bags, were stored at 20°C in deep freezer in the laboratory 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, 1mL of concentrated nitric acid was added to the 1g of dry weight samples and after 24 h, the samples were digested in Kjeldahl 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-coloured 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 the chemicals used were of analytical grade.

Preparation of standard metal ion solutions: Stock solutions (1µg/mL) of each of the metals 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 with distilled water.

Instrumentation: The samples were analysed 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), Mumbai.

RESULTS AND DISCUSSIONS

The results on the metal analysis of prawns and shrimps are given in Table 1.

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 haemocyanin (Engel 1981).

Excess accumulation of copper in hepatic cells causes liver diseases (Walshe 1984). Abnormal accumulation of copper in tissues and blood is a point of similarity with genetic disease of man called Wilson's disease (Jones & Hunt 1983, Lee & 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 diarrhoea, hypertension, uremia and cardiovascular collapse (Gossel & Bricker 1990).

Abu-Samra et al. (1975) reported that the presence of copper in shell fish was 20.0 ppm which was found below the permissible limit. Ismail (1993), Patimah & Dainal (1993) and Awaluddin et al. (1992), have reported that the accumulation of copper in *Penaeus monodon* was 0.8 ppm to 24.0 ppm; 32. 0 ppm to 99.0 ppm and 12.8 ppm to 159.0 ppm which was found above the permissible limit. Krishnamurti et al. (1999) have evaluated the concentration of metals in shrimps and crabs from the Thane-Bassen creek system, Maharashtra and the amount of copper was found in *Parapenaeopsis hardwickii* to be 22.6 ppm to 30.50 ppm; in *Macrobrachium rude* 21.9 ppm; in *Metapenaeus brevicarnis* 41.3; in *Exapalemon stylifera* 33.0 ppm; and in *Penaeus indicus* 25.4 ppm, which was above the permissible limit. Mitra et al. (2010) analysed the concentration of copper in muscle tissue of five commonly edible shrimp species, namely *Penaeus monodon, Penaeus indicus, Penaeus semisulcatus, Penaeus marguensis* and *Metapenaeus brevicornis* from the lower stretch of the River Ganga (in the Sundarbans delta complex) and the concentration ranged from 3.43 ppm to 140.49 ppm, which was above the permissible limit. Tabinda et al. (2010) evaluated the toxic and essential trace element contents in the muscle of prawns of two species from Keti Bunder and found that the concentration of copper in *Penaeus indicus* was 0.002 ppm to 0.171 ppm, and in *Penaeus indicus pencillantus* 0.000 ppm to 0.058 ppm, which was below the permissible limit. Nayem et al. (2011) collected prawn samples from local market and showed concentration of Cu from 0.01 to 0.11 ppm.

In the present work, the values of the mean minimum and maximum concentrations of copper in the prawns and shrimp samples of Malad (east) market was 0.759 ppm in *Acetes indicus* and 2.505 ppm in *Microbrachium rosenbergii,* and from Malad (west) market it was 0.875 ppm in *Microbrachium rosenbergii* and 1.765 ppm in *Penaeus semisulcatus* respectively. These values were below the specified maximum acceptable concentration (30 ppm) as prescribed by WHO (1989) and (10 ppm) by FAO maximum limits for prawn.

Zn: Zinc is called an essential trace element 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 1996).

Both acute and chronic toxicity syndromes occur with large overdoses of zinc and the principal features are epigastric pain, diarrhoea, 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).

Patimah & Dainal (1993) and Ismail (1993) have reported the accumulation of zinc in *Penaeus monodon* (68.8 ppm to 186.0 ppm) and (5.0 ppm to 16.0 ppm) respectively, which was above the WHO limits. Krishnamurti et al. (1999) have evaluated the concentration of metals in shrimps and crabs from the Thane-Bassen creek system in Maharashtra. The amount of Zn found in *Parapenaeopsis hardwickii* was (64.7 ppm to 130.2 ppm); *Macrobrachium rude* (62.0 ppm);

Table 1: Concentration of various metals in prawns and shrimps from Malad market

S.No.	Name of the prawn/ Shrimp	Metals (ppm)									
		Cu	Zn	Mn	Fe	Co	Cr	Ni	Pb	Cd	Hg
MALAD (East)											
1	*Solenocera crassicornis*	1.041	2.407	7.394	8.483	ND	0.048	1.027	3.096	ND	ND
2	*Parapenaeopsis stylfera*	1.351	5.093	8.014	8.127	0.013	0.042	2.022	2.301	ND	ND
3	*Acetes indicus*	0.759	1.897	7.085	6.589	ND	0.046	1.022	2.092	0.124	ND
4	*Metapenaeus kutchensis*	1.631	2.193	7.686	13.306	0.061	0.067	1.04	2.024	ND	ND
5	*Metapenaeus brevicornis*	0.977	1.941	6.66	8.918	0.012	0.054	1.027	1.022	0.110	ND
6	*Parapenaeopsis hardwickii*	1.412	1.709	7.083	7.695	ND	0.056	1.035	4.006	ND	ND
7	*Microbrachium rosenbergii*	2.505	1.74	6.305	2.253	ND	0.057	1.045	1.01	0.174	ND
8	*Penaeus monodon*	2.116	1.865	6.211	6.704	ND	0.061	1.061	1.032	0.213	ND
9	*Penaeus japonicus*	1.816	2.649	7.028	9.012	ND	0.018	1.078	3.067	0.139	ND
10	*Penaeus semisulcatus*	2.211	4.806	7.812	6.121	ND	0.012	1.069	2.029	0.103	ND
MALAD (West)											
1	*Microbrachium rosenbergii*	1.254	2.638	7.2	4.961	0.011	0.049	1.011	1.01	0.171	ND
2	*Solenocera crassicornis*	1.584	1.486	7.951	5.325	ND	0.075	0.028	3.139	ND	ND
3	*Metapenaeus Monoceros*	0.911	1.693	6.823	3.125	ND	0.077	1.028	4.09	ND	ND
4	*Metapenaeus affinis*	0.875	1.789	6.477	4.214	0.012	0.084	0.076	2.04	0.152	ND
5	*Parapenaeopsis hardwickii*	1.11	3.39	7.215	8.422	ND	0.061	0.014	2.121	0.340	ND
6	*Parapenaeopsis sculptilis*	1.142	1.511	7.062	2.053	ND	0.04	1.016	1.037	ND	ND
7	*Penaeus indicus*	1.018	2.762	6.124	5.999	ND	0.05	0.034	1.033	0.033	ND
8	*Penaeus monodon*	1.124	3.428	3.750	2.648	0.011	0.061	1.031	3.213	ND	ND
9	*Penaeus japonicus*	1.178	1.217	4.935	5.961	0.017	0.078	0.057	2.139	0.026	ND
10	*Penaeus semisulcatus*	1.765	2.121	6.323	7.197	0.015	0.069	0.079	1.103	ND	ND

*Each value is the average of 5 determinations.

Metapenaeus brevicarnis (50.7 ppm); *Exapalemon stylifera* (67.5 ppm) and *Penaeus indicus* (67.5 ppm), which was below the WHO limits. Hanan et al. (2009) have found the residues of some heavy metals in freshwater prawn *Macrobrachium rosenbergii* and marine shrimp *Penaeus semisulcatus*. Zinc was 75.614 ppm in freshwater prawn and 51. 834 ppm in marine shrimp. Mitra et al. (2010) analysed the concentration of cadmium in muscle tissue of five commonly edible shrimp species, namely *Penaeus monodon, Penaeus indicus, Penaeus semisulcatus, Penaeus marguensis* and *Metapenaeus brevicornis* collected from the lower stretch of the River Ganga (in the Sundarbans delta complex), and the concentration of zinc ranged from 4.11ppm to 353.45 ppm. Tabinda et al. 2010 evaluated the toxic and essential trace element, contents in the muscle of two prawn species from Keti Bunder and found that the mean concentrations of zinc in *Penaeus indicus* was 1.032ppm to 1.542 ppm, and in *Penaeus indicus pencillantus* 0.191ppm to 0.282 ppm. Levent et al. (2013) have measured the concentration of cadmium in edible tissues of the brown shrimp *Crangon crangon* collected from Samsun coasts in the Black Sea coast of Turkey in 2010. The heavy metal concentration in *C. crangon* was 0.219 ppm to 0.491 ppm, below the WHO limits.

In the present work, the values of the mean minimum and maximum concentrations of zinc in the prawns and shrimp from Malad (east) market were 1.709 ppm in *Parapenaeopsis hardwickii* and 5.093 ppm in *Parapenaeopsis stylfera,* and from Malad (west) market 1.217 ppm in *Penaeus japonicus* and 3.428 ppm in *Penaeus monodon* respectively. These values were found below the acceptable limits (1000 ppm) of WHO (1992) limits.

Mn: Manganese is a mineral that is required in small amounts in the human body. In normal conditions it contains about 10 mg to 20 mg 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).

Hossaina (2001) have found the Mn in penaeid shrimp and spiny lobster from the Bay of Bengal at 3.10 ppm to 15.2 ppm, which was above the permissible limit of WHO (1989). Adedeji & Okocha (2011) evaluated the bioaccumulation of Mn in prawns from Epe Lagoon and Asejire River in southwest Nigeria and found it to be 94.61 ppm, much above the maximum limits (1 ppm).

In the present work, the values of the mean minimum and maximum concentrations of Mn in the prawns and shrimp samples collected from Malad (east) market were

6.211 ppm in *Penaeus monodon* and 8.014 ppm in *Parapenaeopsis stylfera,* and from Malad (west) market were 3.750 ppm in *Penaeus monodon* and 7.951 ppm in *Solenocera crassicornis* respectively. These values were above the (1 ppm) WHO permissible limit.

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 & 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).

Hossaina (2001) has found iron in penaeid shrimp and spiny lobster from the Bay of Bengal above the permissible limit. Hanan et al. (2009) has found Fe in freshwater prawn *Macrobrachium rosenbergii* and marine shrimp *Penaeus semisulcatus* below the permissible limit. Tabinda et al. (2010) have also found iron in *Penaeus indicus* and *Penaeus indicus pencillantus* below the permissible limit.

In the present work, the values of the mean minimum and maximum concentrations of iron in the prawns and shrimp samples were 2.253 ppm in *Microbrachium rosenbergii* and 13.306 ppm in *Metapenaeus kutchensis* from Malad east market, and 2.053 ppm in *Parapenaeopsis sculptilis* and 8.422 ppm in *Parapenaeopsis hardwickii* respectively in Malad west market. These values were below the maximum acceptable concentration (100 ppm) limits by WHO (1989) for prawn.

Co: Cobalt is not often freely available in the environment, but when cobalt is not bound to soil or sediment particles the uptake by plants and animals is higher resulting in its accumulation. Cobalt is used in many alloys, corrosion resistant alloys, high-speed steels, cemented carbide, magnets and magnetic recording media, as catalysts for the petroleum and chemical industries, as drying agents for paints and inks, etc. The radioactive isotope, cobalt-60, is used in medical treatment and also to irradiate food to preserve it. Cobalt is beneficial for humans because it is a part of vitamin B12. However, too high concentration 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, diarrhoea, coma and even death.

Arun Kumar & Hema Achyuthan (2007) have evaluated the concentration of cobalt in certain marine animals along the East Coast of Chennai and found its concentration to be 0.0001 ppm. The study carried by Levent et al. (2013) has measured the concentration of cobalt in edible tissues of the brown shrimp *Crangon crangon* from Samsun coasts in the Black Sea coast of Turkey at 0.24 ppm to 0.61 ppm.

In the present work, the values of the mean minimum and maximum concentrations of cobalt in the prawns and shrimp were 0.012 ppm in *Metapenaeus brevicornis* and 0.061 ppm in *Metapenaeus kutchensis,* 0.011 ppm in *Microbrachium rosenbergii* and *Penaeus monodon,* and 0.017 ppm in *Penaeus japonicus*. These values were higher than the other studies.

Cr: The chromium enters the aquatic medium through effluents discharged from tanneries, textiles, electroplating, mining, dyeing and printing industries (Burton 1995). Chromium compounds are 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).

Arun Kumar & Hema Achyuthan (2007) have evaluated the concentration of chromium in certain marine animals and found it below the permissible limit. Tabinda et al. (2010) also found concentrations of chromium in *Penaeus indicus* and *Penaeus indicus pencillantus* to be below the permissible limit of WHO (50 ppm), but slightly above the FAO maximum limits for prawn (1 ppm).

The values of the mean minimum and maximum concentrations of chromium in the current study in the prawns and shrimp samples were 0.012 ppm in *Penaeus semisulcatus,* 0.067 ppm in *Metapenaeus kutchensis,* 0.04 ppm in *Parapenaeopsis sculptilis* and 0.084 ppm in *Metapenaeus affinis,* which were below the permissible limit as prescribed by WHO (1989) (50 ppm) and by FAO (1 ppm) for prawn.

Ni: Nickel is called the depression and suicide metal as it is associated with these feelings and symptoms. 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 & Oskarsson 1991).

Krishnamurti et al. (1999) have evaluated the concentration of metals in shrimps and crabs from the Thane-Bassen creek system, Maharashtra and the amount of nickel found in *Parapenaeopsis hardwickii* was 0.008 ppm to 0.009 ppm; in *Macrobrachium rude* 0.004 ppm; in *Metapenaeus brevicarnis* 0.010 ppm; in *Exapalemon stylifera* 0.006 ppm and in *Penaeus indicus* 0.04 ppm, which was below the permissible limit of WHO. Hossaina (2001) has found the trace metals in penaeid shrimp and spiny lobster from the Bay of Bengal, and the concentration of nickel was 0.2 ppm and 0.6ppm in penaeid shrimp (*Penaeus monodon*) and spiny lobster (*Panulirus polyphagus*) respectively, which was below the permissible limit of WHO. Tabinda et al. (2010) evaluated the trace elements in the muscle of prawns from Keti Bunder and found that the mean concentration of nickel in *Penaeus indicus* was 0.142 ppm to 0.240 ppm, and in *Penaeus indicus pencillantus* 0.116 ppm to 0.207 ppm.

In the present study, the values of the mean minimum and maximum concentrations of nickel were 1.022 ppm in *Acetes indicus*, 2.022 ppm in *Parapenaeopsis stylfera*, 0.014 ppm in *Parapenaeopsis hardwickii* and 1.031 ppm in *Penaeus monodon*. The upper maximum values were found above the acceptable concentration of 0.5ppm to 1.0 ppm of WHO (1989).

Pb: It is known as deadly and accumulative poison even when consumed in small quantities and is capable of deadening nerve receptor in man (Bodansky & Latener 1987). The main sources of lead pollution in the environment include effluents and 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 & 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, Manahan 1992).

Abu-Samra et al. (1975) reported that the presence of lead in shell fish was 2.0 ppm which was above the permissible limit. Awaluddin et al. (1992), Ismail (1993), Patimah & Dainal (1993) have reported the accumulation of lead in *Penaeus monodon* above the permissible limit. Krishnamurti et al. (1999) have evaluated the concentration of metals in shrimps and crabs from the Thane-Bassen creek system, in Maharashtra and the amount of lead was found in *Parapenaeopsis hardwickii* (0.003 ppm); in *Macrobrachium rude* (0.009 ppm); in *Metapenaeus brevicarnis* (0.00 ppm); in *Exapalemon stylifera* (0.002 ppm) and in *Penaeus indicus* (0.06 ppm) which was below the permissible limit. Hossaina (2001) has found lead in prawns above the permissible limit. Mitra et al. (2010) analysed the concentration of lead in muscle tissue of five commonly edible shrimp species from the lower stretch of the River Ganga in the Sundarbans delta complex and found it above the permissible limit. Okocha & Adedeji (2011) have found that the concentration lead in Prawn (*Macrobrachium Vollenhovenii*) (5.22 ppm) in Asejire river, and 9.18 ppm in Epe lagoon was above the permissible limit.

The values of lead in the prawns and shrimp samples in the present study were found to be 1.01 ppm in *Microbrachium rosenbergii,* 4.006 ppm in *Parapenaeopsis hardwickii*, 1.01 ppm in *Microbrachium rosenbergii* and *Parapenaeopsis hardwickii,* and 4.09 ppm in *Metapenaeus monoceros*. These values were above the specified maximum acceptable concentration as prescribed by WHO (1992) (0.5ppm).

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).

Ismail (1993) and Awaluddin et al. (1992) have found concentration of cadmium in tiger prawn (*Penaeus monodon*) above the maximum permissible limits. Hossaina (2001) analysed concentration of cadmium in abdominal tissue and cephalothorax of *Penaeus monodon* and *Panulirus polyphagus* (3.1 ppm to 15.2 ppm) above the maximum permissible limits. Kaoud & Eldahshan (2010) have found the cadmium accumulation in muscles of *M. rosenbrgii* (0.005 to 0.065 ppm) above the maximum limits. Adedeji & Okocha (2011), Tabinda et al. (2010) and Levent et al. (2013) have also reported Cd above the permissible limits in prawns and shrimps.

In the present work, the mean minimum and maximum concentration of cadmium in the prawns and shrimp samples were 0.103 ppm in *Penaeus semisulcatus,* 0.213 ppm in *Penaeus monodon*, 0.026 ppm in *Penaeus japonicus* and 0.340 ppm in *Parapenaeopsis hardwickii*. These values were above the maximum acceptable concentration of 0.005 ppm prescribed by WHO (1984).

Hg: Mercury is extremely harmful, and even a concentration of 0.03 ppm in drinking water is not permissible. Mercury enters natural water through industrial discharges where by bacterial action it is converted into very stable and water soluble methyl mercury. Mercury, 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 people in the Minamata Island of Japan, due to what goes by name 'Minamata disease'. Mercury deactivates sulphur containing enzymes, 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, and a complete change of personality (Banerjee 1995).

Abu-Samra et al. (1975) reported the presence of mercury in shell fish as 1.0 ppm which was above the permissible limit of 0.02-0.2 ppm for prawn (WHO 1989).

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 the species.

CONCLUSION

The concentration of manganese, cobalt, nickel, lead and cadmium was high in prawn and shrimp samples collected from Malad markets. It can be assumed that the sea from where the prawn and shrimp were collected receive outfalls from industrial waste and sewage from the city. The levels of heavy metals such as copper, zinc, iron and chromium in prawn and shrimp samples were within the permissible limits. These toxicants may be transferred to man on consumption of prawn and shrimp obtained from the market. The prawn and shrimp from Arabian sea should be monitored periodically to avoid excessive intake of these heavy metals 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 to safeguard the aquatic life.

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