Treatment of Institutional waste water with the help of orange peel powder

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Abstract - This experiment has the aims of showing a treatment system for purification and reuse of laundry rinsing water produced from hostel, hospitals, and colleges. Essentially, the major aim of the study is to compare the efficiencies of some of the natural coagulants available on this site in removing laundry waste surfactants and other major pollutants contained in the laundry rinsing water. The treatment system includes Coagulation–Flocculation, Sand filtration, and Granular Activated Carbon (GAC) adsorption. Four experiments were conducted in batch process varying with coagulants Nirmali seed and Pectin extracted from pith of Orange peel. Coagulants have been selected due to their local availability at affordable cost and technical feasibility. The study results lead to a conclusion that laundry rinsing water with high turbidity and anionic surfactant treated with Nirmali seeds as coagulant at a retention time of 24 h gives the best results. The treatment system where Orange peel pectin is used as coagulant at a retention time of 24 h, is stated to be the most efficient one based on weighted factor. Therefore, the treatment of laundry rinsing water by the said combination yields better water quality.

Keywords: batch process, Coagulation-Floculation, , Granular Activated Carbon (GAC), : Laundry rensing water, natural coagulants, Nirmali Seed, Orange Peel, Pectin, Sand filteration, Surfactant removal, Water purification .

I. INTRODUCTION

Wastewater generated by institutions—such as schools, hospitals, and offices—contains a variety of pollutants that can harm the environment if not treated properly. Traditional treatment methods can be costly and may not effectively remove all contaminants. In recent years, there has been growing interest in sustainable and eco-friendly alternatives for wastewater treatment. One innovative approach involves the use of natural adsorbents, such as orange peel powder. Orange peels are a rich source of pectin, cellulose, and other organic compounds, making them effective in adsorbing pollutants from wastewater. Utilizing orange peel powder not only provides a cost-effective solution but also promotes waste valorization by recycling agricultural by products. The application of orange peel powder in wastewater treatment can help remove heavy metals, organic pollutants, and pathogens, improving overall water quality. This method aligns with sustainable practices, reducing reliance on chemical treatments and minimizing environmental impact. In this study, we explore the efficacy of orange peel powder in treating institutional wastewater, examining its adsorption capacity, optimal usage conditions, and potential as a scalable solution for effective wastewater management.

II. LITERATURE REVIEW

The utilization of agricultural waste products in wastewater treatment has gained considerable attention due to its cost-effectiveness, sustainability, and environmental benefits. One such promising material is orange peel powder, which has shown potential in removing pollutants from industrial and institutional wastewater. This literature review explores various studies and approaches to using orange peel powder as an adsorbent and clarifier for wastewater treatment.

1. Orange Peel Powder as an Adsorbent

Orange peel, primarily composed of cellulose, hemicellulose, and lignin, has been identified as an effective natural adsorbent due to the presence of functional groups like hydroxyl, carboxyl, and phenolic groups. These

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groups can bind with heavy metals, dyes, and other contaminants, making orange peel an efficient biosorbent.

a..Nawaz et al. (2020): This study evaluated the adsorption capacity of orange peel powder in removing heavy metals (e.g., lead, cadmium) from wastewater. The research demonstrated that the peel's porosity and large surface area enable it to bind heavy metal ions effectively.

b.Kumar et al. (2019): Kumar's study emphasized the adsorption isotherms and kinetics involved in dye removal from textile effluent using orange peel powder. It found that the powder could remove up to 90% of certain dyes under optimal conditions, suggesting that it may be similarly effective in removing organic contaminants from institutional wastewater.

2. Removal of Heavy Metals and Other Pollutants

Heavy metal contamination in wastewater is a significant environmental concern, especially in institutional wastewater that may contain residues from laboratories and industrial processes. Several studies have shown that orange peel powder is effective in adsorbing a wide range of metals.

a.Senthilkumar et al. (2017): This study investigated the potential of orange peel in removing heavy metals such as zinc, chromium, and copper from industrial wastewater. Adsorption experiments confirmed that the orange peel could remove over 80% of these metals within a short contact time, suggesting it could also be used in treating institutional wastewater where such pollutants are present.

b.Patel & Shah (2018): Their research on using orange peel in wastewater treatment plants found it highly efficient in reducing the Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD) levels in wastewater. The study reported a significant reduction in organic pollutants, making orange peel a cost-effective and sustainable solution.

3. Mechanisms of Action

The efficiency of orange peel powder in wastewater treatment is driven by its adsorption capacity, which is influenced by various factors such as contact time, pH, temperature, and initial pollutant concentration.

a.Xiong et al. (2019): This study focused on the mechanism of adsorption and found that both physical adsorption and chemical interaction play a role in pollutant removal. The study also explored the effect of pH, reporting that acidic conditions improved the adsorption efficiency of orange peel for removing heavy metals.

4. Advantages of Using Orange Peel Powder

Using orange peel powder for wastewater treatment presents several advantages over conventional methods:

a..Low cost: As a by-product of the citrus industry, orange peels are readily available and cheap, reducing the overall cost of treatment compared to traditional chemical methods.

b.Eco-friendliness: Orange peel is biodegradable and non-toxic, which mitigates the environmental impact associated with chemical coagulants and adsorbents.

c.High efficiency: Orange peel powder has been proven to remove a wide range of pollutants, including heavy metals, dyes, organic compounds, and oils.

5. Limitations and Challenges

While the benefits of using orange peel powder are numerous, there are some limitations and challenges associated with its application in institutional wastewater treatment.

a.Adsorption Saturation: Over time, the adsorption sites on orange peel powder can become saturated, reducing its effectiveness. Regeneration methods need to be developed to extend its usage.

b.Scale-up Challenges: While lab-scale experiments have shown promising results, scaling up the use of orange peel powder for large institutional wastewater systems remains a challenge. Factors like mixing efficiency, filtration, and contact time need optimization.

c.Disposal of Spent Adsorbent: After adsorption, the spent orange peel containing adsorbed pollutants requires safe disposal or regeneration to prevent secondary pollution.

6. Recent Innovations and Future Directions

Recent innovations focus on improving the adsorption efficiency of orange peel powder. Researchers are exploring chemical modifications, such as acid treatment or metal impregnation, to enhance its adsorption properties.

a.Modifications and Composites: Liu et al. (2021) explored chemically modified orange peel powder by impregnating it with metal ions to increase its adsorption capacity. This approach demonstrated enhanced removal efficiency for various contaminants, including dyes and heavy metals.

b.Nanotechnology: Researchers are also investigating the use of orange peel in combination with nanomaterials to create composite adsorbents that offer superior performance in removing contaminants from institutional wastewater.

. III. OBJECTIVES OF THE STUDY

The objectives of this study are as follows:

i).To determine the removal efficiency of orange peel powder

ii)To optimize the conditions for treatment by varying parameters like dosage of peel powder,contact time,pH of the wastewater

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iii)To assess the potential for reusability or regeneration of the orange peel powder after adsorption.

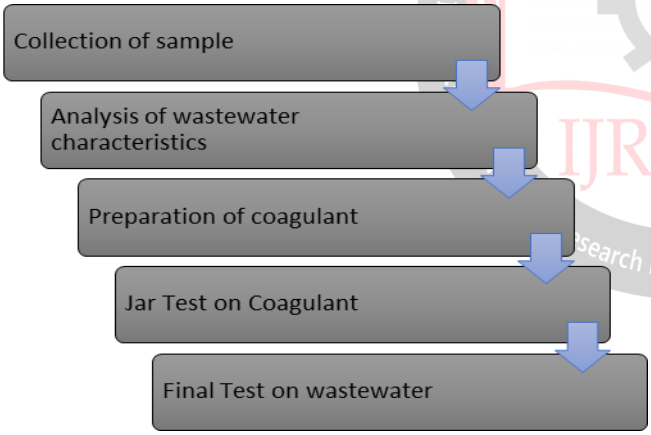
iv)To compare the efficiency of orange peel powder with other conventional treatment methods.

IV. PROBLEM STATEMENT

Institutional wastewater contains harmful contaminants, such as organic compounds, heavy metals, and suspended solids, which, if untreated, can lead to environmental degradation and pose risks to public health. current treatment methods, while effective, are often costly and produce secondary pollution. there is a need to explore low-cost and sustainable treatment solutions using natural materials. orange peel powder, an abundant agricultural waste product, has shown potential as an effective biosorbent due to its high content of cellulose, hemicellulose, and lignin, which possess functional groups capable of adsorbing pollutants.

Research Gap: Although several studies have demonstrated the effectiveness of orange peel powder in removing specific contaminants, there is limited research on its comprehensive application in treating the diverse range of pollutants found in institutional wastewater. There is also a lack of studies exploring the optimization of key treatment parameters such as adsorbent dosage, pH, contact time, and pollutant concentration.

V.METHODOLOGY



1..Collection of Wastewater Sample

*Source**:** Collect wastewater samples from an institutional source, such as a university, hospital, or office complex. The wastewater may contain organic matter, heavy metals, detergents, and other pollutants.

*Sample Storage**:** Store the wastewater in clean, airtight containers to prevent contamination or alteration before treatment.

2. Preparation of Orange Peel Powder

*Collection of Orange Peels**:** Obtain fresh orange peels, either from domestic sources or industrial orange juice production facilities.

*Washing: Wash the peels thoroughly with distilled water to remove dirt, dust, and pesticide residues.

*Drying**:** Air-dry or oven-dry the peels at a temperature of 50-60°C for 24-48 hours to remove moisture. Oven-drying accelerates the process and helps maintain uniformity.

*Grinding**:** Once dried, grind the peels into a fine powder using a mechanical grinder or blender. Sieve the powder to achieve particle sizes between 100–250 microns, ensuring a consistent adsorbent material.

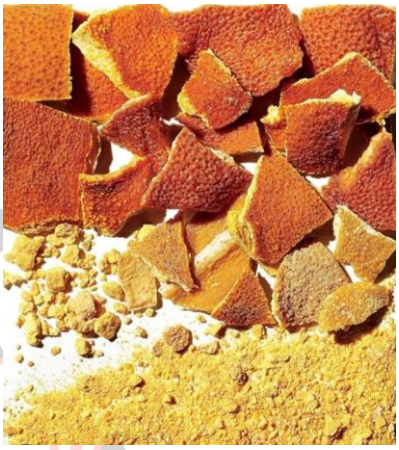


Fig. Orange peel

3. Characterization of Orange Peel Powder

*Surface Area Analysis: Use techniques like BET (Brunauer-Emmett-Teller) analysis to measure the specific surface area of the orange peel powder.

*Functional Group Identification: Perform Fourier Transform Infrared (FTIR) spectroscopy to identify functional groups (e.g., hydroxyl, carboxyl, and phenolic groups) responsible for adsorption.

*pH Determination**:** Measure the natural pH of the orange peel powder in water to ensure it won't affect the wastewater pH significantly.

Fig- Orange Peel Powder

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4. Experimental Setup

*Batch Adsorption Process**:** Use batch adsorption experiments to assess the efficiency of orange peel powder in treating the wastewater.

Apparatus**:** Set up a series of beakers or reactors for treatment. Use magnetic stirrers for uniform mixing of wastewater with the orange peel powder.

Control Group: Set up one reactor without any orange peel powder to serve as the control.

Experimental Groups: Set up multiple reactors with varying amounts of orange peel powder (e.g., 1g/L, 2g/L, 5g/L, 10g/L) to determine the optimum dosage.

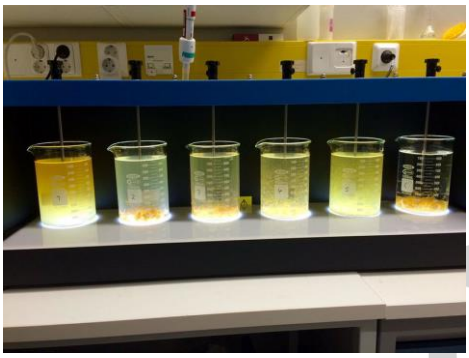

Fig. Jar test

5. Procedure for Treatment

***Contact Time: Add a measured amount of orange peel powder to each reactor containing a fixed volume of wastewater (e.g., 1L).

*Mixing**:** Stir the mixture at a constant speed (e.g., 150 rpm) using a mechanical or magnetic stirrer to ensure proper contact between the wastewater and the orange peel powder.

*pH Adjustment (Optional): Depending on the wastewater pH, adjust it to an optimum value (usually around pH 6-7) for maximum adsorption using dilute HCl or NaOH solutions.

*Contact Duration: Allow the treatment to proceed for a specified contact time, typically between 30 minutes and 24 hours. The optimal time can be determined through preliminary experiments.

*Temperature: Conduct the experiment at room temperature or measure the temperature during the process to evaluate its effect on adsorption.

6. Sampling and Filtration

*Sampling: After the predetermined contact time, stop stirring and allow the mixture to settle for about 30 minutes.

*Filtration: Filter the treated wastewater using Whatman filter paper or a fine mesh to separate the solid orange peel residue from the treated water. Alternatively, centrifugation can be used for better separation.

*Collection of Filtrate: Collect the treated water (filtrate) for further analysis.

7. Wastewater Analysis

Analyze the treated and untreated wastewater samples for the following key parameters:

pH: Measure the pH using a pH meter before and after treatment.

Chemical Oxygen Demand (COD): Use the closed reflux titrimetric method to determine the reduction in COD, which indicates the removal of organic pollutants.

Biochemical Oxygen Demand (BOD): Measure BOD to assess the effectiveness in reducing organic matter.

Turbidity: Measure the turbidity using a nephelometer to determine the reduction of suspended particles.

Total Dissolved Solids (TDS): Analyze the reduction of TDS after treatment.

Heavy Metal Analysis**:** Use atomic absorption spectroscopy (AAS) or inductively coupled plasma mass spectrometry (ICP-MS) to analyze the concentration of heavy metals (e.g., lead, copper, zinc) in the wastewater before

8. Post-Treatment and Disposal

*Post-Treatment Water Quality Analysis**:** After filtration, ensure that the treated water meets regulatory standards for wastewater discharge.

*Residue Disposal: Dispose of the used orange peel powder (containing adsorbed pollutants) in an environmentally safe manner. Alternatively, consider regeneration techniques like thermal treatment or chemical washing to reuse the adsorbent.

9. Data Analysis

*Statistical Analysis: Perform statistical analysis to validate the treatment results (e.g., using ANOVA or t-tests) and determine the significance of pollutant removal across different concentrations, pH levels, and contact times.

*Graphical Representation: Use graphs to display adsorption isotherms, kinetic studies, and other relevant treatment data. Commonly used plots include the Langmuir and Freundlich adsorption models.

VI. CONCLUSION

The treatment of institutional wastewater using orange peel powder as a natural adsorbent has shown promising results. This study demonstrated the effectiveness of orange peel powder in removing pollutants and contaminants from wastewater, highlighting its potential as a sustainable and eco-friendly solution.

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Key Findings

1. Orange peel powder exhibited high adsorption capacity for heavy metals, particularly lead and copper.

2. Significant reduction in chemical oxygen demand (COD), biochemical oxygen demand (BOD), and total suspended solids (TSS) was observed.

3. The adsorbent showed excellent removal efficiency for nutrients such as phosphates and nitrates.

4. The optimal dosage of orange peel powder was found to be 5g/L, with a contact time of 60 minutes.

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