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RSST005 - SUSTAINABLE TREATMENT OF AGRICULTURAL EFFLUENT USING SUGARCANE BAGASSE AND ALUMINIUM SULFATE

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ABSTRACT

Agricultural activities often lead to water pollution due to fertilizer use, which can cause eutrophication and harm ecosystems. This study aims to evaluate the effectiveness of sugarcane bagasse extract and aluminum sulfate as coagulants in treating agricultural effluent, focusing on turbidity, pH, and nitrate removal. A jar test experiment was conducted using various dosages to determine the optimum level for each coagulant. Sugarcane bagasse extract showed its best performance at 12 mg/L, removing about 42% turbidity, while aluminum sulfate achieved 100% turbidity removal at 48 mg/L. However, aluminum sulfate lowered the pH to 3.91, making it less suitable for irrigation. In contrast, sugarcane bagasse maintained a safer pH of 4.705. For nitrate removal, aluminum sulfate showed consistent and stable performance, while sugarcane bagasse results were more variable. Overall, aluminum sulfate is highly effective in removing turbidity and nitrate but may not be ideal for applications requiring a neutral pH. Sugarcane bagasse extract shows potential as a natural coagulant but requires pre-treatment to improve its performance.

Keywords – *agricultural effluent, aluminium sulphate, coagulant, sugarcane bagasses*

INTRODUCTION

One of the key issues contributing to water pollution is the rapid growth of the human population, which leads to increased demand for clean water, particularly in the agricultural sector (Lal & Gupta, 2009). This study focuses on agricultural effluents from paddy fields, where extensive use of fertilizers has led to water quality concerns. In many cases, untreated water from these fields is discharged directly into nearby drainage systems. As a result, fertilizer residues often pollute streams and drains, adversely affecting aquatic ecosystems and communities that depend on clean water (Norlida et al., 2021).

A common method for treating such wastewater is the coagulation-flocculation process, traditionally using chemical coagulants such as aluminium sulfate (alum). However, long-term use of aluminium-based coagulants has been associated with health concerns, including a possible link to Alzheimer's disease (Flaten, 2021). Therefore, exploring alternative, natural coagulants has become increasingly important.

This study aims to evaluate the efficiency of sugarcane bagasse and aluminium sulfate as coagulants in reducing contaminants from agricultural effluent, and to determine the optimum dosage for each. Sugarcane bagasse is a biodegradable and eco-friendly byproduct of sugar production, making it a promising alternative due to its abundance and low cost, especially in developing countries.

A series of laboratory experiments were conducted to compare the effectiveness of sugarcane bagasse extract and aluminium sulfate solution in removing water quality parameters such as turbidity, pH, chemical oxygen demand (COD), nitrate, and ammonia nitrogen. The ultimate goal is to assess the potential of sugarcane bagasse as a sustainable coagulant and to contribute to cost-effective water treatment strategies in rural agricultural communities. Previous studies by Fermino et al. (2017) and Ghebremichael (2004) support the use of natural coagulants for reducing treatment costs and improving accessibility in areas lacking adequate treated water supply.

OBJECTIVE

This study aims to investigate the effectiveness of different coagulants in treating agricultural effluent, specifically from paddy field runoff. The primary objective is to assess the efficiency of sugarcane bagasse, a natural and eco-friendly material, in reducing key water contaminants. Additionally, the study evaluates the performance of aluminium sulfate, a widely used conventional coagulant, for comparison purposes. Finally, the research seeks to determine the optimum dosage for both sugarcane bagasse and aluminium sulfate to achieve the most effective treatment outcomes in terms of contaminant removal.

METHODOLOGY

Sugarcane bagasse was collected from a local vendor in Pekan Sekinchan, Selangor, in wet condition due to its availability from the sugarcane juice extraction process. After washing with tap water, the bagasse was sun-dried for approximately 6 hours daily over four days. It was then ground and sieved through a 500-micron mesh to obtain a fine powder. To prepare the extract, 5 grams of sugarcane bagasse powder was mixed with 1 liter of distilled water, heated to 100°C for 3 minutes, and stirred for 2 hours using a magnetic stirrer. The solution was filtered using vacuum extraction and stored at 4°C. A 10 g/L aluminium sulfate solution was also prepared as a conventional chemical coagulant.

Effluent samples were collected from paddy fields in Sekinchan using a motorcycle, which was more suitable for accessing narrow field roads. A total of 6 liters of agricultural effluent was collected and stored at room temperature. Laboratory experiments were then conducted to evaluate the treatment performance of both sugarcane bagasse extract and aluminium sulfate. The Jar Test method was employed to simulate coagulation-flocculation. Samples were rapidly mixed at 200 rpm for 1 minute, followed by slow mixing at 80 rpm for 30 minutes. The mixtures were then allowed to settle for 1 hour to observe floc formation and sedimentation.

To assess the efficiency of each coagulant, several water quality parameters were analyzed. pH was tested using a pH meter and 100 mL beakers to compare untreated samples with those treated with various coagulant dosages. These tests aimed to observe

the physical and chemical changes in water quality after treatment. Further analysis included nitrate and ammonia nitrogen testing. Nitrate was measured using NitraVer3 and NitraVer6 reagent pillows, with treated samples analyzed in sample cells to evaluate nutrient pollution removal.

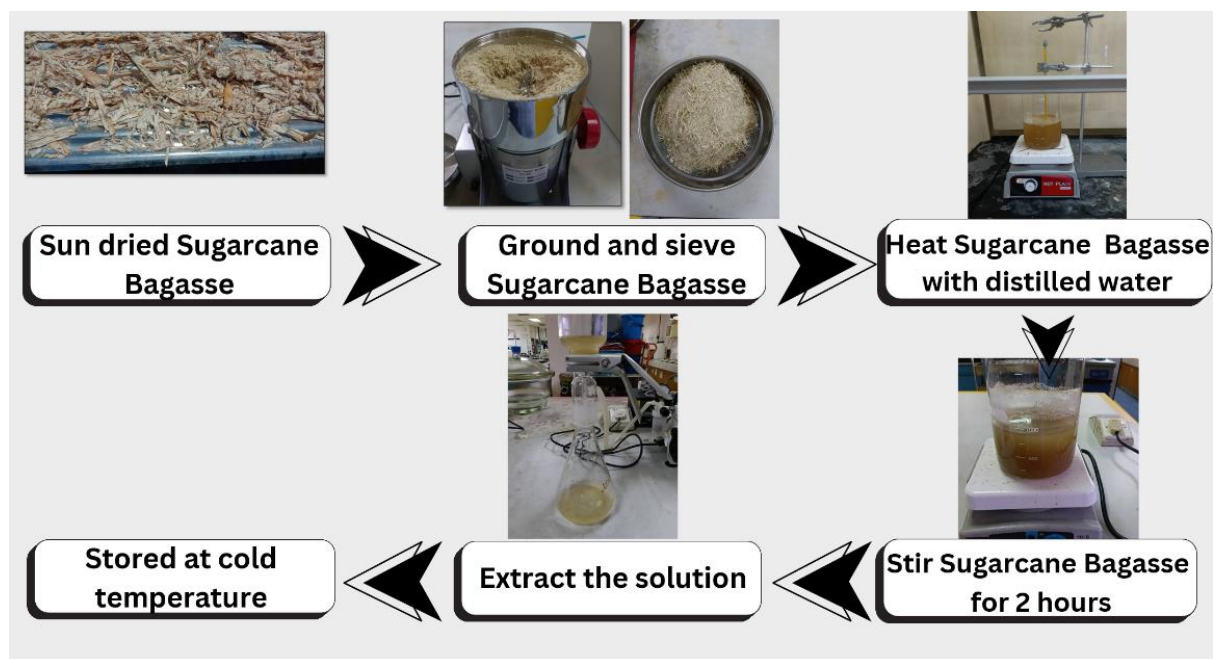


Figure 1: The process of making sugarcane bagasses coagulant

RESULTS AND DISCUSSION

The result shows that aluminium sulfate removed turbidity very effectively, reaching almost 100% removal at 48 mg/L dosage. This makes 48 mg/L the best dosage for aluminium sulfate. Sugarcane bagasse had little effect on pH. The pH remained between 4.7 and 5.5 across all dosages, meaning it does not significantly change the acidity of the water. In contrast, aluminium sulfate reduced the pH steadily as the dosage increased. At 120 mg/L, the pH dropped to about 3.2, showing strong acidification. This suggests that aluminium sulfate may require pH adjustment after treatment, while sugarcane bagasse is more pH-friendly and safer for the environment.

Aluminium sulfate gave better overall nitrate removal, reaching up to 60% removal at higher dosages (around 100–120 mg/L). The removal increased steadily with dosage, showing a more stable trend. Meanwhile, sugarcane bagasse showed some nitrate removal at lower dosages (up to 40% at 20 mg/L), but its performance was inconsistent and dropped at certain points. Although less effective than aluminium sulfate, sugarcane bagasse still shows potential as a natural coagulant for moderate nitrate removal, especially at lower dosages.

CONCLUSION

Sugarcane bagasse showed optimum turbidity removal (42%) at 12 mg/L, but performance dropped at higher doses. Aluminum sulfate performed better, removing

100% turbidity at 48 mg/L. However, it lowered the pH to 3.91, while sugarcane bagasse maintained a pH closer to the original (4.705), making it more suitable for irrigation. For nitrate removal, aluminum sulfate was more effective (62.16%) compared to the inconsistent results from sugarcane bagasse.

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