PHYSIOCHEMICAL AND MICROBIOLOGICAL STUDY OF RIVER WATER IN NAGAPATTINAM DISTRICT TAMIL NADU, INDIA

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ABSTRACT

Water is one of the abundantly available substances in water. The present investigation was carried out to evaluate the physiochemical parameters and bacterial populations from Kollidam, Kaveri, Vetter and Thirumalai Rajan in the Nagapattinam District. Different physiochemical parameters like pH, temperature, total alkalinity, total dissolved substances, free CO₂, sulphate, nitrate, fluoride. These were found be above the permissible limits. Various pathogenic bacteria were isolated from river water. Thus the water of these rivers Kollidam, Kaveri, Vetter and Thirumalai Rajan was found to be unfit for human consumption without treatment. The immediate attention from the concerned authorities is required to protect river from further pollution.

KEYWORDS: Kollidam, Kaveri, Vetter and Thirumalai Rajan.

INTRODUCTION

Water is a resource that has many uses, including recreation, transportation, and hydroelectric power, domestic, industrial and commercial uses. Water also supports all forms of life and affects our health, lifestyle, and economic well being. Although more than three quarters of the earth's surface is made up of water, only 2.8 percent of the Earth's water is available for human consumption.¹ At present, approximately one-third of the world's people live in countries with moderate to high water stress and the worldwide freshwater consumption raised six fold between the years 1900 and 1995 more than twice the rate of population.
growth. Thus, many parts of the world are facing water scarcity problem due to limitation of water resources coinciding with growing population.\cite{2}

Fresh water is a finite resource, essential for agriculture, industry and even human existence, without fresh water of adequate quantity and quality, sustainable development will not be possible.\cite{3} Rivers play a major role in assimilation or carrying off of municipal and industrial wastewater and runoff from agricultural land, the former constitutes the constant polluting source whereas the later is a seasonal phenomenon.\cite{4} With the rapid development in agriculture, mining, urbanization and industrialization activities, the river water contamination with hazardous waste and wastewater is becoming a common phenomenon.

In India almost 70\% of the water has become polluted due to the discharge of domestic sewage and industrial effluents into natural water source, such as rivers, streams as well as lakes.\cite{5} The improper management of water systems may cause serious problems in availability and quality of water.\cite{6} Since water quality and human health are closely related, water analysis before usage is of prime importance. Certain physical, chemical and microbiological standards, which are designed to ensure that the water is palatable and safe for drinking before it can be described as potable.\cite{7} Therefore, present study was aimed to analyze the comparative physicochemical and microbial analysis of five river water samples using standard methods.

Water is one of the most important aspects of survival and a precious resource of the earth. The quality of the water is rapidly changing according to its source. The change in its quality will definitely disturb the harmony in nature, and would become less suitable for use.\cite{8} The safety of water would enhance stability in any community.

**MATERIALS AND METHODS**

**Collection of water samples**

Water samples were collected from four different rivers located in Nagapattinam District Tamilnadu, India from the period of December 2015. The sampling sites and their located districts are shown in table 1. In each river, samples were collected from different areas and mixed in a single sterile polyethylene bottle. The water samples were taken by pumping in order to avoid contamination from the surface of river basin. The samples were stored in 4°C for further analysis.
TABLE: 1

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SAMPLE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kollidam River</td>
<td>1</td>
</tr>
<tr>
<td>Kaveri River</td>
<td>2</td>
</tr>
<tr>
<td>Vettar River</td>
<td>3</td>
</tr>
<tr>
<td>Thirumalairajan River</td>
<td>4</td>
</tr>
</tbody>
</table>

PHYSICO-CHEMICAL PARAMETERS\(^{[9-13]}\)

The methods used for the analysis of various physic-chemical parameters were the same as given in Standard Methods for the Examination of water.

**DETERMINATION OF pH**

pH was recorded at the sampling site using digital pH meter maintained at the room temperature.

**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, taking care not to expose it to heat or direct solar radiation.

**DETERMINATION OF TOTAL ALKALINITY**

**Requirements**

1. Methyl orange
2. 0.02N Sulphuric acid

**Procedure**

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 CaCO\(_3\).

**DETERMINATION OF TOTAL DISSOLVED SOLIDS**

**Requirements**

1. Water bath
2. China dish
3. Desiccators
Procedure
In a pre-weighted dried dish of suitable size were taken and 100ml of filtered water sample was taken evaporated on a water bath. The weight of the dish was noted after cooling it in a desiccators. The total dissolved solids are expressed in mg/l.
Calculation= (final weight-Initial weight).

DETERMINATION OF FREE CARBON DIOXIDE
Requirements
1. N/44 sodium Hydroxide
2. Phenolphthalein indicator

Procedure
Free carbon dioxide was estimated using sodium hydrox ide titrate and phenolphthalein indicator. 50ml of sample was taken in a conical flask and two drops of phenolphthalein indicator were added. If the colour turned pink, free carbon dioxide was takes as absent. If it remained colourless it was titrated with sodium hydroxide until pink colour appeared. The free carbon dioxide are expressed in mg/l.

\[
\text{Calculation} = \frac{\text{ml of NaOH} \times 1000}{\text{Volume taken (sample)}}
\]

DETERMINATION OF SULPHATES
Requirements
1. Whatmann filter paper No.1
2. Sulphate
3. Barium chloride
4. Magnetic stirrer

Procedure
Filtered the water sample through Whatmann filter paper. 50ml of filtered water sample was taken into conical flask containing not more than 10mg/ml sulphate. Added 0.15gm of barium chloride and mixed for 30 minutes using a magnetic stir. Measured the absorbance against distilled water blank at 420nm and compared with the standard curve. The sulphates are expressed in mg/l.
ml of titration × 1000
Calculation= -------------------------------
Volume taken (sample)

DETERMINATION OF NITRATES
Requirements
1. Phenoldisulphonic acid
2. Ammonia hydroxide

Procedure
25 ml of water sample was evaporated to dryness on hot water bath and 1 ml phenoldisulphonic acid was added after rubbing the residue thoroughly. 10 ml of distilled water and 3 ml ammonium hydroxide was added one after other. A yellow colour was developed. Absorbance was read at 410 nm against a bank and compared with standard curve. The nitrates expressed in mg/l.

Test O.D
Calculation= ------------------------------- × Calculation factor
Standard O.D

DETERMINATION OF FLUORIDE
Requirements
1. Tris-Hcl Fluoride (70%) solution
2. NaH₂PO₄-NaOH Buffer (0.1M pH 9)
3. Standard solution (0.1M of sodium fluoride)
4. Working solution (0.0003M)

Procedure
Added sequentially to 5 ml volumetric flasks containing 3.5 ml of THF solution, 0.1 ml of working solution, 1.3 ml of sample and 0.1 ml of NaH₂PO₄-NaOH Buffer. Mixed the content of the flask thoroughly. After 10 min, measure the absorbance at 600 nm using THF-water (7:3 v/v) solution as the reference. The fluoride is expressed in mg/l.

Test O.D
Calculation = ------------------------------- × Calculation factor
Standard O.
MICROBIOLOGY PARAMETERS

IDENTIFICATION OF MICROBES

PREPARATION OF MEDIA

Nutrient Agar (NA-Himedia) Media for Bacteria

Composition of Media

Animal’s tissue : 5.00g
Sodium chloride : 5.00g
Beef extract : 1.50g
Yeast extract : 1.50g
Agar : 15.0g

PREPARATION OF MEDIUM

Suspend 28.0 grams in 1000 ml distilled water. Heat to boiling and dissolve the medium completely. Sterilize by autoclaving at 15 lbs pressure (121°C) for 15 minutes. Mix well and pour into sterile Petri plates.

INOCULATION OF WATER SAMPLES

The samples were taken in a sterile test tube. 1ml of each of sample was aseptically introduced into 9ml of peptone water into test tube; to give 10-1 dilution and spreaded over the nutrient agar medium and the plates were incubated at 35°C for 24hrs after 24hrs the colonies grown on the plates were examined for their morphology.

MICROSCOPICAL EXAMINATION

The morphological analysis of Microorganism was examined by using a sterile loop to pick Culture from the culture plate were placed on a microscope slide, covered with a cover slip and observed under the microscope for structure.

ISOLATION OF GUT MICROBIAL LOAD

Each sample were placed in separate sterile bottle containing 5ml sterile distilled water and vigorously shaken to allow the contained bacteria dislodge into the water. Then from each suspension, 0.1ml was pour-plated using freshly prepared nutrient agar (N.A.) (MERCK) 20ml. The plates, after being covered, were gently swirled to evenly mix-up and allowed to gel. These were inverted and incubated at 37oC for 24 hours. Microbial count (Bacteria load) colonies which developed after incubation were subjected to counting using Gallenkamp colony counter (CX-300) and were also expressed in colony forming unit (CFU).[14]
RESULT AND DISCUSSION

Water is essential for life and access to clean drinking water is a necessity for good health. However, clean drinking water is not available everywhere, due to water scarcity and pollution of existing water resources. The pollution can be in the form of natural or anthropogenic activities.\[^{[15]}\] The quality of river water is influenced by various natural factors such as rainfall, temperature and weathering of rocks and anthropogenic activities which alter the hydrochemistry of river water.\[^{[16]}\] Unplanned urbanization and rapid growth of industrialization increase river pollution crisis in river ecosystem. The problem of water quality deterioration is mainly due to human activities such as discharge of industrial and sewage wastes and agricultural runoff which cause ecological damage and pose serious health hazards.\[^{[17]}\]

PHYSICAL AND CHEMICAL CHARACTERS

In the present study analysis of surface river water quality in four locations was carried out to determine the physical and chemical characteristics of river water.

The result indicate that the quality of water varies from location to location. Table 2 indicates the several parameters are with or not within the permissible limit of WHO. Water quality standards very significantly due to different environmental condition and eco system. The variation observed were probably due to various factors such as trace metal contents, environmental pollutions due to organic pollutant, domestic sewage etc.

Table: 2 The physiochemical parameter of river water samples in Nagappattinam District.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>WHO</th>
<th>Kollidam River</th>
<th>Kaveri River</th>
<th>Vettar River</th>
<th>Thirumalai raja rajan River</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.5-8.5</td>
<td>7.2</td>
<td>7.8</td>
<td>8</td>
<td>8.2</td>
</tr>
<tr>
<td>Temperature °C</td>
<td>25-31</td>
<td>28</td>
<td>27</td>
<td>27.5</td>
<td>26.5</td>
</tr>
<tr>
<td>Total alkalinity (mg/dl CaCO(_3))</td>
<td>75</td>
<td>4</td>
<td>6</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Total Dissolved Substances(mg/dl)</td>
<td>500</td>
<td>232</td>
<td>300</td>
<td>150</td>
<td>178</td>
</tr>
<tr>
<td>Free CO(_2) (mg/dl)</td>
<td>20</td>
<td>4.2</td>
<td>4.8</td>
<td>4.8</td>
<td>5.2</td>
</tr>
<tr>
<td>Sulphates(mg/dl)</td>
<td>200</td>
<td>11000</td>
<td>1185</td>
<td>8520</td>
<td>5035</td>
</tr>
<tr>
<td>Nitrates (mg/dl)</td>
<td>45</td>
<td>162.5</td>
<td>170</td>
<td>160</td>
<td>157.5</td>
</tr>
<tr>
<td>Fluoride (mg/dl)</td>
<td>Nil</td>
<td>0.29</td>
<td>0.31</td>
<td>0.37</td>
<td>0.36</td>
</tr>
</tbody>
</table>
The pH of water is extremely important. The pH values analyzed using pH meter was found to be more or less similar for each sample, where values were ranging from 7.2- 8.2. pH should be in the range of 6.5 to 8.5 for drinking and domestic purposes.\textsuperscript{[18]} The fluctuations in optimum pH ranges may lead to an increase or decrease in the toxicity of poisons in water bodies.\textsuperscript{[19]}

The pH obtained in the river water was within the ranges suitable for aquatic life.\textsuperscript{[20]} Based on these guidelines, the pH of the river water would not adversely affect its use for domestic and recreational purposes. The well buffered nature of the river water can be attributed to the fact that normally running waters are influenced by the nature of deposits over which they flow.\textsuperscript{[21]}

The pH is the scale of intensity of acidity and alkalinity of water and measures the concentration of hydrogen ions. Aquatic organisms are affected by pH because most of their metabolic activities are pH dependent. Optimal pH range for sustainable aquatic life is pH 6.5 – 8.2.\textsuperscript{[22]}

pH value is an important factor in maintaining the carbonate and bicarbonate levels in water. The slight alkalinity may be due to the presence of bicarbonate ions, which are produced by the free combination of CO\textsubscript{2} with water to form carbonic acid, which affects the pH of the water.\textsuperscript{[23]} Carbonic acid (H\textsubscript{2}CO\textsubscript{3}) dissociates partly to produce (H\textsuperscript{+}) and bicarbonate ions.\textsuperscript{[24]}
The mild alkalinity indicates the presence of weak basic salts in the soil. The low pH does not cause any harmful effect.

pH is most important in determining the corrosive nature of water. Lower the pH value higher is the corrosive nature of water. pH was positively correlated with electrical conductance and total alkalinity. The reduced rate of photosynthetic activity the assimilation of carbon dioxide and bicarbonates which are ultimately responsible for increase in pH, the low oxygen values coincided with high temperature during the summer month. Various factors bring about changes the pH of water. The higher pH values observed suggests that carbon dioxide, carbonate-bicarbonate equilibrium is affected more due to change in physico-chemical condition.

The pH values depend on the rate of photosynthesis of algal blooms which cause precipitation of carbonates and bicarbonates. During monsoon rate of photosynthesis is high, thus there is increased precipitation leading to high pH. During winter it is low thus pH values are low. Another reason for high pH values could be due to waste discharge from domestic waste and waste generated due to religious activities.

The pH of water is important because many biological activities can occur only within a narrow range, thus any variations beyond an acceptable limit could be fatal to a particular organism.

pH is the indicator of acidic or alkaline condition of water status. The standard for any purpose in-terms of pH is 6.5-8.5; in that respect the value Gudbahri River water are 7.33 to 8.39. The overall result indicates slightly basic water.

![Temperature Chart](image.png)

**Fig. 2: Comparison of pH in various river water.**
Temperature

Temperature is one of the most important factors that controls the rate of metabolic and reproductive activities of aquatic organisms. The temperature of the water existed from 27°C to 28°C (Table 2). The climate changes had no significant effects on the water.

Water temperature plays an important role in influencing the quality and ecology of streams and rivers. It affects not only the physical nature of water by changing the viscosity, density and surface tension but also the rate and types of chemical reactions that occur within. Water temperature is thus an important factor that influences that rate of all biological activities. Temperature can therefore be used as a first step in predicting the effects of mans activities on the aquatic ecosystem.[31]

Temperature is an important biologically significant factor, which plays an important role in the metabolic activities of the organism.[32]

Temperature is an important water quality parameter and easy to measure in water bodies which show less variation. The variation in temperature of Mullai Periyar river water in the studied stretch did not show wide difference and fluctuating between 25.5°C and 26.5°C (wet season) and 27.7°C – 27.8°C (dry season). The temperature differential is likely to play an important role in governing species diversity because fish, insects, zooplankton, phytoplankton and other aquatic species all have a preferred living and breeding temperature range.[33]

Water temperature show high significant positive relationship with salinity, chloride, sulphate, electrical conductivity, alkalinity and pH. Where aspositive relationship with turbidity.[34]

In an established system the water temperature controls the rate of all chemical reactions and affects fish growth, reproduction and immunity. Drastic temperature changes can be fatal to fish.[35]

Temperature is one of the most important ecological and physical factor which has a profound influence on both the living and non-living components of the environment, thereby affecting organisms and the functioning of an ecosystem. Although temperature generally influences the overall quality of water (physic-chemical and biological characteristics), there are no guideline values recommended for drinking water.[36]
Total alkalinity

The ionic concentration in the water is referred to as alkalinity. The TA has the tendency to neutralize the hydrogen ions. The phenolphthalein alkalinity value is nil, which indicates the absence of carbonate and hydroxyl ions. The bicarbonate alkalinity ranges from 4 mg/dl to 12 mg/dl as shown in Table 2 all the observed values were within the permissible range as prescribed by WHO standard. Moreover, little abnormalities in the value of alkalinity are not harmful for human beings.

Total Alkalinity is the measure of capacity of water to neutralize the acids. Alkalinity increases as the amount of dissolved carbontes and bicarbonates increases. Alkalinity level varied from 175 mg/l to 310 mg/l in the Yamuna River.\textsuperscript{37}

Alkalinity is composed primarily of carbonate (CO\textsubscript{3}\textsuperscript{2}⁻) and bicarbonate (HCO\textsubscript{3}⁻), alkalinity acts as a stabilizer for pH. Alkalinity, pH and hardness affect the toxicity of many substances in the water. Alkalinity in boiler water essentially results from the presence of hydroxyl and carbonate ions. Hydroxyl alkalinity (causticity) in boiler water is necessary to protect the boiler against corrosion.\textsuperscript{35}

Fig. 3: Comparison of Total alkalinity in various river water.
Fig. 4: Comparison of Total Dissolved Substance in various river water.

Total Dissolved Substance
TDS indicates the amount of ions present in water and analyses the quality of water. High TDS in water reduces the clarity of water, decreases photosynthesis and increases the temperature of water, when combined with the toxic compounds and heavy metals. The TDS values ranged from 0.32 mg/dl to 0.98 mg/dl. The minimum values recorded is at the sampling location Thirumalai Rajan and maximum at sampling location Kaveri river, which was within the permissible limit prescribed by WHO standard.

The total dissolved solids (TDS) of the different sites of river and ground water samples were found within the permissible limit (1000mg/l) of WHO standards. Due to the nature of flow, run-off river water occurred during heavy rainy seasons certain variation may occurred, but this variation did not affected the irrigation system of ground water and soils. Reported that TSS and TDS of the Noyyal River in Tiruppur exceeded the tolerance limit in all the sampling point, the addition of these parameters make the Noyyal River dirty and affected the aquatic life in Tiruppur area.

In water, total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium, manganese, organic matter, salt and other particles. The high amount of TDS in turn affects the quality of running water. Higher amount of total dissolved solids leads to increased turbidity.
The mean total dissolved solids concentrations in Gudbahri River was found to be 470.17 mg/L which ranged from 326 to 770 mg/L and it is within the limit. Higher values of total solids are mainly due to the presence of silt and clay particles in the river water. Water high in suspended solid may be aesthetically unsatisfactory for bathing.\textsuperscript{[41-42]}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{fig5.png}
\caption{Comparison of Free CO$_2$ in various river water.}
\end{figure}

**Free CO$_2$**

The values of free CO$_2$ are found in the range of 4.2 to 5.2 (mg/dl) for all river water samples. The minimum and maximum levels were recorded the locations of Kollidam and Thirumalai Rajan river respectively. Bicarbonates are produced from the decomposition and oxidation of organic pollutants\textsuperscript{[43]} and to the frequent exchange of atmospheric CO$_2$ with water to form H$_2$CO$_3$.\textsuperscript{[44]}

Carbon dioxide is the end product of organic carbon degradation in almost all aquatic environments and its variation is often a measure of net ecosystem metabolism.\textsuperscript{[45-47]} Therefore, in aquatic biogeochemical studies, it is desirable to measure parameters that define the carbon dioxide system. CO$_2$ is also the most important green house gas on Earth. Its fluxes across the air-water or sediment-water interface are among the most important concerns in global change studies and are often a measure of the net ecosystem production/metabolism of the aquatic system.
Fig. 6: Comparison of Sulphate in various river water.

**Sulphate**

Sulphate ion is one of the major anions occurring in natural waters. The concentration varied from 5035-11000 mg/dl. The values were high in Kollidam river, Vettariver and Thirumalairajan river compared with Kaveri river which could be due to the hospital, agricultural and animal wastes.

Sulphate is naturally present in water due to the addition of sulphuric acid, zinc sulphate, gypsum and other materials. The concentration of sulphate gets increased with the discharge of wastes. The precipitation of calcium ions and the sodium poisoning of plants could be caused by the sulphate ions.[48]

Sulphate is the stable form of sulphur and is non-toxic, however occurring in excess sulphates form sulphuric acid (H₂SO₄). This acid can have a devastating effect upon aquatic ecosystems.[49-50]

Many sulphate components are readily soluble in water. Most of sulphate components originate from the oxidation of sulphite ores, presence of shales and the solution of gypsum and anhydrite. Under anaerobic conditions, sulphate ion is reduced to sulphate ion, which establishes equilibrium with hydrogen ion to form hydrogen sulphide. The presence of hydrogen sulphide leads to corrosion of pipes.[51]
Sulphur come from runoff water of agricultural fields, which contain relatively large quantities of organic and mineral sulphur compounds. Sulphate show high significant positive relationship with water temperature, Alkalinity and electrical conductivity. And significant negative relationship with total solids.\textsuperscript{[34]}

Sulphate occurs naturally in all the water bodies. Since the kunds at Govardhan are located in the semiarid region, they have higher concentration of the anion due to the accumulation of soluble salts in the soils.\textsuperscript{[52]}

![Nitrates](image)

\textbf{Fig. 7: Comparison of Nitrates in various river water.}

\textbf{Nitrates}

The nitrate value was observed maximum in Kaveri river (170 mg/dl). Surface water generally contains sewage and wastes rich in nitrates. The nitrate pollution would cause Eutrophication, which affects the water quality. This could be due to the disposal of animal and hospital wastes.\textsuperscript{[48]}

The high concentration of nitrate in drinking water is toxic and causes blue baby disease/methaemglobinemia in children and gastric carcinomas.\textsuperscript{[53-54]} Most of the locations the source of nitrate in groundwater occurs by direct anthropogenic pollution (septic tanks etc).

Nitrate in natural waters can be traced to percolating nitrate from sources such as decaying plant and animal materials, agricultural fertilizers, domestic sewage.\textsuperscript{[55]} Nitrate causes the overgrowth of algae, other organism and fouls the water system. Epidemiological studies have predicted association between exposures to nitrate and gastric cancer because of the reaction of nitrate with amine in diet forming carcinogenic nitrosomoamines.\textsuperscript{[56]}
Nitrate show high significant positive relationship with total hardness, Total solids whereas positive relationship with turbidity. And significant negative relationship with pH, DO, BOD,COD and transparency.\[^{34}\] High nitrate content in drinking water may lead to goiter, cancer, and methemoglobinemia.\[^{57}\]

Nitrate concentration depends on the activity of nitrifying bacteria which in turn get influenced by presence of dissolved oxygen. Decrease in nitrate content during winter months was probably due to its utilization by the algal community as nutrient.\[^{58}\] Monitoring of nitrates in drinking water supply is very important because of health effects on humans and animals.\[^{59}\]

Oxidation of ammonia form of nitrogen from animal and human wastes to nitrite is a possible way of nitrate entry into the groundwater aquifer.\[^{60}\] In higher concentrations, nitrate may produce a disease known as Methemoglobinemia (blue baby syndrome) which generally affects bottle-fed infants. Repeated doses of nitrates on ingestion may also cause carcinogenic diseases.\[^{61}\]

Surface water contains nitrate due to leaching of nitrate with the percolating water. Surface water can also be contaminated by sewage and other wastes rich in nitrates.\[^{62}\]

**Fluoride**

Fluoride level was in the range of 0.29 mg/dl to 0.37 mg/dl (Table 2). Fluoride occurs the river water due to the salt deposits, use of inorganic fertilizers, animal feed, detergents and addition of some chemicals.
Fluoride is level from 0.7 to 1.2 mg/l is essential in drinking water and its excess presence will be toxic resulting in dental fluorosis, skeletal fluorosis and non-vertebral fractures, especially hip fractures. Apart from fluorosis, high intake of fluorides may also cause gastrointestinal complaints such as loss of appetite, nausea, vomiting, ulcer pain in the stomach, constipation and intermittent diarrhoea and flatulence. The adolescent age group is most vulnerable to fluoride pollution and it is a worldwide problem.

The concentration of fluoride content present in water is higher and low then various problems are arises in human, animal and plants and also it a source of water pollution.

Probable source of high fluoride in Indian waters seems to be that during weathering and circulation of water in rocks and soils, fluorine is leached out and dissolved in ground water. Excess intake of fluoride through drinking water causes fluorosis on human being.

**MICROBIOLOGY CHARACTERS**

Plate 1-4Observation of Microbial plate after 24 hrs inoculation.
Fig. 9: Morphological characteristics of the organisms from river water samples.

Table: 3 Morphological and cultural characteristics of the organisms isolated from river water samples.

<table>
<thead>
<tr>
<th>S.No</th>
<th>SAMPLES</th>
<th>APPEARANCES OF NUTRIENT AGAR PLATE (AFTER 24 HOURS)</th>
<th>MORPHOLOGY</th>
<th>BACTERIA</th>
<th>(CFU/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kollidam</td>
<td>Mucoid</td>
<td>Spherical</td>
<td>Staphylococci</td>
<td>1.6±0.09 x 10^2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rod</td>
<td>Bacillus</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Kaveri</td>
<td>Mucoid</td>
<td>Spherical</td>
<td>Staphylococci</td>
<td>0.9±1.08 x 10^2</td>
</tr>
<tr>
<td>3</td>
<td>Vettar</td>
<td>Mucoid</td>
<td>Spherical</td>
<td>Staphylococci</td>
<td>1.03±2.7 x 10^2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rod</td>
<td>E. coli</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Thirumalairajan</td>
<td>Mucoid</td>
<td>Spherical</td>
<td>Staphylococci</td>
<td>0.80±1.87 x 10^2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Elongated</td>
<td>Bacillus</td>
<td></td>
</tr>
</tbody>
</table>
In the present study, the presence of bacterial isolates in river water samples in some locations indicated undesirable contamination of the samples. The bacteria that were identified from the water samples included *E. coli*, *Staphylococci*, and *Bacillus*.

Table 3 shows the mean value of the bacteriological counts such as *Staphylococci* and *Bacillus* (1.6×10^2) at Kollidam, *Staphylococci* (0.9×10^2) at Kaveri, *Staphylococci* and *E. coli* (1.3×2.7×10^2) at Vettar, *Staphylococci* and *Bacillus* (0.8×1.87×10^2), at Thirumalairajan river.

Bacterial population were maximum among the microorganisms in kollidam (1.6±0.09×10^2). The maximum quantity may be due to low water level, high organic matter, low bacterivores and optimum growth supporting nutrient favour for higher bacterial count. Even though land washing organic matter and animal manure added by runoff rain water, due to the dilution effect reduce the bacterial count.

From the table 3, it was evident that the river water is highly contaminated and also denotes the potential public health hazards. The maximum permissible value of total coliforms in drinking water is 1 per 100ml[^70] and 10 per 100ml[^71]. *E. coli* can be used as bio-indicators of aquatic ecosystem dynamics and determination of their occurrence may help to assess the water quality. Presence of coliforms organisms in water regarded as evidence of faecal contamination as their origin in the intestinal tract of human and other warm-blooded.
animals. This clearly indicates that the bacterial contamination in the river water is chiefly caused by human excreta and domestic sewage, which is objectionable for drinking purposes. The bacterial genera such as *Escherichia coli*, *Streptococci* sp and *Bacillus* sp were predominant in river watersamples and may be due to domestic solid waste and sewage from various human activities.[72]

Like temperature, pH also plays a role in determining the ability of bacteria to grow or thrive in particular environments. Most commonly, bacteria grow optimally within a narrow range of pH between 6.7 and 7.5. Many biological activities can occur only within a narrow pH range.[73] Any variation beyond acceptable range will affect the growth and density. In the present study, the pH value range from (7.2 to 8.2).

In addition to water, bacteria also require a wide variety of elements, especially carbon, hydrogen and nitrogen, sulfur, phosphorus, potassium, iron, magnesium and calcium.[74-75] High bacterial counts are attributed to contamination by domestic sewage.[76] Significant increase in organic and bacterial load after rain storm from point sources have been linked to increase risk of infectious disease transmission.[77]

The bacteriological examination of water has a special significance in pollution studies, as it is a direct measurement of deleterious effects of pollution on human health. The great danger to health is the presence of excremental bacteria as contaminated water may convey the causative organisms of diseases.[78] Polluted water contains vast amount of organic matter that serve as excellent nutritional source for the microbial tracers because they grow well in aqueous media and are easily detectable.[79] Water bacteriology in distribution systems have received less importance in developing countries, as much time is spent on supplying water in quantity.

According to[80], the unhygienic conditions of water associated with drinking and recreation may result in human infections and diseases through the ingestion of pathogenic microorganisms which are indicated by the presence of indicator bacteria.[81] found that fecal coliform densities were positively correlated with turbidity and negatively with salinity. However, the presence or absence of these bacteria in water is often used to determine whether disinfection of water is working properly or not.
Microorganisms are always present in water that may be pathogenic or non-pathogenic. Pathogenic forms include various species of bacteria, viruses, fungi and protozoans.\textsuperscript{[82]}

Microbial populations depend upon their numbers and quantities of food material dissolved in the water. Climatic, geographical and biological conditions bring about great variations in microbial population of surface water.\textsuperscript{[83]} River and streams shows their highest count during the rainy period. Dust blowing into the rivers and animals also contributes many microorganisms which can be harmful to organisms and plants living in those water bodies or to the humans those used these water.\textsuperscript{[84]}

Water borne pathogen includes various species of bacteria viruses, fungi and protozoa.\textsuperscript{[85-90]} The fungal species cause diseases like Aspergillosis, Coccidomycosis, Blastomycosis, Histoplasmosis and Pneumonia.\textsuperscript{[91]} According to WHO, about 80\% of all the disease in human beings are caused by contaminated water.\textsuperscript{[92-94]}

\textit{Escherichia coli} and intestinal \textit{enterococci} are used worldwide as indicators for the assessment of faecal pollution in the aquatic environment. In fresh water, \textit{E.coli} was shown to be a consistent predictor of gastrointestinal illness.\textsuperscript{[95]}

**CONCLUSION**

Most ancient civilizations grew along the banks of rivers even today, millions of people all over the world live on the banks of rivers and depend on them for their survival.

The rise of the inflow of water in clearly due to the rapid growth of residential and commercial activities in the study area. Due to the discharge of sewage, domestic water and human activities the sulphats, fluoride and nitrate load in river water exceeds the permissible limit of WHO drinking water standards.

The bacteriological counts in the river water make the water unit for human consumption. The ground water around Nagapattinum district was found to be suitable for irrigation purposes and affect soil conditioning.

It is concluded that the river is polluted as it is used as a sewer disposal site, but is also underingse lf purification and has potential for significant improvement in water quality if discharges are ameliorated.
Regular monitoring of river and taking suitable remedial measures like collection of domestic sewage and sefting up the common treatment plant, before discharge of sewage into river system, it should be treatment. This will control pollution and prevent the depletion of the quality of river waters.

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