PHYSICOCHEMICAL ANALYSIS OF WELL WATERS IN MANJERI MUNCIPALITY

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INTRODUCTION

Water is nature's most wonderful, most abundantly available and most widely used resource, without which life cannot exist. Most of the water in this planet is stored in oceans and polar ice caps which is difficult to be recovered for our diverse needs. Most of our demand for water is fulfilled by rain water which gets deposited in surface and ground water resources. Though water is continuously purified by evaporation and precipitation, pollution of water has emerged as one of the most significant environmental problems of recent time. The gross pollution of water has its origin namely in urbanization, industrialization and increase in human population observed during the past one and half century. The impurities present in water vary greatly from one place to another. Water is regarded polluted when it changes its quality or composition either naturally or as a result of human activities.

Ocean

Polar ice caps

Water accounts for about 70% of the mass of our body. It is an essential constituent of all animal and vegetable matter and forms about 75% of matter of earth crust. Since it is one of the constituent in the reaction of photosynthesis which captures energy from sun, it is also an important substance in detecting the energy flow in the living system. In fact life in this planet is possible only because of the presence of abundant water.

All organisms use water in their metabolic process and all the biochemical reactions in the body of living beings take place in the water medium. It dissolves a number of substances without changing their chemical properties, hence carryout transportation of materials in the body. Blood is mostly water. Sperms are also mobile in water medium. Waste products are removed from the body in dissolved state with water. In higher plants the nutrients are carried from roots to other parts in water through xylem.

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SOURCES AND QUALITY OF WATER

Surface and ground water are the two main sources of fresh water. The quantity of water on the land surfaces formed during the hydrological cycle is the sources for all surface water which are mainly distributed in lakes, rivers, streams, irrigation canals, reservoirs and dams. In most of the places major sources of water supply are surface water. The quantity and quality of surface water depends on many factors. So, surface water has to be treated properly before its use.

Lake

River

Stream

Irrigation canal

Reservoir

Dam

Ground water is the important source of fresh water, being 99% of the total. The source of water which supplies water from below the earth's surface is called sub-surface or ground water. The movement of precipitation through the soil surface into the soil and on downwards by gravity, is known as infiltration. Water further moves downwards through the unsaturated layers of soil and voids of rocks which is called percolation. Infiltration and percolation occurs in the sub-terrain region, known as zone of aeration.

The usual method of abstracting ground water is by means of a well. Shallow wells draw water from the previous layer overlying the first impermeable layer. Deep wells are wells, dug into pervious layers below the first impermeable structure. They may be dug well, sunk well, bored well or driven well, depending on construction. Bored wells are useful for obtaining water from shallow as well as deep aquifers. Bored wells draw out a large quantity of water from one or more previous strata. Usually a metal casing is inserted in the regions of loose formations of bore hole. Besides the above methods, infiltration galleries and infiltration wells are also used to tap ground water.

The slow percolation of water through the ground results in the prolonged contact of water with minerals in soil and bed rocks. Many of these minerals are dissolved slowly as ground water passes over them and in time a quasi-chemical equilibrium can be reached between ground water and the minerals in the soil and rocks. The water gets saturated with dissolved solids which are derived from these minerals.

Silica and silicate minerals are abundant in earth crust. But it is not reflected in the concentration of ground water because of its low solubility. The concentration ranges from a few ppm to 60 ppm. Relatively high concentrations are observed in hot springs.

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Iron, one of the most abundant elements in the earth crust, exists as oxide, sulphide, silicate, carbonate and hydroxide minerals. Both iron and manganese when present in excess result in the deterioration of ground water quality.

Most types of rocks – igneous, metamorphic and sedimentary- contain calcium usually as silicate and as carbonates. Sandstones and other deposits also contain calcium carbonate as cementing material. Silicates even though insoluble in water, weathering breaks them down into soluble calcium products. Because of its abundance and solubility calcium is present almost everywhere in groundwater.

Magnesium is also an important component of various rocks forms. Igneous and volcanic rocks, basalts, metamorphic rocks such as talc and sedimentary rocks such as dolomite, contribute to the magnesium content of ground water.

In ground water the calcium content generally exceeds the magnesium content even though the solubility of salts is reversed, due to its relative abundance. Magnesium carbonate is more soluble in sea water, containing large sodium salts. High magnesium content in ground water in coastal areas indicates sea water contamination. Hardness of water, which is quite known, is as a result of the combined calcium and magnesium salts present in water.

Usually chloride content of atmospheric precipitation is less than 10 ppm except in coastal areas. Chloride bearing rock minerals such as sodalite and chlorapatite are minor constituents in rocks. Therefore, the bulk of the chloride in ground water is either from atmospheric sources or by sea water contamination. Chloride salts remain stable, once they enter into solution. Most chloride in ground water is present as sodium chloride. Abnormal concentration of chloride indicates pollution by sewage waste or leaching of saline residues in the soil.

In general the relative concentrations of the common cations and anions present in most ground waters are in the order Ca^{2+}> Mg^{2+}> Na^{+} or Mg^{2+}> Ca^{2+}>Na^{+} and HCO_3^{-}> Cl^{-}> SO_4^{2-} or HCO_3^{-}> SO_4^{2-}> Cl^{-}.

NETWORK OF WATER QUALITY MONITORING

The program involves the collection of information on physical, chemical and biological quality of water to provide an accurate base line data on present condition. The two main activities required to achieve this goal are sampling strategy and sampling techniques. Sampling strategy mainly comprises of location of sampling stations, sampling frequency, temporal and spatial aspects.The aim of sampling is to collect a portion of any material of interest such that their quality represents the quality of that material. The sampling should be representative and valid. Sampling techniques comprises types of sample containers, quantity, different kinds of sampling devices *etc*.

Polluted water is hardly of any use for most purpose. It cannot be used for drinking because of its inherent health risk. Saline water cannot be used for agricultural and for some industries and the quality of water affect the aquatic life. Every use of water requires a certain minimum quality of water with regard to pressure of dissolved and suspended materials of chemical, physical and biological nature.

The achievements of this minimum quality of water for diverse uses have lead to the formation of water quality criteria, water quality objectives and water quality standards. The criteria levels of drinking water source have to be based upon removability of the constituents at water treatment plants and available data on human health. The criteria for the waste water generated from industries may be based on nature of industry and effect of their constituent on water and land.

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Criteria are not set of static values but are subject to modifications as the scientific data get updated and more knowledge is gathered.Water quality objective can be defined as an aim or goal with regard to the water quality which is to be achieved.The team standard applies to any definite principle or measure established by an authority by limiting concentration of constituents in water which ensures the safe use of water and guards the environment.

DRINKING WATER STANDARDS

In view of the direct consumption of water by human beings, the domestic water supply is considered to be the most critical use of water in India.Agencies like the Indian Council of Medical Research (ICMR), Bureau of Indian Standards and Ministry of Work and Housing have formulated certain drinking water standards. WHO also has laid down certain drinking water standards, which are considered as international standards. A copy of Indian standard for drinking water published in 2012 by Bureau of Indian standards is given in Table 1.

NEED OF WATER ANALYSIS IN MANJERI MUNICIPALITY

Manjeri is a Town and Municipality in Malappuram District in the state of Kerala, India. The Municipality has a total population of 97,104 as per the 2011 Census, with a population density of 1,878 per km^2 making it one of the largest towns in Kerala..Males constitute 49% of the population and females 51%. Manjeri has an average literacy rate of 95.8%, higher than the national average of 74.04%. Here, most of the people depends agriculture for their livelihood. Our college is situated in Manjeri municipality Even though Manjeri is very rich in its water resources, it faces water scarcity in summer season. Moreover most of the people depends wells for their water requirements. Water is used for industrial purpose, irrigation, drinking and domestic uses. But, to the best of our knowledge, no studies have been conducted on the quality of well water in this area. From this current situation we have decided to conduct water analysis of Manjeri municipality. Through this study we can check whether the water quality is in compliance with the standard, and hence, suitable for the designated use in order to ensure the public health.

Sampling

Ten samples were collected randomly from Manjeri Municipal area; W_1: Manjeri NSS College Road; W_2: Thurakkal; W_3: Payyanad; W_4: Narukara; W_5: Alukkal; W_6: Patterkulam; W_7: Parakkulam; W_8: Manjeri town; W_9: Unity College; W_{10}: Manjeri Bus Stand.

DETERMINATION OF WATER QUALITY PARAMETERS

pH Analysis

pH is measured using a pH meter which is an electronic digital volt meter sealed to read the pH directly. When a pair of electrodes, namely pH sensitive glass electrode and reference electrode, is dipped in a solution, they generate e.m.f which is proportional to the pH of the solution. The pH of the sample was measured after necessary calibration of the instrument using standard pH buffers advised by the manufactures.

Electrical Conductivity

Electrical conductivity is the measure of the ability of an aqueous solution to carry an electric current. The ability depends on the presence of ions, their total concentration, mobility and valence and on the temperature of the measurement. The measurement consists of altering the variable resistance until no current flows through detecting circuit containing the meter.

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Table 1: Indian Standard (IS 10500: 2012) Drinking Water Specification

Sl. No	*Substance or Characteristics*	*Requirements/Desired Limit*	*Permissible Limit in the absence of alternative sources*
ESSENTIAL CHARACTERISTICS			
1	Color, Hazen unit max	5	15
2	Odour	Agreeable	Agreeable
3	Taste	Agreeable	Agreeable
4	Turbidity ,NTU	1	5
5	pH value	6.5-8.5	No relaxation
6	Total hardness (as $CaCO_3$) mg/L	300	600
7	Iron (as Fe)mg/L	0.3	No relaxation
8	Chloride(as Cl)mg/l	250	1000
9	Residual free chloride mg/L	0.2	1
DESIRABLE CHARACTERISTICS			
10	Dissolved solids mg/L	500	2000
11	Calcium (as Ca)mg/L	75	200
12	Copper (as Cu) mg/L	0.05	1.5
13	Manganese (as Mn)mg/L	0.1	0.3
14	Sulphate (as SO_4) mg/L	200	400
15	Nitrate (as NO_3) mg/L	45	No relaxation
16	Fluoride (as F) mg/L	1.0	1.5
17	Phenolic compound mg/L	0.001	0.002
18	Mercury (as Hg) mg/L	0.001	No relaxation
19	Cadmium (as Cd) mg/L	0.003	No relaxation
20	Selenium (as Se) mg/L	0.01	No relaxation
21	Arsenic (as As) mg/L	0.01	0.05
22	Cyanide(as CN) mg/L	0.05	No relaxation
23	Lead (as Pb) mg/L	0.01	No relaxation
24	Zinc (as Zn) mg/L	5	15
25	Chromium (as Cr) mg/L	0.05	No relaxation
26	Mineral oil mg/L	0.01	0.03
27	Pesticides mg/L	Absent	0.001
28	Alkalinity mg/L	200	600
29	Aluminium (as Al) mg/L	0.03	0.2

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The conductivity K, of a solution contained between electrodes of surface area A, situated at a distance of L apart is given by K = L/AR where, R is the measured resistance and the value (L/A) is the cell constant.

Temperature

Temperature exerts a major influence on biological activity and growth. Temperature governs the kinds of organisms that can live in rivers and lakes. Fish, insects, zooplankton, phytoplankton, and other aquatic species all have a preferred temperature range. As temperatures get too far above or below this preferred range, the number of individuals of the species decreases until finally there are none.

Temperature is also important because of its influence on water chemistry. It is related to the dissolved-oxygen concentration in water, which is very important to all aquatic life. Many lakes experience a "turning" of its water layers when the seasons change. In summer, the top of the lake becomes warmer than the lower layers.

Chemical Oxygen Demand

Chemical oxygen demand (COD) test determines the oxygen required for chemical oxidation of organic matter with the help of strong chemical oxidant. The organic matter gets oxidized completely by $K_2Cr_2O_7$ in the presence of H_2SO_4 to produce CO_2 and H_2O. The excess $K_2Cr_2O_7$ remaining after the reaction is titrated against ferrous ammonium sulphate, $Fe(NH_4)_2(SO_4)_2.6H_2O$. The volume of dichromate consumed gives the oxygen required for oxidation of the organic matter.

Chloride: Argentometric Method

Chloride ion is one of the major inorganic anion in water and waste water. The estimation is based on the reaction between silver nitrate and chloride solution.A standard solution of chloride was prepared using sodium chloride. A measured volume of the standard chloride solution was titrated against silver nitrate solution using potassium chromate as indicater. From the titer value, the strength of silver nitrate solution was determind.When the chloride ions are removed as silver chloride precipitate, the excess of silver nitrate react with potassium chromate forming silver chromate which is red in colour (the end point).

Total Hardness

Hardness is one of the important parameters for quality determination of portable water. Originally, the hardness of water was understood to be a measure of the capacity of the water for precipitating soap. Soap is precipitated chiefly by the calcium and magnesium ions commonly present in water, but also may be precipitated by ions of other polyvalent metals, such as aluminium, iron, manganese, strontium and zinc by hydrogen ions. Because only the first two are usually present in significant concentration in natural waters, hardness is defined as a characteristic of water that represents the total concentration of just the calcium and magnesium ions expressed as calcium carbonate.

Ethylene diamine tetra-acetic acid and its sodium salts (EDTA) from a chelated soluble complex when added to solution of certain metal cations. If small amount of a dye such Eriochrome Black-T is added to an aqueous solution containing calcium and magnesium ions at a pH of 10±0.1, the solution will become wine red. If EDTA is then added as titrant, the calcium and magnesium ions will be complexed with EDTA. After sufficient EDTA has been added to complex all the magnesium and calcium ions, the solution will turn from wine red to blue. This is the end point of titration.

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Iron: Phenanthroline Method

Iron is brought in to solution, reduced to the ferrous state by boiling solution with acid and hydroxylamine and is treated with 1,10 phenanthroline at pH 3.2 to 3.3.Three molecules of phenanthroline chelate with each atom of ferrous iron to form an orange-redcomplex, $[(C_{12}H_8N_2)Fe]^{2+}$. The coloured solution obeys Beer-Lambert's law. A pH between 2.9 and 3.5 insures rapid colour development in the presence of an excess of phenanthroline. Colour standards are stable up to six months.In presence of excessive amounts of organic constituent, the sample is first digested with H_2SO_4 to destroy organic complexes and to ensure complete dilution of iron. The resulting solution is made 7 to 8 N in HCl and iron is separated from the interfering substances by extraction of ferric chloride in to isopropyl ether. After re-extraction of the iron in to water, it is reduced with hydroxylamine.

Sulphate: Turbidimetric Method

Sulphate ion is precipitated in HCl medium with $BaCl_2$ in such a manner as to form $BaSO_4$ crystals of uniform size. The absorbance of the $BaSO_4$ suspension is measured by a nephalo-turbidity meter and the sulphate ion concentration is determined by comparison of the reading with a standard curve.

Total Alkalinity

The alkalinity of water is its quantitative capacity to neutralize a strong acid to a designated pH. Alkalinity is a measure of gross property of water and can be interpreted in terms of specific substance only when the chemical composition of the sample is known. The determination of alkalinity provides an idea of nature of the salt present and it is an important parameter involved in corrosion control. It mainly represents the concentration of carbonate, bicarbonate and hydroxide content. Alkalinity is estimated by titration against a standard acid.

Table 2: Water Quality Parameters of Water Samples from Manjeri Municipality

Sample No	*pH*	*Conductivity*	*Temperature*	*COD*	*Chloride*	*Hardness*	*Iron*	*Sulphate*	*Alkalinity*
W1	7.2	40	28	3.13	22.5	42	0.12	0.11	18
W2	6.9	49	31	1.06	19.99	36	0.11	0.13	19
W3	6.6	40	27	3.56	23.9	32.1	0.05	0.21	15
W4	6.7	57	31.5	1.96	25.5	36.3	0.12	0.18	23
W5	6.8	49	30.5	1.30	31.1	41.3	0.22	0.16	18
W6	7.6	58	29.2	3.86	24	44.5	0.10	0.09	27
W7	6.5	55	31.2	1.2	25.1	43.6	0.02	0.12	21
W8	7.9	60	30.6	5.8	40.6	52.3	0.04	0.19	28
W9	6.8	55	28	2.1	22.1	42.3	0.06	0.14	26
W10	6.6	51	29.5	3.2	29.6	39.5	0.09	0.13	20

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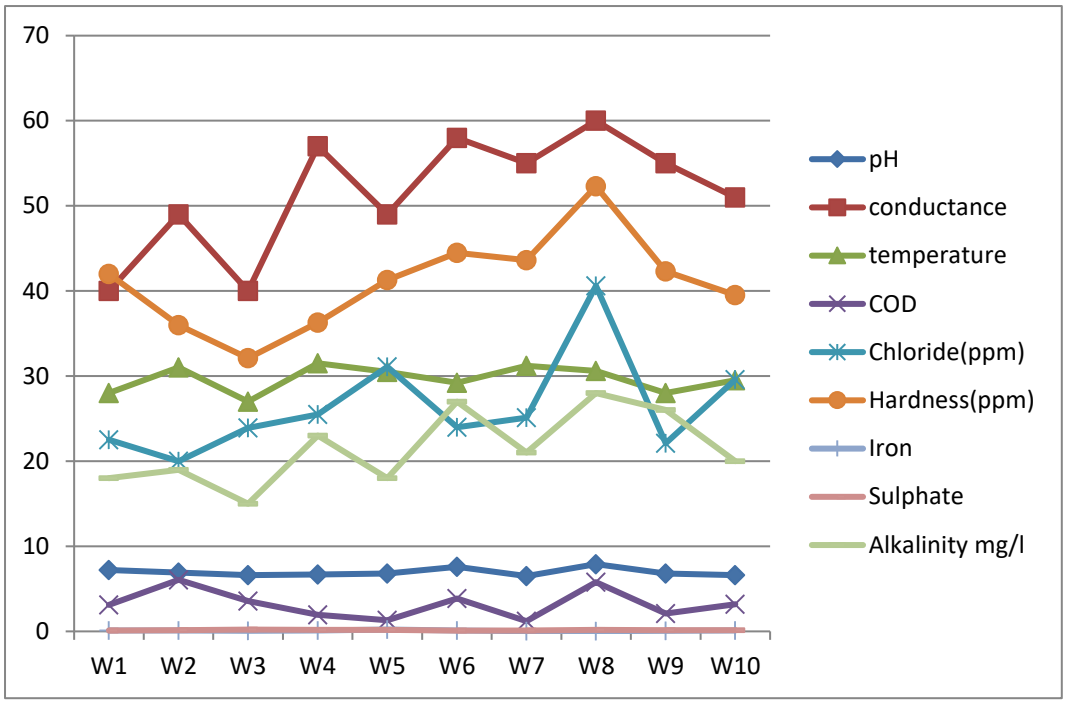

Fig.1: *Water Quality Parameters of Water Samples from Manjeri Municipality*

From Table 2and Fig.1 it is clear that different samples show different values for same parameters. The pH of all samples is within the desired limit (6.5-8.5).The chloride content of all samples is also within the desirable limit. The values of temperature are almost same for all samples.Most of alkalinity in natural waters is formed due to dissolution of CO_2 in water.The conductivity of water is also within the desirable limit.Sample W8 is from an industrial area showing high value of hardness, conductance, chloride and COD.The value of hardness ranges from 30-55mg/L.The values of iron contents are almost same for different samples.Sulphate content is very low in all samples.

CONCLUSIONS

This work provides a comparison between well waters in Manjeri Municipality. From this study it was revealed that the different drinking water parameters of well water in the Manjeri Municipality are comparable to drinking water specification as per Indian Standard. In the present investigation, colour, odour and turbidity of the water samples were measured only qualitatively. Water samples from all the wells have ordinary taste, odour and clear appearance.

The study reveals that the various constituents are within the permissible limits, showing that water from wells of Manjeri Municipality is safe for domestic purposes.The unfavorable nature of one water sample can be attributed to the relatively high hardness, chloride and COD. It is due to soil leaching in industrial area.The parameters lie in the desirable range, indicating no contamination, hence suitable for domestic usages which ensure public health.

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