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Original Research Paper

Assessment of Water Hardness Used for Domestic Purposes in Some Tribal Villages of Dhakuakhana Sub-division, Lakhimpur District, Assam

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ABSTRACT

The quality of water varies widely with respect to its various uses, and the water quality suitable for one purpose may not be satisfactory for the other. Statistical studies have demonstrated significant inverse relationship between cardiovascular disease (CVD) mortality and water hardness even when the environmental and socioeconomic factors are taken into account. The evidence that drinking water quality affects cardiovascular disease has been strengthened by recent research which has shown that very soft water increases CVD and mortality rates by 10%. Keeping this view in mind the assessment of water hardness of this region along with some polyvalent cations (Ca, Mg, Fe) has been carried out for three different seasons in a year. The study reveals that water quality in the study area falls under moderately hard (60-120mg/L) and hard (120-180mg/L). Also it was found that Fe content in the study area was very high as compared to the WHO value of safe drinking water, while other parameters (Ca, Mg) were within the WHO limit.

INTRODUCTION

Hardness is the property of water which prevents lather formation with soap and produces scales in hot water system. It is caused by polyvalent metallic ions particularly that of calcium and magnesium along with some contributions of other metals such as iron, manganese, barium and strontium, if present in appreciable amounts. In general practice, hardness is measured as the concentration of only calcium and magnesium ions (mg/L as $CaCO_3$) because these are far higher in concentration as compared to other cations. The principal sources of these two cations, calcium and magnesium, are sedimentary rocks, seepage, and runoff from soils. Groundwater is harder than surface water because of higher solubilizing potential of groundwater over surface water towards soils or rocks containing minerals like calcite, dolomite and gypsum. Industrial sources of hardness are chemical and mining industries, building industries, pulp and paper production, sugar mills, petroleum refining, tanning, ceramics, etc. Hard water is not suitable for bathing, washing and laundering. However, hardness prevents the corrosion in the pipes by forming a thin layer of scale, and reduces the entry of heavy metal from the pipes to the water. The degree of hardness of drinking water has been classified in terms of its equivalent $CaCO_3$ concentration in the following way (APHA 1995).

1. Soft: 0-60 mg/L
2. Moderately hard: 60-120 mg/L
3. Hard: 120-180 mg/L
4. Very hard: >180 mg/L

Magnesium hardness, when associated with sulphate ion particularly, imposes a laxative effect on unaccustomed persons (Abbasi 1998). Hardness of 150-300 ppm and above may cause kidney problems (Jain 1998). There is a strong statistical evidence of a correlation between increased hardness of drinking water up to about 175 mg/L and reduced incidence of some forms of heart disease (Tebbutt 1998). According to WHO, the maximum permissible value of hardness for drinking water is 500 mg/L. The changes in hardness of consuming water may cause some physiological effects in man. A person who travels from soft water regions to hard water regions and vice-versa may feel minor physiological disturbances in the digestive system. These disturbances are due to change in osmotic pressure at the intestinal blood and body fluids; of course the digestive disturbances usually overcome after a short period of adjustment to the new water.

STUDY AREA

Lakhimpur district is situated in the north-east corner of the Indian state of Assam and lies on north bank of the mighty River Brahmaputra. It is located between the latitudes of 26°48'N to 27°53'N and longitude of 93°42' E to 94°20'E. The district is constituted of two sub-divisions, North Lakhimpur and Dhakuakhana. As per 2001 census, the total population of the district was 8,89,010 out of which S.T (P) population is 2,08,864. The sub-division Dhakuakhana is mainly inhabited by Mising Community. Many places of this sub-division fall under the Mising Autonomous Council. These S.T (P) people of Dhakuakhana sub-division generally inhabit the banks of rivers, especially River Brahmaputra. In monsoon season these areas are affected by flood every year and as a result, sources of drinking water are likely to be contaminated. The supply of pure and safe drinking water remains inadequate in the areas and is almost non-existent in the rural areas of Dhakuakhana sub-division. Only a small segment of the total population was benefited by the public water supply scheme. Tube wells and ring wells are the most common source of drinking water. In some remote areas river and pond water is also used for various domestic purposes including cooking and drinking. The present paper deals with the hardness and the amounts of calcium, magnesium and iron usually encountered in the water bodies of this area

MATERIALS AND METHODS

Water samples were collected from forty sampling stations distributed over twenty locations in the Dhakuakhana sub-division of Lakhimpur district. Samples were collected mainly from tube wells, ring wells, supply waters, ponds and rivers in pre-cleaned plastic containers for various physico-chemical analyses. The containers were first cleaned with detergent then with chromic acid solution, rinsed with distilled water several times and dried thoroughly. The containers were tightly stoppered to avoid contact with air, or to prevent agitation during transport. Storage and preservation of samples and their analysis were done following standard procedure (APHA 1995).

Since hardness of water is directly related to the concentration of calcium and magnesium ions, and partly depends on some other polyvalent metal ions like iron, barium, manganese and strontium, so along with total hardness the concentration of calcium, magnesium and iron were also estimated.

Sampling sources: Water samples were collected from twenty sampling stations distributed over the Dhakuakhana sub-division. The name of these twenty locations are Matmora (Sl. No. 1), Bokulguri (Sl. No. 2), Kathalguri (Sl. No. 3), Alimur Dangdhara (Sl. No. 4), Chekani Dangdhora (Sl. No. 5), Awnibari (Sl. No. 6), Moderguri (Sl. No. 7), Moukhowa No. 1 (Sl. No. 8), Kekuri Pomua (Sl. No. 9), Miligoan(Sl. No. 10), Eken Dighola (Sl. No. 11), Gorusuti No. 12 (Sl. No. 12), Sariani (Sl. No. 13), Lati Borchuk (Sl. No. 14), Khajua Patir (Sl. No. 15), Borkhamukh No. 1 (Sl. No. 16), Borbari (Sl.

No. 17), Lechera (Sl. No. 18), Bali Medak (Sl. No. 19), Patirchuk (Sl. No. 20). Samples were collected from ten tube wells, five ring wells, three rivers and two ponds.

RESULTS AND DISCUSSION

The all season average values of total hardness of water samples along with the concentration of calcium, magnesium and iron are given in Table 1 and Table 2. Water samples were collected from tube well (Sl. Nos. 1-10), from ring well (Sl. Nos. 11-15), from river (Sl. Nos. 16-18) and from pond (Sl. Nos. 19-20). The results showed wide variation from source to source and from season to season.

Total hardness: The highest value (138mg/L) was recorded in sampling point 13 (Ring well, Sarioni). The values of hardness were comparatively higher in the water samples collected during winter (dry) season. It may be due to the accumulation of the constituents in absence of rainfall in this particular season. In monsoon season, the water bodies get diluted which result in lowering of concentration levels of the constituents. The lowest value (63 mg/L) was observed in sampling point 18 (River Lechera). According to WHO (1984), the highest desirable level of hardness of potable water is 100 mg/L. In many cases hardness values exceed the WHO guideline value. Again, water with a hardness value of 180 mg/L or above is treated as very hard water. The all season average values were found to be below 180 mg/L. Hardness is an important water quality parameter for both domestic and industrial purposes. Depending on the interactions of other factors such as pH and alkalinity, water with a hardness value of 200 mg/L may cause scale formation in the distribution system and imposes economic disadvantages such as increased soap and fuel consumption as hardness causes elevation of boiling point of water. In the present study no water sample was found to have a hardness value above 200 mg/L. Water with hardness values less than 10 mg/L may have low buffer capacity and more corrosive to water pipes.

Calcium: The highest average value was seen in sampling point 13 (Ring well, Sarioni), and the lowest value (17.5mg/L) in sampling point 8 (Tube well, Mowkhowa No. 1). The all season average values were within the ISI limit. Calcium is one of the important nutrients required by the organisms. It helps in maintaining the structure of plant cells and soils. According to Srinivas et al. (2000) physiologically calcium is needed for the body in small quantities though water provides only a small proportion of calcium required by the body. Small concentrations of calcium are beneficial in reducing the corrosion in the pipes due to the formation of a thin layer of scale. Its concentration reduces at higher pH due to precipitation as $CaCO_3$. Calcium has no hazardous effect on human health. Higher concentration of calcium is not desirable in washing, bathing and laundering due to its suppression of formation of leather with soap. Scale formation in boilers is also another problem associated with high calcium content. The taste threshold for calcium varies from 100-300 mg/L depending on the anions present in water (WHO 1984). In the present study, calcium concentrations in all investigated samples were lower than the taste threshold limits (100-300 mg/L) as well as WHO guideline limit of 100 mg/L.

Magnesium: The highest magnesium content (39.2 mg/L) was observed in sampling point 2 (Tube well, Bokulguri). The second highest value (32.1mg/L) was observed at sampling points 12 (Ring well, Gorusuti No.2). The magnesium content in the present investigation was within WHO limit. Higher magnesium content was detected in tube wells and ring wells compared to the other sources indicating the possible entry of magnesium into groundwater system from the soil structure. Generally, lower concentrations of magnesium were observed in wet seasons which might be attributed to the dilution during these seasons. In winter seasons magnesium concentrations were found to be

Table 1: Total hardness along with calcium, magnesium and iron content for tube well waters.

Sl No.	Total hardness	Calcium	Magnesium	Iron
1	103	59.5	11.3	3.7
2	128	72.1	39.2	5.3
3	65	31.2	9.7	3.1
4	82	65.0	13.5	0.6
5	67	33.6	7.6	0.9
6	76	40.3	14.7	2.5
7	71	21.6	2.1	4.4
8	72	17.5	3.9	6.7
9	94	58.8	15.1	0.4
10	110	37.3	7.3	1.3

Table 2: Total hardness along with calcium, magnesium and iron content for ring well, river and pond water.

S. No.	Total hardness	Calcium	Magnesium	Iron
11	83	35.6	15.7	4.9
12	107	47.1	32.1	3.1
13	138	75.3	8.5	5.7
14	95	23.6	13.7	2.5
15	84	31.7	11.9	.93
16	120	63.9	18.4	.69
17	76	42.0	12.5	.37
18	63	57.2	4.3	.87
19	65	39.3	6.7	1.9
20	109	53.8	13.1	3.8

higher. Magnesium is not very much significant from the health view point.

Iron: The highest concentration of iron (6.7 mg/L) was observed in sampling point 8 (Tube well, Moukhowa No. 1). and the second highest value (5.3mg/L) was observed in sampling point 2 (Tube well, Bakulguri). The iron content of the tube wells and the ring wells was found to be higher in comparison to the other sources. This may be due to soil origin. The very high value of iron in tube wells water may be due to age old iron pipes used. The presence of iron in water makes the water turbid, besides causing staining of plumbing fixtures, laundry, etc. High value turbidity in the present study can be co-related with high concentrations of iron. Average iron content in all the sampling sources exceeded the WHO guideline value of 0.3 mg/L. Therefore, the water sources in the present study area were found to be unfit for use as drinking water sources with respect to iron. According to Sing (2004), in north-eastern region, the amount of iron is relatively high and almost all states contain iron above the permissible level in drinking water. The iron content of the water samples collected during the monsoon period was found to be generally high indicating that the rains and storm water runoff add to the iron input of all the sources. Further, iron content was found to be heterogeneously distributed in the groundwater of the present study area. Iron can affect the flavour and colour of food and water. Water with high concentration of iron, if used in preparation of tea and coffee, interacts with tannin to give a black inky appearance with a metallic taste. Coffee may even become unpalatable if concentration of iron is more than 1 mg/L. Potatoes also turn black on boiling in such type of water. Iron in higher concentration may also cause vomiting.

CONCLUSION

From the above discussion it was found that water hardness is high in the study area with a high value of calcium and iron content. Based on the above results, the following two simple recommendations are given to improve the water quality used for various domestic purposes in the study area.

a. High iron content can be removed by alum treatment and filtration technique mainly in rainy season.
b. Ion exchange is effective for softening hard water. Hardness can also be simply softened by boiling. This process also kills bacteria.

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REFERENCES

Abbasi, S.A. 1998. Environmental Pollution and Its Control. Congent International.

APHA, AWWA, WPCF 1995. Standard Methods for the Examination of Water and Wastewater, 19th Edition, American Public Health Association, Washington D.C.

Jain, P.K. 1998. Hydrology and quality of groundwater around Hirapur, district Sagar (M.P.) (A case study of protozoic rocks). Poll. Res., 17(1): 91-94.

Singh, A.K. 2004. Arsenic contamination in groundwater of north eastern India. In: Proceeding of 11th National Symposium on Hydrology with Focal Theme on Water Quality, National Institute of Hydrology, Roorkee, India, pp. 255-262.

Srinivas, Ch.,Piska, R. S., Venkateswar, C., Rao, M. S. S. and Reddy, R. R. 2000. Studies on groundwater quality of Hyderabad. Poll. Res., 19(2): 285-289.

Tebbutt, T.H.Y. 1998. Principles of Water Quality Control, 5th ed., Butterworth, Heinmann.

WHO 2004. Guidelines for Drinking Water Quality. 3rd Edition, World Health Organization, Geneva.

WHO 1984. Guidelines for Drinking Water Quality. Vols. 1-3, World Health Organization, Geneva.