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Assessment of Water Quality of Textile Effluent and Its Treatment Using Banana Peel

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ABSTRACT

One of the biggest industrial sectors in the world and a major driver of economic expansion is the textile industry. However, because textile effluents contain a variety of pollutants, such as dyes, heavy metals, and organic compounds, their disposal into water bodies has sparked grave environmental concerns. This study looked into the evaluation of water quality in textile effluent and how to treat it with banana peel, an inexpensive adsorbent. Through batch tests, the efficiency of banana peels (*Musa sapientum*) in eliminating contaminants from textile effluent was assessed and contrasted with traditional treatment techniques. The outcomes showed that banana peels could be a viable substitute for treating textile effluent, providing the textile sector with an economical and environmentally friendly way to reduce water pollution.

Key words: *Textile effluents, Banana peel (*Musa sapientum*), Sustainable, Textile industry effluent treatment, Pollution mitigation.*

Introduction

Textile waste leads to pollution and landfill accumulation, making it a major environmental concern. Conventional approaches of managing textile waste, such as burning and land filling, harm the environment and don't sufficiently handle the expanding issue (Kumar *et al*., 2021). Consequently, there is a need for creative and environmentally responsible methods to address textile waste. It is well recognized that the textile sector has a big waste output and an impact on the environment (Kumar, 2021). Numerous contaminants are released into water bodies during the textile production operations of dyeing, printing, and finishing. Organic dyes, heavy metals, hazardous chemicals, and high concentrations of compounds with chemical and biological oxygen demands (COD and BOD, respectively) are some of these pollutants. These contaminants provide a serious risk to the environment in textile wastewater (Odhaib and Jaeel, 2023). Without enough treatment, it can be released into water bodies and contaminate soil, groundwater, and surface water. This pollution poses threats to human health, harms wildlife, and disturbs aquatic ecosystems. In addition, water scarcity problems in water-stressed areas are exacerbated by the extensive use of water in textile production. The operations of dyeing, rinsing, and finishing demand large amounts of water, which results in high water consumption and the loss of freshwater resources (Sharma, 2014). Regulations and industry monitoring have escalated as a result of environmental concerns about textile waste. Stricter regulations are being implemented globally by governments and environmental organizations to reduce and manage the pollution resulting from textile effluents (Singh and Ansari, 2023). This has led scholars and business experts to investigate economical and environmentally friendly techniques for treating textile wastewater (Rahman, 2022).

Natural adsorbents have drawn interest as an environmentally beneficial water treatment option (Qasim and Mane, 2013). The ability of various agricultural waste materials, including banana peel (*Musa sapientum*), to adsorb and remove contaminants from textile effluent has been investigated. Banana peels are widely accessible, reasonably priced, and have demonstrated encouraging outcomes in the adsorption of heavy metals and organic pigments. Because of their high cellulose and lignin content, banana plants are a natural plant material that is effective at adsorbing and eliminating pollutants from contaminated water. Banana peels' natural qualities, affordability, and ease of availability have made them a popular candidate for elimination of textile waste (Prastuti *et al.,* 2019). Cellulose, a biopolymer found in banana peels, is used for textile production among other things. By removing cellulose from banana peels and using it in the manufacturing of textiles, we may encourage environmentally friendly methods and lessen our need on non-renewable resources. Therefore, recycling can be beneficial for the environment and public health and safety by helping to improve wastewater quality so that it can be utilized again (Pan, 2020).

The plant material banana peel (*Musa sapientum*) was utilized in the current investigation, together with particular coagulants, to evaluate the integrated treatment effectiveness of textile effluent. The significance of this eco-friendly approach lies in several aspects:

Waste Reduction: By keeping organic waste out of landfills, using banana peels to make textiles helps lessen the amount of garbage that is produced and its impact on the environment (Podeh, 2001).

Renewable Resource: An easily accessible agricultural byproduct is banana peels. By using them as a raw material, we may lessen our reliance on non-renewable resources, such synthetic fibers made of petroleum.

Biodegradability: Fabrics made from banana peel fibers have the ability to spontaneously break down without leaving behind any hazardous residues. This feature improves the textile industry's overall sustainability.

Carbon Footprint: Reducing the carbon footprint associated with conventional textile production processes may be possible with the extraction and inclusion of cellulose from banana peels into textiles. This strategy reduces resource use and makes use of waste resources to support a circular economy (Sharma and Kaur, 2018).

Economic Opportunities: Putting this environmentally beneficial strategy into practice could open up new business prospects by assisting local communities that grow bananas and building a value chain for banana peels.

In conclusion, using banana peels as a resource for textile manufacturing offers a sustainable solution to the issue of textile waste. We can minimize the environmental impact of textile manufacturing while reducing waste, promoting sustainability, and creating economic opportunities by utilizing the cellulose content found in banana peels.

Materials and Methods

Sample collection and characterization

From Sangamner textile factories, seven distinct textile effluent samples were gathered. The samples were brought to the lab for examination after being kept in sterile, clearly marked containers (S-1 to S-7). The textile effluent's physicochemical properties, such as pH, conductivity, color, turbidity, total suspended solids (TSS), chemical and biochemical oxygen demand (BOD), and concentrations of particular contaminants (such heavy metals and dyes), were measured (Jaiman *et al*., 2023).

Physico-chemical Analysis

The physico-chemical analysis was performed following standard methods (Agarwal *et al*., 2022). The brief details of analytical methods and equipment used in the study are given in the Table 1.

Experimental Setup

Adsorbent Preparation

Banana peels from the *Musa sapientum* plant were gathered, cleaned with distilled water, and allowed to air dry in order to prepare the plant material for the adsorbent. Using a grinder and pestle, the dried banana peels were ground into a fine powder. In order to achieve a consistent particle size for adsorption studies, the powdered banana peel was sieved. To create a slurry, distilled water was combined with powdered banana peel. To guarantee even dispersion, a magnetic stirrer was used to agitate the slurry aggressively.

Batch Adsorption Experiments

All seven samples (S-1 to S-7) were used in adsorption studies. 500 ml of textile effluent and 100 ml of banana peel slurry were combined. For twenty-four hours, the mixture was stirred at room temperature with a stirrer set at a steady speed. Coagulants (40 g $FeSO_4$ + 10 g CaO) were added after the required contact time, and the mixture was left for two hours. Following the removal of the sedimented sludge, treated samples were separated and examined in order to determine the pollutant concentrations.

Results and Discussion

Physico-chemical characteristics of textiles effluent samples (S-1 to S-7) before and after treatment are depicted in Table 2 and 3 respectively.

Studies comparing the physical and chemical properties before and after treatment (Tables 2 and 3) amply demonstrate a discernible drop in pH, TDS, BOD, COD, and other indices (Odhaib and Jaeel, 2023). Figure 1 displays the percentage reduction in features.

As a result, treating the plant material with banana peels was very successful in absorbing textile effluents, and applying coagulants-a mixture of FeSO4 and CaO-further sped up and improved the effectiveness of the pollutant removal process. The best place to forecast the results is from the graphs in Figures 2 and 3, which compare the levels of BOD

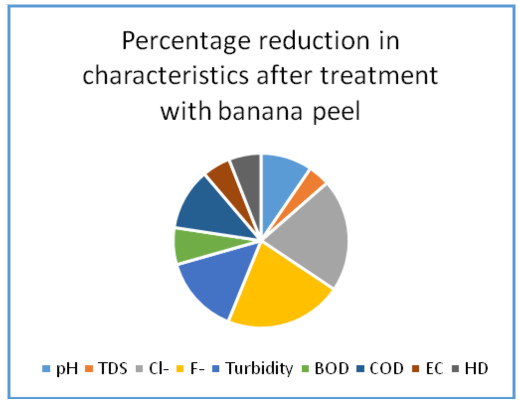

Fig. 1. Percentage reduction in characteristics pH, TDS, BOD, COD, EC and HD.

Table 1. Parameters and Methods Employed for Measurement Physiochemical Analysis

S.No	Parameter	Methodology	Unit
1	pH	pH meter	-
2	Electrical Conductivity (EC)	Digital conductivity meter	mhos/cm
3	Temperature	Thermometer	°C
4	Total Suspended Solids (TSS)	Digital conductivity meter	mg/l
5	Total Hardness (HD)	With EDTA volumetrically	mg/l
6	Chloride (Cl^-)	With AgNO3 volumetrically	mg/l
7	Fluoride (F^-)	UV-visible spectrophotometer	mg/l
8	Alkalinity	With HCl volumetrically	mg/l
9	BOD	Winkler's Method	ppm
10	Turbidity	Nephlometer	NTU

Table 2. Physico-chemical characteristics of textiles effluent samples before treatment

Sample code	→S1	S2	S3	S4	S5	S6	S7	MEAN	SD	MAX	MIN
→pH	8.7	8.5	9.2	8,2	7.8	9.8	9,3	8.80	0.75	9.8	7.8
TDS	405	395	410	390	435	410	445	412.86	20.18	445	390
Cl-	147	126	183	126	189	143	166	154.29	25.65	189	126
F-	1.4	1.2	1.7	1.5	1.6	1.9	1.3	1.51	0.24	1.9	1.2
Turbidity	9.4	8.2	8	7.6	9.3	8.5	9.2	8.60	0.71	9.4	7.6
BOD	530	440	540	410	600	530	590	520.00	71.18	600	410
COD	1560	1550	1385	1410	1435	1500	1485	1475.00	67.70	1560	1385
EC	1300	1175	1298	1073	1361	1043	1375	1232.14	135.60	1375	1043
HD	202	162	238	182	129	176	235	189.14	39.23	238	129
Temp	27.8	28	29.4	28.7	28.6	26.7	27.5	28.10	0.89	29.4	26.7

Table 3. Physico-chemical characteristics of textiles effluent samples after treatment

Sample code	S1	S2	S3	S4	S5	S6	S7	Mean	SD	Max	Min
pH	7	7.1	7.3	7.2	7.6	7.6	7.1	7.27	0.24	7.6	7
TDS	385	315	400	395	410	365	410	382.86	33.77	410	315
Cl-	103	85	95	80	100	98	110	95.86	10.35	110	80
F-	0.7	0.8	1	0.7	1.2	1.1	0.9	0.91	0.20	1.2	0.7
Turbidity	6.5	5.4	5.5	6.2	7.5	7.8	5.5	6.34	0.98	7.8	5.4
BOD	420	380	480	380	520	480	530	455.71	62.68	530	380
COD	1485	950	1105	870	1235	1300	1240	1169.29	211.29	1485	870
EC	1255	1080	1150	980	1245	960	1135	1115.00	116.62	1255	960
HD	185	155	205	170	115	145	205	168.57	33.00	205	115
Temp	25	23	27	26	24	22	28	25.00	2.16	28	22

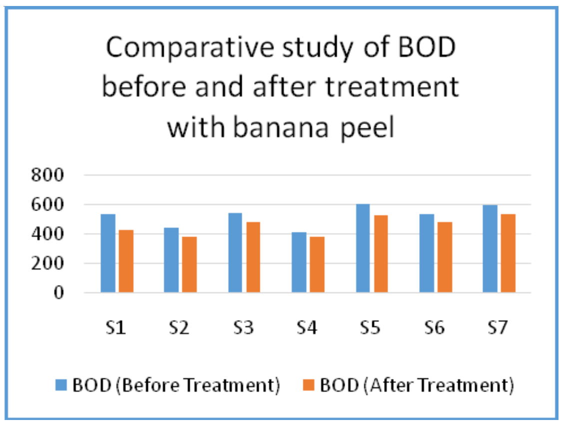

Fig. 2. Comparative study of BOD before and after treatment with banana peel

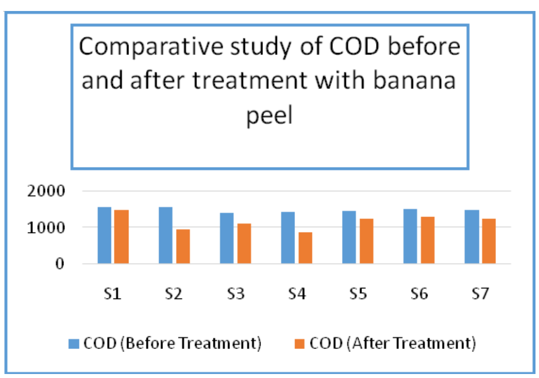

Fig. 3. Comparative study of COD before and after treatment with banana peel

and COD before and after treatment with banana peel.

Conclusion

The results of this study unequivocally demonstrate that banana peels are inexpensive, readily accessible, natural plant material that may be utilized to treat textile wastewater. The plant components are inexpensive, widely accessible, plentiful, and easily cultivable at a low cost. Nevertheless, treating textile effluent with banana peel and a specific mixture of coagulants ($FeSO_4$+CaO) improved the water's quality and reduced the amount of BOD and COD as well as the pollutant load and color.

Conflict of Interest: None

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