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PHYSICO-CHEMICAL AND MICROBIAL ANALYSIS OF GODAVARI RIVER WATER

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ABSTRACT
Rivers are crucial sources of surface water for humans and the environment, providing habitats, supporting nutrient cycles in aquatic ecosystems, and linking forests, wetlands, and oceans. Climate change, population growth, and rising pollution have made access to clean water challenging. Thus, physical, chemical, and biological evaluations are necessary to determine water stability, ensure health standards compliance, and assess river health. The present investigation was conducted to study the physicochemical and microbial characteristics of the Godavari River. Analysis was carried out over a one-year period from October 2018 to September 2019. Three sampling stations were selected; water samples were collected and analyzed using standard methods. During the study, temperature, pH, electrical conductivity, TDS, and dissolved oxygen were analyzed. To determine the presence of microbial contamination in the water, the Most Probable Number (MPN), Total Fecal Coliform (TFC), and Escherichia coli (E. coli) were examined. Microbial analysis of water is essential; it involves the detection and quantification of microorganisms for identification of potential contamination associated with health risks.

INTRODUCTION
Water is essential for all living organisms. Untreated domestic effluent, agricultural chemical runoff, industrial development, and urban expansion have contributed to the contamination of water resources [1]. To mitigate pollution, water must be free from pathogenic substances, including minerals, organisms, and microorganisms [2]. Water pollution adversely affects the entire biosphere, causing detrimental effects on natural biological communities, including individual organisms and populations [3]. Anthropogenic activities contribute to the contamination of surface and groundwater resources with coliform bacteria, including Escherichia coli [4]. Certain physicochemical parameters demonstrate correlation with biological and microbial factors. Specifically, electrical conductivity exhibits a positive relationship with coliform bacteria. [5] The overflow of sewage pipes and the discharge of fecal matter into the river may contribute to the elevated coliform count observed during the dry season [6]. According to the Bureau of Indian Standards (BIS) limit for total coliform and E. coli , these microorganisms shall not be detectable in any 100 mL sample. (BIS, 2012) [7] The present investigation was conducted to perform physicochemical and microbial analyses of the Godavari River.

MATERIALS AND METHODS
Three sampling sites from the Godavari River were selected for the collection of water samples: Site 1 Domalgaon, Site 2 Shahagad, and Site 3 Gondi village. The samples were collected at monthly intervals from November 2018 to October 2019, encompassing three seasons from the three sampling sites. One-liter plastic bottles were utilized for the collection of water samples, which were obtained once a month between 8:00 and 9:00 AM. Temperature, pH, turbidity, and electrical conductivity were analyzed immediately following sample collection. Samples for physicochemical and microbial analysis were collected from each station in pre-sterilized bottles without air bubbles. All samples were stored at a temperature below 4°C and above the freezing point to minimize volatilization or biodegradation between sampling and analysis.For sample collection, preservation, and estimation of physicochemical and microbial parameters such as Temperature, pH, Electrical Conductivity, Dissolved Oxygen (DO), Turbidity, Total Dissolved Solids (TDS), and E. coli, standard APHA methods were employed.

RESULT AND DISCUSSION

Temperature

The temperature of any water body is a crucial factor for its aquatic ecosystem, as it influences the dissolved oxygen percentage in water, thereby affecting aquatic life. Parameters such as BOD, taste, odor, and color exhibit variations in accordance with temperature fluctuations. Water temperature is a ubiquitous factor that directly influences the physicochemical properties and biota of aquatic ecosystems.[9] In the present investigation, the temperature exhibits seasonal variations at all sites; the highest temperature was observed at site 2 in the month of May during the summer season, whereas the lowest temperature was recorded in winter.

Temperature ^{O}C												
	OCT	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**AUG**	**SEPT**
Site 1	20.8	19.6	19.6	20.0	26.3	26.4	27.9	28.2	24.4	23.3	22.9	22.2
Site 2	21.1	19.8	19.7	21.4	26.0	26.7	27.7	**28.4**	24.1	23.4	23.1	23.2
Site 3	21.0	19.6	19.7	20.8	26.4	26.9	27.6	27.9	24.1	23.6	23.0	23.1

pH

The acidity or alkalinity of water is quantified by its pH value. Uncontaminated water generally exhibits a pH range of 6.5 to 7.5; however, effluents from sewage, industrial processes, or agricultural activities can potentially alter the pH of riverine systems, thereby affecting aquatic organisms. Substantial alterations in pH concentration can result in elevated heart rate, spinal curvature, cephalic malformation, modified metabolism, and potential mortality [10]. The pH values ranged from 7.3 to 8.6. The maximum pH value of 8.6 was observed in September at site two, while the minimum value of 7.3 was recorded at site three in March and April.

pH												
	OCT	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**AUG**	**SEPT**
Site 1	8.0	7.9	7.9	7.6	7.9	7.2	7.7	7.4	7.9	8.1	8.1	7.9
Site 2	8.1	7.9	7.6	7.7	7.8	7.4	7.4	7.7	8.3	8.2	8.4	**8.6**
Site 3	7.9	7.8	7.8	7.7	7.5	7.3	**7.3**	7.7	7.9	8.0	8.1	7.9

DO

Dissolved oxygen is a critical parameter for evaluating water quality and sustaining viable aquatic ecosystems. Diminished dissolved oxygen concentrations can result in a reduction of organism populations within the habitat. The presence of dissolved oxygen in an aquatic ecosystem is correlated with biochemical changes and metabolic activities of organisms [11]. The dissolved oxygen concentration was sufficient during winter but decreased at sites one and two in July and August. This reduction likely result from organic matter decomposition, suggesting elevated pollution levels in the water [12].

DO mg/lit												
	OCT	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**AUG**	**SEPT**
Site 1	6.4	8.2	8.6	9.8	8.2	7.3	6.4	6.2	4.9	4.8	4.6	5.2
Site 2	6.2	8.4	8.0	9.2	7.9	7.6	6.2	6.0	5.1	4.8	4.4	5.0
Site 3	7.0	7.9	7.9	9.2	7.8	7.4	6.4	6.4	5.2	5.1	5.2	5.2

TDS

Total dissolved solids (TDS) denote the concentration of inorganic salts and minimal organic matter in water, primarily comprising cations such as calcium, magnesium, potassium, and sodium, along with anions including carbonate, bicarbonate, chloride, Sulfate, and nitrate [13]. During analysis, TDS values ranged from 276 mg/L to 506 mg/L. The highest TDS was observed at site two in the month of August. Bawa and Gaikwad observed that sewage, soap,And detergent contributes to elevated Total Dissolved Solids (TDS) levels in river water, with TDS ranging from 184 to 800 mg/L [14].

TDS mg/lit												
	OCT	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**AUG**	**SEPT**
Site 1	284	286	280	284	286	290	294	296	278	286	288	292
Site 2	478	484	492	502	498	492	478	484	498	502	**506**	501
Site 3	288	**276**	284	288	290	304	310	318	328	334	342	368

Turbidity

Turbidity characterizes the optical properties of water resulting from suspended particles impeding light transmission, which can be attributed to organic matter, inorganic matter, or a combination thereof. The observed turbidity values ranged from 6.1 to 44.5 NTU.

Multiple factors contribute to water turbidity, including the disposal of human cremated remains, religious practices, and the direct deposition of solid waste into aquatic ecosystems.[15]

Turbidity NTU												
	OCT	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**AUG**	**SEPT**
Site 1	6.4	6.6	**6.1**	7.6	7.1	6.9	7.1	7.6	17.1	17.4	18.6	18.1
Site 2	18.5	12.7	12.1	11.4	11.2	12.3	11.5.	12.1	38.6	43.5	**44.5**	41.4
Site 3	7.2	7.1	7.6	8.1	7.9	7.7	7.9	8.1	18.4	18.6	17.4	16.2

Electrical Conductivity (EC):

Water conductivity refers to its capacity to conduct electrical current, which is determined by the concentration of cations and anions. Variations in these concentrations adversely affect aquatic organisms. Water at elevated temperatures exhibits enhanced electrical conductivity. Electrical conductivity serves as a critical parameter for assessing water quality, which increases in the presence of inorganic acids, alkalis, or salts.[16] Electrical conductivity ranged from 210 to 510 µS/cm, exhibiting higher values during summer across all sites and lower values during winter.

Electrical Conductivity µS/cm												
	OCT	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**AUG**	**SEPT**
Site 1	264	220	180	240	264	294	324	340	390	460	444	310
Site 2	310	314	312	364	388	404	498	**510**	468	438	390	360
Site 3	**210**	180	186`	244	258	284	334	324	360	410	260	328

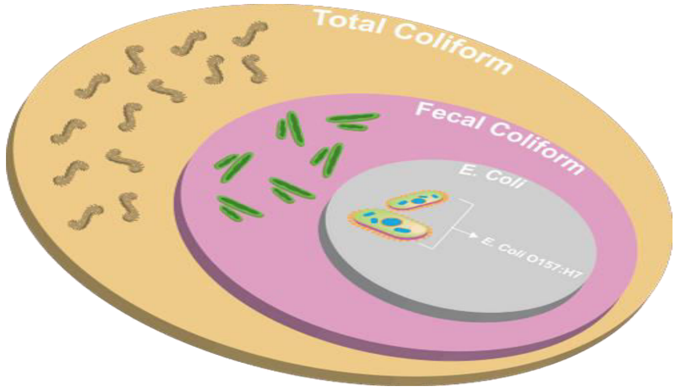
Total Alkalinity:

The alkalinity of natural water, primarily attributed to the presence of carbonates and bicarbonates, influences its organoleptic properties and functions as a pH buffer. Total alkalinity exhibits seasonal fluctuations, reaching its maximum during the summer months and its minimum during the monsoon season. Deshmukh J.U. observed comparable values of total alkalinity during their analysis of Godavari River water [17].

Total Alkalinity mg/lit												
	OCT	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUNE**	**JULY**	**AUG**	**SEPT**
Site 1	189	194	200	202	214	222	212	238	140	161	171	169
Site 2	308	326	344	342	366	384	382	398	264	278	290	286
Site 3	178	198	210	204	218	226	234	266	146	159	159	171

E-Coli:

The presence of E. coli in water indicates recent fecal contamination and suggests the potential presence of pathogenic microorganisms. Coliform bacteria function as indicator organisms, signifying the presence of pathogenic sources, and E. coli contamination presents an immediate health risk.



Total coliforms are present in soil and water environments, with their prevalence influenced by animal excreta. Fecal coliforms, a subset of total coliforms, serve as a more accurate indicator of animal or human waste contamination. Escherichia coli (E. coli), a predominant component of fecal coliforms, is considered the most reliable indicator of fecal pollution in aquatic ecosystems.

E-Coli colonies/ml												
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT
Site 1	2836	2454	1446	410	344	370	364	298	5580	6356	5902	4764
Site 2	3810	2278	1640	380	348	398	336	322	6220	8244	7800	5400
Site 3	1800	1442	1133	368	302	208	198	218	3288	4464	3614	2014

Escherichia coli concentration exhibited peak levels during the monsoon season and reached its minimum during the dry season at all sampling stations, demonstrating a positive correlation with nutrients, specifically Ammonia Cal-N and phosphate.[18] There is a very negligible correlation between E. coli and physical parameters.[19] E. coli contamination in the bore well increased due to rapid urbanization and inadequate sanitation.[20]

CONCLUSION

This investigation aimed to evaluate water quality with respect to physicochemical and microbial properties. The observed variations in physicochemical parameters within the study area indicate an imbalanced state of the river, which adversely affects aquatic life. Elevated concentrations of all parameters, including E. coli, were observed at site two, Shahagad, presumably attributable to the high population density and extensive agricultural land use, which contribute to agricultural runoff and sewage discharge into the River. Consequently, the water quality is deemed unsuitable for potable use. It is advisable to prohibit direct waste disposal into rivers and mitigate the utilization of chemical fertilizers and pesticides in agricultural practices to minimize environmental hazards associated with agricultural runoff.

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