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International Journal of Current Research
Vol. 7, Issue, 01, pp.12006-12010, January, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

BACTERIOLOGICAL AND PHYSICOCHEMICAL ANALYSIS OF DRINKING WATER SAMPLES IN AND AROUND JAVARANAHALLI, MANDYA, KARNATAKA

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ARTICLE INFO

Article History:
Received 26th October, 2014
Received in revised form
27th November, 2014
Accepted 20th December, 2014
Published online 31st January, 2015

Key words:

Water quality, Physicochemical characteristics, Faecal coliform, fluoride, Bureau of Indian Standard BIS).

ABSTRACT

Water quality is an index of health and well being of a society. The water quality is determined by the amount and kinds of suspended and dissolved substances in water. Industrialization, urbanization and modern agricultural practices have direct impact on water resources quantitatively and qualitatively. The objective of the present study was to determine the bacterial contamination and physicochemical characteristics of drinking water samples collected from various villages in and around Javaranahalli Gram Panchayat, Nagamangala Taluk, Mandya district, Karnataka state. All the water samples tested were clear, colourless, odourless and had other parameters like P^H, alkalinity, total hardness, chloride, fluoride, iron, ammonia, nitrite, nitrate and total dissolved solids within the permissible limits of Indian Standard for drinking water -specification, Bureau of Indian Standard (BIS). The samples tested were also free from faecal coliforms. Water sample from Bellur had fluoride content higher than BIS guidelines and required defluorination before human consumption.

INTRODUCTION

Water is the elixir of life, a precious gift of nature to mankind and millions of other species living on the earth. It is fast becoming a scare commodity in most part of the world. Though water is available in the universe in huge quantity in the order of 1400 x 10^6 km, only 3% of the waters in the universe are fresh water. Among the fresh waters, only about 5% of them or 0.15% of the total world waters are readily available for beneficial use. The total water resource available in India is 1850 km^3, which is roughly 4% of the world's fresh water resources (EPA-PWD, 2001). Although statistics vary, the World Health Organisation (WHO) reports that approximately 36% of urban and 65% of rural Indian's were without access to safe drinking water (WHO, 2009). About 95% of rural population living in India depends on ground water for domestic use (Moharir *et al*., 2002). Ground water is generally considered as a safe source of fresh drinking water (Haloi and Sarma, 2011). The demand for quality drinking water had changed considerably with the development in olden days, the only requirement of drinking water was that it should be free flowing and non turbid. The need for better environment and health cannot be over emphasized. With increasing industrialization, urbanization, and growth of population, India's environment has become fragile and has been causing concern (Mohapatra and Singh, 1999). Almost 70% of the water in India has become polluted due to the discharge of domestic sewage and effluents into natural water sources, such as rivers, streams as well as lakes (Sangu and Sharma, 1987). Other sources that contaminate the water are domestic waste water, storm water runoff, cattle feedlots runoff, effluent from septic tank, sewage etc (Geldeich, 1987). These effluents contain human and animal faeces along with pathogenic microorganisms. The most dangerous water pollutants are pathogenic microorganisms which includes *Salmonella sp, Shigella sp, Vibrio cholerae* and *E.coli* (Cunningham, 2005; Tortora and Funke, 2002). Consumption of contaminated water leads to water borne diseases like cholera, typhoid fever, diarrhoea etc and death of more than 1.5 million children each year (Fenwick, 2006).

Excessive ground water exploitation has resulted in lowering of water table in rural and urban areas of India. The water quality parameters decide the portability of water (WHO, 2004). Pollution parameters have been classified as physical, chemical and biological on the basis of analytical tests. Physical

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parameters include temperature, turbidity, colour, odour, taste, suspended and floating matter etc. manifesting palatability and aestheticity. Chemical parameters include organic and inorganic dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), nitrogen in various forms, P^H, alkalinity, chlorides, sulphates, heavy metals, pesticides etc.

Bacteriological quality of drinking water is primarily determined by using "indicator organisms" whose presence indicates faecal contamination (Duling and Wanda, 2008). Higher level of indicator bacteria, higher the level of faecal contamination and greater risk of contracting disease (Alonso *et al*., 1996). Coliforms especially E.coli is recommended indicator organism for portable water and indicator of direct or indirect faecal contamination (Mercado and Hazon, 1987). This study was undertaken to determine bacteriological and physicochemical characteristics of drinking water from some villages of Javaranahalli Gram Panchayat, Nagamangala Taluk, Mandya district, Karnataka.

MATERIALS AND METHODS

Study area

A total of 27 drinking water samples (Bore well) from villages in and around Javaranahalli Gram Panchayat, Nagamangala Taluk, Mandya district, Karnataka state were tested for bacteriological and physicochemical parameters. The study was conducted at Sri Adichunchanagiri College of Pharmacy, B.G.Nagara, Mandya district, Karnataka between April to October 2013.

Sample collection

Drinking water samples for the study of bacteriological and physicochemical characteristics were collected aseptically in sterile containers during the day between 9.00 hrs and 11.30 hrs. The samples were transported by standard methods as mentioned in APHA, 2005 to the laboratory for analysis within 2 hours and in case of delay the samples were preserved at 4^0C.

Bacteriological analysis

The most probable number (MPN) method was employed for the total and faecal coliforms. Presumptive coliform test was done using multiple 5 tubes MPN dilution technique using Mac Conkey broth. MPN of faecal coliforms were estimated following standard methods for examination of water and waste water (APHA, 2005).

Physico-chemical analysis

The water samples were analyzed for 15 various physicochemical parameters including colour, odour, appearance, P^H, turbidity, alkalinity, hardness, chloride, fluoride, iron, ammonia, nitrite, nitrate, phosphate, total dissolved solids by standard methods (APHA, 2005). The results were compared with Indian standard for Drinking water specification, Bureau of Indian standard (BIS, 1991).

RESULTS

The results of the Bacteriological and physicochemical characteristics of drinking water samples tested are shown in Table 1.

Table 1.

S..No	Name of the village	P^H	Alkalinity	Hardness	Cl^-	Fl^-	Fe^+	Ammonia	Nitrite	Nitrate	Phosphate	TDS	MPN index per 100ml Total coliform
	Bis guidelines desirable limit	6.5	200mg/l	300mg/l	250mg/l	1.0mg/l	0.3mg/l	--	-	45mg/l	-	5000mg/l	
	permissible limit	9.2	600mg/l	600mg/l	1000mg/l	1.5mg/l	1.0mg/l	1.0mg/l	1.0mg/l	100mg/l	1.0mg/l	2000mg/l	0
01	Vaddarahalli	6.5	370	220	370	0.5	0.3	00	0.2	00	00	1152	0
02	Lakshmipura	7.0	350	250	380	00	00	00	00	20	00	1176	0
03	Devihalli	7.0	340	370	410	00	00	00	00	00	00	1344	0
04	Rahamath Nagara	7.5	390	300	60	1.0	00	0.5	00	20	1.0	900	0
05	Javaranahalli	7.0	430	360	130	0.5	0.3	00	0.2	4.5	00	1104	0
06	Chakenahalli	7.5	410	400	370	0.5	0.3	00	00	20	0.5	1416	0
07	Chamalapura	6.5	420	390	360	0.5	00	00	0.2	00	00	1404	0
08	Senabu	6.5	310	380	360	00	0.3	00	0.5	00	00	1260	0
09	Maruthipura	6.5	380	410	430	0.5	0.3	00	0.5	20	00	1464	0
10	Manthanahalli	7.0	370	370	390	0.5	0.3	0.0	0.2	00	00	1356	0
11	Doddegatta	7.0	410	320	380	0.5	0.3	00	0.5	20	00	1332	0
12	Bommanahalli	7.0	500	480	460	0.5	0.3	00	00	20	00	1728	0
13	Kannagatta	6.5	410	330	340	0.5	0.3	00	0.5	20	00	1296	0
14	Agabanahalli	7.5	480	460	460	0.5	0.3	00	00	20	00	1680	0
15	Govindagatta	6.5	380	320	360	0.5	00	00	0.2	20	00	1272	0
16	Huclenahalli	7.0	320	310	380	00	00	00	0.2	00	00	1212	0
17	Chamanakoppala	7.0	380	460	390	0.5	0.3	00	0.2	20	00	1476	0
18	Palyadha halli	6.5	410	390	400	00	0.3	00	0.5	20	00	1440	0
19	Varahsandhra	7.5	440	440	320	00	0.3	0.0	0.2	20	0.0	1440	0
20	Manthanahalli	6.5	480	360	410	0.5	0.3	0.0	0.5	20	0.0	1500	1
21	Dhadaga	7.5	460	310	380	0.5	00	00	0.5	2.0	0.0	1380	0
22	Dyamasandhra	7.0	440	410	440	0.5	0.3	00	00	00	00	1548	0
23	Nagalapura	6.5	410	470	410	0.5	00	00	00	00	00	1548	0
24	Nayakana koppala	7.0	380	330	370	0.5	00	00	00	20	00	1296	0
25	Siddayan thota	7.5	480	410	420	00	00	00	00	00	00	1572	0
26	Bellur	7.5	370	450	190	2.0	00	00	00	45	00	1212	0
27	Gondenahalli	7.0	420	440	400	1.5	00	00	0.5	45	1.0	1356	0

All the water samples tested were clear, odourless and free from turbidity. Most of the water samples tested had other parameters like P^H, alkalinity, total hardness, chloride, fluoride, iron, ammonia, nitrite, nitrate, total dissolved solids within the permissible limits of BIS (1991) guidelines and were free from faecal coliforms. Water sample from Maradvenahalli was found to have microbial numbers within the maximum permissible limit of 1 coliform per 100ml as per the safe drinking water act (George and Schroeder, 1985) and on further testing it was found negative for faecal coliform. Water sample from Bellur had fluoride content higher than guidelines of BIS (1991) and required defluorination before human consumption.

DISCUSSION

The clarity of water is an important determinant of its condition and productivity. Turbidity in water is caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, plankton and other microscopic organisms. All the samples studied in the present study were clear, odourless and free from turbidity. P^H is the measure of intensity of acidity or alkalinity and the concentration of hydrogen ion in water. P^H of water is very important as it plays a role in the growth of flora and fauna of water body and also indicates whether the water is safe for drinking and irrigation purpose. P^H levels of water samples above 8.5 affect mucus membrane and or water supply system. P^H of all the water samples tested was within the range of BIS (1991) guidelines. Our study is in accordance with the studies of Dinesh and Rajesh, (2013) who also reported P^H of the drinking water sources in Tembhurkheda and Jarud region, Dist.Amaravati, MS, India in the range of 6.83 to 7.34. Alkalinity is important factor in determining the ability of water samples to neutralize the acidic pollution. The alkaline nature of the water could be attributed to the buffering properties of some inorganic substances (Kang *et al*., 2001). All the samples tested in the present study had alkalinity values in the range of 310 to 500 and within the permissible limits of BIS (1991) guidelines. Radhakrishnan *et al*. (2007) have reported the alkalinity of bore well waters in the range of 250-730 mg/l in Sivakasi. However, Priscilla *et al*. (2013) have reported the alkalinity of the drinking water samples in the range of 22 to 256mg/l in their study.

Total hardness of water is an important consideration in determining the suitability of water for domestic and industrial uses. Hardness is caused by multivalent metallic cations and with certain anions present in the water to form scale. The principal hardness causing cations are the divalent calcium, magnesium, strontium, ferrous ions and magnous ions. In the present study, total hardness of most of the water samples tested had a hardness of above 300 mg/l and requires purification before consumption. Nirmala *et al*. (2013) have reported the total hardness of selected ground water samples of Tumkur district, Karnataka in the range of 200-500 mg/l whereas studies of Parihar *et al*. (2012) have reported hardness of the underground water in and around Gwalior City, MP, India in the range of 152-332 mg/l.

Chlorides occur naturally in all types of waters. High concentration of chlorides is considered to be indictors of pollution due to organic wastes of animal or industrial origin. Chlorides are troublesome in irrigation water and also harmful to aquatic life (Rajkumar *et al*., 2004). In the present study all the water samples tested had chloride levels within permissible levels of BIS (1991) guidelines. Our findings are comparable with findings of Dinesh and Rajesh (2013) and Nirmala *et al*. (2013). However, Radha Krishnan *et al*. (2007) have reported high levels of chloride in drinking water samples in Sivakasi.

Fluoride (F^-) concentration is an important aspect of hydrogeochemistry, because of its impact on human health. The recommended concentration of F^- in drinking water is 1.50 mg/l. Low F^- content (<0.60mg/l) causes dental caries, where as high (>1.20mg/l) fluoride levels result in fluorosis (Venkateshraju *et al*., 2010). Bureau of Indian Standard for drinking water (BIS, 1991) has specified a fluoride limit between 1.0 and 1.5 mg/l for drinking water. In the present study, most of the water samples had fluoride levels less than 0.5mg/l. Water sample from Bellur had higher level (2.0mg/l) and may cause dental fluorosis, skeletal fluorosis and non-vertebral fractures, especially hip fractures. Apart from fluorosis, high intake of fluorides may also cause gastrointestinal complaints such as loss of appetite, nausea, vomiting, ulcer pain in the stomach, constipation and intermittent diarrhea and flatulence (WHO, 1970; Susheela *et al*., 1992; Teotia *et al*., 1998; Pillai and Stanley, 2002). The adolescent age group is the most vulnerable to fluoride pollution and it is a worldwide problem (WHO, 2004). Samples exceeding the fluoride level greater than 1.5mg/l are needed to be defluorinated with immediate attention in order to prevent negative impacts of high fluoride levels on human consumption in Bellur area. This is in accordance with the studies of Pavendan *et al*. (2011).

Phosphate and nitrate determinations are important in assessing the potential biological productivity of surface waters. Increasing concentration of phosphorous and nitrogen compounds in lakes and reservoirs leads to eutrophification. All the samples in the present study had iron, nitrite, nitrate, ammonia and phosphorous levels within the permissible limits of BIS (1991) guidelines. Studies of Nirmala *et al*. (2013) have reported the iron of selected ground water samples of Tumkur district, Karnataka in the range of 0.3 to 1.0 mg/l and nil phosphate. Total Dissolved solids (TDS) of water refers to the inorganic salts and organic matter present in water which may be due to the presence of sodium, potassium, calcium, magnesium, carbonates, hydrogen carbonate and ions of chloride, sulfate and nitrate (WHO,1996). Total dissolved solids content of all the water samples tested in the present study were within the permissible limits BIS (1991) guidelines. A high value of TDS reduces water quality for drinking, irrigation and agricultural purposes (WHO, 1996). Increase in TDS is mainly due to sea water intrusion and increase in salts (Mittal *et al*., 1994).

Most of the water samples tested in the present study was negative for both total and faecal coliforms and safe for human consumption. Water sample from Manthanahalli was found to have microbial numbers within the maximum permissible limit

of 1 coliform per 100ml as per the safe drinking water act (George and Schroeder, 1985) and on further testing it was found negative for faecal coliform.

Conclusion

The study provides information about the water quality status of some villages in and around Javaranahalli Gram Panchayat. The parameters namely P^H, alkalinity, total hardness, chloride, ferrous, nitrite, nitrate, ammonia, phosphate, total dissolved solids were within the permissible standard limits and satisfy the requirement for the use of various purposes like domestic, agricultural etc except hardness. The microbiological quality of all the water sources was good as they were free from faecal coliforms. Only one water sample had high fluoride content and therefore treatment is required before use and care should be taken for handling of such water.

Acknowledgement

The authors are grateful to Poojya Guru Sri Sri Sri Nirmalananda Mahaswamiji, President, Sri Adichunchanagiri Trust ®. We are thankful to Dr.M.G.Shivaramu, Principal Adichunchanagiri Institute of Medical Sciences, B.G.Nagara for his encouragement.

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