ANALYSIS OF HEAVY METALS AND COLIFORM IN SAMPLES OF DRINKING WATER COLLECTED FROM MUNICIPAL AND PRIVATE SCHOOLS OF GOREGAON SUBURBAN OF MUMBAI, INDIA

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Abstract:

The 15 samples of waters were collected from the Municipal and private schools from Goregaon suburban of Mumbai in the month of October-November, 2013. The samples of drinking-water were analyzed for Cu, Zn, Fe, Ca, K, Na, Pb, Mg, As and Hg. From the results so obtained, the contamination due to heavy metals –. Cu (0.012 ppm and 0.052 ppm), Zn (0.028 ppm and 11.559 ppm), Fe (0.042 ppm and 0.24 ppm), Ca (9.504 ppm and 11.545), K (0.289 ppm and 404 ppm), Na (3.51 ppm and 6.704 ppm), Pb (0.122 ppm), Mg (3.663 ppm and 4. 245 ppm) . The contamination Zn, K, and Pb, was found above the acceptable limits whereas Cu, Fe, Ca, Na and Mg were found below the acceptable limits than the WHO standard and no As and Hg in the samples of drinking-water samples, it's content was less than 0.001 ppm and hence not detected. In the present work, MacConkey Broth was used as a differential medium for detection and enumeration of coliforms from a wide variety water samples. The presence of positive doubtful presumptive test immediately suggests that the water is non potable (i.e., both acid and gas develops in a tube after 48 hours incubation). Confirmation suggests that there is fecal contamination in the water under investigation and hence it is non potable. All the fourteen samples (streaked from positive Ma cConkey broth tubes) were found to be contaminated with E. coli, which was further confirmed by the presence of colonies with green metallic sheen observed under a microscope confirmed that the said samples were contaminated with E. coli - the major indicator of fecal contamination.

Keywords:

Heavy Metals; Coliform; MacConkey Broth; E. coli; Drinking Water.

Introduction:

Water-related diseases are responsible for 80% of all illnesses/deaths in developing countries, and they kill more than 5 million people every year (WHO, 1995) (UNESCO, 2007). Water, the precious gift of nature to human being is being polluted day by day with increasing urbanization. Although three-fourth part of earth is surrounded by water but a very small portion of it can be used for drinking purposes. Ground water is an important source of drinking water for humankind. It contains over 90% of the fresh water resources and it is an important reserve of good quality water. Ground water, like any other water resource, is not just concerned with public health but is also of economic value (Armon and Kitty 1994).

Water is one of the essentials that supports all forms of plant and animal life (Vanloon and Duffy, 2005) and it is generally obtained from two principal natural sources: Surface water such as fresh water from lakes, rivers, streams, etc. and Ground water such as borehole water and well water (McMurry and Fay, 2004; Mendie, 2005). Water is not pure as it acquires contaminants from its surrounding and those arising from humans and animals as well as other biological activities (Mendie, 2005).

The water pollution by heavy metals has become a question of considerable public and scientific concern in the light of the evidence of their toxicity to human health and biological systems (Anazawa *et al.,* 2004). Heavy metals receive particular concern considering their strong toxicity even at low concentrations (Marcovecchio *et al.,* 2007). They exist in water in colloidal, particulate and dissolved phases (Adepoju and Alabi,2009) with their occurrence in water bodies being either of natural origin (e.g. eroded minerals within sediments, leaching of ore deposits and volcanism extruded products) or of anthropogenic origin (i.e. solid waste disposal , industrial or domestic effluents) (Marcovecchio *etal.,* 2007).

The ever increasing human population and industrialization has resulted in tremendous build up of organics in many forms in water. Many unexpected organics are reported to be found even in remote parts like hills of Himalayas, Alaska and North Pole due to man-made devastation of our environment. The environmental education has aroused much awareness about the toxicity of traces of environmental pollutants in general and organics in particular.

Internationally several organizations namely Food and Agriculture Organization FAO (1983)), APHA: (1992), Environmental Protection Agency (EPA) US (2000), US Public Health Services (USPHS) (1991). The National Academy of Sciences (NAS) (1999), 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, have also been reported along with toxicity tests.

Adequate water resources for future generations are not only a regional issue but also a global concern. Our country's fresh water wealth is under threat due to variety of natural and human influences. Arsenic, fluoride and heavy metals occur as minor constituents of ground water in all categories of hydro-geological settings in India. The high concentration of these minor constituents including iron and nitrate is of concern as large amount of ground water is abstracted by drilling water-wells both in rural and urban areas for drinking and irrigation purposes. Sixteen states in India- Andhra Pradesh, Bihar, Delhi, Gujarat, Haryana, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Orissa, Punjab, Rajasthan, Tamil Nadu and Uttar Pradesh have already been identified endemic to fluorosis (Mariappan et al., 2000). Arsenic contamination of ground water in eight districts of West Bengal is well documented and more cases are also reported from eastern part of Bihar, Gorakhpur, Balia, Western part of Uttar Pradesh and Chattishgarh (Singh, 2006). The intensive farming belt of Western U.P., Haryana, Punjab, and parts of Rajasthan, Delhi and West Bengal have been reported to contain high NO_3 in groundwater (Malve and Dhage, 1996).

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 contamination of drinking waters, 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 detail and to dig the thought under the problem.

It is therefore necessary to determine the extent of contaminants in the water 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 15 samples of waters were collected from the Municipal and private schools from Goregaon suburban of Mumbai in the month of October-November, 2013. The water samples were collected in propylene bottles and were stored at – 20^0C in freezer in the Department of Zoology, S.S & L.S. Patkar College, Goregaon (West) Mumbai for further treatment.

b) Sample Treatment

Water samples were randomly collected from above 14 sampling sites. They were collected directly from the Drinking of each office located at east and west Suburban's from Dahisar to Andheri of B.M.C (Bombay Municipal Corporation) in a propylene bottles. The water sampleswere well mixed with 2mL concentrated HNO_3 per liter sample and capped tightly until they were ready for analysis. (Ehi-Eromosele and Okiei 2012).

c) Preparation of MacConkey Broth:

MacConkey Broth was used as a differential medium for detection and enumeration of coliforms from a wide variety water samples.

Composition

Ingredients Gms / Litre

Peptic digest of animal tissue 20.000g; Lactose 10.000g; Bile salts 5.000g; Sodium chloride 5.000g Neutral red 0.075g. All the above ingredients were Suspended (40.07 grams) in 1000 ml distilled water. The suspended material was heated to dissolve the medium completely and final pH was adjusted (at 25°C) 7.4±0.2. The medium was distributed into tubes with inverted Durhams tubes and sterilize by autoclaving at 15 lbs pressure (121°C) for 15 minutes. The tubes were cooled before inoculation.

d) 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.

e) 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 and Himedia were of AR grade quality.

RESULTS AND DISCUSSION:

Table 1. Concentration of metal ions in drinking water samples obtained from Municipal and private schools from Goregaon suburban of Mumbai in the month of October-November, 2013

Sr.No.	Water Sample	Cu Ppm N=3	Zn Ppm N=3	Fe Ppm N=3	Ca Ppm N=3	K ppm N=3	Na ppm N=3	Pb ppm N=3	Mg ppm N=3	As ppm N=3	Hg ppm N=3
01	Adarsha Vidyalaya(w)	0.017	0.101	0.085	10.863	0.572	5.663	ND	4.245	ND	ND
02	Motilal Nagar B.M.C. School No-1,(w)	ND	11.559	0.24	9.504	0.334	3.583	0.122	4.104	ND	ND
03	Siddhartha Nahar B.M.C. School ,(w)	0.012	0.207	0.117	9.84	404	3.762	ND	4.043	ND	ND
04	Bangur Nagar Vidyalaya & Jr. College,(w)	0.012	0.123	0.081	10.214	0.397	3.871	ND	4.013	ND	ND
05	M.T.S. Khalsa High school & Jr. College,(w)	0.014	0.139	0.065	9.94	0.364	3.667	ND	3.89	ND	ND
06	Small M.T.S. High school, (w)	0.02	0.188	0.042	10.172	0.541	4.262	ND	3.918	ND	ND
07	Children's Public High school, (w)	0.012	0.212	0.072	9.938	0.915	6.704	ND	4.104	ND	ND
08	S.T. Thomas School (w)	0.015	0.093	0.119	11.545	0.289	3.792	ND	3.663	ND	ND
09	Sanskardham School (w)	ND	0.111	0.13	9.716	0.365	3.529	ND	4.01	ND	ND
10	SamnitraMandal High School (E)	ND	0.028	0.062	9.618	0.344	3.601	ND	3.859	ND	ND
11	Nandadeep Vidyalaya (E)	ND	0.137	0.064	10.476	0.336	3.654	ND	3.809	ND	ND
12	Unnat Nagar B.M.C. School (W)	ND	0.171	0.064	10.553	0.382	3.558	ND	3.814	ND	ND
13	I.B. Patel B.M.C. School (W)	ND	0.041	0.048	9.764	0.383	3.549	ND	3.873	ND	ND
14	Vivek Vidyalaya (W)	0.052	0.041	0.13	10.979	0.357	3.51	ND	3.907	ND	ND
15	Pahadi B.M.C. School (E)	0.013	ND	0.068	9.896	0.369	3.753	ND	3.949	ND	ND

Total reading taken = N (Average reading=3) ND= Not detected or less than 0.001ppm

Table 2. Determination of MPN (Coliform) in drinking Drinking water samples obtained from Municipal and private schools from Goregaon suburban of Mumbai in the month of October-November, 2013

Sr.No.	Water Sample	No. of tubes showing Positive test (10mL) N=3	No. of tubes showing Positive test (1mL) N=3	No. of tubes showing Positive test (0.1mL) N=3	MPN /100 mL
01	Adarsha Vidyalaya(w)	03	02	00	14
02	Motilal Nagar B.M.C. School No-1,(w)	03	02	00	14
03	Siddhartha Nahar B.M.C. School ,(w)	02	03	00	12
04	Bangur Nagar Vidyalaya & Jr. College,(w)	03	02	00	14
05	M.T.S. Khalsa High school & Jr. College,(w)	02	00	01	07
06	Small M.T.S. High school, (w)	04	03	00	27
07	Children's Public High school, (w)	04	04	00	34
08	S.T. Thomas School (w)	04	03	00	27
09	Sanskardham School (w)	04	04	00	34
10	SamnitraMandal High School (E)	03	02	01	17
11	Nandadeep Vidyalaya (E)	02	01	01	09
12	Unnat Nagar B.M.C. School (W)	01	01	00	06
13	I.B. Patel B.M.C. School (W)	01	01	00	06
14	Vivek Vidyalaya (W)	01	01	00	06
15	Pahadi B.M.C. School (E)	04	04	00	34

(Note: With presumptive test both acid and gas formation is taken as positive)

Average readings = N=3 MPN= Most probable number of Coli form

W= west E= east

World Health Organization.1983

Heavily polluted = 10000 bacteria / L of water

Polluted = 100 bacteria / L of water

Slightly polluted = 10 bacteria / L of water

Satisfactory quality = 05 bacteria / L of water

Drinking water = 03 or less bacteria / L of water

Cu

Contamination of drinking water with high level of copper may lead to chronic anemia (Acharya et al., 2008). Studies have shown that ingesting copper may also be implicated in coronary heart diseases and high blood pressure, although coronary heart diseases have also been linked to copper deficiency.

High levels of copper in drinking water can cause vomiting, abdominal pain, nausea, diarrhea and has been reported that copper leached into drinking water from copper pipes (Darthmouth 2001). Just as little copper is essential for good health (0.01 mg/l), too much can be harmful. Ingesting large amounts of copper compounds (such as copper sulphate) can cause death by nervous system, liver and kidney failure.

The effect of heavy metal concentration which was higher in untreated sewage water of Musi river near Hydrabad, India was studied by Raj et al (2006). Sewage water collected all along the Musi river at different sites was contaminated with Cu, with mean concentration of 0.011 ppm respectively. A sample analyzed has fewer amounts of heavy metals than WHO permissible limits. The distribution and characterization of heavy metals in water in Jeedimetla industrial area in Andhra Pradesh showed concentration of Cu (4.2 – 13.7ppb), the concentration of this element was found to be far above the permissible level in water (Govil,2001). The estimated mean concentration of Cu, was 0.500 ppm, in regions around a fertilizer factory in Punjab (Dey et al, 1997) was found below the permissible limits. Water sample in industrially polluted areas in Bangalore, Karnataka, India had higher concentration of Cu 33.63ppm (Gowda et, al, 2003). Monitoring and assessing the heavy metal like Cu contents in the industrial effluents from Ambanath area in Maharashtra state India, revealed that Cu concentration varied from 80 to 10.2 ppm which is above the specified Maximum acceptable concentration (1.0 mg/L) WHO (Lokhande & Sathe, 2001). Tuzen1 and Soylak, 2006, evaluated the lowest and highest values of copper in Resadiye and Erbaa, were in the range of 4.44-7.43 µg/l respectively, and was considerably above the limit of 1.0 mg/l permitted by WHO in drinking waters WHO. 1998.

In the present work, the lowest and highest mean concentrations of copper are 0.012 ppm and 0.052 ppm respectively. None of the water samples contained copper above the specified Maximum acceptable concentration as prescribed by (1.0 ppm) WHO 1998.

Zn

The main industrial uses of zinc are galvanization and preparation of alloys. It is believed that galvanized pipes, through which water is supplied to various places, is the source of zinc in natural waters including drinking water.

Gowda et al. (2003) found that the levels of zinc in the water samples obtained from industrially polluted ares in Bangalore, India, were higher (41.09 ppm) than the limit prescribed by WHO 1998.

It has been reported that the levels of zinc ranged from 4.16 ug/L to 8.44 ug/L (lowest in Almus and highest in Niksar), the mean level of zinc being 6.12 ug/L(Tuzen, Soylak 2006).

The mean level of zinc in drinking water samples in drinking water from Xian, China has been reported as 21.84 µg/l (Guo 2004) and that from Tehran, Iran, has been reported as 220 ug/L (Yamini et al. 2004).

It has been reported that the concentrations of zinc ranged from 0.086 ppm to 0.163 ppm in samples of drinking water obtained from the surface water level of lower lake in Bhopal, India. These values are lower than the value prescribed by WHO 1998 (Gupta et al 2005).

In the present work, the lowest and highest mean concentrations of zinc are 0.028 ppm and 11.559 ppm respectively. Thus, the highest mean concentration of zinc is found to be higher than the (5.0 ppm) WHO 1998 standard.

Fe

Iron in drinking water is present as Fe2+ and Fe3+ in suspended form Sonawane 2003. Drinking water containing iron above 1.00 mg/L is not considered to be suitable for drinking purposes.

As per the standards set by WHO, the permissible level of iron is 0.3ppm. Above 1.00 ppm of iron in drinking water is not considered to be suitable for drinking purposes WHO 1993. In North-East region of India, the amount of iron is relatively high and almost all states of India contain iron above the permissible limit. While the lowest iron level was found in water samples obtained from Niksar (14.5±0.1ppm), the highest iron concentration was found in water samples obtained from Resadiye (34.6±0.3ppm). WHO has proposed a guideline value of 0.3 ppm for drinking-water Singh 2006.

In the present work the lowest and highest mean concentrations of iron are 0.042 ppm and 0.24 ppm respectively, none of the water samples contained iron above the specified maximum acceptable concentration as prescribed by WHO 1993.

Ca

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 and magnesium content in drinking water was found below the permissible limit in almost all the states of North-East region of India. The mean value of the concentration of calcium in water samples obtained from Meghalaya has been reported as 75.42 mg/L and that of water samples obtained from Arunachal Pradesh has been reported as 75.08 mg/L) was detected just above the drinking water permissible level of 75 mg L-1. Singh, 2006

In the present work, the values of the mean minimum and maximum concentrations of calcium in the drinking water samples are found to be 9.504 ppm and 11.545 ppm respectively. These values are below the prescribed limit WHO 1993.

Potassium (K)

Potassium is an essential element in humans and occurs widely in the environment, including all natural waters. The primary source of potassium for the general population is the diet, as potassium is found in all foods, particularly vegetables and fruits. Some food additives are also potassium salts (e.g. potassium iodide).

Potassium is seldom found in drinking water at levels that could be a concern for healthy humans. However, the contamination of drinking-water by potassium can occur due to the use of excess of potassium permanganate as an oxidant in water treatment and due to the consumption of water obtained from a water softener that uses potassium chloride.

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, Smith & Hodge, 1984). Alberta water supplies rarely contain more than 20 mg/L (Gosselin, Smith & Hodge, 1984). In the United Kingdom, a survey carried out for the Regional Heart Study (Powell & Jolly, 1987) found a mean potassium concentration of 2.5 mg/l in drinking-water.

In the present work, the values of the mean minimum and maximum concentrations of potassium in the drinking-water samples are found to be 0.289 ppm and 404 ppm respectively. These values were found above the specified Maximum acceptable concentration WHO 1993.

Na (Sodium)

In the human body, sodium helps in maintaining the water balance. Human intake of sodium is mainly influenced by the consumption of sodium as sodium chloride or table salt. The treatment for certain heart conditions, circulatory or kidney diseases, or cirrhosis of the liver may include sodium restriction. Diets for these people should be designed with the sodium content of their drinking water taken into account. The recommended maximum level for people suffering from certain medical conditions such as hypertension, congestive heart failure or heart disease is 20 mg/l.

The National Academy of Sciences has suggested a standard for public water allowing no more than 100 mg/l of sodium. This would ensure that the water supply adds no more than 10% of the average person's total sodium intake. The American Health Association recommends a more conservative standard of 20 mg/l to protect heart and kidney patients.

A normal adult may consume 5,000 to 10,000 milligrams of sodium per day without adverse effects. The average intake of sodium from water is only a small fraction of that consumed in a normal diet. Softening by ion exchange or limesoda ash increases the sodium content. Such treatment includes the use of potassium chloride instead of sodium chloride softener pellets (softener salt).

In the present work, the values of the mean minimum and maximum concentrations of sodium in the drinking water samples are found to be 3.51 ppm and 6.704 ppm. These values are below the prescribed WHO 100 mg/l limit.

Pb

Lead is a commulative poison and a possible human carcinogen (Bakare - Odunola, 2005). It is a neurotoxin and is responsible for the most common type of human metal toxicosis (Berman, 1980). Also, studies have linked lead exposures even at low levels with an increase in blood pressure (Zietz *et al.*, 2007) as well as with reduced intelligence quotient in children (Needleman, 1993) and with attention disorders (Yule and Rutter, 1985). The possible long term effects of chronic exposure to lead present in drinking water are subject to considerable public concern (Zietz *et al.*, 2007).

Some of the common sources of lead poisoning are from lead paints, utensils made of lead containing alloys and tetraethyl lead, used as an anti-knock agent in motor fuel. The lead compounds carried into the air as fumes of lead oxide and lead bromide (from motor exhaust) ultimately settle in the field and through food and drinks enter human body Banerjea, 1995.Adepoju and Alabi, 2005) carried out the analysis of 10 samples of well-water and 19 samples of borehole-water and, of these, they found that 6 of the well-water samples and 12 of the borehole-water samples representing 36.73% of the total, contained lead in levels above the Maximum Contaminant Level (0.01mg/l) with the maximum concentration detected being 0.024 mg/l. These results are of concern as lead has been recognized for centuries as a cumulative general metabolic poison. Bakir et al., 2003 found that the lead contents of the water samples investigated from Tokat city were below 5 µg/l and this level of lead is below the limit prescribed 0.01 mg/L by WHO 1993.

In the present work, no lead was detected in the drinking-water samples under investigation except one sample. The value of the mean minimum and maximum concentrations of lead in the drinking water is found to be 0.122 ppm respectively. The above value is above the limit prescribed WHO 1993.

Mg

Magnesium is another constituent causing "hardness" in water. Higher levels of magnesium may produce a bitter taste but are not normally a health hazard.

In the present work, the values of the mean minimum and maximum concentrations of magnesium in the drinking-water samples are found to be 3.663 ppm and 4. 245 ppm respectively. These values are below the limit prescribed WHO 1993.

As

At certain concentrations, arsenic causes problems such as changes to the skin (relaxing and dilatation of the pores) with secondary effects on the nervous system; irritation of the respiratory organs and gastrointestinal tract and altered hematopoiesis. Arsenic can also accumulate in the bones, muscles and skin and, to a lesser degree, in the liver and kidneys. Epidemiological evidence from people who have suffered prolonged exposure to inorganic arsenic in drinking water is hyperkeratosis of the hands and feet, the principal manifestation of which is skin pigmentation and calluses on the palms and soles of the feet.

The main forms of human exposure to arsenic are ingestion and inhalation. The main source of contamination of drinking-water is the naturally occurring arsenic in groundwater. Some of the countries that have such extensive naturally occurring arsenic in groundwater and hence, potentially in drinking water include - India (especially in Bengal), Bangladesh, Nepal, Thailand, China, Mongolia, Tibet,Vietnam, Laos, Cambodia, Myanmar, various

South American countries and areas in North America and Western Australia (Michael et al., 2001).

The arsenic concentration was found to be a major threat in northeast states of India. It has been reported that arsenic concentration in groundwater exceeds the permissible level (50 µg/l) in Assam, Arunachal Pradesh, Nagaland, Manipur and Tripura states; Arunachal Pradesh 0.00 -657; Assam 0.00-108; Manipur 0.00-986; Meghalaya 0.00-26.79; Nagaland 0.00-278; Sikkim 0.00-444; Arsenic concentration was found to be higher in the area adjacent to foothills bounded by Himalayan mountains. The concentration of arsenic was relatively high in shallow tubewell (15- 40 m deep) as compared to deep tube well and rings-well (Singh 2004).

In the present work, no arsenic was detected in the drinking-water samples under investigation. It can therefore be concluded that, if at all arsenic was present in the drinking-water samples, it's content was less than 0.001 ppm and hence not detected.

Hg

Naturally occurring mercury has been widely distributed by natural processes such as volcanic activity. Mercury finds use in industrial processes, in electrical appliances (lamps, mercury cells), in industrial and control instruments (thermometers, barometers), in laboratory apparatus and as a raw material for various mercury compounds. The latter are used as fungicides, antiseptics, preservatives, pharmaceuticals, electrodes and reagents. Mercury has also been widely used in dental amalgams. A less well characterized use is in ethnic and folk remedies, some of which can give rise to significant exposure of individuals (IPCS, 2003). Levels of mercury in rainwater are in the range 5–100 ng/litre, but mean levels as low as 1 ng/litre has been reported (IPCS, 1990). Naturally occurring levels of mercury in groundwater and surface water are less than 0.5 µg/ litre. Ware, 1989 has reported that a small number of ground waters and shallow wells in the USA were shown to have mercury levels that exceeded the maximum contaminant level of 2 µg /litre set by the US

Environmental Protection Agency,1975 for drinking-water. An increase in the mercury concentration up to 5.5 µg/litre was reported for wells in Izu Oshima Island (Japan), where volcanic activity is frequent (Magara et al., 1989). In a contaminated lake system in Canada, methylmercury was found to constitute a varying proportion of total mercury, depending on the lake (IPCS, 1990). There have been no reports of methylmercury being found in drinking-water.

In the present work, no mercury was detected in the drinking-water samples under investigation. It can therefore be concluded that, if at all mercury was present in the drinking-water samples, it's content was less than 0.001 ppm and hence not detected.

MPN (Most probable Number)

The presumptive test (i.e. the development of both acid and gas in the tube after 48 hours incubation) is specific for detection of coli form bacteria in water samples and for obtaining some index as to the possible number of organisms present in the samples under analysis. A positive presumptive test suggests that water sample is non potable and is contaminated with E. coli, the major indicator of fecal contamination.

The presence of E. coli in the samples of drinking-water is a major health concern and calls for remedial attention. The presence of this pathogen in the samples is an indication of the likely presence of other enteric pathogens suggesting that the samples of drinking-water are heavily contaminated with feacal matter (Petridis et al., 2002).

The water supplied to the Mumbai city from the different lakes might not be free from contamination. The location of water-pipelines close to potential dumps containing wastes such as expired drugs, batteries, waste oils, synthetic detergents, disinfectants, human and animal wastes, etc. could lead to ground water pollution. Detergents and other chemicals released in water due to activities such as bathing, washing of clothes, etc. in the vicinity of the water body can pollute the groundwater with complex organic and inorganic chemicals. The location of water-pipelines close to drain-pipelines can cause faecal contamination. These contaminants may infiltrate into the lakes thereby constituting a serious health threat. Diseases such as diarrhea, meningitis, acute renal failure, urinary tract infections, and haemolytic anaemia have been known to result from consumption of such contaminated waters as described by (Petridis et al., 2002).

Bearing the above-stated facts in mind, this study was conducted during and after rainy season. The bacteria isolated in this study, namely, Escherichia coli (E. coli) is regarded as the most sensitive indicator of faecal contamination.

In the present work, all the fourteen samples (streaked from positive MacConkey broth tubes) were found to be contaminated with E. coli, which was further confirmed by the presence of colonies with green metallic sheen observed under a microscope.

Conclusion:

The 15 samples of waters were collected from the Municipal and private schools from Goregaon suburban of Mumbai. The samples of drinking-water were analyzed for Cu, Zn, Fe, Ca, K, Na, Pb, Mg, As and Hg. From the results so obtained, the contamination due to heavy metals Zn, K, and Pb, was found above the acceptable limits whereas Cu, Fe, Ca, Na and Mg were found below the acceptable limits than the WHO standard and no As and Hg in the samples of drinking-water samples, it's content was less than 0.001 ppm and hence not detected. Therefore, it can be concluded that if excess of the elemental toxicants enter the human / animal body through drinking water, they can pose health hazards because of their cumulative effect in the body.

In view of these findings, the lakes which supply the drinking water to the Mumbai city should be monitored periodically to avoid excessive intake of trace metals by human, and to monitor the pollution of aquatic environment. Further, strict method of waste disposal control should be adopted to ensure the safety of the environment and to safeguard our aquatic life. MacConkey Broth was used as a differential medium for detection and enumeration of coliforms from a wide variety water samples. The presence of positive doubtful presumptive test immediately suggests that the water is non potable (i.e., both acid and gas develops in a tube after 48 hours incubation). Confirmation of these results is the presumptive tests of result of coli form origin that is recognized as indicators of fecal contamination.

With confirmed test all the fourteen samples (streaked from a positive MacConkey broth tubes from the presumptive test) were found to be contaminated with E. coli the major indicator of fecal contamination (presence of colonies with green metallic sheen)

As there is an indication of the presence of E. coli in all the samples, it has been concluded that the samples are contaminated and are not free from fecal contamination. The present reports however may eliminate the possibility of opportunistic pathogens in the water samples. There may be a possibility of contamination of ground water also and care should be taken to avoid the contact of water bodies with sewage drainage of water sources. The intermittent bacteriological analysis is needed to rule out the presence of opportunistic pathogens and recent fecal contamination if any.

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