ANALYZE THE WATER QUALITY OF GROUND WATER IN THREE DIFFERENT AREA OF (NEW BUS STAND, OLD BUS STAND AND MEDICAL COLLEGE) THANJAVUR CITY, TAMIL NADU.

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ABSTRACT

In the present study was to analyze the water quality of ground water in three different area of (New Bus stand, Old Bus stand and Medical college) Thanjavur city, Tamil Nadu. Physico-chemical analysis such as temperature, pH, alkalinity, total dissolved solids, chloride, total alkalinity, COD, BOD, calcium hardness, sulphate, nitrate, fluoride of ground water of different locations were carried out. The following conclusion obtained from the study. Physico-chemical analysis all Stations as tap water were observed within the ranged as prescribed by WHO, ICMR and Indian standards. The sulphate level is higher in pond and river water as compared to Indian standards recommended by ICMR and WHO. The nitrate level is higher in pond water as compared to standard recommended by ICMR and WHO. Therefore boiling of water is essential before consumption of water by the people living in this area. From the data of drinking water we should know the properties of bore-well drinking water which is used to enhance our plant growth.

KEYWORDS: Physico-chemical analysis, Ground water, ICMR and WHO.

INTRODUCTION

Water is a universal solvent and the most plentiful substance on earth. Due to its high specific heat, higher dielectric constant, maximum density at 4°C with a liquid range of 0 - 100°C, it is one of the most eccentric chemicals. Water is a basic, indeed an absolute requirement for the survival of human race (WHO, 1995). An adequate supply of good quality safe water is
essential for the promotion of public health. Generally in less developed parts of the world and particularly in tropical areas, the health hazards caused by polluted water supplies are more numerous and more serious than those in temperate and more developed areas of the world (Vijayakumar et al., 2016). Natural resources are naturally occurring substances that are valuable in their relatively unmodified form. A natural resources value rests in the amount of the material available and the demand for it. Unplanned urbanization because of pressure of anthropological activities on hydro - geomorphologic results in alteration of the existing recharge process and causes many adverse environmental effects. As per continuous exploitation of the natural resources, beyond their threshold limit of resilience causes imbalance in natural ecosystem (Jat, 2009). Water is a unique natural resource among all sources available on earth. It plays an important role in economic development and the general well being of the country. The dynamic and renewable nature of the water resources and the recurrent need for its utilization requires that water resources are measured in terms of flow rates (Joseph Bonny, 2009). It is the basic duty of every individual to conserve water resources (Jothivenkatchalam et al 2010).

Water is a unique natural resource among all sources available on earth. It plays an important role in economic development and the general wellbeing of the country. Ground water is one of the earths widely distributed, renewable and most important resources which exist in the zone of saturation, so it may be fresh or saline. Ground water quality is as important as the quantity. Its poor quality harmfully affects the plant growth and human health. So monitoring the ground water quality is essential for survival of organism. Keeping this in view, in the present study was to analyze the water quality of ground water in three different area of (New Bus stand, Old Bus stand and Medical college) Thanjavur city, Tamil Nadu.

MATERIALS AND METHODS

Sample Collection
The sampling has been taken in pre cleaned polyethylene bottles. Plastic bottles of one liter capacity was used to collect the samples. Before sampling, evacuation of the stored water in the pipelines has been made to take the fresh drinking water sample from the selected sampling sites. The drinking water samples were collected from New Bus stand, Old Bus stand and Medical College of Thanjavur city, Tamil Nadu (India).
Physico-chemical parameters
The methods used for the analysis of various physico-chemical parameters were the same as given in Standard Methods for the Examination of water (APHA, 1985, 1989, 1998, Golterman et al., (1978) and National Environmental Engineering Research Institute (NEERI, 1986).

Determination of Temperature
The water temperature was recorded at the sampling area by using digital thermometer. Surface water temperature was recorded by dipping thermometer directly into water in a container and measured reading in the meter.
Determination of pH
pH was recorded using digital pH meter maintained at the room temperature.

Electrical Conductivity
Conductivity of the water samples were measured by using a conductivity meter. The values were expressed in mmhos/cm.

Determination of Total Dissolved Solids
In a pre-weighted dried dish of suitable size were taken and 100ml of filtered water sample was taken and evaporated on a water bath. The weight of the dish was noted after cooling it in a desiccator. The total dissolved solids are expressed in mg/l.

Determination of Total Alkalinity
Two drops of methyl orange indicator were added to the solution in which phenolphthalein alkalinity has already been determined. This was titrated with sulphuric acid to an end point when colour changed from yellow to orange. The total alkalinitities are expressed in mg/l.

RESULTS AND DISCUSSIONS
The human race is under tremendous threat due to undesired changes in the physical, chemical and biological characteristics of air, water and soil. Due to increased human population, industrialization, use of fertilizers and man-made activities, water is highly polluted with different harmful contaminants (Patil et al., 2012). It has been suggested that it is the leading worldwide cause of deaths and diseases and that it accounts for the deaths of more than 14,000 people daily. An estimated 700 million Indians have no access to a proper toilet, and 1,000 Indian children die of diarrheal sickness every day. Some 90% of cities suffer from some degree of water pollution and nearly 500 million people lack access to safe drinking water (APHA, 1995).

In addition to the acute problems of water pollution in developing countries, developed countries continue to struggle with pollution problems as well. The specific contaminants leading to pollution in water include a wide spectrum of chemicals, pathogens, and physical or sensory changes such as elevated temperature and discoloration. While many of the chemicals and substances that are regulated may be naturally occurring (calcium, sodium, iron, manganese, etc.) the concentration is often the key in determining what is a natural component of water and what is a contaminant. High concentrations of naturally-occurring
substances can have negative impacts on aquatic flora and fauna. Water which is used for drinking purpose should be free from toxic elements, living, nonliving organisms and excessive amount of minerals because they may be harmful to human health (Palanisany et al., 2007). Good water quality produces healthier humans as compare to poor water quality. Water should be purified for a better life style because so many chemicals are involved in it.

4.1 Physico-chemical Characteristics

It is very essential and important to test the water before it is used for drinking, domestic, agricultural or industrial purpose. Water must be tested with different physico-chemical parameters. Selection of parameters for testing of water is solely depends upon for what purpose we going to use that water and what extent we need its quality and purity. The term physicochemical quality is used in reference to the characteristics of water which may affect its acceptability due to aesthetic considerations such as colour and taste; produce toxicity reactions, unexpected physiological responses of laxative effect, and objectionable effects during normal use such as curdy precipitates (WHO, 1995).

The chemical composition of natural waters is the result of a variety of chemical reactions and physico-chemical processes acting in concert. These reaction include, acid-base reactions, gas solution processes, precipitation and dissolution of solid phases, co-ordination reactions of metal ions and ligands, redox reactions and adsorption processes at interface (Stumm and Morgan, 1970). An aquatic ecosystem normally responds to variations in temperature, pressure, pH, oxygen concentration, nitrogen, carbon, phosphorus. Biological activity of water can be too high (eutrophication) or too low (oligotrophication) Eutrophication is caused by an excess food or energy source in a water body. A suggested method of controlling the very high rate of eutrophication is the lowering of levels of nitrogen and phosphorus (Stumm and Morgan, 1970).

Water samples were analyzed of different localities for varied physical and chemical parameters including quality parameters for evaluating Water Quality Index (Temperature, EC, pH, Dissolved Oxygen, Total Hardness, Total Alkalinity, Total Acidity, Biological Oxygen Demand, Chemical Oxygen Demand, Calcium Hardness, Magnesium Hardness, Chloride, Total Solids, Total Dissolved Solids, Total Suspended Solids, Silicate, Nitrate, Phosphate, Sulphate) using standard methods.
The research work was based on the sampling and analysis of ground water from different source (bore well, well, hand pump) during two season (Pre Monsoon and Post Monsoon) throughout the district of Ariyalur, Perambalur and Guddalore. Study areas are divided into sixteen locations of each district. The drinking water sample from different sites has been characterized in terms of values have been tabulated. The values are the average of triplicate analysis. Physico-chemical characteristics of the studied Ground water samples have compared with BIS (1998) ICMR (1994) and WHO (1998) standards for drinking water. The standard values of various physico-chemical parameters for drinking water as per BIS, ICMR and WHO are given (Table-4.1).

**Table 4.1: Drinking water quality standards (BIS, ICMR and WHO).**

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>P</td>
<td>E</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td><strong>Physical parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>Temperature</td>
<td>27.5</td>
<td>36.25</td>
<td>26.53</td>
</tr>
<tr>
<td>02</td>
<td>pH</td>
<td>6.5</td>
<td>9.2</td>
<td>7.0-8.5</td>
</tr>
<tr>
<td>03</td>
<td>Turbidity</td>
<td>5</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>04</td>
<td>Electrical conductivity</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>05</td>
<td>Total dissolved solids</td>
<td>500</td>
<td>1000</td>
<td>300</td>
</tr>
<tr>
<td>06</td>
<td>Total solid substances</td>
<td>500</td>
<td>1000</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td><strong>Chemical parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>Total alkalinity</td>
<td>120</td>
<td>150</td>
<td>100</td>
</tr>
<tr>
<td>08</td>
<td>Total Hardness</td>
<td>300</td>
<td>600</td>
<td>300</td>
</tr>
<tr>
<td>09</td>
<td>Dissolved oxygen</td>
<td>3</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>Biological oxygen demand</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>Chemical oxygen demand</td>
<td>-</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>Calcium</td>
<td>75</td>
<td>200</td>
<td>75</td>
</tr>
<tr>
<td>16</td>
<td>Chloride</td>
<td>250</td>
<td>1000</td>
<td>250</td>
</tr>
<tr>
<td>17</td>
<td>Bicarbonate</td>
<td>200</td>
<td>600</td>
<td>-</td>
</tr>
<tr>
<td>18</td>
<td>Sulphate</td>
<td>200</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>19</td>
<td>Nitrate</td>
<td>40</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>20</td>
<td>Phosphate</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>21</td>
<td>Fluoride</td>
<td>0.6-1.2</td>
<td>1.5</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: P = Permissible limit; E = Excessive limit

All parameters are expressed in mg/L except pH, Turbidity (NTU), Electrical conductivity (µmohs/cm).

**pH**

pH refers to a scale of intensity of acidity or alkalinity. This is regarded as a measure of concentration of H⁺ ions in water. It is one of the important indicators of water quality and is
of great importance to living systems because both cell structure and function can be affected by even small changes in pH (Weber and Stun, 1963). Low pH in water is caused by acids, acid-generated salts, and dissolved carbon dioxide. Low pH values gives water acidic, acid-sour taste and kill small microorganisms. High pH is from carbonates, bicarbonates, hydroxides, phosphates, silicates and borates and very high value of pH makes water strongly alkaline and bitter in taste making it unfit for human consumption. The acidity (low pH) will not affect the health, but slightly acidic groundwater is corrosive and can dissolve metals, especially copper from pipes and pumps. The corrosion can shorten the economic life of plumbing and hot water cylinders and in some cases, the dissolved metals in the water may cause illness (Banerji, 1999; Mahesha et al., 2004).

Most natural water is generally alkaline due to presence of sufficient quantities of carbonates. pH of water gets drastically changed with time, due to the exposure to air, biological activity and temperature changes. Significant change in pH occurs due to disposal of waste effluent water, acid, minerals etc, in natural water. pH also changes diurnally and seasonally. Due to variation in pH, photosynthetic activities which increase with pH and due to consumption of CO₂. It is most outstanding physiological characteristics of the soil and water. It influences many physical and chemical properties of the soil and governs the growth of plants and the activity of micro-organism in it (Suvaranakumari et al., 1997; Indirabai et al., 2005).

The property of chlorine in water to kill bacteria gets reduced if the pH of water is more. When the pH of water is high, formation of tri-halo-depravities’, which are toxic in nature, takes place easily. If the pH of water is low corrosion of metallic surfaces in contact starts which releases toxic metals compounds from Zinc, Lead, Cadmium and Copper. In water supplies, pH is also an important factor in fixing alum dose in drinking water treatment. The activity of bacteria in soil and sediments considerably decreases, when pH falls below five to three. Under normal biological environment a pH rang is 6.0 to 7.5 is considered normal optimum nitrifications in soil take place vigorously (Garg, 2008).

In the present study, the pH of Station I, II and III was examined and represent in table 4.2 and Fig 1. The pH of Station I was 7.02, Station II was 7.12 and Station III was 7.08. All the Stations were within the limit. Among the three stations, station II has highest pH value observed then station I and III. The pH values were within the permissible limit in total area according to the (WHO, 1998; BIS, 1998). The pH values in study area were within the permitted limit of BIS, ICMR and WHO standard. The recommended value of pH for

Table 4.2 shows the Physical characters of Station I, II and II.

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>Parameters</th>
<th>Station I</th>
<th>Station II</th>
<th>Station III</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Clarity</td>
<td>Clear</td>
<td>Clear</td>
<td>Clear</td>
</tr>
<tr>
<td>2.</td>
<td>Colour</td>
<td>Silver white</td>
<td>Silver white</td>
<td>Silver white</td>
</tr>
<tr>
<td>3.</td>
<td>Odour</td>
<td>No characteristics</td>
<td>No characteristics</td>
<td>No characteristics</td>
</tr>
<tr>
<td>4.</td>
<td>pH</td>
<td>7.02</td>
<td>7.12</td>
<td>7.08</td>
</tr>
<tr>
<td>5.</td>
<td>Temperature (°C)</td>
<td>28.2</td>
<td>30.5</td>
<td>29.53</td>
</tr>
<tr>
<td>6.</td>
<td>Electrical conductivity (mmhos/l)</td>
<td>179</td>
<td>166</td>
<td>174</td>
</tr>
</tbody>
</table>

Values were expressed as mean ± SD for triplicates

Station I: New Bus Stand, Station II: Old Bus Stand and Station III: Medical College.

**Temperature**

Temperature is the measurement of hotness of any material. It affects the physical and chemical properties of water and also affects the aquatic vegetation, organisms and their biological activities. A rise in temperature of water leads to the speeding up of chemical reactions in water, reduces the solubility of gases and amplifies the tastes and odours. The growth rate of microorganisms, some of which produce bad tasting metabolites is positively associated with temperature. The odour of substance is also temperature influenced because of relationship between odour and vapour pressure, therefore odour measurement usually specify temperature. In Indian sub-continent temperature of water bodies ranges between 27.8°C to 38.5°C (Sehgal et al., 1980).

In the present study, the temperature of Station I, II and III was examined and represent in table 4.2 and Fig 1. The temperature of Station I was 28.2 °C, Station II was 30.5 °C and Station III was 29.53 °C. All the Stations were within the limit. Among the three stations, station II has highest temperature value observed then station I and III.

Electrical conductivity (EC)

Electrical conductance is very important regarding the salinity to indicate the purity of water. Water capacity of substance or a solution to conduct electric current is denoted by E.C. when the resistance is less the conductivity is more and Conductivity is the reciprocal of the resistivity. Conductivity is a measure of the ability of water to conduct an electrical current. It is highly dependent on the amount of dissolved solids (such as salts) in the water. Pure water, such as distilled water has a very low specific conductance. Sea water has a very high specific conductance. Conductivity is an important water-quality parameter because it can be used to estimate dissolved solids concentrations which may affect the taste of water and suitability for various uses. Higher conductivity values indicate higher dissolved solids concentration in waters (Morrison et al., 2001).

Conductivity is expressed in mmho or µmohs/cm. Conductivity is highly dependent up on temperature at 25°C. EC was calculated at 25°C to maintain the comparability of data from various sources. The electric conductance of water is the sum of all ionic conductance’s of the ionic constituents. The conductivity of distilled water ranges from 0.001 to 0.005 mmoh/cm but the presence of salt and contamination with waste water increases the conductivity of the water. It has no health significance as such. However it is an important criterion for determining stability of water and use of waste water for irrigation conductance in sediments depend up on the percentage of ion such as Cl⁻, SO₄²⁻, PO₄³⁻, HCO₃⁻, Na⁺K⁺, Ca²⁺,Mg²⁺ etc and also lower conductance will indicate presence of silicate material (Sirajudeen et al., 2014b).

In the present study, the electrical conductivity of Station I, II and III was examined and represent in table 4.2 and Fig 2. The electrical conductivity of Station I was 179 mmhos/l, Station II was 166 mmhos/l and Station III was 174 mmhos/l. Among the three stations, station I has highest electrical conductivity observed then station II and III. Electrical conductivity has shown strong positive correlation with turbidity, total dissolved solids, total hardness, calcium, magnesium, sodium, potassium, chloride, sulphate, iron, bicarbonate and carbonate. The correlations established by electrical conductivity in the present study are similar to those of Kaushik et al., (2002) and Sirajudeen et al., (2014a) studies.
Table 4.3 shows the Chemical characters of Station I, II and II.

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>Parameters</th>
<th>Station I</th>
<th>Station II</th>
<th>Station III</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Free carbon dioxide as CaCO₃ (mg/L)</td>
<td>11.32</td>
<td>19.65</td>
<td>14.74</td>
</tr>
<tr>
<td>2.</td>
<td>Total Dissolved Substances (mg/L)</td>
<td>224</td>
<td>346</td>
<td>304</td>
</tr>
<tr>
<td>3.</td>
<td>Calcium Harness (mg/L)</td>
<td>4.2</td>
<td>6.0</td>
<td>5.1</td>
</tr>
<tr>
<td>4.</td>
<td>Total alkalinity (mg/L)</td>
<td>142</td>
<td>150</td>
<td>144</td>
</tr>
</tbody>
</table>

Values were expressed as mean ± SD for triplicate

Station I: New Bus Stand, Station II: Old Bus Stand and Station III: Medical College.

**Free Carbon Dioxide**

In water body the presence of carbon dioxide is due to respiratory activity of aquatic life and the process of decomposition, the CO₂ is useful for the photosynthetic activities of plants; the high range of carbon dioxide is present in polluted water. In present study the values of carbon dioxide were observed in 11.32 mg/dl for Station I, 19.65 mg/dl for Station II, 28.66±4.21 mg/dl for Station III and 14074 mg/dl for Station IV (Table 4.3 and Fig 3). All the Stations were within the limit.

**Total Dissolved Solids (TDS)**

The term solid refers to the matters either filterable or non-filterable that remain as a residue in water i.e., total dissolved solids of water includes all soluble salts like carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrates of calcium, magnesium, sodium, potassium and iron. The high content of dissolved solids increases the density of water and influences osmoregulation of fresh water organisms. Total dissolved solids values are estimated by pursuing the empirical relationship (Rambabu et al., 1996 and Chandanakeri, 1996).

In the present study, the TDS of Station I, II and III was examined and represent in table 4.3 and Fig 3. The TDS of Station I was 224 mg/L, Station II was 346 mg/L and Station III was 304 mg/L. Among the three stations, station I has highest electrical conductivity observed then station II and III.

In the present investigation TDS values are showed within the prescribed limit given by BIS, ICMR and WHO standard. The recommended value of TDS for drinking purposes is between 500 - 1500 mg/L (BIS, 1998; ICMR, 1994; WHO, 1998). The TDS concentration was found
to be above the permissible limit may be due to the leaching of various pollutants into the ground water which can decrease the pot ability and may cause gastrointestinal irritation in human and may also have laxative effect particularly upon transits. High level of TDS may aesthetically be unsatisfactory for bathing and washing (Abdul Jameel et al., 2006). Sirajudeen et al. (2013) and Meena et al., (2016) also made similar observations. Total dissolved solids did not show any negative correlations with the parameters studied.

**Calcium Hardness**

The calcium hardness range is from 4.2 mg/dl for Station I, 6.0mg/dl for Station II, and 5.1mg/dl for Station III (Table 4.3 and Fig 4). Calcium contents in all Stations collected fall within the limit prescribed. Calcium is needed for the body in small quantities, though water provides only a part of total requirements.

**Total Alkalinity**

The value of alkalinity in water provides an idea of natural salts present in water. The cause of alkalinity is the minerals which dissolve in water from soil. The various ionic species that contribute to alkalinity include bicarbonate, hydroxide, phosphate, borate and organic acids. These factors are characteristics of the source of water and natural processes taking place at any given time (Sharma, 2004).

In the present study, the Total alkalinity of Station I, II and III was examined and represent in table 4.3 and Fig 4. The Total alkalinity of Station I was 142 mg/L, Station II was 152 mg/L and Station III was 140 mg/L. All the Stations were within the limit. Among the three stations, station I has highest electrical conductivity observed then station II and III. Our result agrees with the earlier report (Dattatraya Bharti et al., 2011; Meena et al., 2016).

**Table 4.4:** shows the Chemical characters of Station I, II and II.

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>Parameters</th>
<th>Station I</th>
<th>Station II</th>
<th>Station III</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>BOD (mg/L)</td>
<td>4</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>COD (mg/L)</td>
<td>3</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>

Values were expressed as mean ± SD for triplicates.

Station I: New Bus Stand, Station II: Old Bus Stand and Station III: Medical College.

**Bio-chemical oxygen demand (BOD) and Chemical oxygen demand**

Chemical oxygen demand (COD) is defined as the measure of oxygen which is required in oxidizing the organic compounds present in water by means of chemical reactions involving
oxidizing substances. Bio-chemical oxygen demand (BOD) is the amount of oxygen required by the living organisms engaged in the utilization and ultimate destruction or stabilization of organic water. Both the BOD and COD tests are a measure of the relative oxygen-depletion effect of a waste contaminant. Both have been widely adopted as a measure of pollution effect. The BOD test measures the oxygen demand of biodegradable pollutants whereas the COD test measures the oxygen demand of oxidizable pollutants. The COD is a determinant of the level organic matter and carbon (Rice, 1938).

An indication of organic oxygen demand content of wastewater can be obtained by measuring the amount of oxygen required for its stabilization either as BOD and COD. Biological Oxygen Demand (BOD) is the measure of the oxygen required by microorganisms whilst breaking down organic matter. While Chemical Oxygen Demand (COD) is the measure of amount of oxygen required by both potassium dichromate and concentrated sulphuric acid to breakdown both organic and inorganic matters. BOD and COD concentrations of the water body were measured, as the two were important in unit process design (Mane and madlapure, 2002).

In the present study, the BOD of Station I, II and III was examined and represent in table 4.4 and Fig 5. The BOD of Station I was 4 mg/L, Station II was 7 mg/L and Station III was 5 mg/L. The COD of Station I, II and III was examined and represent in table 4.4. The COD of Station I was 3 mg/L, Station II was 6 mg/L and Station III was 5 mg/L. All the Stations were within the limit. Among the three stations, station I has highest electrical conductivity observed then station II and III. The same results were observed by Indrani Gupta (2011). BOD is a measure of biodegradable materials in water. High values recorded in pre monsoon may be attributed to the maximum biological activity at elevated temperatures whereas the lowest BOD in post monsoon may indicate lower biological activity. There is an inverse relationship between DO and BOD.

The COD values at all sampling stations are exceeded the permissible limit (10 mg/l) according to WHO. High COD may cause oxygen depletion on account of decomposition of microbes to a level detrimental to aquatic life (Sivakumar and Jaganathan, 2002). COD values exceed the permissible limit, which indicate the pollution by biodegradable and chemically degradable organic matter. The high value of COD in pre monsoon is due to the inorganic contaminants from the industry and domestic wastes. The BOD and COD values were inter related there by an increasing COD reduces the BOD. Similar results have been
reported by Sedamkar and Angadiv (2003). Similar results have also been observed by Sirajudeen and Mohamed Mubashir, (2013) studies.

**Table 4.5: shows the Chemical characters of sample I, II and II.**

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>Parameters</th>
<th>Station I</th>
<th>Station II</th>
<th>Station III</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Chloride (mg/L)</td>
<td>220</td>
<td>384</td>
<td>286</td>
</tr>
<tr>
<td>2.</td>
<td>Sulphates (mg/L)</td>
<td>146</td>
<td>202</td>
<td>182</td>
</tr>
<tr>
<td>3.</td>
<td>Nitrates (mg/L)</td>
<td>25</td>
<td>36</td>
<td>32</td>
</tr>
<tr>
<td>4.</td>
<td>Fluoride (mg/L)</td>
<td>0.42</td>
<td>0.94</td>
<td>0.61</td>
</tr>
<tr>
<td>5.</td>
<td>Phosphate (mg/L)</td>
<td>0.001</td>
<td>0.003</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Values were expressed as mean ± SD for triplicates.

Station I: New Bus Stand, Station II: Old Bus Stand and Station III: Medical College.

**Chloride (Cl⁻)**

Chloride ion is generally present in natural waters. The salty taste produced by chloride depends on the chemical composition of the water. Inland natural waters are generally having low chloride concentration, often less than that of bicarbonates and sulphates. However, inland saline waters, coastal, estuarine and seawater are having moderate to very high chloride content. In natural fresh waters, high concentration of chlorides is regarded as an indicator of pollution because of organic wastes of animal origin (animal excreta is having high quantity of chlorides along with nitrogenous waste (Sirajudeen et al., 2014). The permissible limit to chloride concentration for potable use of water is 250 mg/L and excessive limit is 1000 mg/L (BIS, 1998; WHO, 1998). In the present study, the chloride concentration in most of the water samples analysed are well within the permissible limit of 250 mg/L indicating that water is suitable for drinking purposes.

In the present study, the Chloride of Station I, II and III was examined and represent in table 4.5 and Fig 6. The Chloride of Station I was 4 mg/L, Station II was 7 mg/L and Station III was 5 mg/L. All the Stations were within the limit. Among the three stations, station I has highest electrical conductivity observed then station II and III. A similar observation has been made by Sirajudeen and Abdul Vahith (2014) and Josephine Sharmila and Rajeswari, (2015).

**Nitrate (NO₃⁻)**

Nitrate is colorless, odorless naturally occurring compound that is formed in the soil when nitrogen and oxygen combine. Autotrophic oxidation of ammonia is known to occur in two steps, the first to nitrite and then from nitrite to nitrate. Nitrate is essential for the growth of many plant species, including most of those we eat. Yet it becomes a problem if it gets into
water in excess amounts. Although it is a plant nutrient, beyond certain levels in the groundwater, it is a potential threat to human health. Decomposition of organic matters in soils, leaching of soluble chemical fertilizers, human and animal excreta, untreated effluents of nitrogenous industries and sewage disposal are potential sources of nitrate contamination in groundwater (Kumara Swamy and Reddy, 1994).

Beck et al. (1985) have stated that fertilizer application has been causing elevated nitrate concentration in groundwater in many areas of the United States and around the world. Research work over the last decade has clearly showed that agriculture is the most extensive source of nitrate delivered to ground water. Nitrate concentration in groundwater on Long Island, New York, have increased markedly in the last 30 years and this increase has been attributed to lawn and garden fertilizers in addition to septic tank and cesspool discharges (Flipse et al, 1985).

Nitrate pollution is not a new problem. Excessive concentrations are recorded in many domestic wells. What is new is the public concern about nitrate. For most people consuming small amounts of nitrate is not harmful. Nitrate can cause health problems for infants especially those six months of age and younger. Nitrate interferes with their blood's ability to transport oxygen. This causes an oxygen deficiency, which results in a dangerous condition called “methemoglobinemia” or “blue baby syndrome” in adults (Gilli, 1984).

It not only causes cyanosis among infants when present in considerable quantity, but also have reported to cause gastric cancer when present in high quantity (Faster et al, 1980). The most common symptom of nitrate poisoning is bluish skin colouring, especially around the eyes and mouth. Cattle, horses, sheep, baby pigs and baby chickens are also susceptible to nitrate poisoning.

In the present study, the Chloride of Station I, II and III was examined and represent in table 4.5 and Fig 6. The Chloride of Station I was 28 mg/L, Station II was 36 mg/L and Station III was 32 mg/L. Among the three stations, station I has highest electrical conductivity observed then station II and III.

Nitrate values within the permissible limit of WHO for (50mg/l) all the groundwater samples. The low nitrate content encountered may be due to the less usage of nitrogen fertilizers and less disposal of wastes around these stations. The high nitrate concentrations in groundwater
could pose potential hazard to infant health (Jeevanandam et al 2007; Vijayakumar et al. (2016) and Sharma and Chhipa, (2016).

**Phosphate**

Phosphorus is necessary for life as an essential component of phospholipids in cell membranes and high energy compounds such as adenosine triphosphate (ATP), creatine triphosphate (CTP); and arginine triphosphate (ATP) and phosphates are necessary for the growth and maintenance of animal and human bones and teeth while organo phosphates are required for all division involving production of nuclear DNA (deoxyribonucleic acid) and RNA (ribonucleic acid). Phosphate minerals exist in soluble and insoluble forms in rocks and soil. Phosphates are present in very minute quantity in natural waters unless they are contaminated by sewage and agricultural wastes, phosphate is an essential nutrient for the growth and development of flora in any ecosystem but excess of phosphorus promotes the abundant growth of algae. Phosphate along with other salts are the prime contributors for the degradation of water quality (Robert et al., 1983).

Phosphate, like nitrogen is essential to all forms of terrestrial life for sustaining primary productivity in the ecosystem. The concentration of phosphate ranged between 0.001, .003 and 0.002mg/L station I, II and III respectively. Generally, phosphate levels in natural waters are low and occur between 0.001 mg/L to 0.024 mg/L having an average of 0.012 mg/L in the tropical rivers (Maybeck, 1982). However, the presence of phosphorous at higher concentration in fresh water indicates pollution through industrial waste and sewage (Kotaiah and Kumaraswamy, 1994).

Phosphorus is not a problem in groundwater; as it is not very mobile in soils, it is considered to be retained in the soil zone as sediments and is then unlikely to perforate to groundwater. The higher concentration of phosphate observed in post monsoon and lower concentration observed in the pre monsoon. The excessive amount of phosphate actually constitutes pollution, usually by infiltration of wastewater from domestic and industrial sources, agricultural runoff, etc.

**Sulphate (SO$_4^{2-}$)**

The sulphate ions usually occur in natural water. Many sulphate compounds are readily soluble in water. Most of them originate from the oxidation of sulphate ores, the solution of gypsum and anhydrite, the presence of shales, particularly those rich in organic compounds.
Higher concentration of sulphate (>200 mg/L) causes gastrointestinal irritation and miss functioning of alimentary canal (WHO, 1998) in human beings. Hence, it is essential to know the concentration of sulfate in fresh waters before it is used for drinking purposes.

The permissible limit of sulphate in drinking water is 200 mg/L. It has a cathartic effect on human beings and cattle when the concentration exceeds the upper limit 250 mg/L. If the concentration is more than 500 mg/L, it causes diarrhoea in human and cattle. Aeration is very effective in removing as H₂S. Sulphate concentration was higher may be due to the of leaching and anthropogenic activities in a metamorphic environment by the release of sulfur gases from industries and urban utilities get oxidized and enter into the groundwater system (Saxena, 2004). Higher levels of sulphate in groundwater may be due to dissolution of gypsum and potassium sulphate added to soil as fertilizers (Al-Tamir, 2007; Lateef, 2011).

In the present study, the Sulphate of Station I, II and III was examined and represent in table 4.5 and Fig 6. The Sulphate of Station I was 140 mg/L, Station II was 202 mg/L and Station III was 180 mg/L. Among the three stations, station I has highest electrical conductivity observed then station II and III. The Sulphate values were in permissible limit in total study area. Our result agrees with the earlier reports (Shanthi et al. 2016; Shyamala et al. 2008).

Fluroides

Fluorides come naturally into water by dissolving minerals that contain fluor, such as fluorite (CaF₂), the most common fluor mineral, apatite (Ca₅(Cl,F,OH)(PO₄)₃), cryolite (Na₃AlF₆). Amphibole minerals, such as hornblende and some sorts of mica, can contain fluor that partially replaces hydroxide ion. Rocks rich in alkali metals have a larger content of fluoride than other volcanic rocks. Fresh volcanic ash, as well as the ash of the other sediments can contribute to fluor content increasing in surface waters. According to values for the dissolving result of calcium fluoride in water, where activity of calcium ion is 0.001mol/dm³, concentration of fluoride ions is 3.1 mg/dm3. Total concentration of fluoride ions will be somewhat higher, which depends on ion strength and complexing effects, and it will be higher in waters where the concentration of Ca²⁺ ion is smaller (that is, in waters with low hardness) (Hem, 1985).

Fluoride ion in traces in drinking water helps in growth and development of healthy, resistant teeth and bones. In many researches it was determined that fluorides are efficient in prevention of dental caries. Teeth enamel is mostly made of mineral hydroxyapatite.
Hydroxyapatite contains hydroxide ion, which fiercely attacks acids (results of bacteria in mouth where they are feeding with sugar), as a difference from much weaker basis, fluoride-ion in fluoroapatite (Dalmacija, 2000).

Surplus of fluorides in organism can provoke teeth and skeleton fluorose. Fluorides inhibit many enzymes. Affected enzyme contains metal ion which unites with fluoride and creates metal-fluoride complex. Fluor in organism has its optimal, security-tolerant and toxic dose, which depends of person’s age, weight and health. In the first year of life the optimal content of fluor is 0.045 mg/kg of body mass, tolerant 0.073 mg/kg, chronically toxic 0.150 mg/kg. Optimal dosage of fluor for adults is 0.020-0.025 mg/kg of body mass (www.mineralwaters.org).

In the present study, the fluoride of Station I, II and III was examined and represent in table 4.5 and Fig 8. The fluoride of Station I was 0.42 mg/L, Station II was 0.94 mg/L and Station III was 0.61 mg/L. Among the three stations, station I has highest electrical conductivity observed then station II and III. Natural water contains less than 0.1 ppm fluoride ions, and in our waters it moves from 0.05 to more than 0.6 ppm. Mineral waters consist, on average 0.16 to 6.45 ppm. Recommended limited value for fluoride in drinking water by World Health Organisation (WHO) is 1.0-1.5 mg/L ppm (WHO, 1984).

**CONCLUSION**

Physico-chemical analysis such as temperature, pH, alkalinity, total dissolved solids, chloride, total alkalinity, COD, BOD, calcium hardness, sulphate, nitrate, fluoroide of ground water of different locations were carried out. The following conclusion obtained from the study. Physico-chemical analysis all Stations as tap water were observed within the ranged as prescribed by WHO, ICMR and Indian standards. The sulphate level is higher in pond and river water as compared to Indian standards recommended by ICMR and WHO. The nitrate level is higher in pond water as compared to standard recommended by ICMR and WHO. Therefore boiling of water is essential before consumption of water by the people living in this area. From the data of drinking water we should know the properties of bore-well drinking water which is used to enhance our plant growth.
REFERENCES


groundwater quality assessment of lower part of the ponnaiyar river basin, Cuddalore
Dist, South India. Environmental Monitoring and Assessment, 132: 263-274.
Characteristics of Selected Ground Water Samples of Chennai City, Tamil Nadu. Int. J.
Drinking Water Quality in and Around Perur Block of Coimbatore District, Tamil Nadu,
suitability assessment of urban ground water of HIsar and Panipat in Haryana.” J. of
charotar publishing house, Anand - 388001 (India).
unsewered sanitation - A case study", Journal of the IPHE, India, 4: 52-61.
36. Lateef KH. (2011) Evaluation of ground water quality for drinking purpose for Tikrit and
472-481.
Sci, 282: 401-450.
Suitability for Drinking and Domestic Uses by Using WQI and Statistical Analysis in
River Basin Area in Jahzpur Tehsil, Bhilwara District (Rajasthan, India). International
Environmental Protection, 13: 577-579.
source pollution from the Keiskammahoek Sewage Treatment Plant on the Keiskamma


