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EVALUATION OF GROUNDWATER QUALITY AND ITS SUITABILITY FOR DRINKING AND AGRICULTURAL USE IN ARYAD PANCHAYATH OF ALAPPUZHA

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ABSTRACT

Groundwater is a very important and needful component for our population. Every single aspect of the developing process needs groundwater availability. A study was conducted to check the quality of groundwater in Aryad panchayath located in the coastal belt of Alappuzha district which lies in the coastal lowland division of Kerala. The sample collected was tested at Water Care Laboratories Thrissur and found that iron content is significantly high which imparts a rust color to the sample collected and makes it unfit for drinking. Also, the test confirmed the presence of pathogens. These two factors make the groundwater of Aryad panchayath unconsumable. The water must be treated sufficiently to eradicate pathogens and also to bring down iron content to an optimum amount which makes water consumable

1.0 INTRODUCTION

For the existence of life, water is essential. Other than being a basic human entity water is uses for several purposes like agriculture, industrial, household, and environmental activities. The majority of the liquid freshwater which is consumable for human use is from groundwater (Foster 1998). There is now a higher demand for fro freshwater due to overexploitation and overpopulation. Approximately one-third of the world's total population use groundwater for drinking (Nickson et al .2005). Since there is a tremendous hike in the population, it is very important to uplift the quality of groundwater available. According to Babiker et al.(2007), the chemistry of groundwater is not only related to lithology but also reflects inputs from the atmosphere, from the soil, and as well as from pollutant sources such as saline intrusion and industrial and domestic wastes. Considering the situation of Kerala, per capita, water availability has decreased fivefold. Groundwater used for domestic and irrigation purposes can vary greatly in quality depending upon the type and quantity of dissolved salts in it. Dissolved salts should be present in irrigation water in relatively small but significant amounts. They originate from the dissolution of lime, gypsum, and other slowly dissolved soil minerals

Study Area

The study area lies in the Alappuzha district, which is in the southern part of Kerala. Covering 1,414 km^2. The present study area lies in Aryad panchayat of Alappuzha with a total area of 6.87 km^2 and with a population density of 9000/sq mi. Mainly two seasons are experienced by the study area, one is southwest monsoon season that is from June to September and the other one is northeast monsoon season from October to December. The average annual rainfall of the study area ranges between 2,180 to 3,484 mm.

Ground Water Scenario

Net annual groundwater availability for the total Alappuzha district is approximately about 453 MCM. The stage of groundwater development of the whole district is about 28.5%, when considering the situation of Aryad panchayat it is 60%.

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Assessment Unit	Annual Extractable Groundwater Recharge (Ha.m)	Current Annual Ground Water Extraction (Ha.m)	Annual Groundwater Allocation for Domestic use as of 2025 (Ha.m)	Net Ground Water Availability for future use (Ha.m)	Stage of Ground Water Extraction (%)
Aryad Panchayat	2528.30	1676.972	1380.76	838.88	66.33

Table 1.1 Ground Water Scenario in Aryad Panchayat
(Central Ground Water Board (CGWB) (2007))

2.0 METHODOLOGIES

Groundwater samples were collected from a shallow open well during November which represents the post-monsoon season of Aryad panchayat in Alappuzha. The samples were filled up to the brim in a high-density polyethylene bottle and to avoid exposure to air it was labeled and scaled systematically. The standards recommended by the American Public Health Association (ADHA 1995) were strictly followed to ensure data quality while collecting the water sample. The water sample was sent to Water Care Laboratories Thrissur for assessing the quality of the collected sample. Various physicochemical parameters like Ph, turbidity, TDS, conductivity, alkalinity, acidity, Cl, $CaCo_3$, Ca, Mg, Fe, So_4. Were tested. The methods used to determine the presence of the ions mentioned above were volumetric and chlorimetric methods. The evaluation of suitability of the collected sample of groundwater was done by comparing the values of different water quality parameters with those of the World Health Organisation (WHO 2004) and Indian Standard specification (ISI 1993) defined values for drinkable water. (S.V Sarath Prasanth et al. 2012)

2.1 Measuring Methods According to Indian Standards

Ph (IS 3025 : 1983)

To measure the ph value of the sample water electrometric method is used. It is done by the measurement of the electromotive force of a cell which has an indicator electrode which is immersed in the test solution and a reference electrode. A liquid junction which the part of the reference electrode enables the contact between the test solution and reference electrode. The most commonly used electrodes are a combination of hydrogen gas electrodes along with a calomel electrode and the reference potential is a saturated calomel electrode. The working of the system is such that the glass electrode experiences a change of 1 ph unit which produces an electric charge of 59.1 mV at 298 K.

Turbidity (IS 3025 : 1984)

Turbidity is measured using an instrument called nephelometry. The principle for measuring turbidity is based on the comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by the reference suspension under the same condition. Generally, formazin polymer is the turbidity standard.

Total Dissolved Solids (IS 3025 : 1984)

Total dissolved solids either referred to as filterable residue is sorted out using the gravimetric method and this method applies to all types of water and wastewater. The sample water is filtered and is evaporated in a tared dish on a steam bath. The residue after evaporation is dried to constant mass at 103-105 °C.

Chloride (Cl) (IS 3025 : 1998)

Since the sample is colored, potentiometry is the method used to detect chlorine. This is done by titration with silver nitrate solution with a glass and silver-silver chloride electrode system. The endpoint of the titration is that the instrument reading greatest change in voltage has occurred for a small and constant increment of silver nitrate.

Total Hardness ($CaCo_3$) (IS 3025 : 2009)

The most common method for determining the total hardness of water sample is by Ethylenediamine tetraacetate acid (EDTA), it is based on the reaction between calcium and magnesium salts with ethylenediaminetetraacetic acid or its disodium salt and applies to all type of water except wastewater.

Calcium and Magnesium (Ca, Mg) (IS 3025 : 2009)

The method used to detect both the presence of calcium and magnesium in water is the volumetric method using EDTA. When the sample is treated with EDTA at ph 10 using Erichrome black-T as an indicator the presence of calcium is detected. To detect the presence of magnesium a separate titration

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against EDTA at ph 12 is done using murexide as an indicator

Iron and Sulphate (Fe, SO_4) (IS 3025 : 2003), (IS 3025 : 1986)

The standard method for determining the presence of iron in a water sample is by phenanthroline method. In this method iron in the sample is reduced to the ferrous state by boiling it with hydrochloric acid and hydroxylamine and treated with 1,10 phenanthroline at a pH of 3.3. Three molecules of phenanthroline chelate each atom of ferrous iron to form an orange-red complex which can be later separated. In the case of sulphate thorin method is done to ensure their presence, the sulphate ion is titrated under controlled acid conditions in an alcoholic condition using thorin as an indicator. The standard used in this case is barium chloride.

E.coli (IS 1622 : 1981)

E.coli is one of the members of fecal coliforms whose presence confirms the existence of other dangerous pathogens. When using brilliant green bile lactose these coliforms ferments the lactose at 44.5 °C within 24 hours as well as produce indole from tryptophane at 44-5°0 within 24 hours. At the end of the incubation period of 26 hours, test for indole production by adding a few drops of Kovac's reagent. The positive test will give a pink color while the negative test will give a yellow color.

3.0 RESULTS AND DISCUSSIONS

The quality standards of drinking water have been specified by the World Health Organisation (WHO) in 2004. The influence of major ions and physicochemical parameters such as ph, electrical conductivity, total hardness, and the suitability of groundwater in the study area are discussed below**.** Bacteriological analysis of the sample is also done.

Sl.No	Parameters	Unit	Acceptable Limit	Permissible Limit	Result
1	Ph	-	6.5-8.5	No relaxation	6.7
2	Turbidity	NTU	1	5	0.1
3	Total Dissolved Salts	mg/l	500	2000	170
4	Conductivity	µS/cm	400	-	304.6
5	Alkalinity	mg/l	200	600	68.4
6	Acidity	mg/l	-	-	7.3
7	Chloride (cl)	mg/l	250	1000	43.7
8	Total Hardness ($CaCo_3$)	mg/l	200	600	40.5
9	Calcium (Ca)	mg/l	75	200	12.3
10	Magnesium (Mg)	mg/l	30	100	6.5
11	Iron (Fe)	mg/l	0.3	1.0	3.4
12	Sulphate (SO_4)	mg/l	200	400	2.4
13	Coliforms	No.of coliforms in 100 ml	-	-	542
14	*E.coli*	No.of *E.coli* in 100 ml	-	-	present

Table 3.1 Test Results

Chlorine (Cl)

The presence of chlorine in the groundwater in this area is mainly due to the leaching of sedimentary rocks and the intrusion of saltwater. In the study area concentration of chlorine is 43.7 mg/l. The desirable limit of the chloride in drinking water is specified as 250 mg/l. So we can conclude that the water has only the desired level of chlorine in it.

Total Hardness ($CaCo_3$)

The hardness of the groundwater is due to the dissolved alkaline earth metals. The hardness of the water makes it unfit for drinking purposes. The limit of the hardness of water as per the guidelines of the World Health Organization and Indian Standards is 200 mg/l. The water sample taken from the study area contains 40.5 mg/l which falls under the acceptable limit.

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Calcium (Ca) and Magnesium (Mg)

These are the most abundant element in groundwater. As per the Indian Standards, (ISI 1993) desirable limit of calcium concentration is 75 mg/l. the calcium content in the sample taken is 12.3 mg/l which indicates a safe level of calcium in the sample. Considering the case of magnesium, the maximum permissible limit as per the guidelines of WHO and ISI are 30 mg/l. The sample contains 6.5 mg/l traces of magnesium which indicates a safe mark.

Iron (Fe)

Iron is an essential element in human nutrition. An estimate of the minimum daily requirement of iron ranges from 10 to 50 mg/day. In drinking water supplies iron salts are unstable which settles out as rust. In ordinary cases, there will be less discoloration or turbidity in water. When directly pumped from a well. Iron content also promotes bacterial growth. The permissible amount of iron in the water as per the guidelines of the World Health Organisation is 0.3 mg/l but the water sample contains 3.4 mg/l making it unfit and harmful for drinking purposes. (WHO 2004).

Sulphate (SO_4)

Sulphate is a general combination of solar and oxygen which is occurred in some soil or rock formation that contain groundwater. They can cause scale buildup in a water pipe and may assign a bitter taste in water which makes them unfit for drinking, they can even have a laxative effect on humans and young livestock. The permissible limit of the sulphate content in drinking water is 200 mg/l, whereas the content in the sample tested is only 2.4 mg/l which indicates the safe level.

Ph

The ph of the solution is the negative common logarithm of Hydrogen ion activity.

$$\mathbf{Ph = -(\log H^{+})}.$$

Or in other words, it can be stated as the measure of acid-base equilibrium. Considering most natural waters ph is controlled by carbon dioxide-bicarbonate- carbonate equilibrium system. Temperature also has a significant role in ph of water. In the case of pure water, a decrease in ph about 0.45 occurs as the temperature is raised by 298 Kelvin. The ph of drinking water relies on between 6.5-8.5. The most common method to measure the ph of an aqueous sample is electrochemical with a glass electrode. The ph of the groundwater sample collected is 6.7 which falls under the permissible limit as per the guidelines of the World Health Organization.

Turbidity

Turbidity refers to the cloudiness of aqueous solutions. Some of the major reasons for turbidity are Phytoplankton, sediments from erosions, water discharges, algae growths, and urban runoff. Turbidity is generally measured by an instrument called a nephelometer in NTU. Turbidity has direct control in reducing the oxygen content of water, suspended particles, absorb heat from sunlight making the water warmer and thus reducing the concentration of oxygen. The WHO establishes that the turbidity of drinking water shouldn't be more than 1 NTU. The turbidity of the sample water collected is 0.1 NTU which marks the safe level.

Total Dissolved Salts

Total dissolved solids account for the inorganic salts and small amounts of organic matter in solution in water. The individual constituents are mainly calcium, magnesium, sodium, potassium cations, and carbonate, hydrogen carbonate, chloride, and nitrate anions. In a study conducted in Australia, an increased level of TDS shows a significant rise in heart diseases. According to WHO water containing TDS concentrations below 1000 mg/l is usually an extremely low concentration of TDS unacceptable for consumption due to its flat and insipid taste. The water sample contains 170 mg/l of TDS which indicates the water is fit for consumption.

Electrical Conductivity

Conductivity is the ability to pass an electric current. In water, conductivity is affected by the presence of inorganic solids such as chloride nitrate sulphate and phosphate anions (-ve charge) or sodium, magnesium, calcium, iron, and aluminum cations. Conductivity is directly proportional to temperature. According to WHO standards conductivity value in consumable water should not exceed 400 µS/cm, the sample has a conductivity of 304.6.

Coliforms and *E.coli* Bacteria

Coliforms are a common form of bacteria present in the environment and feces of all warm-blooded animals and humans. Even though they are unlikely to cause illness, their presence in drinking water indicates that pathogens could be in the water system. It is a tough task to test all possible pathogens in drinking water, since it is very easy and inexpensive to test for coliform bacteria their detection can conform to other pathogens in the water. Mainly there are three groups of coliform bacterias indicating different levels of risks. Total coliform bacteria are very common in the environment. If the presence of Total coliform bacteria is confirmed it is probably due to environmental and fecal contaminations. Fecal

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coliform bacteria exist in the intestines and feces of people and animals. *E.coli* is a subgroup of the fecal coliform group. The presence of *E.coli* in the drinking water sample usually highlights fecal contamination, indicating the greater risks that pathogens are present.

4.0 CONCLUSION

Groundwater is an important source of drinking water, about one-third of the total population depends on groundwater. Contamination of groundwater results in the degradation of water quality and creates potential health problems. The area subjected to the study has groundwater that is unfit for consumption. The sample was taken from an open well and was tested for 14 physiochemical parameters and bacteriological analysis was also conducted. The results illustrated that the physical parameters like ph, turbidity, total dissolved solids, and conductivity falls under the acceptable limit. All the chemical parameters except iron were under the acceptable limit. The high traces of iron in the sample imparts a rust color to the sample. The bacteriological analysis was tested positive for E.coli which depicted the presence of dangerous pathogens in it. According to the guidelines of the World Health Organization (WHO) and Indian Standards (IS), the groundwater sample taken from Aryad panchayath is unfit for drinking and irrigation purposes.

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