Remediation of waste water through natural coagulants such as lemon and banana peel

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Abstract. Water is not only necessary for survival, but it also adds significantly to the quality of our lives. The rapid increase in population, economic expansion, and industrialization in developing nations has led to an unexpected need for water in cities. The capacity for water uses and wastewater generation in residential sectors has significantly risen during the past few decades. Wastewater treatment is an essential procedure in the sanitation system. Reusing resources and adhering to environmental regulations require efficient treatment and pollution management of municipal wastewater resources. The most preferred method for treating wastewater among the many options currently available is the coagulation and flocculation processes. People widely use this treatment due to its low-energy consumption, reliability, affordability, and ease of use. This study evaluated the use of banana and lemon peels as coagulants in water treatment using coagulation-flocculation procedures as a potential substitute for alum. We determined the pH and coagulant dose for both banana and lemon peel combinations. The results of this experiment show that lemon peel works well as a coagulant to absorb biological oxygen demand. It has been discovered that the dehydration procedure works better with peels from bananas and lemons. The ideal duration of contact between lemon and banana peels is 90 minutes. For peels of bananas and lemons, the optimal particle size is 300μm, and the ideal dosage of adsorbent is 0.3g.

Keywords: Natural Coagulants, Lemon, Banana, Turbidity.

1 Introduction

Water is an essential element for sustaining existence. Each and every living thing requires water to survive. Water is utilized in numerous ways, including for heating, drinking, irrigation, and manufacturing [1]. Despite the fact that water covers over 70% of the Earth's surface, the proportion of pure water in this resource is negligible, amounting to less than 1%, and its distribution across the globe is uneven. There are over a billion people globally who do not have access to clean drinking water, primarily in poorer nations. In addition to the lack of water, many regions of the world face numerous other

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difficulties in providing a sufficient, safe, and consistent supply of water [2]. Due to overexploitation, ground and surface water levels are continuously declining, while the demand for water around the world is rising daily as a result of the rapidly growing population. Treatment and reuse of wastewater is one popular approach to finding alternatives for water supply.

The consequence of this is that a significant amount of wastewater is produced, which contains a high concentration of organic elements such as lipids, proteins, and carbohydrates [3–6]. Given the large variety of methods that are used for wastewater treatment, the purpose of the current study was to investigate the possibility of using low-cost adsorbents that were formed from banana and lemon peels for the treatment of wastewater using these materials. In every region of the world, people throw away banana peels since they are considered to be agricultural waste. Despite their promise for compost and cosmetics, they pose a challenge to waste management. Both personal care and medical purposes can benefit from the material's antifungal and antibacterial qualities. In addition, banana peels have the ability to absorb substances. It is extremely beneficial for purification and refining procedures. It has the ability to adsorb copper, certain pigments, and chromium from wastewater. In water treatment facilities, lemon peels can be utilised as an inexpensive natural coagulant agent during the coagulation process, making them a valuable and eco-friendly resource [7-9]. Lemon peels can reduce the turbidity of artificially turbid water by acting as a coagulant agent.

1.1 Objective of study

1. In order to investigate the characteristics of wastewater.
2. To gain an understanding of the influence that the dosage of the adsorbent, pH, contact time, and particle size have.
3. To investigate the influence that turbidity holds.
4. To investigate the influence and variations of waste water characteristics, such as biological oxygen demand (BOD), dissolved oxygen (DO), and other similar factors.

1.2 Coagulation Activities

Sand Filtration
Sand filtration is a fast and simple pre-treatment process. The sand container is filled with gravel and has a spout at its bottom. Water is taken from a transport container and pumped into the container [8]. The water is then pumped into the storage tank. Sand filtration is easy and fast for the user, effective in removing certain bacteria, and cost-effective if sand is available locally.

Settling & Decanting
Turbidity can be decreased through settling and decanting, which involves permitting particulates to settle to the container's bottom for two to four days. Following this, the uppermost volume of the purified water is transferred to an alternative receptacle. One benefit of settling and decanting is that it can be performed using only containers and no other equipment [9].
2 Materials and methodology

2.1 Methods

The household waste of banana peels and citrus was gathered. Moreover, tap water was gathered. The pH of the sample was ascertained utilizing a digital pH electrode. Using a nephelometer, the turbidity was determined after forty minutes of mixing at 100 rpm with a rotational shaker. A sequence of conical glass containers, each containing a distinct volume, was inspected individually. After adding 20 ml of sample to each flask, the volume was diluted to 100 ml [10-12]. For each coagulation experiment, synthetic turbid water was utilized. Coagulation of synthetic turbid samples was performed in the coagulation experiment using pre-mixed coagulant in a conventional jar test apparatus.

2.2 Synthetic Water Preparation

To make synthetic turbid water for the jar tests, we mixed the collected tap water with clay particles. The clay components were combined with approximately 30 grams of tap water to make one liter. For almost half an hour, we mixed the suspension to make sure the clay particles were evenly distributed. In order for the clay components to completely hydrate, we allowed it to settle for at least 24 hours. Blending the sample water with the synthetic turbid water supernatant suspension right before coagulation allowed us to attain the desired turbidity [13].

2.3 Preparation of Stock solution using Natural Coagulants

The peels of bananas and lemons are permitted to undergo natural drying until they reach a state of desiccation. Allow the banana and lemon peels to naturally dry until they turn brown. The lemon and banana were pulverized into a fine powder using a household blender to facilitate the dissolution of the active compounds present in the peel. The ultimate outcome possessed a dimension of 300 μm. In order to create a 1% suspension, the powder was combined with distilled water. Prior to filtration with filter paper, the solution underwent strong agitation for a duration of 40 minutes using a magnetic stirrer to facilitate the extraction of coagulant proteins through water. We utilized the constituents of the filtrate to produce an ample quantity of organic coaguants. In order to cease the progression of aging, fresh remedies were formulated and refrigerated on a daily basis. Prior to use, the liquids were forcefully blended.

2.4 Jar Test Procedures

The jar test is widely used as the most common experimental method for coagulation-flocculation. A sample of intentionally turbid water was allowed to coagulate in the trials using a standard jar test apparatus with a range of coagulants. Six steel paddles with six spindles and six beakers were utilized in the batch test. We thoroughly mixed the sample before conducting the jar test. The samples should next have their turbidity assessed. The beakers were
filled with varied concentrations of regulators. The jar test (Fig. 1) was carried out with varying rotation speeds during the entire process.

![Fig. 1. Jar Test Apparatus](image)

### 2.5 Filter Construction

The colour of the wastewater changes to dark brown after being coagulated with banana peel powder. Furthermore, eliminating BOD and raising dissolved oxygen (DO) in wastewater did not result from it with lemon and banana peel powder. For this, a straightforward and inexpensive filter made of sand and charcoal was built. We built a straightforward and inexpensive filter from sand and charcoal for this purpose. We took some fresh charcoal and ground it up into little piece. We were able to save money and reduce waste by placing two plastic bottles with a cylindrical shape and a capacity of two liters each inside of a container. On top of the mesh was a layer of gravel that had been compressed firmly. For the purpose of providing the layers above with strength and support, we placed gravel at the bottom of the structure. Following that, the charcoal fragments were ground into a powder and applied to a more substantial layer. Because of its adsorbent characteristics, charcoal would be able to strip away both scent and color. In order to achieve mechanical screening, coagulation, flocculation, and biological activity, this layer was subsequently coated with a layer of well-compacted sand. Additionally, coconut fiber was added to the mixture in order to impart antifungal properties. Next, we used tap water to completely saturate the filter and eliminate all dust and dirt particles. Fig. 2 shows the constructed filter.
3 Results and Discussions

3.1 Effect of pH

Each sample received 0.1 gm of 300µm coagulant, which was weighed using an electronic scale. The pH range of 6 to 8 is where lemon and banana peels are eliminated the most in all situations.

3.2 Effect of Contact Time

At varying contact durations of 30, 60, and 90 minutes, 0.1 g of 300 μm of coagulant was added. As time advances, the elimination percentage rises progressively. Nonetheless, there was a minor drop in the percentage removal of banana and lemon peel after 120 minutes.

3.3 Effect of Adsorbent Dosage

0.1 g of 300 μm coagulant, administered at 0.05, 0.1, 0.2, and 0.3 g dosages, in that order. The bulk of the coagulant dosage rose in proportion to removal. The greatest removal was attained at 0.3g.

3.4 Effect of Particle Size

300 μm coagulant in 0.1 g portions, with varying particle sizes of 300, 425, and 600 μm, respectively. A reduction in the size of adsorbent particles leads to a rise in the percentage of BOD removed. At 300 μm, the highest removal takes place. Because of their high organic carbon content (41.37%), selected banana peels serve as a bio-adsorbent. These peels have undergone bio-methanation to produce biogas. We used the peels as a material to produce charcoal and
activated charcoal adsorbents. We performed an experiment to assess the efficacy of lemon peels as a coagulant in decreasing the cloudiness of artificially cloudy water. We used the Jar test apparatus to test different dosages and pH levels. The average percentage of coagulant elimination efficiency is displayed in the Table 1 below.

**Table 1. Coagulant elimination efficiency**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Before water treatment</th>
<th>Standard values</th>
<th>After water treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity</td>
<td>70 NTU</td>
<td>5-10 NTU</td>
<td>8 NTU</td>
</tr>
<tr>
<td>Hardness</td>
<td>900 mg/l</td>
<td>300-600 mg/l</td>
<td>513 mg/l</td>
</tr>
<tr>
<td>BOD</td>
<td>95 mg/l</td>
<td>&lt;30mg/l</td>
<td>20 mg/l</td>
</tr>
<tr>
<td>pH</td>
<td>6.7</td>
<td>6.5-8.5</td>
<td>8.2</td>
</tr>
<tr>
<td>DO</td>
<td>5.6 mg/l</td>
<td>mg/l</td>
<td>13.2 mg/l</td>
</tr>
</tbody>
</table>

![Variation of Turbidity and BOD](image)

**Fig.3. Variations of parameters (Turbidity & BOD)**

Turbidity and BOD changed both before and after treatment, as seen in Fig. 3. The plot clearly demonstrates that the turbidity value went from 70 NTU to 8 NTU after water treatment, and the BOD value went from 95 mg/l to 22 mg/l after treating with the coagulant extract.
The change in pH and DO levels before and after water treatment is illustrated clearly in Fig. 4. The dissolved oxygen (DO) level rose from 5.6 mg/l to 13.2 mg/l and the pH level from 6.7 to 8.2 following treatment.

4 Conclusion

Dosage, pH, and turbidity reduction percentage were determined by two separate variables in the water sample. The results showed that increasing the dosage improved the synthetic water sample's turbidity removal capabilities. The addition of locally abundant natural coagulants, such as lemon and banana peels, greatly enhanced the removal of turbidity and BOD from synthetic tap water. Waterways that were extremely muddy saw the most decrease in turbidity. Its use greatly enhances methods for refining and purifying. The water-soluble extract of lemon and banana peels reduced turbidity from 70 to 8 NTU after filtering following dosage. Additionally, it was discovered that these organic coagulants reduced BOD by 75–80%. The most successful was found to be lemon peel.

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