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Assessment of Physico Chemical Characteristics of Ground Water around Debre Tabor Town, Ethiopia

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ABSTRACT

Quality of water is an important criterion for evaluating the suitability of water for Domestic purposes. In this regard the quality of ground water around town of Debre tabor was assessed in this study in terms of some physicochemical parameters. Samples of ground water were collected from four different sample sites of the town and subjected for comprehensive physicochemical analysis. The physicochemical parameters studied include pH, Electrical Conductivity, Alkalinity, Total hardness, Total Dissolved Solids, total suspended solid and acidity, on comparing the results against drinking water quality standards laid by World Health Organization. The data revealed as there is no considerable variations in the assessed parameters except pH in one of the sample site (kebele 04 which is above the permissible limit set by world health organization).

Keyword: water standard, physicochemical parameters, water pollution

INTRODUCTION

Water is one of the most important and abundant compounds of the ecosystem. All living organisms on the earth need water for their survival and growth. As of now only earth is the planet having about 70 % of water. Water constitutes about 70% of the body weight of almost all living organisms. Life is not possible on this planet without water. It acts as a medium for both chemical and Biochemical reactions [1].

Ground water and surface water are the two main sources of fresh water. Ground water is considered as one of the purest forms of water available in nature and meets the overall demand of rural as well as urban population. It is used for domestic, industrial water supply and irrigation all over the world. This water meets domestic needs of more than 80 % rural and 50 % urban population besides irrigation. In the last few decades, there has been a rapid increase in the demand for fresh water due to rapid growth of population, unplanned urbanization, industrialization and too much use of fertilizers and pesticides in agriculture [2]. Some metals are essential to human health. Heavy metal pollution is a serious and widespread environmental problem due to the toxicity of the metals [3]. Pollutants are responsible for many illnesses such as cancer, neurological conditions and chronic bronchitis [4]. Pollutants therefore have been classified into two groups; primary pollutants which are those exert harmful effects in the form in which they enter the environment and secondary pollutants which are synthesized as a result of chemical processes from less harmful precursors in the environment. Most pollutants enter the environment as emissions or discharge either from discrete point such as factories, hospitals or diffuse sources such as runoff from agricultural lands. The effect of any pollutant discharged into the environment depends on its toxicity, persistence, dispersion properties, chemical reactions including the decomposition of the compound, tendency to be bio accumulated in food chains and ease of control. Every type of pollution has a pathway which involves the pollutant, the source, the medium of transport (air, water and land) and the target ecosystem. The addition .of various kinds of pollutants and nutrients through the agency sewage, industrial effluents, agricultural runoff etc in to the water bodies brings about a series of changes in the physicochemical characteristics of Water, which have been the subject of several investigations [5,6].

With the growth of industry the ground water is made expose for contamination due to addition of waste materials. Waste materials from the factories percolate with rain water and reach aquifer resulting in erosion of ground water quality. According to WHO, about 80% of all the diseases in human beings are caused by water pollutants. Adequate supply of fresh and clean drinking water is a basic need for all human beings on the earth. The sources of fresh water are threatened by overexploitation, poor management and pollution [7].

Water having different sources is very essential constituent in all living things. Ground water is the purest form of water among the different form of water sources. But in recent time this purest form of water is getting polluted by different wastes. In this regard large populations of Debre tabor town people use ground water for their house hold needs including for washing and drinking purpose. But, since the geographical distribution of ground water is much closer to the toilets, the researcher frustrates about a possible linkage of water from the toilet to the ground water that brings the quality of ground water under question. Therefore this study targeted to assess the quality of ground water in Debre tabor town in terms of its different physicochemical parameters. From these stand points, this study mainly focused on the assessment of some physiochemical characteristics of ground water around Debre Tabor town by comparing measured parameters with the standard of WHO values of the physicochemical characteristics of fresh ground water. This study also deals with the linkage of ground water with toilet around Debre tabor town.

Therefore the result obtained in this study gives information and create awareness about quality of ground water for the society who uses it for different purpose in Debre Tabor town.

2. MATERIALS AND METHODS

2.1 Description of Study Area and sample collection

The study was conducted around Debre Tabor town located in altitude and longitude of 11°51N 38º1'E/11..850ºN 38.017ºE with

an elevation of 2706 meters (8,878 ft) above sea level. Samples were collected randomly by assuming homogeneous distribution within a period of one week for analysis in May 2017 from four different sampling sites, four samples from each study area. .

A total of sixteen ground water samples were collected from four sampling points' kebele1, kebele2, kebele3 and kebele4. From each ground water samples four (500cm^3) were fetched from each of the sampling point and transported to the laboratory within three hours of collection.

2.3 Analysis of the Physicochemical Parameters

Some parameters such as pH, electrical conductivity and temperature were measured in-situ. All field meters and equipment were checked and calibrated according to the standard calibrating procedure. PH was calibrated by using buffer solution of known (PH= 4, 7, 10) for acidic, neutral and basic condition respectively and the conductivity meter was calibrated with 0.01M of KCl solution according to the manufacturer's specifications. Each parameter was measure with five replicates and the average of the five replicates were taken to report the level of the parameter at the end.

Determination of Conductivity [7,8]

Conductivity of the ground water samples were determined using the standard procedure approved by AOAC (1998). The conductivity meter (Hanna model CO150) was used. The power key and the conductivity key of the conductivity meter were switched on, and the temperature of the meter adjusted; the instrument was calibrated with 0.001 M KCl to give a value of 14.7ms/m at 25ºC. The probe was dipped below the surface of samples. Time was allowed for the reading to be stabilized and the reading was recorded.

Determination of Temperature [9]

The temperature was measured using Hanna model. The thermometer was immersed in the sample long enough to permit accurate and stable reading and the result was recorded.

Determination of pH [9]

The pH was measured using a pH meter. The electrode was washed thoroughly first with distilled water and then with the sample. The pH meter was standardized using buffer solution of (PH=4, 7and 10) to give accurate measurement. Then the PH meter was immersed in to the samples. The pH of the samples was measured and the readings recorded.

Determination of total dissolved solid

The mass of a clean dry evaporating dish was measured (A). Afterward 20ml of a filtered water sample was added in to dried evaporating dish. Then the sample was evaporated in to a dust free oven at 180 degree celicious. Then the mass of cool dried evaporating dish was measured (B).Then total dissolved solid was calculated by using the following formula.

$$Total\ dissolved\ solid\ (mg/L) = \frac{1000(B-A)}{V}$$

Where: A is mass of clean evaporating dish, B is mass of cool dried evaporating dish and V is volume of sample

Determination of total suspended solid.

The mass of dry filter paper was measured (A'), and 100 ml of water sample was filtered. Then the filter paper was dried at about 105ºC overnight and the mass of the dried filter paper was measured(B').Finally total suspended solid was calculated as follow;

$$Total\ suspended\ solid\ (mg/L) = \frac{1000(B'-A')}{V}$$

Where: A' is mass of dry filter paper, B' is mass of dried filter paper and V is volume of sample

Determination of alkalinity

50ml of well mixed water sample was transferred in to a flask .Then the burette was rinsed three times with 0.01N HCl and then filled with the same solution in to the sample. Afterward four drops of phenolphthalein indicator solution was added in to the sample .Then the solution was titrated with a standard 0.01NHCl solution till the pink color disappeared. The volume of HCl was measured (a). Then four drop of methyl orange indicator was added in to the same flasks contain the above solution and again titrated with standardized 0.01N HCl solution. Then the volume of HCl acid was measured (b). Then total alkalinity was calculated as follow;

$$Total\ alkalinity\ (mg/L) = \frac{50000N(b+a)}{V}$$

Where: (a+b) is Total volume of HCl acid used in titration, N is normality of HCl acid and V is volume of sample

Determination of Hardness of water

First 0.01N of EDTA was taken in to the burette. Then 20ml of water sample was taken in to conical flask. Afterward 5ml of ammonia ammonium chloride buffer (PH=10) solution was added and three drops of EBT indicator was added until wine red solution was observed. Then the wine red solution was titrated with 0.01N EDTA until sky blue color was appeared. Then the volume of EDTA was measured(C). Then Hardness of water was calculated as;

$$Hardness(mg/L) = \frac{1000N_{EDTA}\ x\ C_{EDTA})}{V}$$

Where: N_{EDTA} is normality of EDTA, V_{EDTA} is volume of EDTA and V is volume of sample

Determination of total acidity

50 ml of water sample was taken in to a conical flask and three drops of methyl orange indicator was added in to the sample. Then burette was filled with 0.02N NaOH solution. Then the solution was titrated with 0.02N of NaOH solution until the faint orange color was observed. Then volume of NaOH was recorded(C).Total acidty was calculated as;

$$Tital\ acidity\ \left(\frac{mg}{L}\right) = \frac{N*C*1000}{V}$$

Where, N is normality of NaOH, C is volume of NaOH and V is volume of sample

3. RESULT AND DISCUSSION

3.1 measured values of water physicochemical parameters

Table 1: value of measured parameter with comparison of standard value

Parameters	Kebele				Maximum permissible limit set by WHO [7]
	01	02	03	04	
PH	6.6	7.3	6.4	6.2	6.5-8.5
Temperature(℃)	19.1	18	17.9	18.7	24.8
Total dissolved solid (mg/L)s	40	71	88	78	500
Total suspended solid (mg/L)	0.037	0.39	0.7	0.48	30
Conductivity (µs/cm)	98	142	175	156	400
Alkalinity	58	150	50	190	600
Total Hardness	48	50	54	52	500
Acidity	90	400	200	250	-

PH

PH is a term used universally to express the intensity of the acid or alkaline condition of a solution. Most of the waters are slightly alkaline due to presence of carbonates and bicarbonates. The pH

values of water samples varied between 6.2 and 7.3 and were found within the limit prescribed by WHO except kebele3 and kebele 4. High values of pH may result due to waste discharge, microbial decomposition of organic matter in the water body [10]. In the present study all the samples have pH near to the prescribed values.

Alkalinity

Alkalinity of water is its capacity to neutralize a strong acid and it is normally due to the presence of bicarbonate, carbonate and hydroxide compound of calcium, sodium and potassium. The alkalinity values in the study area found to vary from 50 to 190 mg/L. Total alkalinity values for all the investigated samples were found to be less than th maximum value prescribed by WHO. Alkalinity around 150 mg/L has been found conductive to higher productivity of water bodies.

Electrical Conductivity (EC)

Electrical conductance is reciprocal to electrical resistance and EC values show total ion per cm. It is numerical expression of the ability of water sample to carry an electric current. The value ranged from maximum of 98µs/cm to 175µs/cm. The present study all the samples have less than the maximum permissible value.

Total Dissolved Solids (TDS)

Total dissolved solids indicate the salinity behavior of groundwater. Water containing more than 500 mg/L of TDS is not considered desirable for drinking water supplies, but in unavoidable cases 1500 mg/L is also allowed. TDS values of present samples varied from 40 mg/L to 88 mg/L. All the sampling point shows below the maximum prescribe limit given by WHO. High values of TDS in ground water are generally not harmful to human beings but high concentration of these may affect persons, who are suffering from kidney and heart diseases.

Total Hardness (TH)

Hardness is the property of water which prevents the lather formation with soap and increases the boiling points of water. Hardness of water mainly depends upon the amount of calcium or magnesium salts or both. The hardness values shown range from 48 mg/L to 52 mg/L. The Hardness is one of the most important properties of drinking water. Total Hardness in the study localities for the ground water samples are below the maximum prescribed limit of WHO.

Temperatures

Temperature governs the biological species present and their rate of activity as well as rate of chemical reaction in water in large extent. It affects nearly all other water quality parameters. The measured temperature found in the study area varied between 17.9Cto 19.1ºC which is much with the standard value 24.8ºC.

Acidity

Acidity of water is its quantitative capacity to react with a strong base to designed PH. The total acidity found area varied between 90 mg/ L to 400 Mg/L.

Total suspended solid

Total suspended solid consist of inorganic substance such as clay, silt or organic particles such as fiber, algae and bacterial remains. Other results due to human activity .Environmental protection agency set a maximum suspended solid standard of 30 mg/l for most treated waste water discharges. The measured TSS value from study area varies from 0.039mg/L to 0.7mg/L.

4. CONCLUSION AND RECOMMENIDATI0N

4.1 Conclusion

The present study analyzed pH, electrical conductivity, total dissolved solid, total suspended solid, alkalinity, acidity and temperature. The measured value of pH was between 6.2 to 7.3 which met with the permissible value of 6.5 to 8.5 except kebele 3 and kebele 4 which is slightly greater than the permissible values of WHO. And total dissolved solid ,total alkalinity, temperature ,total Hardness and conductivity measurement varied 40 mg/l, to 88mg/l ,50mg/l to 190mg/l ,17.9ºC to 19.1ºC ,48mg/l to 52 mg/l and98µs/cm to 175µs/cm respectively. These all values are below the maximum permissible value, which are 500mg/l, 600 mg /l, 24.8ºC, 500 mg/l and 400µs/cm respectively stated by WHO.. The data obtained in this study are below the maximum permissible limit set by world health organization studies except pH values of kebele 3 and kebele 4 which is not even significantly far from the prescribed value of WHO. Therefore present study shows the ground water around Debre Tabor area fit for domestic purpose.

4.2 RECOMMENDATIONS

Relative to my study findings most physical, chemical and biological parameters were not assessed due to inadequate access of materials required for such assessment. Therefore I recommend that further studies should be carried out on BOD, COD, DO, microbial analysis, heavy metal analysis and how degrade organic pollutants of ground water in to harmless compound forms.

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