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ASSESSMENT OF PHYSICO-CHEMICAL PARAMETERS OF SURFACEWATER IN COORG AND WYNAD DISTRICTS (WESTERN GHATS)

K.S. Divya[1] and Dr. S. Mahadeva Murthy[2]

[1]Research Scholar, Department of Microbiology, Yuvaraja's College, Mysore, India
Email: ksdivya1983@gmail.com
[2]Associate Professor, Department of Microbiology, Yuvaraja's College, Mysore, India
Email: smmurthy2025@gmail.com

ABSTRACT

This paper aims mainly to evaluate the physico-chemical properties in the ecological system of selected six surfacewater sampling spots from Coorg and Wynad districts (Western ghats). Samples were collected in the year 2011 for every even months. Water samples were analysed for various physical parameters like pH, turbidity, conductivity and total dissolved solids; chemical parameters like total hardness, calcium, magnesium, nitrate, sulphate, phosphate, iron, fluoride, alkalinity, carbonate, bicarbonate, COD, DO and BOD. The results obtained were compared with the standards of WHO. Statistical analysis showed non-significant relation between the sampling sites. Oneway ANOVA and the distance similarity matrix of cluster analysis/dendrogram were carried out.

Keywords: Water Quality, Surfacewater, Physico-Chemical Parameters, Coorg and Wynad, Western Ghats

INTRODUCTION

The Western Ghats have an ancient history. The past 12,000-5,000 years have seen a lot of changes in terms of the magnitude and distribution of biodiversity due to settled agriculture and extensive transformation of habitats in and around the Western Ghats. What is present today is the testimony to the human interference in the area. It is estimated that 12,450 km^2 of natural forest cover exist in the Western Ghats, which is about 6.8% of the original forest cover. Irrigation and hydroelectric power projects, timber operations and agriculture expansion are the major reasons for the decline in forest cover. The once continuous tropical rainforests in the Western Ghats have been modified into heterogeneous mosaic of evergreen, semi-evergreen and moist deciduous formations.

Water is the most vital resources for all kinds of life on this planet is also the resources, adversely affected by both qualitatively and quantitatively by all kinds of human activities (Gupta and Shukla, 2004). Water pollution is a major problem in the global context. It has been suggested that waterborne diseases are the leading worldwide cause of disease and death. About 30,000 people die everyday in developing countries due to unclean water

(WHO, 1993,1996). Rivers are playing major task of an important water resource for our planet. Unfortunately, river is being polluted by indiscriminate disposal of sewerage, industrial waste and plethora of human activities, which affects its physico-chemical characteristics and microbiological quality (Koshy and Nayar, 1999). The lifeline of majority of population in cities, towns and villages are considered sacred. In the recent past, expanding human population, industrialization, intensive agricultural practices and discharges of massive amount of wastewater into the river have resulted in deterioration of water quality (Boyd and Tucker, 1998; Ali et al., 2000). All cities in India have a common problem of supplementing their water to urban population with surfacewater sources. Sizable proportion of rural people also depends on surfacewater. An attempt was made to study the environmental impact of dredging on surface water quality parameters by Iwuoha and Osuji (2012) and showed that the impact of dredging on the water quality was localized and of short term.

Pollution occurs when a product added to our natural environment adversely affects nature's ability to dispose it off. Generally, most pollutants are introduced in the environment as sewage, agricultural waste, domestic waste, human contamination etc. A large number of factors and geological conditions influence the correlations between different pairs of physico-chemical parameters of water samples (Khare et al., 2011). Our present study represents most of the sewage contamination in S2 spot and other spots shows human contamination as they are the tourist spots. The quality of the water need to be evaluated thoroughly to generate the base line information for the welfare of the society.

In order to introduce the alleviation measures of water first a systematic study on the levels of pollution from the different sources in different season is to be made. With this objective in view the present work was planned from six sampling spots Kaveri Nisargadhama (S1), Abbey falls (S2), Bhagamandala (S3), Talacauveri (S4), Irrity river (S5) and Pazhassi dam (S6); first four spotting from Coorg district of Karnataka and the other two from Wynad district of Kerala.

MATERIALS AND METHODS

Surfacewater is water collecting on the ground or in a stream, river, lake, wetland or ocean; it is related to water collecting as groundwater or atmospheric water. Surfacewater is naturally replenished by precipitation and naturally lost through discharge to evaporation and sub-surface seepage into the groundwater (Tukura et al., 2012). The Western Ghats also known as the Sahyadri Mountains, is a mountain range along the western side of India. It runs north to south along the western edge of the Deccan Plateau and separates the plateau from a narrow coastal plain along the Arabian Sea. The Western Ghats block rainfall to the Deccan Plateau. The range starts near the border of Gujarat and Maharashtra, south of the River Tapti and runs approximately 1600 km through the states of Maharashtra Goa, Karnataka, Tamil Nadu and Kerala ending at Kanyakumari, at the southern tip of India. This ghat section covers around 1,600 km (994 mi), N-S in length, 100 km (62 mi) E-W in width and a total area of 160,000 km^2 (61, 776 sq mi).

Sample Collection

Samples were collected in pre-sterilized (121°C for 15 min) dark coloured plastic cans. The collection process was carried out meticulously to avoid external bacterial contamination.

The bottles were dipped bit away from the shore and approximately 15 ft depth. All precautionary measures were taken to prevent contamination during sampling process. The samples were properly labeled and transported immediately by holding in an ice box; the samples were stored in a refrigerator. Aseptic precaution as well as growth limitation in samples of water was followed as per standard practices of assessment of microbial impurities (APHA, 1998). The results were compared with the standards prescribed by WHO (2004) guidelines.

The pH and temperature were recorded at the sampling site. The physical factors contribute greatly for the water quality (Sivakumar et al., 2003). For the estimation of DO samples were collected in separate sterilized 300 ml BOD bottles at each site and fixed immediately using Winkler's reagent and later analyzed in the laboratory. In addition to this raw sample, samples acidified with H_2SO_4 and nitric acid was collected in three separate sterile polythene bottles of 50 ml. The acidified samples were used for the analysis of BOD and the raw samples for immediate analysis in the laboratory for acidity, alkalinity and inorganic ions.

All the samples were properly labeled and transported in an ice box to the laboratory for further analysis. The physico-chemical parameters analyzed were - pH, Temperature (°C), Electrical conductivity (μmho cm^{-1}), Turbidity (NTU), Alkalinity (mg/L), Total Hardness (mg/L), Calcium (mg/L), Magnesium (mg/L), Chloride (mg/L), Fluoride (mg/L), Nitrate (mg/L), Sulphate (mg/L), Phosphate (mg/L), Iron (mg/L), Dissolved oxygen (mg/L), Biological oxygen demand (mg/L) and Chemical oxygen demand (mg/L). The standard methods prescribed by Trivedy and Goel (1986), APHA (1995) and AWWA (1995) were used.

pH and temperature were recorded at the spot using digital pH meter and digital thermometer respectively. Conductivity was measured in the laboratory using microprocessor controlled conductivity meter model 306 (Systronics India Ltd., Bangalore). The instrument probe was previously calibrated with 0.1M KCl solution. Alkalinity content was determined by titrating the water samples with a strong acid (HCl or H_2SO_4) method. Turbidity was measured in the laboratory using Digital – Nephelo - turbidity meter model 132 (Systronics India Ltd., Bangalore). The hardness content determined by EDTA (Ethylene Diamine Tetra Acetic acid) titrimetric method.

Data were subjected to determine the statistically significant values using SPSS for Windows release 6.0 (Norusis, 1993). Oneway ANOVA was performed which showed comparison between the groups and within the groups. Using hierarchical cluster analysis or dendrogram interrelationship between the parameters was studied (Hammer et al., 2001).

RESULTS AND DISCUSSION

Raised values of physico-chemical parameters indicate the pollution of riverine ecosystem due to domestic wastes, to some extent municipal sewage and anthropogenic activity that influence the water quality directly or indirectly (Shraddha et al., 2011). An average values of the comparative analysis of physical and chemical parameters has been studied and the results are presented in Table 1 according to seasons for the year 2011.

Table 1. Descriptive statistics of physico-chemical parameters

Parameter	Min	Max	Mean	Std. Deviation	Std. Error
pH	6.20	7.80	7.28	0.36	0.06
Turbid	0.30	9.20	4.18	3.23	0.59
Cond	80.00	1794.00	274.28	367.46	61.24
TDS	42.00	1166.00	175.55	242.72	40.45
TH	12.00	648.00	63.33	118.88	19.81
Ca	9.00	48.00	20.77	8.91	1.48
Mg	2.00	620.00	42.27	117.79	19.63
Nitrate	0.24	30.00	2.54	5.61	1.08
Sulphate	1.00	24.20	7.35	6.14	1.02
Phosphate	0.300	2.160	0.88	0.43	0.07
Fluoride	0.20	0.30	0.20	0.01	0.00
Alkalinity	16.00	76.00	34.77	11.89	1.98
Bicarbonate	16.00	76.00	34.77	11.89	1.98
COD	80.00	350.00	153.33	57.37	9.56
DO	6.50	7.50	7.03	0.24	0.04
BOD	0.80	1.80	1.13	0.23	0.03

Physical Parameters

pH: is the hydrogen ion activity and a measure of acidity and alkalinity in aquatic bodies. pH ranged between 6.8 and 7.6. Lowest was recorded in December S6 and highest in February S1.

Turbidity: Results revealed that turbidity value ranged from 0.5 to 134.6 NTU. The maximum permissible value ranged from 0 to 10 NTU (WRC, 2003). In S1 spot high turbidity was recorded which almost makes it impossible to purify.

Electrical conductivity and total dissolved solids: It is the measurement of water's capacity for carrying electrical current and is directly related to the concentrations of ionised substances in water. Levels affected by the electrical conductivity of water are a direct function of its total dissolved solids, organic compound and temperature. Conductivity value ranged from 106.8 to 1005.8 µs/cms. Bit variation in conduction is not a problem and does not assure of any illness. The fluctuation in the electrical conductivity correlated positively with the TDS which are the common indicators of polluted waters. TDS ranged from 64.1 to 653.8 mg/L. It was in the permissible limit when compared to WHO guidelines (1000 mg/L).

Chemical Parameters

Total hardness: Water hardness is the capacity of the water to precipitate the soap. It is mainly precipitated by calcium and magnesium and is the sum of the same concentration mg/L. Lowest value of hardness was seen in the month of August in spot S5 (18 mg/L) and highest in S1 in the month of February (207.3 mg/L). On the other hand calcium and magnesium were seen lowest in August in S3 (13.6 and 4.3 mg/L respectively) and highest calcium content in October S5 spot (21.1 mg/L) and for Magnesium in February S1 (187.3 mg/L).

Nitrate: The lowest nitrate value was recorded in June S3 (0.1 mg/L) and highest value in February S1 (6.2 mg/L).

Sulphate: The lowest sulphate value was recorded in June S3 (1.48 mg/L) and highest in August S4 (14.3 mg/L). High content of this causes diarrhea.

Phosphate: Phosphates come from pesticides, fertilizers, industry and cleaning compounds. The lowest phosphate was observed in December S6 (0.5 mg/L) and highest from S4 in August (1.18 mg/L). High level of phosphate and nitrate can lead to eutrophication which in turn leads to increase in algal growth and ultimately reduces dissolved oxygen in the water.

Iron: Lowest value of iron 0.0001 mg/L in S4, S5 and S6 in the month of August, October and December respectively and highest in February S1 (0.06 mg/L). The permissible limit is between 0.3 and 1.0 mg/L.

Fluoride: Fluoride showed constant values for all the sampling spots and in all the seasons of 0.2 mg/L. It was below permissible limit.

Alkalinity: Alkalinity shows the acid neutralization capacity of water. The solubility of substances directly depend on the alkalinity of the water. Highest recorded was in S1 in February (47.3 mg/L) and lowest in June in S3 (26 mg/L). Recorded alkalinity was below the permissible limit (200-600 mg/L).

Carbonate and Bicarbonate: Carbonate level was always below the detection level and highest bicarbonate level was seen in S1 in February (47.3 mg/L) and lowest in June in S3 (26 mg/L).

Chemical oxygen demand: Increased COD and BOD represents the depletion of DO in the water level. Highest COD was estimated in S1 February (247.5 mg/L) and lowest in S6 December (97.5 mg/L). All samples showed excessive values for COD.

Biological oxygen demand: Increased organic matter results in the excess oxidation of organic matter to carbondioxide and the water creates an atmosphere of oxygen depletion and results in high BOD levels. The lowest value of BOD was estimated in S6 in December (0.8 mg/L) and highest in S1 in February (1.4 mg/L). Results showed that waste discharge was in limit and is below permissible limit.

Dissolved oxygen: It is one of the most and important and critical characteristic of water quality assessment. DO ranged from 6.7 to 7.4 mg/L. Highest was recorded in August in S4 (7.4 mg/L) and lowest in October S5 (6.7 mg/L). This was also below permissible limit.

Statistical Analysis

Hierarchical cluster analysis: Cluster analysis is an unsupervised pattern recognition technique that uncovers intrinsic structure or underlying behaviour of a dataset without making a prior assumption about the data to classify the objects of the system into categories or clusters based on their similarities (Vega et al., 1998). Hierarchical agglomerative cluster analysis was performed on the normalized dataset. Cluster analysis was applied to the obtained results of the sapling water sites for quality dataset with a view to group the similar

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sampling sites. Highest correlation was seen between sulphate and conductivity parameters which forms one cluster. These two control other parameters (Fig. 1).

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                      Rescaled Distance Cluster Combine

    C A S E      0         5        10        15        20        25
  Label     Num  +---------+---------+---------+---------+---------+

  ALKALINI   12   òø
  BICARBO    13   òú
  PH          1   òú
  DO         15   òú
  PHOSPATE   10   òôòòòø
  BOD        16   òú   ó
  FLUORIDE   11   òú   ó
  NITRATE     8   òú   ùòø
  TURBID      2   òú   ó ó
  SULPHATE    9   òú   ó ùòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòø
  CA          6   ò÷   ó ó                                         ó
  COD        14   òòòòò÷ ó                                         ó
  TH          5   òûòòòòò÷                                         ó
  MG          7   ò÷                                               ó
  COND        3   òòòòòòòòòòòûòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòòò÷
  TDS         4   òòòòòòòòòòò÷
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Figure 1. Hierarchical cluster analysis of physico-chemical parameters

Oneway ANOVA: Interrelationship: Descriptive statistics including the mean, standard deviation, standard error, maximum and minimum values are represented in Table 2 is widely used correlation coefficient which indicates the sufficiency of one variable to predict the other. All parameters showed non-significant correlation ($P>0.005$).

Table 2. Significance of physico-chemical parameters between and within groups

ANOVA						
Parameter		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
pH	Between Groups	0.691	5	0.138	1.066	0.399
	Within Groups	3.892	30	0.130		
	Total	4.583	35			
Turbid	Between Groups	34.733	5	6.947	0.621	0.686
	Within Groups	257.462	23	11.194		
	Total	292.195	28			
Cond	Between Groups	105328.511	5	21065.702	0.137	0.982
	Within Groups	4620816.292	30	154027.210		
	Total	4726144.803	35			
TDS	Between Groups	57144.137	5	11428.827	0.171	0.971
	Within Groups	2004931.133	30	66831.038		
	Total	2062075.270	35			
TH	Between Groups	50538.667	5	10107.733	0.683	0.640
	Within Groups	444165.333	30	14805.511		
	Total	494704.000	35			

Table 2. Significance of physico-chemical parameters between and within groups (Contd….)

ANOVA						
Parameter		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Ca	Between Groups	565.222	5	113.044	1.528	0.211
	Within Groups	2219.000	30	73.967		
	Total	2784.222	35			
Mg	Between Groups	52834.222	5	10566.844	0.732	0.605
	Within Groups	432805.000	30	14426.833		
	Total	485639.222	35			
Nitrate	Between Groups	159.937	5	31.987	1.016	0.433
	Within Groups	661.163	21	31.484		
	Total	821.100	26			
Sulphate	Between Groups	124.171	5	24.834	0.622	0.684
	Within Groups	1197.529	30	39.918		
	Total	1321.699	35			
Phosphate	Between Groups	1.418	5	0.284	1.605	0.189
	Within Groups	5.301	30	0.177		
	Total	6.719	35			
Fluoride	Between Groups	0.001	5	0.000	0.840	0.532
	Within Groups	0.010	30	0.000		
	Total	0.012	35			
Alkalinity	Between Groups	1079.556	5	215.911	1.672	0.172
	Within Groups	3874.667	30	129.156		
	Total	4954.222	35			
Bicarbonate	Between Groups	1079.556	5	215.911	1.672	0.172
	Within Groups	3874.667	30	129.156		
	Total	4954.222	35			
COD	Between Groups	2519.667	5	503.933	0.134	0.983
	Within Groups	112688.333	30	3756.278		
	Total	115208.000	35			
DO	Between Groups	0.488	5	0.098	1.728	0.159
	Within Groups	1.695	30	0.057		
	Total	2.183	35			
BOD	Between Groups	0.151	5	0.030	0.501	0.773
	Within Groups	1.812	30	0.060		
	Total	1.963	35			

Note: Df- degree of freedom; F- frequency; sig- significance

CONCLUSION

The study of physical and chemical characteristics of water provides an insight in knowing the water quality. Assessment of water quality is a critical factor for assessing the pollution level. Results from the present study clearly show the highest values in the month of February (winter) except for the parameters like calcium, sulphate, phosphate and DO. The high value obtained can be justified due to the fact mainly because of leaf litter dropping, animals, to some extent human activity as it is mainly a tourist spot. The values gradually decrease from February to December except some increase in the month of August as it is monsoon and surfacewater gets contaminated. These waters need conventional treatment including disinfection.

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