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Determination of Toxic Elements in Water Sediments and Commercially Important Shrimps *Penaeus Indicus* and *Penaeus Japonicus* Collected From Gorai Creak of Mumbai Suburb of (West Coast) India

KEYWORDS: Toxic elements, Creak, Shrimps, sediments, contamination

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ABSTRACT *The toxic elements such as Al, B, Ba , Be, Bi, Ca, Cr, Ga, K, Li, Mg, Se, Te, and Ti are potentially harmful and caused toxic effects to most organisms even in very low concentrations. The research paper is focused on distribution of trace elements in various tissues of different species of shrimps, and in surface and bottom water sediments. The possible roles of these trace elements in this regard are emphasized. Moreover, patterns of trace elements bioaccumulation and their order of occurrence have been evaluated. Another part of this paper deals with comparison of the related data from different aquatic environments as well as existing guidelines and limits for human consumption. Comparison between the mean concentrations of the trace elements in Carapace, gills, remaining body tissues and whole body tissues and in water samples are compared with existing guidelines indicate that the concentrations of Al, Ba, Ca, Cr, K and Mg are well below the permissible levels for human consumption. However the concentrations of Be, Bi, Li, Se, Sr, TI were observed somewhat greater than some of the recommended levels and cited literature. The amount of B, Ga and Te present in different tissues of shrimps and in water samples are not comparable with that of the other aquatic animals, drinking water standards or with the human body because there are no such guidelines.*

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. The tendency of heavy metals and some toxic elements to get accumulated in marine animals is of scientific interest in heavy metal chemistry. The bioavailability of trace metals is the key factor determining tissue metal levels in the marine biota. Trace metal uptake occurs directly from surrounding marine water across the permeable body surface and from food along with the seawater to the gut (Depledge and Rainbow, 1990). Fish, crab and prawn form an important link as possible transfer media to human beings. Information on the level of heavy metal pollution in coastal environment is important as they cause serious environmental health hazards (Nitta, 1992; Gupta and Srivastava, 2006; Shukla et al., 2007).

Arabian Sea enriches the Mumbai with a shore line of 100 Km, coastal areas in and around Mumbai are biologically most productive areas supporting a wealth of marine resources. Seafood mainly fish, Prawns and shrimps consisting of fats and proteins obtained from seas around Mumbai serves as a vital diet to the population of over fourteen million of Mumbai and satellite areas. It is well known that numerous industries around Mumbai discharge their effluents containing toxic materials. In the Ullhas estuaries, Vasai creeks, Thane creek, Mumbai bay and several minor creeks like Manori, Malad, Gorai and Mahim. The untreated domestic effluents containing high nutrients also enter the sea through eight main outfalls and several non point sources. Consequently these areas are reported to be highly polluted Chouksey (2002) and Aniruddha Ram (2003). 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 metal elements such as Al, B, Ba , Be, Bi, Ca, Cr, Ga, K, Li, Mg, Se, Sr, Te, and Ti are potentially harmful and caused toxic effects to most organisms even in very low concentrations. These toxic effects can be introduced to large populations of Mumbai those who are consuming prawns and shrimps as one of the major source of sea food. 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).

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 build up marine organisms particularly fish 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.

Internationally several organizations namely Food and Agriculture Organization FAO (1983)), APHA: (1992), Environmental Protection Agency (EPA) US, US Public Health Services (USPHS 1986), National Academy of Sciences (NAS 1980), USA. Etc. have worked on toxicity levels that can influence the human beings on short and long term basis and correlated corresponding symptoms chronic effects and diseases observed. The contaminants contributed in water, sediments and tissues of several marine organisms have also been reported along with toxicity tests.

However, in India, the contaminations of sea food studies have not been seriously attended so far. Only few reports are available on this topic. The concentration of the above elements in sea food and contamination of these elements in the diet and other relations with various symptoms have not been studied in India.

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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.

Materials and methods

a) Sample Collection

The Shrimp samples of were collected from local markets of Mumbai city from September, 2014 to, December 2014. The Shrimp samples, packed in propylene bags, were stored at – 20 ^{0}C in deep freeze in the Department of Zoology, S.S & L.S. Patkar College, Goregaon (West) Mumbai for further analysis.

b) Sample Digestion:

The samples were identified as per the FAO guidelines manual and were brought to the laboratory in the Department of Zoology S.S & L.S. Patkar College Goeregaon (West) Mumbai, and washed in sea water. Five replicates of the above samples containing shrimps in a Petri dish were oven dried at 80°C for 2 days to get the dry weight (DW). The dried samples were crushed into a fine powder by mortar and pestle and pass through a 2 mm sieve and stored in amber colored bottles in vacuum desiccators. 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 water samples were well mixed with 2mL concentrated HNO_3 per liter sample and capped tightly until they were ready for analysis as proposed by (Ehi-Eromosele and Okiei 2012). The above procedure was repeated for all the other samples. All above chemicals used were of analytical grade.

c) Preparation of standard metal ion solutions:

The instrument was calibrated by using standard solution of metal with different concentration 1, 2, 3, 10, 20 ppm (Merck, Sigma Aldrich). The graph is plotted as area Vs concentration and from this graph unknown concentration of metal was determined. The standard metal ion samples were prepared by dissolving 1.00 g of appropriate standard metal ion in 5 mL Conc. HNO3 diluted to 50 mL solution. The working standards of these metal ion solutions were prepared by appropriate dilutions in deionized distilled water to get the final 10 ppm concentration.

d) Instrumentation:

The Elemental concentration was determined by Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES, Model Spectro Arcos, FHS-12) at the Catalysis & Inorganic Chemistry Division, National Chemical Laboratory, Dr. Homi Bhabha Road Pune 411008, India

Results and Discussion:

Table 1: Range of toxic elements in shrimps and water samples collected from Gorai creak of suburban of Mumbai west coast of India

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

N = 5 (Average of Five determents) ND = Not detected or less than 0.0001ppm)

Aluminium (Al): Aluminium is present in the human diet. Normal dietary levels of intake of aluminium are not associated with adverse health effects. Aluminum poisoning in humans appears to be rare. Smith (1928) reported that ingestion of 150 mg of aluminum per day is without obvious effects on normal humans; 200 mg may, however, give rise to mild catharsis, which increases with the dose. Sorenson and others (1974) reported that 5.5 mg of aluminum per kilogram of body weight in food and drink does not cause adverse effects in humans, probably because the aluminum is usually in the less-toxic colloidal form. A number of observations indicate that high concentrations of aluminum may be toxic to the nervous system (Crapper and others, 1973). These authors analyzed the brains of persons who died with Alzheimer's disease (a disease occurring after the age of 40 and producing progressive dementia) and found concentrations of aluminum similar to those in the brains of experimental animals that had been injected with 150-225 /ug aluminum, as aluminum chloride, and that as a result had developed neurological symptoms similar to those of Alzheimer's disease in humans. A recent guideline study (Tox Test THE, 2010) has demonstrated mild neurological effect in rats exposed to high levels of aluminium. Recent studies investigating whether there is a link between aluminium levels in drinking water and Alzheimer's disease have provided inconclusive results. Considering all sources of evidence related specifically to Alzheimer's disease, the current weight of evidence does not support a primary role for aluminium in causing this condition (Tox Test THE, 2010). Pulmonary fibrotic reactions to inhaled silica and certain aluminum-containing compounds can result in silicosis, aluminosis, aluminum lung, and bauxite pneumoconiosis (Sorenson and others, 1974). The evidence from several epidemiological studies does not support an association between breast cancer and aluminium-containing antiperspirants (Namer et al., 2008). It has been determined that fish tend to be more sensitive to aluminum toxicity than aquatic invertebrates (Sparling et al., 1997)

The result obtained from our present analysis, in the mean highest concentration of Al was found in surface water sample (0.173 mg/L) whereas lowest concentration was recorded in Penaeus japonicus (0.160 mg/L). In our study the concentration of Al is found within the tolerable limits. Although the toxicity information about Al is generally lacking, potential health effects of Al have been subject to extensive scientific evaluation, further research in certain areas with respect to Al is needed.

Boron (B): Boron is a non-metal element in Group 13 of the Periodic Table. Properties of Boron are very close to carbon and silicon. Due to small size and high ionization energies, boron results in covalent bonding rather than metallic bonding (Kot, 2009). The reported developmental toxicities occurring after boron exposure include high pre-

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natal mortality, reduced fetal body weight, cardiovascular system, central nervous system, malformations of the eyes, cardiovascular system, and axial skeleton (Heindel et al., 1992 and Price et al., 1996)

The result obtained from our present analysis, in the mean highest concentration of B was found in Penaeus japonicus (0.047 mg/L) whereas lowest concentration was recorded in bottom water sediments (0.004 mg/L). There is no guideline or recommended limit for B in water. In our study the mean lower and higher concentration of B was found lower as cited in the above literature.

Barium (Ba): Barium compounds, including barium sulfate and barium carbonate, are used in the plastics, rubber, electronics and textile industries, in ceramic glazes and enamels, in glass-making, brick-making and paper-making, as a lubricant additive, in pharmaceuticals and cosmetics, in case-hardening of steel and in the oil and gas industry as a wetting agent for drilling mud (Miner, 1969; Brooks, 1986). Barium in water comes primarily from natural sources. The solubility of barium compounds increases as the pH level decreases (US EPA, 1985a). Elevated levels of barium can induce a wide range of effects in mammals including gastrointestinal distress, muscular paralysis, and cardiovascular effects. Barium does not bioaccumulate, and concentrations in higher species rarely exceed 10 mg/kg (Moore 1991).

The result obtained from our present analysis, in the mean highest concentration of Ba was found in Penaeus indicus (0.038 mg/L) whereas lowest concentration was recorded in Penaeus japonicas, surface water and bottom water sediments (0.037 mg/L). The result obtained from our present analysis, the mean minimum and maximum concentration of Ba detected in the shrimps and water samples were found below the specified Maximum acceptable concentration as prescribed by (ICRP, 1975); 0.75 mg/day, (IPCS, 1990) 0.6 mg/day from total diet (Schroeder et al., 1972) range 0.65–1.8 mg/day.

Beryllium (Be): Beryllium is found in the Earth's crust at an average concentration of approximately 2.8–5.0 mg/kg. Beryllium-containing minerals are processed to beryllium metal, beryllium alloys, and beryllium oxide for use in aerospace, weapons, nuclear, and electronics industries. Beryllium is released to water in some industrial wastewater effluents, most notably treated wastewaters from iron and steel manufacturing and non-ferrous manufacturing industries (ATSDR, 1993). The US EPA (1987) estimated total daily beryllium intake as 423 ng, with the largest contributions from food (120 ng/day, based on daily consumption of 1200 g of food containing 0.1 ng beryllium/g fresh weight) and drinking-water (300 ng/day, based on daily intake of 1500 g of water containing 0.2 ng beryllium/g. Tobacco smoke is another potential source of exposure to beryllium in the general population. Beryllium levels of 0.47, 0.68, and 0.74 μg/cigarette were found in three brands of cigarettes (Zorn & Diem, 1974). Between 1.6 and 10% of the beryllium content, or 0.011–0.074 μg/cigarette, was reported to pass into the smoke during smoking. Assuming the smoke is entirely inhaled, an average smoker (20 cigarettes per day) might take in approximately 1.5 μg beryllium/day (3 times the combined total of the other routes). Beryllium is not significantly bioconcentrated from water by aquatic species (Callahan et al., 1979; Kenaga, 1980; US EPA, 1980). It is also apparently not bioaccumulated from sediment by bottom feeders; beryllium levels in clams and oysters from Lake Pontchartrain, Louisiana, USA, were similar to levels in the surface sediments (Byrne & DeLeon, 1986). There is no evidence for significant biomagnification of beryllium within food chains (Callahan et al., 1979; Fishbein, 1981).

The result obtained from our present analysis, in the mean highest and lowest concentration of Be was in both the species of shrimps and in bothe the water samples are found same (0.081 mg/L). In our study the concentration of Be was found higher than the tolerable limits. Although the toxicity information about Be is generally lacking, potential health effects of Be have been subject to extensive scientific evaluation, further research in with respect to seafood contamination is needed.

Bismuth (Bi): Considering human health, the biotransformation of harmless metals, such as bismuth, by the human intestinal microbiota is a highly relevant process. Due to the low toxicity of metallic bismuth and its inorganic salts, bismuth has been classified as a "green element" (Mohan, R. 2010). Bismuth is therefore widely used in a variety of applications such as cosmetics, catalysts, industrial pigments, and ceramic additives (Michalke et al., 2008). Bismuth is, however, associated with several adverse reactions such as encephalopathy, renal failure, and even cases of death in the 70s and 80s (Martin-Bouyer 1981; Islek, et al., 2001). It has been suggested that derivatives of this metal may be responsible for these damages.

The result obtained from our present analysis, in the mean highest concentration of Bi was found in surface water sample (0.048 mg/L) whereas lowest concentration was recorded in Penaeus indicus (0.035 mg/L). In the literature there are no such guidelines or recommended limits for Bi in water. Therefore we are unable to find out whether the above concentrations (higher and lower concentrations) of Bi in our study are exceeds the tolerable limits or not.

Calcium (Ca): Calcium as an essential element for the human body. The recommended limit for calcium is 200 mg/L; however, there is no federal or provincial guideline WHO. Calcium is one constituent of "hardness" in water and is not a hazard to health. Calcium is undesirable because it may be detrimental for household uses such as washing, bathing and laundering. It also tends to cause encrustations in kettles, coffee makers and water heaters and may impair treatment processes. Calcium is part of bones and teeth. In addition, it plays a role in neuromuscular excitability (decreases it), good function of the conducting myocardial system, heart and muscle contractility, intracellular information transmission and blood coagulability. Osteoporosis and osteomalacia are the most common manifestations of calcium deficiency; a less common but proved disorder attributable to Ca deficiency is hypertension. Based on newly acquired epidemiological data, implication of Ca deficiency in other disorders is currently being discussed (Scientific Committee for Food, 1993; Committee on Dietary Reference Intake, 1997). The recommended Ca daily intake for adults ranges between 700 and 1000 mg (Scientific Committee for Food, 1993; Committee on Dietary Reference Intake, 1997).

The result obtained from our present analysis, in the mean highest concentration of Ca was found in Penaeus japonicus (0.42 mg/L) whereas lowest concentration was recorded in bottom water sediments (0.034 mg/L). The result obtained from our present analysis, the mean minimum and maximum concentration of calcium detected in the shrimps and water samples were found below the specified Maximum acceptable concentration as prescribed by (200 mg/L) WHO (1989).

Cromium (Cr): In the environment, chromium exists primarily in the tetravalent and hexavalent forms, predominantly as the trivalent form in natural waters. The particulates of chromium enter the aquatic medium through effluents discharged from tanneries, textiles, electroplating, mining, dyeing and printing industries (Mertz 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 (Lingard et. al 1979). 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. The maximum permissible limit of Cr as prescribed by WHO is (50 ppm) (1989) and (1 ppm) by FAO.

The result obtained from our present analysis, in the mean highest concentration of Cr was found in Penaeus japonicus (0.124 mg/L) whereas lowest concentration was recorded in surface water sample (0.121 mg/L). In the present work, the values of the mean minimum and maximum concentrations of Cr in the shrimp and water samples are found below the specified Maximum acceptable concentration (50 ppm) WHO (1989) and (1 ppm) by FAO maximum limits for prawn.

Gallium (Ga): Gallium is a group IIIA metal, atomic number 31 in the periodic table of elements. First discovered in 1875 by Paul-Emile Lecoq de Boisbaudran in France, the name of this metal appears to be derived from "Gallia", the Latin word for France. It is one of the few metals that is near-liquid at room temperature and can melt when held in the hand. The application of gallium in medicine raises questions about the pharmacology, clinical efficacy, and potential side-effects of gallium compounds as drugs. The use of gallium arsenide in the electronics industry raises questions about the potential risks of exposure to this compound as an environmental toxin. Although gallium has no known physiologic function in the human body, certain of its characteristics enable it to interact with cellular processes and biologically important proteins, especially those of iron metabolism (Jakupec et al ., 2008) . This has led to the development of certain gallium compounds as diagnostic and therapeutic agents in medicine especially in the areas of metabolic bone disease, cancer, and infectious disease. The discovery that gallium displayed semiconducting properties led to its development as gallium arsenide for use in the electronics industry (Moskalyk 2003).

The result obtained from our present analysis, in the mean highest concentration of Ga was found in Penaeus japonicus (0.290 mg/L) whereas lowest concentration was recorded in bottom water sediments (0.225 mg/L). In the present work, the values of the mean minimum and maximum concentrations of Ga in the shrimp and water samples were found can't compared with the specified Maximum acceptable concentration limits for prawn and water samples because of there are no such guideline recommendations fir Ga.

Potassium (K): Water softeners that regenerate using potassium chloride can significantly raise the level of potassium in water. It is recommended that people with kidney disease or other conditions such as heart disease, coronary artery disease, hypertension, diabetes and those who take medication that interferes with how the body handles potassium do not drink water from a water softener that uses potassium chloride. In some countries, potassium chloride is being used in ion exchange for household water softening in place of, or mixed with, sodium chloride, so potassium ions would exchange with calcium and magnesium ions. Adverse health effects due to potassium consumption from drinking-water are unlikely to occur in healthy individuals. Potassium intoxication by ingestion is rare, because potassium is rapidly excreted in the absence of pre-existing kidney damage and because large single doses usually induce vomiting (Gosselin & Hodge, 1984).

The result obtained from our present analysis, in the mean highest concentration of K was found in Penaeus japonicus (0.620 mg/L) whereas lowest concentration was recorded in bottom water sediments (0.588 mg/L). There is no guideline or recommended limit for potassium in water. In our study the mean lower and higher concentration of potassium was found lower as cited in the above literature.

Lithium (Li): The Australia Inventory of Chemical Substances (AICS, 2007) has classified metallic lithium as a health, physiochemical and ecotoxicological hazard according to the National Occupational Health and Safety Commission (NOHSC) approved criteria for classifying hazardous substances. Lithium, lithium aluminium hydride, and lithium methanolate are found on the Danish list of dangerous substances (Kjolholt et al., 2003). The primary target organ for lithium toxicity is the central nervous system (Kjolholt et al., 2003), therefore, lithium is used therapeutically on membrane transport proteins when treating manic depression. Chemically, lithium resembles sodium but is more toxic. In humans, 5 g of LiCl can result in fatal poisoning. In therapeutic doses, damages on the central nervous system and the kidneys have been reported (Le'onard et al., 1995. Lenntech, 2007). A review of lithium in the aquatic environment in the US (Kszos and Stewart, 2003) found that lithium was detected at low concentrations (-0.002 mg/L) in the major rivers of the US. Further studies (Kszos et al., 2003) identified lithium concentrations in surface waters were typically -0.04 mg/L but could be elevated in contaminated streams.

The result obtained from our present analysis, in the mean highest concentration of Li was found in Penaeus japonicus (0.030 mg/L) whereas lowest concentration was recorded in bottom water sediments (0.028 mg/L). In our study the mean lower and higher concentration of Li was found above the lowest concentrations (-0.002 mg/L and -0.04 mg/L concentrations in surface waters) as proposed by (Kszos and Stewart, 2003 Kszos et al., 2003).

Magnesium (Mg): Magnesium is constituent causing "hardness" in water. Higher levels of magnesium may produce a bitter taste but are not normally a health hazard. Magnesium plays an important role as a cofactor and activator of more than 300 enzymatic reactions including glycolysis, ATP metabolism, transport of elements such as Na, K and Ca through membranes, synthesis of proteins and nucleic acids, neuromuscular excitability and muscle contraction etc. Magnesium deficiency increases risk to humans of developing various pathological conditions such as vasoconstrictions, hypertension, cardiac arrhythmia, atherosclerotic vascular disease, and acute myocardial infarction, eclampsia in pregnant women, possibly diabetes mellitus of type II and osteoporosis (Rude, 1998; Innerarity, 2000; Saris et al, 2000). These relationships reported in

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multiple clinical and epidemiological studies have recently been more and more supported by the results of many experimental studies on animals (Sherer et al, 2001). The recommended magnesium daily intake for an adult is about 300-400 mg (Scientific Committee for Food, 1993; Committee on Dietary Reference Intake, 1997).

The result obtained from our present analysis, in the mean highest concentration of Mg was found in Penaeus japonicus (0.061 mg/L) whereas lowest concentration was recorded in surface water sample (0.015 mg/L). In our study the mean lower and higher concentration of Mg was found below the tolerable limits as to that of the recommended guideline value 150 mg/L of Mg in drinking water. None of the shrimp samples or water samples was analyzed for manganese exceeded the limit permitted by WHO.

Selenium (Se): Selenium (Se) is present in the earth's crust, often in association with sulfur containing minerals. Selenium undergoes bioconcentration, bioaccumulation, and biomagnifications as trophic levels increase (Taylor et al., 1992). In aquatic organisms, the following adverse effects have been observed: loss of equilibrium and other neurological disorders, liver damage, reproductive failure, reduced growth, reduced movement rate, chromosomal aberrations, reduced hemoglobin and increased white blood cell count, and necrosis of the ovaries. Most drinking-water contains concentrations of selenium that are much lower than 10 µg/l except in certain seleniferous area. Very low selenium status in humans has been associated with a juvenile, multifocal myocarditis called Keshan disease and a chondrodystrophy called Kaschin-Beck disease (Hogberg & Alexander, 1986; IPCS,1987 FAO/WHO, 2004).

The result obtained from our present analysis, in the mean highest concentration of Se was found in bottom water sediments (0.096 mg/L) whereas lowest concentration was recorded in Penaeus japonicus (0.036 mg/L). In our study the mean lower and higher concentration of Se was found above the tolerable limits as prescribed by (Högberg & Alexander, 1986; IPCS, 1987; FAO/WHO, 2004) as very low selenium (10 µg/l in drinking water) status in humans has been associated with a juvenile, multifocal myocarditis called Keshan disease and a chondrodystrophy called Kaschin-Beck disease.

Strontium (Sr): Strontium occurs naturally in Earth's crust (at approximately 0.02–0.03%) in the form of minerals such as celestite (strontium sulfate) and strontianite (strontium carbonate). Minor amounts occur in other mineral deposits and in, or near, sedimentary rocks associated with gypsum, anhydrite, rock salt, limestone anddolomite. Strontium can also occur in shales, marls and sandstones (ATSDR, 2004). It is released into the air by natural processes, such as weathering of rocks by wind, entrainment of dust particles, resuspension of soil by wind and sea spray. Oceanic strontium can leave the oceans by sea spray and by deposition in marine carbonate sediment (Capo et al., 1998). Air in coastal regions has higher concentrations of strontium as a result of sea spray (Capo et al., 1998). The only studies located regarding death in humans following inhalation exposure to stable strontium are related to strontium chromate. Strontium chromate has been implicated as a cause of increased deaths from lung cancer in occupational studies (Davies 1979, 1984). The only report of adverse respiratory effects in humans resulting from the inhalation of stable strontium is a case report of an anaphylactic reaction to smoke from an ignited roadside flare (Federman and Sachter 1997). A single study documented adverse cardiovascular effects in humans resulting from the inhalation of stable strontium in smoke from an ignited roadside flare (Federman and Sachter 1997). Osteoporosis is characterised by reduced bone mass and disruption of bone architecture, resulting in increased bone fracture and fragility, and thereby imposing a significant burden on both the individual and society (Federman and Sachter 1997).

The result obtained from our present analysis, in the mean highest concentration of Sr was found in bottom water sediments and surface water sample (0.042 mg/L) whereas lowest concentration was recorded in Penaeus japonicus (0.036 mg/L). In our study the mean higher concentration of Sr was found above the value estimated by USEPA, 2002 and USEPA, 1981 (The surface waters, dissolved strontium was detected with an average concentration of 0.36 mg/l and the concentration of dissolved strontium in influents from publicly owned treatment works was between 0.025 and 0.45 mg/l) .

Tellurium (Te): Tellurium as an alloying additive in steel; as a (minor) additive in copper alloys, in lead alloys, in cast and malleable iron; in the chemical industry as a vulcanizing agent and accelerator in the processing of rubber, and as a component of catalysts for synthetic fiber production; in the production of cadmium-tellurium-based solar cells; in photoreceptor and thermoelectric electronic devices, other thermal cooling devices, as an ingredient in blasting caps, and as a pigment to produce various colours in glass and ceramics (George 2012) in the past, therapeutically, in the (intramuscular) treatment of syphilis, leprosy, trypanosomiasis (through intramuscular injections), and against excessive sweating (Larner 1995).

The result obtained from our present analysis, in the mean highest concentration of Te was found in Penaeus indicus (0.476 mg/L) whereas lowest concentration was recorded in Penaeus japonicus (0.465 mg/L). Although tellurium is not regarded as a true trace element, in that there is no recognized biological role for tellurium in human tissues and no clinical deficiency syndrome, nonetheless the amounts of tellurium in the human body are reported to be higher than several of the recognized trace elements.

Thallium (Tl): Thallium is readily absorbed through the GI tract and distributed throughout the organs and tissues of the body (Sabbioni et al., 1980 b). Once thallium is distributed, elimination occurs mainly in the urine and feces with the amounts in each varying by species. The lowest known dose to cause symptoms is a single dose of 0.31 g; the patient recovered after treatment (Cavanagh et al., 1974). Studies of thallium toxicity in humans are comprised of clinical reports, case studies, and medical surveys. As indicated by case reports, the acute toxicity of thallium is characterized by alopecia (hair loss), severe pain in the extremities, lethargy, ataxia, abdominal pain or vomiting, back pain, abnormal reflexes, neuropathy, muscle weakness, coma, convulsion, other neurological symptoms (i.e., mental abnormalities, tremors, abnormal movements, abnormal vision, and headache), and death (Lu et al., 2007; Tsai et al., 2006; Saha et al., 2004). Low rates of bioconcentration may occur in aquatic systems and thallium may be as toxic as copper on a weight basis (Zitko et al., 1975). Thallium can cause reductions in larval fish growth and percent embryo hatchability and mortality (Le Blanc and Dean 1984).

The result obtained from our present analysis, in the mean highest concentration of Tl was found in surface water sample (0.094 mg/L) whereas lowest concentration was re-

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corded in Penaeus japonicus (0.072 mg/L). In our study the mean lower and higher concentration of Tl in shrimp species and in water samples were found above as proposed by Carson and Smith (1977) reported, " 'Non-effect levels' for mammals have not been established experimentally, but levels of near 3 ppb thallium in an animal's diet are likely to produce toxic effects detrimental to the individual's survival."

Conclusion:

The toxic elements such as Al, B, Ba , Be, Bi, Ca, Cr, Ga, K, Li, Mg, Se, Te, and Ti are potentially harmful and caused toxic effects to most organisms even in very low concentrations. From the above results it is expected that the sea food available in and around Mumbai may have elevated levels of pollutants. These toxic elements may cause dermatological diseases, skin cancer and internal cancers (liver, kidney, lung and bladder), cardiovascular disease, diabetes, and anemia, as well as reproductive, developmental, immunological and neurological effects in the human body. These toxic elements 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 toxic elements, 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 and toxic elements 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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