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Studies On Geochemical Distribution And Contamination Assessment Of Metals In The Water Of Kollam District, Kerala

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Abstract

The water quality was investigated in the Kollam District, Kollam, to ensure the continuous supply of clean and safe drinking water for the public health protection. In this regard, a detailed physical and chemical analysis of drinking water samples was carried out in different residential and commercial areas of the state. A number of parameters such as pH, turbidity, conductivity, total suspended solids (TSS), total dissolved solids (TDS), and heavy metals were analysed for each water sample collected during the period (September 2020 to August 2021). The obtained values of each parameter were compared with the standard values set by the World Health Organization (WHO) and local standards BIS. The values of each parameter were found to be within the safe limits set by the WHO and BIS. Overall, the water from all the locations was found to be safe as drinking water. However, it is also important to investigate other potential water contaminations such as chemicals and microbial and radiological materials for a longer period of time, including human body fluids, in order to assess the overall water quality of Kanyakumari District, Tamil Nadu. This study investigates the physico-chemical and bacteriological characteristics of 32 water samples with respect to WHO standards. The water samples were collected from wells, boreholes and small drinking water supply systems (DWS) in and around the township of Kollam. The Water Quality Index (WQI) tool was used to assess the overall water quality with different physico-chemical parameters. Where the pH of the samples was acceptable, the samples showed higher levels of mineralization and deoxygenation.

Keywords: Water, samples, chemical, Analysis, contaminations

Introduction:

The consumption of clean and safe drinking water has been associated to positive health outcomes and vice versa. Continuous and sustainable access to potable water supply remains a major challenge to millions of people around the world. This problem is aggravated in rural areas of most developing countries due to the lack of water supply infrastructure or the inadequate supply of potable water. In the absence of sustainable access to potable water, people are left with no choice than to seek for alternative sources of water which are often groundwater sources through shallow or deep wells and boreholes or the abstraction of water from rivers and lakes (Diuof K 2014).

Previous research work has highlighted the several incidences of water-borne illnesses due to intake of contaminated water samples from surface and groundwater (Fawell J 2003). Most of the analytical determination was performed on the quality index of groundwater and surface fails to present the status of water resources bodies to the policymakers and the society (Sobsey M D 2002). The quality of water was confirmed based on the physical, chemical and biological constituents. Ground water is the most consistent source of drinking water and contains ammonia as one of the pollutant present up to 3 mg/L as per WHO guidelines. If the concentrations in excess of drinking water can be oxidized to toxic nitrite, support the growth of bacteria, (Nitrosomonas and Nitrobacter) and create taste and other problems in treatment plants and the distribution network.
In Tamil Nadu, population density is very high and is increases by day to day. This increases the level of contaminations in air, soil and water. From which, water is one of the evident victim of pollution. Kanyakumari is one of the most thickly populated districts in Tamil Nadu, India. As per the huge population, the drinking water sources in Kanyakumari may be polluted by various constituents. Ammonia is one of the important pollutants found in drinking water sources nowadays. Ammonia is entered into the aquatic environment through municipal effluent discharges and excretion of nitrogenous waste from animals and nitrogen fixation, air deposition and run off from agricultural lands. Many technologies, such as adsorption (Jiang Z 2004, Ji Z Y 2007), biological denitrification (Hu Z 2013, Gregory S P 2012), chemical precipitation (Wen T 2010, Hu J 2017) and ion exchange (Aiyuk S 2004), have been applied to remove nitrogen from wastewater sources.
The removal of nitrogen in groundwater sources was performed through adsorption (Yang Y Z 2013) and biodegradation (Wang X L 2010) protocols. Among the protocols, the adsorption method have shown wider advantages than others owing to simple, rapid and reasonably priced and excellent treatment efficiency (Sarioglu M 2005, Yu Y 2001). Accordingly, the adsorption method is widely used in the treatment of ammonia nitrogen- and nitrate nitrogen-contaminated groundwater (Saltal K 2007, Mizuta K 2004). The choice of materials play a vital role in the adsorption treatment with water sample. The currently utilized materials are zeolite (Huang H 2010), modified zeolite (Zhao Y 2015, Haji S 2015), coal gangue (Zhang L Y 2013), and carbon (Zhu Y 2016). These materials have different abilities with respect to the removal of ammonia nitrogen and the interaction mechanisms were analysed and presented. In the present perspectives, the low cost charcoal was arrived from natural waste materials utilized for the removal of organic pollutants.
Based on the literature facts, the present investigations was focused on the quantity of ammonia contamination in different drinking water sources in Kanyakumari district, Tamil Nadu and also studied the different techniques to adopt for removing of ammonia from water especially by adsorption by using different charcoals. These parameters were compared to the standard limits framed by the BIS and WHO.

2. Material and Methods

2.1. Study Area.

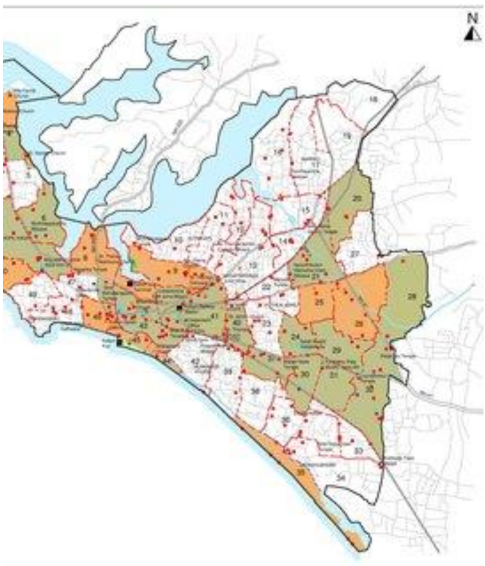

Figure 1. Kollam District map

2.2 Sample collection

The samples were numbered from S1 to S10 against their locations and sources (Table 1). The samples were collected in 1-liter polyethylene (PE) bottles, which were washed with deionized water before use. These sample bottles were sealed and placed in a dark environment at a constant temperature range of 4–10∘ C to avoid any contamination and the effects of light and temperature. The physico-chemical analysis of collected water samples (in ten different locations and the month of September, October, November, December 2020 & January 2021) were performed.

On-site analyses of pH, conductivity, and turbidity were carried out at the site of sample collection following the standard protocols and methods of American Public Health Organization (APHA) and American Society for Testing and Materials (ASTM) using different calibrated standard instruments. The pH of the water samples was measured by using a pH meter (Systronics pH meter). The pH meter was calibrated, with three standard solutions (pH 4.0, 7.0, and 10.0), before taking the measurements. The value of each sample was taken after submerging the pH probe in the water sample and holding for a couple of minutes to achieve a stabilized reading. After the measurement of each sample, the probe was rinsed with deionized water to avoid cross contamination among different samples. The conductivity of the samples was measured using a conductivity meter. The probe was calibrated using a standard solution with a known conductivity. The probe was submerged in the water sample and the reading was recorded after the disappearance of stability indicator. After the measurement of each sample, the probe was rinsed with deionized water to avoid cross contamination among different samples. The turbidity of the water samples was measured using a turbidity meter. Each sample was poured in the sample holder and kept inside for a few minutes. After achieving the reading stability, the value was recorded. Gravimetric method was used to determine the amount of total dissolved solids present where the water was heated to a temperature of 250^0C. EDTA titration was performed to determine the hardness of water. The chloride content was estimated by argentometric titration. Turbidity was determined spectrophotometrically at 450 nm and a light path of 4 cm by Systronics Nepheloturbidimetric meter. The method of Rodier et al. (2009) on the complexometric determination of calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions with ethylene diamine tetraacetate (EDTA) in the presence of eriochrome black T (EBT) and Patton and Reeder reagent allowed to assess the water hardness. Nitrate (NO_3^-) was determined by UV–Visible spectrophotometry. The measurement of nitrate ions was a simple determination with concentrated sulphuric acid at 216 nm wavelength. Alkalinity (Carbonate and Bicarbonate) was determined by titration of the sample with a standard solution of a strong sulphuric acid as described by Rainwater and Thatcher, (1960). Sodium (Na) and potassium (K) were determined Flame photometrically (model systronic 128). Chloride (Cl) was analysed by silver nitrate method (Mohr's method or Argentometric method). Phosphorus was determined by colorimetric method (Berenblum & Chain, 1938). Total amount of sulphate was determined by gravimetric method. The fluoride in water was measured using digital fluoride meter after calibrated the instrument with standard fluoride (100 ppm, 10 ppm) solution. The values fluoride in water samples were noted directly from the instrument and the result was expressed in ppm. The concentration of dissolved oxygen and primary productivity can be readily and accurately measured by the method originally developed by Winkler in 1888 (Ber.DeutschChem.Gos., 21, 2843). The BOD determination for such samples were less than 5 mg/L, may be carried out as such without any dilution. Determined initial Dissolved Oxygen (DO) for the samples in BOD bottles and kept for incubation at 27°C for 3 days. After 3 days of incubation at 27°C, determined final DO in incubated samples. The dissolved oxygen content was expressed as mg/L.

2.3 Quality of water for irrigation

The irrigational quality of the lower reaches of Pazhayar river water was identified through hydro-chemical parameters and various quality parameters. The ionic concentrations mentioned in the below equations were expressed in meq/l.

The analysed hydrological were used to characterize the lower reaches of Pazhayar river and Mankudy estuary water quality and its suitability for drinking and irrigational purposes.

2.3.1 Sodium Adsorption Ratio (SAR)

The sodium or alkali hazards are typically expressed as the Sodium Adsorption Ratio (SAR). The sodium hazard of irrigation water can be well estimated by determining the SAR, which can be calculated by the following formula proposed by Richards (1954).

2.3.2 Soluble Sodium Percentage (SSP)

Soluble Sodium Percentage (SSP) or % of Na is used to measure sodium hazard. According to Doneen (1964), SSP is calculated using this formula

$$SSP = \frac{Na^{+} + K^{+} \times 100}{Ca^{2+} + Mg^{2+} + Na^{+} + K^{+}}$$

2.3.3 Residual Sodium Carbonate (RSC)

Residual Sodium Carbonate (RSC) is calculated by Eaton (1950), Richards (1954), Ragunath (1987) is also used to identify the irrigation quality of water is calculated as follows.

$$RSC = (CO_3^{2-} + HCO_3^{-}) – (Ca^{2+} + Mg^{2+})$$

2.3.4 Residual Sodium Bicarbonate (RSBC)

Residual Sodium Bicarbonate or Residual Alkalinity (RA) was calculated using the formula.

$$RSBC = HCO_3^{-} - Ca^{2+}$$

2.3.5 Magnesium Adsorption Ratio (MAR)

Raghunath (1987) defined Magnesium Adsorption Ratio (MAR) or Magnesium hazard for irrigation quality classification of water, which depends on magnesium and calcium ions and calculated as follows

$$MAR = \frac{Mg^{2+} \times 100}{Ca^{2+} + Mg^{2+}}$$

2.3.6 Permeability Index (PI)

Permeability Index (PI) is used to assess the soil permeability, which is also used to identify the quality of water for irrigation according to Doneen (1964) is represented by

$$PI = \frac{Na+ + \sqrt{HCO_3^{-}} \times 100}{Ca^{2+} + Mg^{2+} + Na^{+}}$$

3. Results & discussion

The physico-chemical parameters directly related to the safety of the drinking water to human consumption. The physico-chemical water quality parameters provide important information about the wealth of a water bodies. These parameters are used to find out the quality of water for drinking purpose. Water samples were collected from various places of Kanyakumari district and analysed as per the standard protocol. The method of sampling is random selection and collected from 10 different locations and then systematically analysed. As a first step, check the physical appearances of these samples. The water quality parameters were analysed as per the directions of the 21st edition of 'Standard Methods for the examinations of water & waste water' prepared and published jointly by American public health association; American water works association and water environment federation in 2005. The quality standards followed as per the chart of IS 10500:2012 published by Bureau of Indian standards about water quality. All reagents used were of analytical grade and solutions were made of distilled water.

3.1 Temperature

Temperature is a vital parameter in an aquatic environment for its effects on the Chemistry and biological reactions in the organisms. The change in atmospheric temperature with change in places imparted some desirable changes in the water temperature. The difference in atmospheric temperature and groundwater temperature are under the influence of high specific heat of water. The variation in temperature of groundwater samples under the studied area from 15 to 35^{o}C.

3.2 Colour

According to the WHO guidelines, it should not be more than 15 TCU, which is the maximum permissible limit. The variation in water colour of resources under investigation may be attributed to the variation in the amount of dissolved and colloidal substances present. The higher water colour in the sources is noteworthy that it increases the expenses of water treatment.

The observation of results of different physico-chemical parameters of water samples are indicated in the following tables (table 1-3). In these tables, the water sample was collected from 10 different locations.

Table 1. Physico-Chemical parameters of different water samples and WHO values

Sl.No	Parameters	1	2	3	4	WHO Desirable limit
1	Turbidity	4.3	2.6	0.2	2.6	5
2	Taste, Colour, Odour	objectionable Taste, Colour and odour	objectionable Taste, Colour and odour	objectionable Taste and odour	objectionable Taste, Colour and odour	Unobjectionable
3	Temperature	33.4	33.4	31.1	30.7	27-33°C
4	pH	7.24	6.70	5.82	5.56	6.5-8.5
5	E C	286.0	301.0	131.5	172.0	300
6	T D S	191.6	205.0	88.1	115.2	500
7	Acidity	4.0	12.0	22.0	26.0	30
8	Alkalinity	68.0	68.0	18.0	38.0	200
9	Total Hardness	146.0	166.0	220.0	360.0	500
10	Calcium	8.82	12.02	4.81	7.21	75
11	Magnesium	5.83	8.75	2.46	4.37	30
12	Chloride	62.0	54.0	20.0	32.0	200
13	Flouride	0.6	0.9	0.5	1.0	1-1.5
14	Iron	1.83	0.82	1.07	0.29	0.3
15	Nitrate	28.62	10.44	54.82	18.75	45
16	Sulphate	86	120	145	180	200

BDL-Below Desirable Limit

Table 2. Physico-Chemical parameters of different water samples and WHO values

Sl. No	Parameters	5	6	7	8	WHO Desirable limit
1	Turbidity	8.3	2.6	0.2	2.6	1
2	Taste, Colour, Odour	objectionable Taste, Colour and odour	objectionable Taste, Colour and odour	objectionable Taste and odour	objectionable Taste, Colour and odour	Unobjectionable
3	Temperature	33.4	33.4	31.1	30.7	27-33°C
4	pH	7.24	6.70	5.82	5.56	6.5-8.5
5	E C	286.0	306.0	131.5	172.0	300
6	T D S	191.6	205.0	88.1	115.2	500
7	Acidity	4.0	12.0	22.0	26.0	30
8	Alkalinity	68.0	68.0	18.0	38.0	200
9	Total Hardness	46.0	66.0	22.0	36.0	500
10	Calcium	8.82	12.02	4.81	7.21	75
11	Magnesium	5.83	8.75	2.46	4.37	30
12	Chloride	62.0	54.0	20.0	32.0	200
13	Flouride	BDL	BDL	BDL	BDL	1-1.5
14	Iron	1.83	0.82	1.07	0.29	0.3
15	Nitrate	BDL	10.44	54.82	18.75	45
16	Sulphate	BDL	22.0	BDL	BDL	200

BDL-Below Desirable Limit

Table 3. Physico-Chemical parameters of different water samples and WHO values

Sl. No	Parameters	9	10	WHO Desirable limit
1	Turbidity	8.3	2.6	1
2	Taste, Colour, Odour	objectionable Taste, Colour and odour	objectionable Taste, Colour and odour	Unobjectionable
3	Temperature	33.4	33.4	27-33°C
4	pH	7.24	6.70	6.5-8.5
5	E C	286.0	306.0	300
6	T D S	191.6	205.0	500
7	Acidity	4.0	12.0	30
8	Alkalinity	68.0	68.0	200
9	Total Hardness	46.0	66.0	500
10	Calcium	8.82	12.02	75
11	Magnesium	5.83	8.75	30
12	Chloride	62.0	54.0	200
13	Flouride	BDL	BDL	1-1.5
14	Iron	1.83	0.82	0.3
15	Nitrate	BDL	10.44	45
16	Sulphate	BDL	22.0	200

3.3 TURBIDITY

The turbidity analysis of water samples reveals the transparency. It is mainly influenced by the constituents present in sample. Water with less than 5 NTU is more appealing to drink (WHO guidelines). In the present study, many of the samples were attained within the desirable limit of 1 NTU (Fig.3) whereas turbidity of four samples (three samples from open wells and one sample from borewell) exceeds the permissible limit of 5 NTU. The main reason for high turbidity values may be due to the presence of iron contamination as well as the presence of suspended organic substances. The turbidity of water provides the presence and amount of harmful toxicants or the concentrations of other constituents i.e., toxic to environments because some of the toxic substances are adsorbed or absorbed on particulate organic matter, suspended solids and settle able solids. The high turbidity value of sample no.4 is 16.5 NTU corresponds to the concentration of iron, suspended solids and can also be attributed to the condition of the pump. The suspended solids are harmful and elimination imparts the aesthetic quality and acceptability of water. Then, the toxic contaminants were adsorbed which in turn may be ingested by humans and caused health problems. As a consequence, the turbidity water samples may be microbiologically contaminated and indirectly responsible for health concern.

3.4 pH

The pH is one of the most important parameters of water quality. It influences physical and chemical water characteristics. The pH promotes the solubility of certain substances that are harmful to water quality. The waters sampled from Tamirabarani river are slightly acidic and basic. The main adverse direct effect caused by extreme pH values (5 ≥ pH, pH ≤ 11) is an increase in skin and eye irritation. In the present investigations, the majority of water sources was observed a pH value is lower than the neutrality (Fig.4). Among the samples, the low pH values were observed in the boreholes and open dug wells, while pond water samples appeared near to neutrality. Literature data established that, at low pH, water may be corrosive & damage the equipment and also increase the metal leaching from pipes and fixtures. As a consequence, the low pH samples may be indirectly influence the human health (releasing heavy metals from pipes). In the present study, the fluctuation of pH values (5.7 to 9.0) in the samples was contributed based on the different climate and geographical situations. According to Boone and Xun (Boone D 1987), the pH value is greater than 7.0 is vibrant for microbial growth and reproduction of pathogenic bacteria involved in the biodegradation of organic matter dissolved in water. In the present study, the sample Nos.1 & 13 exhibited pH value is greater than 7 and all other samples below 7.

According to Table 1, the seasonal mean pH value with respect to its sea sonal variation was within the permissible limit (Table 2) for diverse uses such as irrigation, domestic purposes, and recre ational purposes. The normal range of pH for surface water systems is 6.5e8.5, and the optimum limit for irrigation and fish culture is from 6.5 to 8.0 (DoE, 1997). Parker et al. (1992) reported the influence of water acidity on the presence of fish and aquatic invertebrates in order to shed light on how these variables might influence the distribution of waterfowl in the freshwater system. Their observations revealed that piscivores were abundant with a pH of 5.5, whereas insectivores/omni vores exhibited no selection for freshwater systems with specific acidity. In the present study, pH was slightly different in winter, but it was fairly consistent in other seasons. The pH values remained at around 7. Therefore, pH does not act as a limiting factor in the distribution of aquatic populations except in winter. The highest seasonal pH value in the Turag River was 8.09 ± 0.11 in winter, and the lowest was 6.74 ± 0.15 in summer (Table 1). Significant variation of pH occurred among different seasons.

3.5 ELECTRICAL CONDUCTIVITY (EC) & TOTAL DISSOLVED SOLIDS (TDS)

The electrical conductance (EC) and TDS (total dissolved solids) parameter depends on the type of substance present in water, in particular chloride or fluoride or sulphide or phosphate and hardness producing salts (carbonates and others). In the present study, all the samples should not exceed the desirable limit of TDS (Fig.6). The TDS was arrived from the interaction of water with the sediments originating from different parent materials in the saturated zone, unsaturated zone and on the surface during runoff. Generally, high TDS which is greater than 1000 mg/L is commonly objectionable or offensive to taste (WHO recommendation) and the TDS levels over 2000 mg/L are considered undrinkable due to intensely unpleasant taste. In the present study, the high conductivity values was noticed at sample no.23 (Fig.5) which may be attributed to high concentrations of dissolved solids. The higher conductivity values indicated that the water sample contains higher amount of salts present. The variation of TDS and EC may be due to geomorphological features of the area under investigations.

3.6 ACIDITY

Acidity is always associated with low pH. When pH is maintained in drinking water as 6.5-8.5, there is no significance for acidity. In the present study, most of the water samples showed pH value within the permissible limit.

3.7 IRON

The desirable limit of iron in drinking water is 0.3 mg/L. Excess iron in drinking water may be cause problems such as bad taste, brown precipitate, colour change, staining on cloths, tiles, sink, closets, utensils etc. In the present study, the sample no. 1, 4, 8, 14, 17, 20 & 23, the iron concentration was observed beyond the acceptable limit and may be influence iron induced diseases. Based on the reports, the groundwater sample in this area is not suitable for drinking purpose (sample no. 1, 4, 8, 14, 17, 20 & 23, Fig.7), which needs some treatment to reduce the iron concentration and improve the quality index of groundwater in the area.

3.8 CHLORIDE

Generally, the chloride ion concentration in the water samples are not exceeded the desirable limit of 250 mg/L. Dissolution of salt deposits, discharge of effluent from chemical industries and sea water intrusion in coastal regions are the important sources of chloride contamination. In Kanyakumari district, there is no chloride contamination was observed in the study area. The maximum chloride presence is 188 mg/L as per BIS and WHO. Normally, in open wells, the presence of chloride is comparatively low whereas in coastal regions, it become increases but normally not exceeded the limit. Chloride in the study area may be varied due to sediments originating from igneous rocks, evaporates, pit latrines and animal waste. Generally, excess of chloride ion present in water offered salty taste with laxative effect during the consumption. In the present case, the presence of chloride in slightly higher concentration in the sample no. 18 (Fig.8) owing to the mixing of salt water into surface of water resources or induces some sewage effluent from industrial or agricultural or domestic waste.

3.9 TOTAL HARDNESS AND ALKALINITY

Calcium and magnesium salts of carbonates, sulphates, chlorides present in water produce total hardness. The maximum tolerable limit of total hardness for drinking purpose is 600 mg/L. Hardness more than 300 mg/L may be cause heart and kidney problems. In the present study, the total hardness and alkalinity of all samples (Fig.9) are not exceeds the desirable limit of 200 mg/L.

The permissible limit of alkalinity of water sample is 120 mg/L. In the present case, the alkalinity values of Kanyakumari area was 150.85 mg/L which exceeded the desirable limit in all stations. The alkalinity measurement provides an idea of natural salts present in water and derived from various contamination present in the soil or sewage or dumping of waste in the landfills. The influence of various constituents increase the alkalinity in the water sample. It can be controlled if the proper selection of experimental protocols to remove salts from water sample. The small scale industrial units present in Kanyakumari Dist and do not have proper drainage system. They discharge the waste waters into the soil. This may lead to increase in alkalinity of ground water in these areas.

3.10 MAGNESIUM and CALCIUM

In the present investigations, the values of magnesium and calcium were observed within the desirable limit of all samples. They have no significant role in the quality issues of the tested samples. The desirable limit of calcium as Ca^{2+} is 75 mg/L and that of Mg^{2+} is 30 mg/L as per BIS.

3.11 FLOURIDE

Flouride showed a result of below detectable level in most of the samples. Only in four samples fluoride gave a result of around 0.5 mg/L and these values are below the desirable limit. The low fluoride concentrations in the study area can be associated with deeper groundwater which was sampled and also the dilution effect from the rain water. Fluoride concentration in natural waters is usually limited by saturation with respect to fluorite (CaF_2) and due to this constraint the waters containing high concentration of Ca^{2+} are characterized by low F^- content. The dominance of calcium in the groundwater of Kanyakumari area is likely to be another important factor that may have resulted in low fluoride levels. Fluoride in the study area may be derived from sediments which originated from fluorspar (fuorite), apatite, topaz and cryolite which forms part of the aquifer material. The breaking of rocks or extraction of compounds from rock is utilized to produce phosphate containing fertilizer and deposited into soil. It may contain 4% of 4% fluorine. The municipality people is used fluorosilicic acid, sodium hexafluorosilicate & sodium fluoride for defluoridation schemes. The accumulation of fluoride contents depend mainly on the nature of geographical area. At concentrations from 0.5 to 1 mg/l, it reduces dental caries (WHO, 2008) whereas amounts substantially in excess of 1.0 to 3.0 mg/l causes mottling of teeth and excessive amounts are toxic.

3.12 SULPHATE

Sulphur is utilized in the form derivatives for commercial products and industrial raw materials. Sulphate are used in the production of many utility chemicals like glass, paper, dyes, fungicides, soaps, insecticides and others. They are also used in the different industrial processes (mining, pulp, sewage treatment and leather processing). Alum (Aluminum sulphate) is used in water treatment as sedimentation agent and $CuSO_4$ as to control blue-green algae in raw and public water supplies. If the drinking water contains excess of sulphate ion produces bitter taste and unpleasant “rotten-egg” odour. There is no symptoms associated with sulphate deficiency. According to WHO guidance level the maximum permissible limit of sulphate in drinking water supply is limited to 250mg/l. Accordingly, the laboratory results of study area were summarized in tables 1-5 and the values below the maximum permissible limit framed by WHO. Therefore, the results clearly indicated that there is no significance effect on the health of consumers.

Dissolved Oxygen (DO)

The concentration of dissolved oxygen (DO) is a vital issue for aquatic organisms in surface waters. The required level of DO based on the WHO guidelines (4–6 mg/L) The optimum level of DO is 6 mg/L for significant growth of fish and other aquatic life. There is a progressive drop of DO level from 6 mg/L induces some stress to aquatic species. The continual intake of DO levels below 3 mg/L, the survival of aquatic species is minimum. In the present study, the DO was observed in the sampling area in the permissible limits. Therefore, the water sample is safe for aquatic life.

Biological Oxygen Demand (BOD)

BOD is the quantity of oxygen essential for the decomposition of dissolved organic substance under aerobic conditions. It is vital technique to ascertain the strength of pollution, nature of sewage and the type of effluent present. A high level of BOD indicates the presence of higher quantity of microorganisms which deliberately increase the level of pollution in the water bodies.

Table 8 BOD levels and their water quality

BOD level (mg/L)	Water quality
1-2	Excellent
3-5	Good
6-9	Poor- Polluted
More than 10	Very poor- Highly contaminated

CONCLUSION

The impressive growth of industrial processes and agriculture productivities leads to increasing geographical and environmental concerns. The growth human populations and utilities of materials also play a role in the enhancement of contamination in the water resources. The Government from developing countries spent huge amount of financial support and intensive support have been made to reduce and improving the quality of potable water sources to human consumption and industrial/ agricultural productivities. As a result, the need for water pollution treatment has become urgent. Huge amounts of money have been spent and sufficient effort has been made by the municipalities, industries and governments during the last four decades to enhance the quality of water for domestic and industrial consumption and reduce its pollution.

The present investigations were focused on the analysis of various drinking water sources in Kanyakumari district, Tamil Nadu. The samples of water were collected at various places and different sources as random method of sampling and analysed using standard analytical methods. It is well known that many of our fresh water sources are polluted by the excess of iron, nitrate, ammonia, suspended solids, organic wastes etc.

Everyone know that water is most expensive and requisite resources in the living world. It is very essential to protect and conserve it. The dumping of wastes in the surroundings of water bodies should be restricted and give a timely awareness to the people for the disposal of waste by proper method. Efforts have been made to develop responsiveness among the humans to maintain the surface as well as groundwater at their extreme quality and saving the water with their maximum purity. It is therefore recommended that areas of safe limits of chemical quality of groundwater should be opted for development notwithstanding their convenience and reliability. It is further recommended that thorough groundwater quality investigations should be carried out before drilling of boreholes to avoid investing in construction of boreholes which will not be used. It is concluded that the performance of various analysis indicated that the sample collected from Kanyakumari dist is well suited for human consumption, agricultural productivity, industrial processes whereas some sample needs appropriate treatments for the removal of contaminants before utility.

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