



Eco-Friendly Water Filtration Using Indica, Gossypin, Coconut Derived Biochar And Vetiver: A Research

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Abstract: Large amounts of wastewater, including dyes, are released by Tirupur's textile manufacturers, seriously contaminating nearby waterways. The purpose of this work was to create a low-cost, environmentally friendly natural filtration system for textile wastewater treatment employing cotton, vetiver (*Chrysopogon zizanioides*), coconut coir biochar, and canna indica. Samples of water were taken from dyeing facilities and passed through a multi-layer filter. Following filtering, notable gains were seen in pH, iron content, total dissolved solids (TDS), and total suspended solids (TSS). The Total Suspended Solids (TSS) reduced from 568 mg/L to 232 mg/L, while the Total Dissolved Solids (TDS) dropped significantly from 13,616 mg/L to 4,913 mg/L after filtration Iron content decreased from 0.793 mg/L to 0.302 mg/L, while pH values returned to normal between 11.3 and 6.8. The outcomes demonstrate the efficacy of this natural filtration technique in enhancing the quality of textile wastewater and providing an environmentally friendly option for industrial water reuse.

KEY WORDS - Textile wastewater, Natural filtration, Cotton filter, Biochar, Coconut coir, Vetiver grass Canna indica, Water reuse, Eco-friendly treatment, Dye removal, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Iron removal, pH normalization, Low-cost filtration, textile industry, Industrial effluent treatment, Phytoremediation.

I. INTRODUCTION

Authorities are encouraging wastewater reuse as a result of the rapid depletion of natural water supplies brought on by drought and population increase. Textiles and other water-intensive industries must manage wastewater more sustainably due to rising costs and stringent disposal laws (Amar et al., 2020). As a result, treated wastewater is today seen as a valuable resource, and sustainable production depends on its effective use, treatment, and reuse (Lafi et al., 2021).

For procedures including bleaching, dyeing, and printing, the textile industry uses 100–200 litres of high-quality water per kilogramme of fabric, resulting in significant amounts of effluent that is laden with dyes (Jager et al., 2018). According to Lara et al. (2017), this effluent is one of the most polluting industrial wastes and has a significant negative influence on aquatic ecosystems due to its high concentration of poisonous dyes, detergents, and salts. These difficulties highlight the necessity of effective wastewater treatment and reuse techniques.

Textile wastewater often contains high salinity—up to 6.0 wt% NaCl or 5.6 wt% Na₂SO₄—which must be addressed for reuse (Lin et al., 2019). Membrane-based techniques like ultrafiltration (UF) and reverse osmosis (RO) improve water quality by removing dyes and salts (Lara et al., 2017). UF-diafiltration has shown 98% desalination and over 97% dye recovery (Lin et al., 2019), while UF-electrodialysis-treated effluent meets reuse standards (Lafi et al., 2021). Integrated treatments, such as biological treatment with nanofiltration (NF) or RO, are effective in denim wastewater reuse (Amar et al., 2020). RO can reduce colour from 660 to 12 ADMI units (Jager et al., 2018) but has a lower yield and produces concentrated waste. NF has better COD removal but poorer salt rejection (Lafi et al., 2021).

There are drawbacks to other techniques, such as ion exchange, activated carbon filtration, and built wetlands (Zhu et al., 2019; Musmarra et al., 2020). Ozonation is a very successful AOP, particularly when combined with biological treatment (Oppong et al., 2021; Musmarra et al., 2020), while UF is a dependable pre-treatment step (Lin et al., 2019). However, at a larger scale, advanced treatment combinations such as O₃/UV or O₃/UV/H₂O₂ are often cost-prohibitive and impractical for widespread application (Lafi et al., 2021).

MATERIALS AND METHOD:

3.1 Sample collection

In Tirupur, Tamil Nadu, an area renowned for its high concentration of textile manufacturers, water samples were taken from dyeing facilities. Based on obvious indicators of pollution, including discolouration, a strong smell, and suspended particles, sampling sites were chosen. Sterilised 1–2 L plastic containers were used to collect the samples, which were then rinsed three times with sample water, labelled with the date, time, and location, and brought to the lab for examination under chilled circumstances. Prior to and following treatment, measurements were made of physico-chemical parameters like pH, total dissolved solids (TDS), total suspended solids (TSS), total hardness, and iron concentration.

3.2 Filtration Bed Preparation

There were two clear plastic containers used, one of which served as the collection unit and the other as the filtration unit. Based on their individual roles—mechanical filtration, adsorption, and phytoremediation—cotton, coconut coir charcoal, vetiver roots, and powdered *Canna indica* were layered one after the other in fabric pouches to create the natural filtration bed.

3.3 FILTER MEDIA PREPARATION

3.3.1 Layer 1: Gossypium cotton

The initial layer utilised to remove coarse particles was cotton. It is appropriate for mechanical filtration due to its high absorbency and porous nature. It is environmentally benign, non-toxic, and biodegradable.

3.3.2 Layer 2: Biochar from Coconut Coir

After being cleansed with deionised water, coconut shells were crushed into powder and oven-dried for 48 hours at 80°C. After being impregnated with concentrated phosphoric acid (H₃PO₄), the powder was carbonised for two hours at 600°C in a 2ZTF-1100-2035 furnace, cooled, cleaned to neutral pH, and oven-dried once more for twenty-four hours at 80°C. Heavy metals and colours were adsorbed using the resultant biochar.

3.3.3 Layer 3: Vetiver (*Chrysopogon zizanioides*)

The fresh vetiver roots were shade-dried for three to five days after being cleaned five to eight times with distilled water. Heavy metals and microbiological pollutants were eliminated using the cleaned roots, which are renowned for their phytoremediation potential.

3.3.4 Layer 4: *Canna indica* (Kalvalai)

After five to seven thorough washings, the *Canna indica* plants were shade-dried for five to six days before being milled into a fine powder. The powder was used to further remove heavy metals and nutrients after being packed into cotton pouches.

3.4 CHEMICAL AND PHYSICAL ANALYSIS

3.4.1 Total Dissolved Solids (TDS)

Principle: TDS levels were calculated from the electrical conductivity of the water sample using a calibrated digital meter.

Procedure: The meter probe was rinsed with distilled water, dried, and immersed in the sample. After the reading stabilised, the value was recorded in mg/L.

3.4.2 Total Suspended Solids (TSS)

Principle: The idea is to filter water using a glass fibre filter that has been previously weighed. To determine TSS, the filter is reweighed after being oven-dried.

Procedure: 100 mL of water was filtered. The filter was dried at 103–105°C, then cooled in a desiccator before being weighed.

3.4.3 Total Hardness

Principle: Determined by complexometric titration using EDTA and Eriochrome Black T indicator.

Procedure: 50 mL of sample was titrated with 0.01 M EDTA in the presence of ammonia buffer and indicator.

3.4.4 pH

Principle: The principle is based on the potential difference generated by hydrogen ions in solution, measured using a pH meter with a glass electrode.

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RESULTS AND DISCUSSION

Using the created natural filtering system, the physico-chemical characteristics of textile effluent were examined both before and after treatment. Table 1 shows the variation in the amount of iron, total dissolved solids (TDS), total suspended solids (TSS), and total hardness.

PARAMETERS	PRE TESTING	POST TESTING
Total Dissolved Solids	13616 mg/L	4913mg/L
Total Suspended Solids	568 mg/L	232 mg/L
Total Hardness	230 mg/L	140 mg/L
pH	11.3	6.8
Iron	0.793 mg/L	0.302 mg/L

5.1 TEST FOR TOTAL DISSOLVES SOILD (TDS)

Excessive TDS levels in textile effluent raise the salinity of the water, which harms aquatic life, soil, and sources of drinking water. TDS decreased from 13,616 mg/L to 4,913 mg/L thanks to the filter system, demonstrating efficient pollutant removal and enhanced water quality appropriate for non-potable reuse.

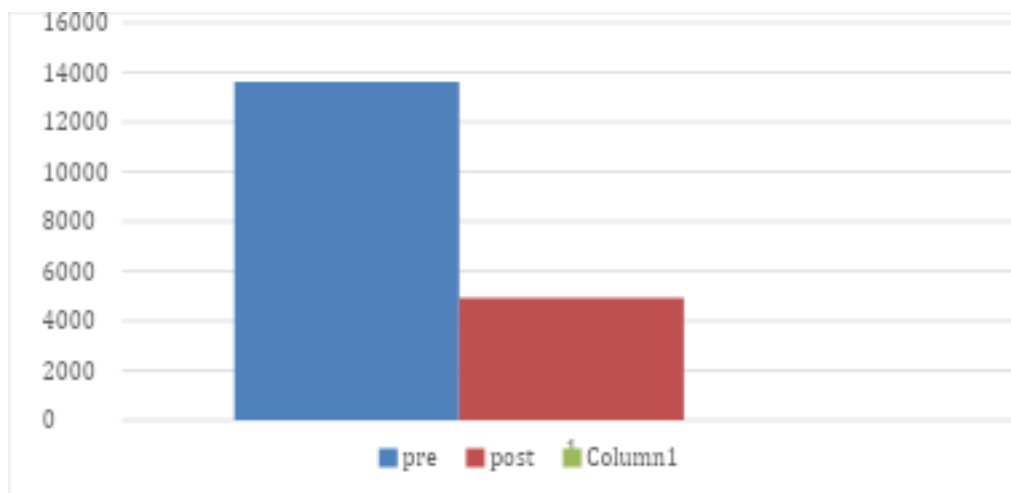


Table 1.1 Shows the observed value of (TDS)

5.2 TOTAL SUSPENDED SOLIDS(TSS)

In aquatic environments, TSS stands for undissolved particles like fibres and dyes that raise turbidity and interfere with photosynthesis. TSS was reduced from 568 mg/L to 232 mg/L following the treatment process. This decrease makes the effluent safer for irrigation or discharge by improving water clarity and minimising ecological disturbance.

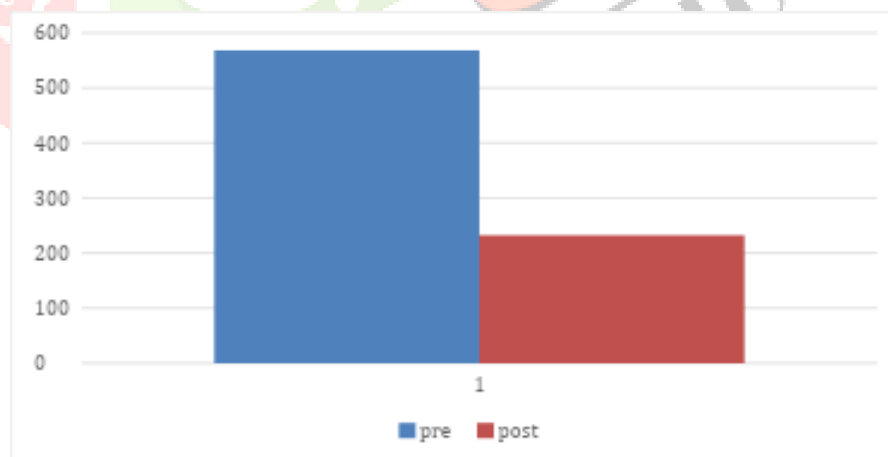


Table 1.2 Shows the observed value of (TSS)

5.3 Total Hardness

High hardness, which is brought on by calcium and magnesium ions, has an impact on soil structure and industrial machinery. Hardness was reduced from 230 mg/L to 140 mg/L by the filtering unit, suggesting that the water is now softer and more suitable for reusing in industrial or agricultural settings.

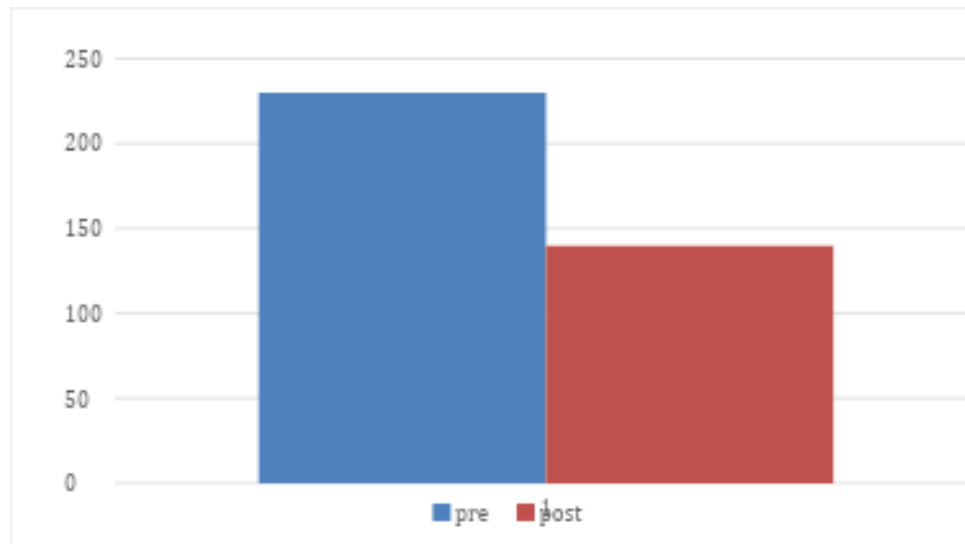


Table 1.3 Shows the observed value of Total hardness

5.4 pH

Untreated wastewater with strong alkalinity (pH 11.3) poses a risk to aquatic ecosystems and disrupts the natural chemical balance of water bodies. Following treatment, the pH dropped to 6.8, which is close to neutral, ensuring that the water is safe for the environment and complies with discharge regulations.

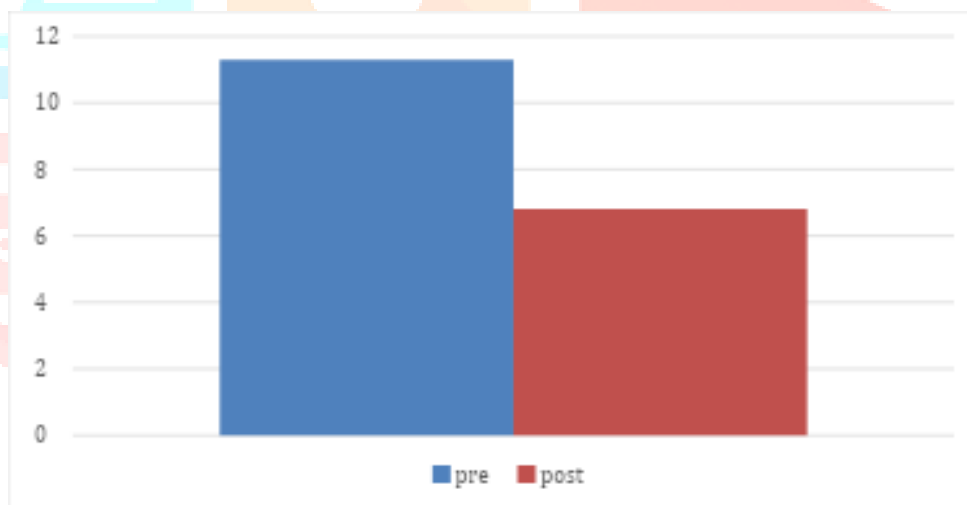


Table 1.4 Shows the observed value of pH

5.5Content of Iron

Wastewater containing too much iron discolours and encourages bacterial growth, which impacts aquatic life and irrigation systems. The effective removal of metal contaminants was demonstrated by the filtering system, which decreased the iron concentration from 0.793 mg/L to 0.302 mg/L.

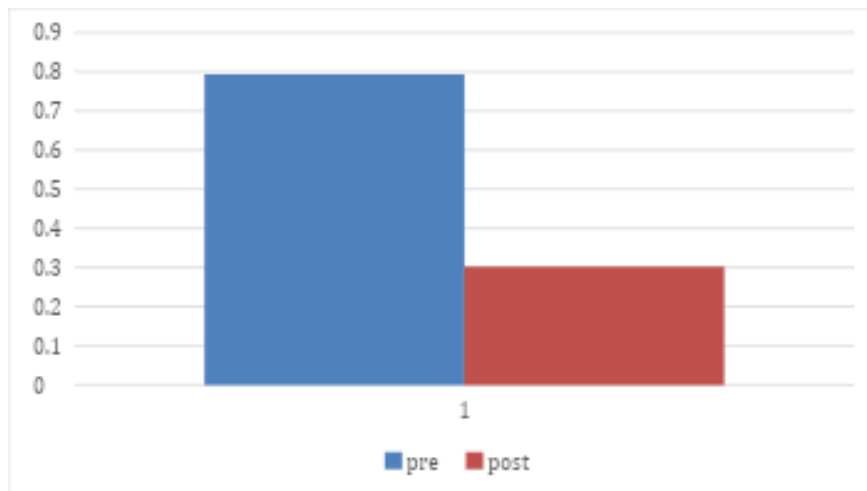


Table 1.5 Shows the observed value of iron

CONCLUSION:

This study evaluates a natural, multi-layered filtration system made of cotton, vetiver, coconut coir biochar, and *Canna indica* used to treat dye-contaminated textile effluent from Tirupur. While maintaining pH stability, the filtration unit successfully eliminated important contaminants such as iron, total dissolved solids (TDS), and total suspended solids (TSS). This is achieved through the combined mechanisms of physical filtration, chemical adsorption, and phytoremediation. The water quality significantly improved, according to the data, demonstrating the system's potential as an affordable and sustainable substitute for traditional treatment techniques. This natural filtration method is appropriate for small-scale companies and water-stressed areas because of the materials' biodegradability, affordability, and local availability. Through future process optimisation and scaling, the system's usefulness in managing industrial wastewater can be further enhanced.

Implementing such nature-based solutions can help restore local water bodies, improve public health, and support sustainable industrial practices. This project serves as a model for integrating traditional ecological knowledge with modern environmental engineering. The success of this natural filtration system demonstrates a practical approach to eco-friendly wastewater management in developing regions. By using locally sourced, biodegradable materials, the system minimises its environmental footprint while providing an affordable solution for pollution control. Its simplicity and adaptability make it ideal for deployment in small-scale textile units that often lack access to centralised treatment facilities.

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