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A Study of Ground Water Quality by Volumetric Method

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Abstract: One of the main concerns of our developing country is impurities in the drinking water. A small attempt is made to analyse this problem through the present paper. To conduct the study, ten samples were collected from ground water resources, mostly from wells, boreholes and tube wells situated in local areas of Bhiwani district of Haryana (India). The water quantity analysis was made based on Hardness, Alkalinity, TDS (total dissolved solid) and pH. The studies are based on the Volumetric Method to determine hardness in the ground water sample using ethylene diamine tetraacetate (EDTA) by complexometric titration. At First, the total hardness of ground water samples was determined. Further, it was found that the permanent hardness is caused by salts of calcium and magnesium. The difference between the total hardness and permanent hardness gives the value of temporary hardness. By this study it was conclude that the hardness of water was not affect the human health.

Keywords: Hardness, Alkalinity, pH, TDS and Carbonate

I. INTRODUCTION

In rural areas, ground water is the main source for drinking and for domestic use. Water hardness is traditionally defined as the capacity of water to react with soap to produce a lather. Most people do not like to use hardwater due to its salty taste. Though it is not that much harmful for the health. Definition states that hard water requires more amount of soap to form lather. The water hardness occurs due to multivalent metallic cations in which calcium and magnesium are most abundant. The increasing order of abundance of metal cations in ground water are $K^+ < Mg^{2+} < Ca^{2+} < Na^+$ and for anion the series is $F^- < NO_3^- < SO_4^{2-} < Cl^- < HCO_3^-$. So, Hardwater forms a precipitate of insoluble metal, soaps and salts in bathtub, container, handpumps, tap and sink that is very problematic for housewives [1]. But, this precipitate is not formed by just a single metal but by many types of polyvalent metal cations likes aluminium, barium, iron, manganese, strontium and zinc. Though, most abundant calcium and magnesium form white and light-yellow precipitate [1]. Water hardness can be classified in two categories i.e., temporary hardness and permanent hardness. The temporary hardness (carbonated hardness) is formed not only by monovalent metal cations but also by divalent and polyvalent metal cations and anions like carbonate and bicarbonate. In this case, these carbonates and bicarbonates can be removed by simple boiling. The permanent hardness (non-carbonated hardness) is formed mainly by the calcium and magnesium divalent cations and anions like sulphates, chlorides and sometimes nitrates cannot be removed by simple boiling. Generally, water softening is used to remove excess amount of calcium and magnesium. In 1960 De Sousa reported the amount of calcium and magnesium in sea water by using titration against ethylene di-nitrilo tetra-acetic acid [2]. Inadequate supplement of pH value in water sample and alkalinity results in skin disorder, eyes irritation and damaged mucous membrane and hair fibers swelling [3]. The high TDS value and insufficient intakes of calcium increase risks of kidney stones, osteoporosis, colorectal cancer, stroke and hypertension, coronary artery disease, insulin resistance and obesity [4,5].

II. METHODOLOGY AND MATERIAL

In the areas of present study, 60-70% of water used for drinking, domestic and irrigation purposes is from groundwater resources. These ground water resources are facing problems of quality of water; therefore, their water is unfit without treatment for drinking. The ten water samples were collected from the ground water resources i.e. bore holes, wells and handpumps. The study area was chosen from Bhiwani district of Haryana. All-natural water contains sodium, potassium, calcium and magnesium as these are among the abundant elements and these areas also important part of our body fluids. This study gives us some useful knowledge about the quality of water used for drinking and domestic purposes.

A. Sampling

Ten samples were collected from the ground water resources like wells, borewells and handpumps in the different villages of Bhiwani district of Haryana. Sample quantity was enough to determine the total and permanent hardness of water. The number of samples was enough to do two titrations, one for total hardness and another for permanent hardness.

1) Experiment 1

a) **Determine The Total Hardness:** 50ml of water sample in 250ml conical flask was taken, added pinch of eriochrome black-T as an indicator and to maintain pH add 10ml ammonia buffer solution of pH 10 and titrated it with di-sodium salt of ethylene diamine tetra acetate (EDTA) of 0.01M concentration. Before starting titration, the initial reading was noted. When titrated, there the end point indicated by changing the colour from wine red to blue. Then the final reading of EDTA was noted subsequently [6]. The hardness can be determined by the given formula

$$\text{Total Water Hardness (mg/l)} = \frac{\text{Volume of EDTA used in titration} \times 1000}{\text{Volume of sample taken}}$$

2) Experiment 2

b) **Determine the Alkalinity:** Alkalinity is due to CO_3^{2-} , OH^- , HCO_3^- was determine by Volumetric or titration method. Took 100ml water sample and add phenolphthalein if pink color appears titrate it against 0.02 N H_2SO_4 and after disappearance of pink color this was call first step of titration. And then methyl orange indicator was added and titrate again till end-point reach this was second step of titration. And if after addition of phenolphthalein no pink color appear the skip first step of titration and proceed [7].

$$\text{Total Alkalinity (mg/l)} = \frac{\text{Volume of H}_2\text{SO}_4 \text{ used in titration} \times 1000}{\text{Volume of sample taken}}$$

pH was determined by analytical method by using pH- meter (SYSTONIC Digital PH-Meter S-109) and calibrate the PH-meter by using 4-pH and 7 pH buffer solution. And TDS was determined by using TDS meter (Digital LCD – TDS Meter).

III. RESULT AND DISCUSSION

Hardness is measured in milligrams per litre of salt of calcium. As given in World Health Organization standard if the hardness value is less than 60mg/l, water is classified as soft water;60-120mg/l, as moderately hard; 120-180mg/l, as hard and if hardness value is greater than180mg/l, then water is considered as very hard (Mc Gowan 2000) [8].

Table 1 Detail of experimental value of total hardness(mg/l), alkalinity(mg/l), pH and TDS (mg/l) and their classification on the basis of Hardness of water.

Water Sample	Total Hardness (mg/l)	Alkalinity (mg/l)	pH	TDS (mg/l)	Hardness classification
Sample 1	766	184	7.11	2634	Very Hard
Sample 2	421	154	6.57	1614	Very Hard
Sample 3	408	353	7.71	2250	Very Hard
Sample 4	311	259	8.20	1086	Very Hard
Sample 5	363	244	7.46	896	Very Hard
Sample 6	353	215	7.30	798	Very Hard
Sample 7	242	248	7.41	802	Very Hard
Sample 8	276	389	8.34	1135	Very Hard
Sample 9	726	279	7.54	2965	Very Hard
Sample 10	314	296	8.12	889	Very Hard

As per the World Health Organization guidelines, the amount of calcium and magnesium in drinking water is limited up to 1000-1200 mg/day and 200-400 mg/day respectively. As per BIS parameter the if the total hardness is < 200mg/l then it is desirable and the permissible limit up to 600mg/l when alternate is unavailable [9].

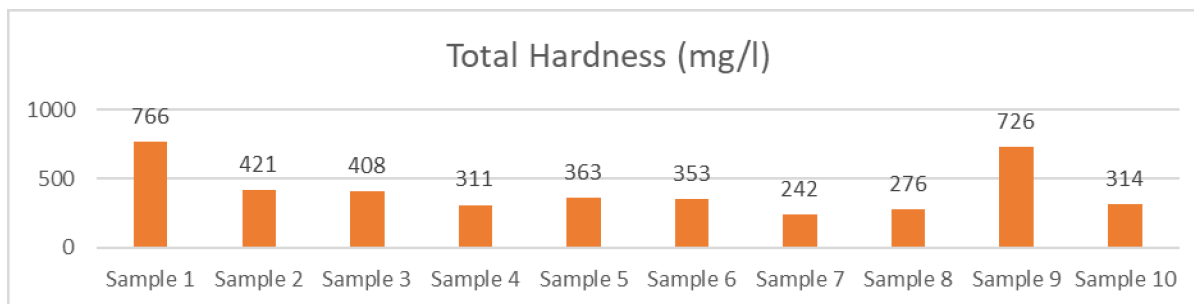


Fig 1. Total Hardness

As per the World Health Organization 2011 the standard parameter for hardness given

Table 2

Total Hardness (as CaCO ₃ mg/l)	Classification	Numbers of samples	Percentage of samples
<60	Soft	0	00.00
60-120	Moderately Hard	0	00.00
120-180	Hard	0	00.00
>180	Very Hard	10	100

A. Alkalinity

The desirable value of Alkalinity is <200mg/l, And if it is 200-600 mg/l then it is permissible but if it exceeds then 600mg/l then it was not permissible [9].

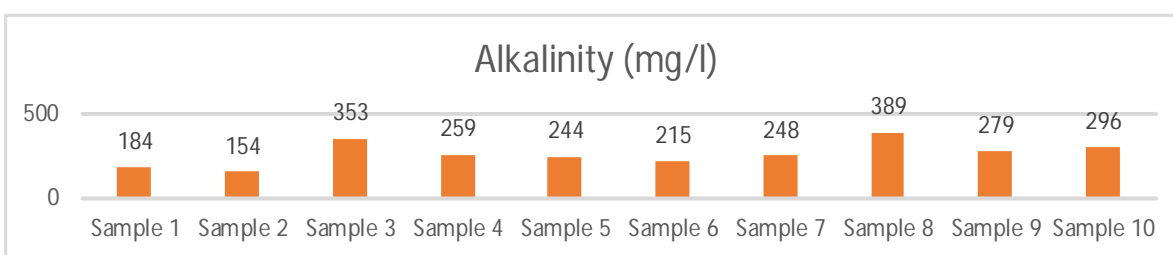


Fig 2. Alkalinity

B. pH

The desirable pH range is 6.5-8.5. and if the pH beyond this value the water sample are not permissible [9].

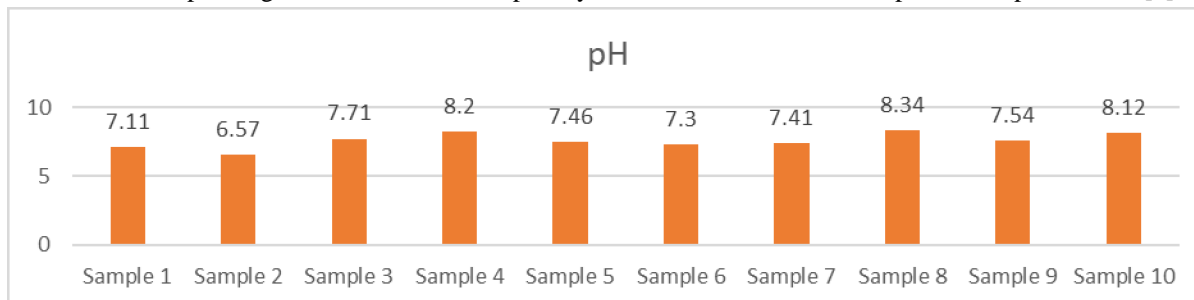


Fig 3. pH

C. TDS (Total Dissolved Solids)

The desirable value of TDS are 500mg/l and permissible value are 500-2000mg/l and the value exceed 2000mg/l the water sample for drinking was not permissible [9].

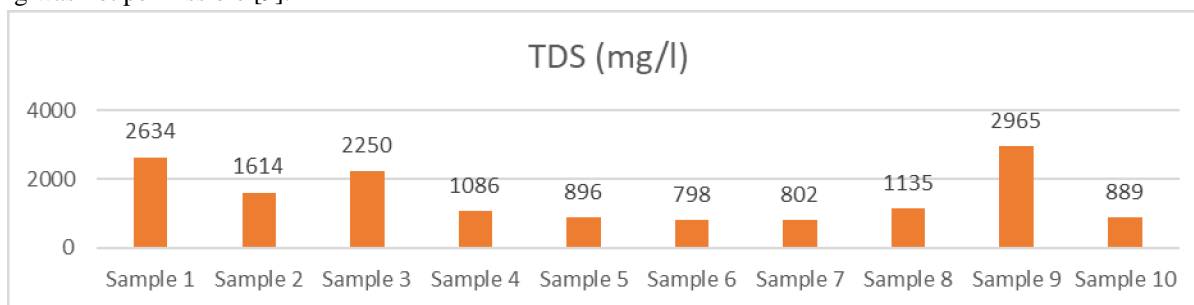


Fig 4. Total Dissolved Solid mg/l (TDS)

Ninety nine percent of body calcium is in bones and teeth. So, the drinking water is used as main source of intake of calcium and magnesium [10,11], calcium also increases bone mass that reduces the risk of bone fracture. Daily intake of calcium is 1200mg per day [4]. As per WHO report, magnesium is second most abundant metal in body fluid and its 60% part is used in bone formation. Insufficient magnesium level increases risks of hypertension, coronary heart disease and metabolic syndromes. And its excess intake can cause diarrhea [5]. But Arnedo-Pena in his disquisition says “generally hardwater is not harmful for body” [12]. By the study it was concluded that total hardness having value from 242 mg/l to 766 mg/l and its average value was 418 mg/l. The present study disclosed that out of ten water samples none of these was soft, moderately hard, hard so, all samples was very hard. 100% of sample was very hard. Kozisek, (2003) in his disquisition says that insufficient degree (very soft and very hard) of intake of hard water is harmful to human health [13] and it creates a serious problem for housewives that hard water sticks on the surface of water containers like tubs and sinks, diminishes the shining of the clothes and produces irritation and roughness on the skin. Excessive hardness decreases the quality of food nutrients; modify the dyeing colour and negative impact on fertility [14]. But excessive concentration of calcium and magnesium has adverse impact on cardiovascular mortality [5].

IV. CONCLUSION

Drinking water is the only source from where need of most of the minerals is fulfilled. The extreme level of hardness was present in 100% of samples which was not as much as dangerous for human health (WHO 2003). It is the type of water, places, treatments, and water resources that decides the quantity of mineral consumption. The required amount of calcium and magnesium can be modified by a technical alternate that can make water suitable for drinking. So, disinfection should be adopted. In Haryana, water is supplied from water works after treatment but in some areas, where this type of supply is not available, people should use water treatment plant, water softener and filter at home. But it is the matter of awareness that people should use ion exchanger in which the quantity of sodium increase, and water hardness decrease, and it is beneficial for health as sodium is most important element of body fluid. Variety of techniques can be used for water softening as per the condition of pipes, material, corrosion, hardness in an area. As a result, this research provides water quality data in the local area to recommend the suitable means to maintain the desired quantity of minerals in ground water and suggests people to further planning for improving water quality.

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