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Physicochemical analysis of water samples from three polluted sites of Tiruchirappalli, Tamil Nadu, India

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Abstract
Water quality affects the biotic community of an aquatic ecosystem ultimately reducing the primary productivity and several altered physicochemical factors could cause stress thereby adversely affecting aquatic fauna. The physicochemical characteristics of water collected from three sites of Tiruchirappalli district, Tamil Nadu, India *viz*., sugarcane waste mixing zone at Pettavaithalai (Site 1), oil effluent mixing zone at Edamalaipattiputhur (Site 2) and sewage effluent mixing zone at Palakarai (Site 3). Various physicochemical parameters were assessed using standard methods for the examination of water samples from the above mentioned three sites. On comparison with the parameters under the International Standards, water sample from Pettavaithalai showed high calcium, sulphate and nitrate levels when compared to water sample from Edamalaipattiputhur. Water sample from Palakarai showed a lower level of contamination. Further studies should be carried out to check the efficiency of treating the water samples and reusing the same for further use.

Keywords: physicochemical parameters, water quality, Tiruchirappalli district

1. Introduction
Life is not possible on this planet without water as it is one of the most indispensable resources and is the elixir of life. Good quality water is essential for all living organisms and the characteristics of water affect the survival, growth and reproduction of aquatic organisms. A change in water quality affects the biotic community of an aquatic ecosystem ultimately reducing the primary productivity and several deviated physicochemical factors could cause stress thereby adversely affecting the aquatic fauna. In this respect a regular monitoring of water quality is essential to determine the status of water bodies with reference to aquatic fauna. Water quality assessment generally involves analysis of physicochemical, biological and microbiological parameters and reflects on abiotic and biotic status of the ecosystem [1-5]. The problem of water pollution is mainly linked with human activities in both the developed as well as the developing countries. It upsets the dynamic balance in the aquatic ecosystem. Studies have been carried out on ecological condition of freshwater bodies in various parts of India [6-10] but with regard to the southern part of Tamil Nadu, it is scanty [11]. Tiruchirappalli is one of the most important industrial cities in Tamil Nadu situated on the bank of river Cauvery. Ground water is the principle source of drinking water in rural areas of India and it is indispensable source of life. The problems of ground water quality are more acute in the areas which are densely populated and thickly industrialized. Therefore an attempt has been made to assess the quality of water in and around the district of Tiruchirappalli, Tamil Nadu, India and the present study has been planned to evaluate the physico-chemical characteristics of water collected from three sites of Tiruchirappalli district, Tamil Nadu, India.

2. Materials and Methods
Tiruchirappalli district (10°08'11°30' N; 79°48'79°30' E), Tamil Nadu, India is situated on the banks of the river Cauvery It is centrally located in Tamil Nadu with an area 11,098Km^2. The northeastern part of Tiruchirappalli district is occupied by alluvium of the river Cauvery while the residual hills are seen in the northeastern part of the city. It is an inland city without any coastline. The water samples taken for the investigation were obtained from three sites of Tiruchirappalli district, *viz*., sugarcane waste mixing zone at Pettavaithalai (Site 1), oil effluent mixing zone at Edamalaipattiputhur (Site 2) and sewage effluent mixing zone at Palakarai (Site 3). The various physicochemical parameters, *viz*., colour, pH, temperature, Electrical Conductivity (EC), free carbon dioxide, Total Dissolved Solid (TDS), calcium, Total Alkalinity (TA), Phenolphthalein Alkalinity (PA), chloride, fluoride, nitrate, phosphate and sulphate were carried by the standard methods for the examination of water and waste water [12-14].

3. Results and Discussion
Water is one of the most important commodities, which man has exploited than any other resources for the sustenance of his life. It is not only the basic need for human existence but also a vital input for all development activities. The use of water for drinking and other domestic purposes is generally conceded to be its highest and most essential purpose.

Pollution of water bodies is increasing steadily due to rapid population growth, industrial proliferation, urbanization, increasing living standards, and wide sphere of human activities. The physciochemical parameters obtained from the water samples of the three study sites are presented in Table 1. The pH value is an important factor in maintaining the carbonate and bicarbonate levels in water. The pH values were acidic for water samples in all the sampling stations. The mild alkalinity indicates the presence of weak basic salts in the soil [15]. The pH values are found to be within the permissible limit of WHO in all the water samples. No abnormal changes in water samples were recorded. EC is the ability of water to carry an electrical current. The importance of electrical conductivity is its measure of salinity, which greatly affect the taste and has significant impact of the user acceptance of the water as potable [16]. The higher the ionisable salts, the greater will be the EC. High EC affects the germination of crops and it may result in much reduced yield [17]. EC was found to be below the permissible limits set by WHO. The value of TDS for all the water samples ranged from 220 to 248mg/L. TDS denote various types of minerals present in water in the dissolved form. The water samples showed higher values of TDS and were well above the permissible limit of WHO (500ppm). It may be due to percolation of sewage and industrial effluents. The accumulation of organic and inorganic solids also contributes to high TDS [18]. The value of chloride for all the water samples ranged from 182 to 397mg/L. Excess chloride (<250ppm) imparts a salty taste to water. Excessive chloride in potable water is particularly not harmful but the criteria set for chloride value is based on its potentially high corrosiveness. Soil porosity and permeability also plays an important role in building up chloride in water [16]. Increase of chloride in water is injurious to people who are affected with heart and kidney diseases. High concentration of chloride is considered to be an indicator of pollution due to contamination by organic waste of animals and from industries [16]. The value of calcium for all the water samples ranged from 258 to 390mg/L. Calcium may dissolve readily from calamite rocks and limestone or leached from soils and is an essential nutritional element for human being and aids in maintaining the structure of plant cells and soils. In the present study, the calcium values were found above the maximum permissible limit (200ppm) which may be due to the cationic ion exchanges with sodium [17]. The nitrate values are found to be in the range of 300 to 450mg/L. Most of the water samples were polluted and the nitrate in water may be responsible for the growth of blue green algae [15]. The sulphate values were recorded within the range of 400 and 800mg/L. All the water samples were found to be above the permissible limit of WHO (250ppm). Phosphate in water samples ranged between 0.13 and 0.66mg/L and were found above the permissible limit of 0.1ppm of WHO. Normally ground water contains only a minimum phosphorous level because of the low solubility of native phosphate minerals and the ability of soils to retain phosphate [19]. Further, the phosphate values of all the ground water samples did not pose any problem to the quality of water [20]. The value of fluoride for the water samples were recorded between 1.61 and 3.61mg/L. The maximum permissible limit of fluoride according to WHO is 1.0ppm. The fluoride values for all the ground water samples were above the permissible limit. The high concentration of fluoride in ground water may be due to break down of rocks and soils or infiltration of chemical fertilizers from agricultural land. Skeletal fluorosis is an important disease due to the presence of high fluoride content in ground water [21]. On comparison with the parameters under the international standards [22], water sample from Pettavaithalai showed high calcium, sulphate and nitrate levels when compared to water sample from Edamalaipatti puthur. Water sample from Palakarai showed a lower level of contamination.

There are several causes of water pollution. The main causes are rapid urbanization which during recent decades has given rise to a number of environmental problems, *viz*., water supply, wastewater generation and its collection, treatment and disposal. Many towns and cities which came up on the banks of rivers have not given a proper thought to safe disposal of wastewater, sewage, etc. In urban areas, water is tapped for domestic and industrial use from rivers, streams, lakes, ponds, wells, etc. Nearly 80% of the water supplied for domestic use passes out as wastewater. In most cases, this wastewater is let out untreated and causes large scale pollution of the surface water and a part of it percolates into the ground and contaminates the ground water. Treated or partly treated or untreated wastewater disposed into natural drains joins rivers or lakes or are used on land for irrigation/fodder cultivation or to the sea or a combination of them by the municipalities. Municipal water treatment facilities in India, at present, do not remove traces of heavy metals. According to estimates made by the Central Pollution Control Board (CPCB), only 22% of the wastewater from cities and 14% from rural area is being collected through sewerage. A large number of cities/towns either do not have any sewerage system or the sewerage system is overloaded or defunct. The other significant contributors of wastewater are paper mills, steel plants, textiles and sugar industries. The major contributors in terms of organic load are distilleries followed by paper mills [23]. Given the fact that heavily polluted rivers are the major sources of municipal water for most towns and cities along their courses and it is believed that every consumer has been, over the years, exposed to unknown quantities of pollutants in water they have consumed. To add to this, Indian towns and cities have grown in an unplanned manner due to rapid population growth. Most Indian rivers and other sources of fresh water are polluted by industrial wastes or effluents. All these industrial waste are toxic to life forms that consume this water. Therefore, further studies can be carried out to check the efficiency of treating the water samples and reusing the same for further use.

Table 1: Physicochemical parameters of water samples obtained from three sites of Tiruchirapplai district, Tamil Nadu, India

S. No.	Parameters	Site 1	Site 2	Site 3
Physical parameters				
1.	Colour	Pale yellow	Pale yellow	Pale yellow
2.	pH	4.7	5.02	5.4
3.	Temperature (°F)	25.8	26.4	26.2
4.	Electrical conductivity (mmhos/I)	1.8	2.3	2.7
Chemical parameters (mg/L)				
5.	Free carbon dioxide as $CaCO_3$	190.0	105.0	80.0
6.	Total dissolved solids	340.0	480.0	220.0
7.	Calcium	390.6	277.2	258.3
8.	Phenolphthalein alkalinity	9.4	7.2	6.4
9.	Total alkalinity	12.0	8.0	6.0
10.	Chloride	397.9	218.7	182.1
11.	Fluoride	3.61	2.5	1.6
12.	Nitrate	450.0	350.0	300.0
13.	Phosphate	0.7	0.3	0.1
14.	Sulphate	800.0	550.0	400.0

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