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Purification of Wastewater by Charcoal Treatment and Dye Preparation Techniques

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Abstract: *Water is essential for maintaining life on Earth, controlling the climate, and forming the land. Water quality is routinely evaluated using physical, chemical, and biological characteristics and has a substantial impact on human health and the health of the environment. Aquatic habitats have been severely contaminated by rapid industrialization and overuse of chemical pesticides and fertilizers in agriculture, which has led to a decline in water quality and a loss of aquatic biota. The frequency of waterborne illnesses has increased due to the usage of contaminated water, underscoring the necessity of routine water quality monitoring.*
In the current study, factors including temperature, pH, turbidity, salinity, nitrates, and phosphates were analyzed in order to assess the water quality. Additionally, the assessment of aquatic macroinvertebrates was used as a biological indication of the health of aquatic ecosystems. Wastewater containing dyes was produced concurrently with the synthesis of dyes using regular tap water in both basic and acidic conditions. After that, the effluent was purified utilizing color preparation and charcoal treatment methods. Because of its large surface area and potent affinity for dye molecules and organic contaminants, activated charcoal was employed as an efficient adsorbent. Color, turbidity, and pollutant load were all significantly reduced as a result of the treatment procedure. This study shows that charcoal-based treatment is an easy, affordable, and eco-friendly way to purify dye-contaminated waste water.

Keywords: A study of Electronic and Magnetic properties of solid-state materials

I. INTRODUCTION

All plants and animals need water to survive. There can be no life on earth without water. Because 60 percent of our body weight is made up of water. Our bodies use water in all the cells, organs, and tissues, to help regulate body temperature and maintain other body functions, like loss of water through breathing, sweating, and digestion.

India is facing a serious shortage of natural resources, especially water. With the population growing and the economy developing, the demand for water keeps increasing. Unfortunately, most freshwater sources around the world are becoming polluted, which makes clean drinking water harder to find. All life depends on water, and it exists in many forms in nature—like oceans, rivers, lakes, clouds, rain, snow, and fog. But if we're being precise, truly pure water doesn't exist naturally for long.

A lake is a large body of water surrounded by land, and it's home to many types of aquatic life. In practical terms, "pure" water usually means water with low amounts of dissolved or suspended substances, harmful gases, and biological life. This kind of high-quality water is mostly needed for drinking. For uses like farming or industry, the water doesn't have to be that clean—
some level of pollution is acceptable and can still be considered usable.
The health of lakes and the variety of life they support are closely connected to the overall health of the environment. Lakes go through natural changes as part of the water cycle, but human activities have made things worse. Rapid

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development has led to many lakes getting polluted or even drying up. Common problems include stormwater runoff and sewage being dumped into lakes. These bring in too many nutrients, which can throw off the balance in the lake and lead to its decline.

One of the biggest water quality issues lakes face is eutrophication. This is the process where a lake slowly "ages" because nutrients, silt, and organic matter from the surrounding land build up in the water. Plants and sediments in the lake can both store and release these nutrients. When too many nutrients—especially phosphorus and nitrogen—enter a lake, they can cause a spike in algae growth. This leads to things like excessive algae blooms (often from harmful blue-green algae), a decline in other aquatic plants, and poor water quality overall.

Water, a prime natural resource and precious national asset, forms the chief constituent of ecosystem. Water sources may be mainly in the form of rivers, lakes, glaciers, rain water, ground water etc. Besides the need of water for drinking, water resources play a vital role in various sectors of economy such as agriculture, livestock production, forestry, industrial activities, hydropower generation, fisheries and other creative activities. The availability and quality of water either surface or ground, have been deteriorated due to some important factors like increasing population, industrialization, urbanization etc.

Water quality of any specific area or specific source can be assessed using physical, chemical and biological parameters. The values of these parameters are harmful for human health if they occurred more than defined limits [2,3,4,5]. Therefore, the suitability of water sources for human consumption has been described in terms of Water quality index (WQI), which is one of the most effective ways to describe the quality of water. WQI utilizes the water quality data and helps in the modification of the policies, which are formulated by various environmental monitoring agencies. It has been realized that the use of individual water quality variable in order to describe the water quality for common public is not easily understandable [5,]

That's why the Water Quality Index (WQI) is useful—it takes a lot of complex water data and turns it into a single number, making the information easier to understand and more logical. It gathers data from different sources and combines it to give an overall picture of the condition of a water system.

This helps both government policy makers and the general public better understand important water quality issues. This study looks at some of the main types of water quality indices used around the world. It explains how they are calculated, what factors they include, and what their strengths and weaknesses are.

All life depends on water, which is also vital to many biological processes and ecosystems. To understand how water sustains life on Earth, one must be aware of its special qualities, such as its high heat capacity and solvent capabilities. Studying water is crucial for sustainable management and conservation initiatives because its importance goes beyond biological processes; it also affects geological processes, climate patterns, and human activity. Water and the environment have a complex relationship, which emphasizes the need for continued research to solve issues like pollution, scarcity, and the effects of climate change Understanding the many functions of water not only advances our scientific understanding but also helps guide practices and policy choices meant to protect this priceless resource for coming generations. It is essential to comprehend how ecosystems, human civilizations, and water systems are interconnected in order to create practical solutions that lessen the negative consequences of environmental change Governments, researchers, and communities must work together to adopt creative solutions that guarantee fair access to and conservation of water resources because of the critical role that water plays in supporting life and fostering ecological balance.

By working together, we can create sustainable practices and technology that improve water quality and conserve it, which will help us become more resilient to environmental concerns in the future. Communities can actively participate in these efforts through innovative projects like rainwater collecting, wastewater recycling, and the restoration of natural water bodies. Campaigns for education and awareness can encourage people to adopt water-saving practices and support laws that put protecting this valuable resource first.

Communities can develop comprehensive policies that address present and future water issues by encouraging cooperation amongst different stakeholders, such as local governments, non- governmental organizations, and the corporate sector. By including underrepresented groups in water resource decision- making, such cooperative models not only guarantee sustainable water management but also advance social fairness. These programs have the potential to produce creative solutions that strengthen climate change resilience and make communities more equipped to withstand severe weather and water shortages. When access to clean water is acknowledged as a basic human right and protected for future generations, such preemptive actions can ultimately lead to a more sustainable future. By establishing collaborations and promoting information exchange between these parties, communities can leverage diverse expertise and resources to implement effective water conservation practices that benefit both people and the environment. Collaboration between local governments, NGOs, and community organizations can further amplify these efforts, creating a unified approach to tackle the challenges posed by water scarcity and environmental degradation. This collective action not only strengthens community resilience but also promotes innovative solutions that can address the root causes of water-related issues, paving the way for a more equitable distribution of resources and enhanced ecological health. Such initiatives can also inspire policy changes at higher levels; water conservation remains a priority in legislative agendas and fostering sustainable practices on a broader scale. Assuring that water conservation stays a top priority in legislative agendas.

Individuals and communities can be empowered to take proactive measures in their everyday lives by implementing educational programs that increase knowledge of the significance of water conservation. This will ultimately result in more sustainable behaviors and a culture of stewardship towards this essential resource. These initiatives may have a cascading effect, promoting cooperation between different stakeholders, such as governments, private companies, and non-profits, in order to accomplish all-encompassing water management plans. In addition to optimizing the efficiency of water conservation initiatives, this cooperative strategy strengthens community resilience to the effects of climate change, guaranteeing that future generations will inherit a more sustainable and healthier environment. Communities can create creative solutions suited to their particular problems by establishing collaborations and exchanging best practices. clearing the path for a more sustainable future in which everyone's access to water resources is protected. By providing people a say in decision-making procedures and encouraging a sense of pride in their water resources, such programs can also strengthen local communities. This empowerment fosters a culture of stewardship and sustainable practices, which eventually improves water resource management for the benefit of local economies and the environment. Communities can encourage people to take action in their daily lives by emphasizing education and awareness, which will further support the group's efforts to save water and safeguard important ecosystems. Such group initiatives foster a robust network of cooperation among stakeholders in addition to increasing resilience against climate change. guaranteeing the successful implementation and long-term maintenance of sustainable water management techniques.

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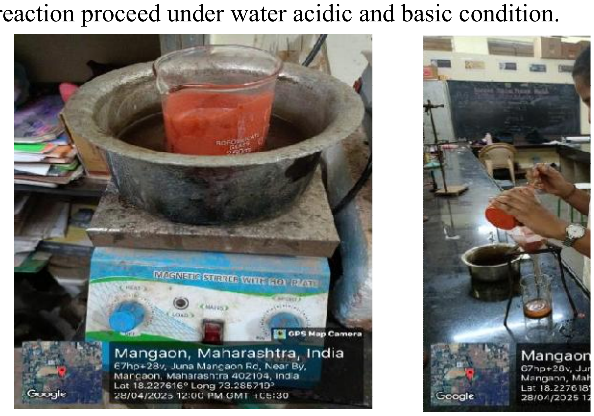
II. METHODOLOGY

4.1 Figure: Sources of Water

The source water for a municipal surface water treatment plant is typically a tap water, MIDC purifier water, local river, lake, or reservoir. There must be a method to get this water to check the water quality.

Before conducting our water quality analysis, we first tested some reactions using tap water. After obtaining the resulting wastewater, we began a comparative analysis and found that..

Microbial resistance is one of the world's most pressing public health issues and has therefore become a great challenge as far as delivery of healthcare is concerned. For instance, various strains of organisms are showing resistance towards current antimicrobial agents. Emergence of new strains of organisms is also contributing to the observed resistance to antimicrobial species. This phenomenon has necessitated the quest for new range of antimicrobials that will counter these observed resistances. Although synthetically tractable, azo dyes have received minimal attention inhe search for more effective antimicrobial agents. Despitefew reported cases of antimicrobial properties of azo dyes, their investigation as potential antimicrobial agents has not been fully explored and, very little effort has been invested. Also this reaction proceed under water acidic and basic condition.



4.2 Figure: General Procedure for Synthesis of Azo Compound

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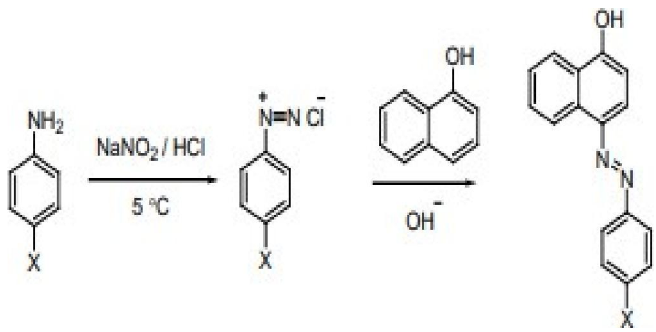
Experimental

All reagents and solvents were obtained from BDH Chemicals as technical or analytical grade. Reaction progress was monitored using thin layer chromatography (tlc) technique, which was performed on pre- coated silica gel plate and visualized with UV light or anisaldehyde spray. Compounds were purified by recrystallization from appropriate solvent mixtures. Melting points were determined by open capillary method using thiele tube melting point apparatus and are uncorrected.



Scheme 1: General route for the synthesis of azo dye

General method for the synthesis of diazonium salt

Amine (15 mmol) was stirred in concentrated hydrochloric acid (20 ml) until a clear solution was obtained. The mixture was cooled to 0– 5°C in an ice bath. A cold solution of sodium nitrite (50 ml) was then added drop-wise to the acidified amine solution, keeping the internal temperature of the mixture below 5°C. This was stirred for a further 30 min below 5°C to give the diazonium salt which was used immediately in the coupling reaction.

General method for coupling reactions

A mixture of naphthol (or coupling partner) (15 mmol) in 3 M NaOH (50 ml) was cooled to 5°C in an ice bath. This was then added to the cold benzene diazonium salt and the resulting mixture stirred slowly below 5°C for 30 min. Crystals that precipitated were collected by filtration, washed with cold water and dried. Recrystallization from appropriate solvent gave the desired azo compound, table 1.

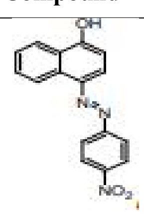
Compound	Mol. Formula	Mol. weight	%ofyield	MP°C	rf
	$C_{16}H_{11}N_3O_3$	293.28	93.5	123-125	0.65

Table 4.1: Synthesized azo compound and their physical data

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Figure 4.3: pH meter

Procedure

Calibration Using the buffer solutions calibrate the instrument.

Step 1: In a 100 ml beaker take pH 7.0 buffer solution and place it in a magnetic stirrer, insert the Teflon coated stirring bar and stir well. Now place the electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 7.0, using the calibration knob adjust the reading to 7.0. Take the electrode from the buffer, wash it with distilled water and then wipe gently with soft tissue.

Step 2: In a 100 ml beaker take pH 9.2 buffer solution and place it in a magnetic stirrer, insert the Teflon coated stirring bar and stir well. Now place the electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 9.2, using the slope knob adjust the reading to 9.2. Take the electrode from the buffer, wash it with distilled water and then

III. LITERATURE REVIEW

The first step in a literature study would normally be to identify and review the important water quality measures that are frequently examined. These could include chemical characteristics like dissolved oxygen, nutrients, heavy metals, pesticides, and organic compounds; physical parameters like temperature, pH, turbidity, and colour; and biological parameters like coliform bacteria, algae, and other microorganisms. Reviewing the procedures and methods for measuring and interpreting these parameters, including recommended standards from regulatory organizations like the World Health Organization or the U.S. Environmental Protection Agency (EPA), may be part of the literature survey (WHO).

Sr.No.	Studied Parameter	Method used
1	pH	Recorded by pH meter
2	Hardness	EDTA Method
3	Total alkalinity	Neutralizing with Std. HCl
4	Phosphate	Spectophotometric

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5	Chloride	Mohrs method
6	Nitrate	Spectophotometric
7	Sulphate	Spectophotometric
8	B.O.D	Titrometric
9	C.O.D	Titrometric
10	D.O	Titrometric

Table 3.1: Analysis of Water Quality by using Different Methods

The many analytical techniques used for analyzing the quality of water may be the focus of the literature review. This could involve both conventional laboratory-based techniques like spectrophotometry, chromatography, and titration and more sophisticated ones like mass spectrometry, electrochemical analysis, and molecular biology-based approaches. The survey may go over the benefits, drawbacks, and application of these approaches for various water quality metrics and matrices, as well as any new developments and trends in analytical methods for assessing water quality.

The methods used for sample preparation and sampling are another crucial component of water quality analysis. The best methods for collecting water samples, including ideas for sample placement, sample size, and sample preservation, may be examined in the literature review. It might also go through various sample- preparation methods, like filtration, extraction, and concentration, which are frequently used to get water samples ready for testing. The survey might emphasize how crucial precise and representative results in water quality analysis depend on sample preparation and sampling done correctly.

Water's essential function as drinking water is a significant daily intake. Contamination by microorganisms (bacteria or viruses) on water sources and drinking water supplies is a common cause in developing countries like Indonesia. This paper will discuss the sources of clean water and drinking water and their problems in developing countries; water quality and its relation to public health problems in these countries; and what efforts that can be make to improve water quality. The method used is a literature review from the latest journals. Water quality is influenced by natural processes and human activities around the water source Among developed countries, public health problems caused by low water quality, such as diarrhea, dysentery, cholera, typhus, skin itching, kidney disease, hypertension, heart disease, cancer, and other diseases the nervous system. Good water quality has a role to play in decreasing the number of disease sufferers or health issues due to drinking and the mortality rate. The efforts made to improve water quality and public health are by improving WASH (water, sanitation, and hygiene) facilities and infrastructure and also WASH education.

The discharge of effluent from domestic wastewater and industrial sources into aquatic systems has necessitated the establishment of monitoring frameworks aimed at characterizing pollution levels. Significant pollution levels in developing nations have been intensified by rapidly increasing populations and inadequate enforcement of sustainable management practices. The Water Quality Index (WQI) serves to bridge the gap between water quality reporting and monitoring by providing a straightforward and effective method to assimilate and convey results derived from extensive datasets. Water Quality Indices function as communication instruments that can enhance knowledge dissemination between academics and the general populace. The deterioration of natural aquatic resources, including lakes, streams, and estuaries, constitutes the most pressing challenge confronting humanity. Contaminated water exerts extensive repercussions on every facet of life. Consequently, the management of water resources is imperative to optimize water quality. Should data be scrutinized and water quality be forecasted in advance, the issue of water pollution may be effectively mitigated. Despite this topic having been the focus of numerous prior investigations, further research remains necessary to comprehensively comprehend the efficacy, reliability, accuracy, and application of contemporary methodologies in water quality management. In the present study, an extensive review has been undertaken concerning water quality assessment utilizing artificial techniques. This review encompasses 75 scholarly works pertaining to water quality analysis. The data amassed from each scholarly work have undergone thorough analysis. Furthermore, the types of water resources, including surface water, groundwater, and drinking water, have also been evaluated. The parameters examined in each study include "Dissolved Oxygen (DO), Potential of Hydrogen (pH), Biochemical Oxygen Demand (BOD), Total Dissolved Solids (TDS), Chemical Oxygen Demand (COD), chloride, hardness, alkalinity, and nitrate–nitrite." Additionally, the Artificial Intelligence methodologies employed for water quality analysis are also assessed. Lastly, the research gaps identified in the realm of water quality detection are delineated.

The various technical research paper on the assessment of water quality for lake, river, sea and different areas have been presented at research level for the study. These papers are presented below.

Bhagat S. Chauhan and S. K. Sagar [07] have conducted a comprehensive investigation aimed at the assessment of the physicochemical parameters and the quality of the Sutlej River in the Nangal region of Punjab, India. The physicochemical parameters were meticulously studied and analyzed over a span of one year, specifically from July 2010 to June 2011. A variety of physicochemical parameters, including water temperature, water color, turbidity, free ammonia, total dissolved solids, pH, dissolved oxygen, free CO2, total hardness, total alkalinity, chlorides, biochemical oxygen demand (BOD), nitrates, phosphates, and sulfates, were evaluated. The findings indicated that a significant seasonal variation existed among certain physicochemical parameters, and it was determined that the river water in the Nangal area exhibited moderate pollution levels. Based on this preliminary study, it was evident that the water was unsuitable for potable use; however, it may be utilized for the purposes of wildlife propagation, fisheries, and irrigation.
Manjusha Bohr, Prakash Kadave, Sheetal Bhor, and Manisha Bhosale [08] have conducted an assessment of the water quality of the River Godavari, specifically at Ramkunda in Nashik. Three samples were procured from three distinct locations throughout the area. The study was carried out during the months of June, August, and October, respectively. In the course of the present investigation, several physical and chemical properties were analyzed. The parameters of temperature, pH, and Total Dissolved Solids (TDS) were measured in situ. Immediately following the collection of samples, utilizing a portable water quality analyzer, the concentrations of Chlorides, Total Hardness, Calcium (Ca), and Total Alkalinity were assessed. The findings of the study indicate that the river is subject to pollution at the Ramkunda site. It is posited that the ongoing pollution of water sources due to various human activities may precipitate health issues for the population. The values of correlation coefficients and their respective significance levels will facilitate the selection of appropriate treatments to mitigate the contamination of the river water of Godavari at Ramkunda.

Pratiksha Tambekar, Pravin P. Morey, R.J. Batra, and R.G. Weiginnwar [09] have conducted a comprehensive analysis of the physico-chemical parameters pertaining to the evaluation of water quality in the vicinity of Chandrapur (Maharashtra). Two sampling stations were meticulously selected downstream of Chandrapur City. Water samples were systematically collected from the Wardha River at three distinct locations. This sampling was conducted over a span of twelve months throughout the year. A variety of physicochemical parameters were rigorously examined. In the present investigation, we endeavor to assess numerous physico-chemical characteristics and their behavioral patterns in the river water samples across various seasons and sampling sites. Numerous parameter values exceeded the maximum permissible limits.
The findings of this study underscore the urgent necessity for extensive water quality monitoring efforts and the identification of remedial measures to safeguard this vital natural water resource within the study area.

Vijaya Kumar K.M. and Vijaya Kumara [10] have conducted an extensive study on the physico-chemical analysis of the water quality within the Kundapur Mangrove forest located in Karnataka. The research encompassed four distinct sampling stations over a span of one year, specifically from April 2011 to March 2012, during which seasonal variations of various parameters were meticulously investigated. The parameters assessed included pH levels ranging

from 6.65 to 8.42, dissolved oxygen concentrations between 3.25 and 11.78 mg/l, biochemical oxygen demand (BOD) levels from 0 to 3.65 mg/l, carbon dioxide (CO_2) concentrations varying from 0.55 to 2.3 mg/l, electrical conductivity measurements from 0.36 to 29.1 ms-1, potassium levels ranging from
0.12 to 9.74 mg/l, calcium concentrations between 0.50 and 42.34 mg/l, magnesium levels from
0.25 to 109.5 mg/l, sodium concentrations ranging from 0.017 to 878.04 mg/l, bicarbonate levels from 1.40 to 6.23 mg/l, carbonate levels recorded as nil, and chloride concentrations varying from 2.23 to
380.70 mg/l. The findings of the study indicate that fluctuations in the physicochemical characteristics of the water are observed in correlation with seasonal changes, which can be attributed to the ebb and flow of rainwater, as well as variations in temperature and salinity throughout different seasons. Furthermore, significant pollution arising from both agricultural runoff and shrimp aquaculture activities severely compromises the water quality of the mangrove ecosystems.
J.G. Koliyar and N.S. Rokade [11] have conducted an investigation aimed at comprehending the water quality within the pond lake located in Mumbai. The objective of the survey was to gather information regarding the utilization and significance of water quality enhancement at Powai. The findings indicate that contaminants are indeed present in the lake. Numerous distinct parameters have been observed to escalate during the summer season and subsequently become diluted during the rainy season. The deficiency of oxygen content may result in the mortality of fish, and the absence of fish facilitates the proliferation of malaria-carrying mosquitoes, as mosquitoes serve as a natural food source for fish. The disposal of waste materials and refuse into the lake water must be rigorously prohibited to ensure proper bioremediation techniques should be employed to enhance the quality of the water.

Prabhakar R. Pawar and Balasaheb G. Kulkarni [12] have conducted a comprehensive study on the assessment of water quality in the Karanja Creek (Raigad). The continuous monitoring of coastal water quality is of paramount importance in the identification and evaluation of marine water pollution. In the course of the current investigation, various physical and chemical parameterswere systematically monitored during both spring low and high tides for a duration of 24 months (from January 2004 to December 2005). It has been observed that, at present, the water in Karanja Creek remains relatively unpolluted, with variations in physical and chemical characteristics of surface water being seasonal in nature and not significantly influenced by anthropogenic pressures. The pollution load within the Karanja Creek remains within the assimilative capacity of the ecosystem. Furthermore, data concerning nutrient levels suggest that sewage introduced into the creek is either diluted or repurposed as a source of nutrients for photosynthetic processes.

Budharatna Bhavare, Miguel A. Rodriguez, and Anil Kurthe [13] have conducted an investigation into various physicochemical parameters and nutrient levels present in the waters of the Bhatye estuary, located in Ratnagiri, along the central West coast of India. The current study was undertaken to ascertain the variations in physical and chemical parameters across different locations within the Bhatye Estuary. The preliminary data regarding the physical, chemical parameters, and nutrient concentrations in this region will serve as a valuable resource for future endeavors related to ecology, biodiversity, and cultural aspects of the Bhatye estuary.

Francis Andrade, H.B. Arvinda, and E.T. Puttaiah [14] have conducted an investigation into the pollution of coastal waters in Mangalore through the analysis of various physical and chemical parameters. The effluent samples were systematically collected from six distinct locations within the study area. The physicochemical analysis of the samples was conducted three times during the year 2008, specifically during the pre-monsoon, monsoon, and post-monsoon seasons, adhering to standard methodologies (APHA-1995). In light of rapid industrialization and the development of Special Economic Zones, there exists a pressing necessity to curtail the proliferation of pollution in coastal waters.

Ramalingam Manikannan, Subramanian Asokan, and A.H.M.S. Ali [15] have conducted an investigation into the seasonal fluctuations of physicochemical characteristics of the Great Vedaranyam Swamp located within the Point

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Calimere Wildlife Sanctuary along the southeastern coast of India. The current research endeavor aimed to analyze the physicochemical variability present in this region. The examination of seasonal variation was undertaken to assess the levels of fluctuating physicochemical parameters, including Temperature, Salinity, pH, Dissolved Oxygen, Nitrate, Nitrite, Electrical Conductivity, Phosphate, Turbidity, Total Dissolved Solids, and Water Depth. The present baseline data concerning the physicochemical properties of water shall serve as a valuable resource for subsequent ecological evaluations and monitoring of this wetland within the Point Calimere Wildlife Sanctuary.

Sujata Sen, Dr. Minal Kanti Paul, and Madhab Borah [16] studied the physico-chemical parameters of pond and river water in Lumding town, Assam. They analyzed various parameters such as temperature, pH, conductance, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), turbidity, hardness, total alkalinity, dissolved oxygen, chemical oxygen demand (COD), fluoride (f-), nitrate (NO3-), bicarbonate (HCO3-), chloride (Cl-), sulfate (SO4-2), sodium (Na+), potassium (K+), calcium (Ca+2), magnesium (Mg+2), and iron (Fe). Their correlation analysis revealed that some parameters showed positive correlations while others showed negative correlations, indicating pollution in the surface water of the locality.

G. Velsamy, N. Manoharan, and S. Ganesan [17] have conducted an investigation into the analysis of physicochemical variations in sea water samples from the Uppanar estuary located in Cuddalore, Tamil Nadu, India. The current study examines the physicochemical variations at two distinct stations along the Cuddalore coastline during the period of July to December 2012, focusing on the monthly fluctuations of physicochemical parameters, which include atmospheric temperature, surface water temperature, pH, salinity, total solids, total dissolved solids (TDS), dissolved oxygen (DO), nitrate, nitrite, phosphate, and silicate. The alterations in physicochemical parameters are primarily influenced by monsoonal precipitation.

B. N. Tandel, Dr. J. Macwan, and C. K. Soni [18] have conducted a comprehensive study, revealing that the water quality index is a singular numerical representation that encapsulates the quality of water by amalgamating various water quality parameters. Its primary objective is to furnish a straightforward and succinct approach for delineating the water quality pertinent to diverse applications. The current research pertains to the assessment of the fluctuations in the seasonal water quality index of several strategically chosen surface water bodies. The index enhances the understanding of overarching water quality concerns, conveys the status of water quality, and exemplifies the necessity for, as well as the efficacy of, protective measures. It has been observed that in all instances, the variations in the WQI value adhere to a similar pattern throughout the duration of the study. The quality of the lake water is determined to be satisfactory (WQI - 67.7 to 78.5) across both seasons. Nonetheless, it has been noted that the water quality of the lake experiences a slight decline from the winter to the summer season, attributable to the elevated microbial activity and the increased concentration of pollutants as a result of water evaporation.

IV. RESULTS AND DISCUSSION

Water Quality Analysis

The analysis of water quality parameters revealed noticeable variations in the physical and chemical characteristics of the source water. Temperature values remained within an acceptable range, indicating minimal thermal pollution. The pH of the water samples was found to be slightly acidic to neutral, which is suitable for most aquatic organisms; however, minor fluctuations indicated the influence of external inputs such as agricultural runoff. Turbidity values were moderately high in some samples, suggesting the presence of suspended particles and organic matter. Elevated concentrations of nitrates and phosphates were observed, likely due to the indiscriminate use of chemical fertilizers in nearby agricultural areas. Such nutrient enrichment can lead to eutrophication and degradation of aquatic ecosystems. The assessment of aquatic macroinvertebrates showed reduced diversity in polluted samples, confirming the impact of deteriorating water quality on biological communities.

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Dye Preparation and Wastewater Characteristics

Dyes synthesized using tap water under acidic and basic conditions produced colored wastewater with high turbidity and intense coloration. The presence of dye molecules significantly affected the visual quality and chemical nature of the wastewater, making treatment essential before discharge or reuse.

Purification of Wastewater by Charcoal Treatment

The dye-containing wastewater was treated using activated charcoal as an adsorbent. After charcoal treatment, a significant reduction in color intensity was observed, indicating effective adsorption of dye molecules onto the charcoal surface. Turbidity and odor were also reduced considerably, resulting in visibly clearer water. The efficiency of dye removal can be attributed to the high surface area and porous structure of activated charcoal, which facilitates strong interactions between the adsorbent and dye molecules.

Discussion

The results demonstrate that activated charcoal is an efficient, low-cost, and environmentally friendly material for the purification of dye-contaminated wastewater. The combined study of water quality analysis and charcoal-based treatment highlights the importance of regular monitoring and sustainable wastewater management practices to protect aquatic ecosystems and public health.

V. CONCLUSION

The present study highlights the importance of water quality analysis in understanding the condition of aquatic environments and ensuring the safety of water for various uses. The assessment of physical, chemical, and biological parameters such as temperature, pH, turbidity, alkalinity, acidity, electrical conductivity, and biological indicators revealed variations in water quality influenced by natural processes and anthropogenic activities. The results indicate that while some water samples were within permissible limits, others showed deviations that may pose potential risks to aquatic life and human health if left untreated. These findings emphasize the need for regular monitoring and effective management of water resources.

In addition to water quality assessment, the study successfully demonstrated the synthesis of dye under acidic and basic conditions and addressed the treatment of the resulting dye-containing wastewater. The application of activated charcoal for wastewater purification proved to be highly effective, resulting in a significant reduction in color, turbidity, and odor. The treated water exhibited improved quality, approaching acceptable standards for reuse or safe disposal.

Overall, the study confirms that charcoal-based treatment is a simple, economical, and environmentally friendly method for the purification of dye-contaminated wastewater. The integration of systematic water quality analysis with low-cost treatment techniques provides a sustainable approach for minimizing environmental pollution and protecting public health. The outcomes of this study support the adoption of charcoal treatment methods in laboratory-scale and small industrial wastewater management practices.

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Conflict of Interest

The authors have no conflict of interest in publication of this article.

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