ISSN: 2754-4982

Journal of Civil Engineering Research & Technology

SCIENTIFIC Research and Community

Research Article

Open Access

A Comparative Analysis of The Effectiveness of Plantain Peels and Papaya Seeds for Wastewater Treatment

Jeje JO[1]*, Akanmu AS[1] and Agunbiade AO[1]

Department of Civil Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria

ABSTRACT

This study investigated the effectiveness of plantain peels and papaya seeds used as natural coagulants on the physicochemical properties of wastewater obtained from the oxidation pond at Obafemi Awolowo University (OAU), Ile-Ife. Water quality parameters; Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), turbidity, alkalinity, total solid (TS), total suspended solid (TSS) and pH were determined for raw wastewater. Prepared coagulants of 25 ml concentration (1%, 2% and 3%) of plantain peels and papaya seeds were added to 500 ml of wastewater and the mixture stirred rapidly for 60 seconds and then slowly for two minutes. The treated wastewater samples were then allowed to settle for 24 hours before re-checking the wastewater parameters. Comparing the results and taking the concentration of 5000 mg/L as the most effective for both coagulants, all the results are within the WHO standard except for BOD result which can be said to require higher concentration or dosage of coagulant for significant removal. Papaya seed coagulants was observed to be more effective in the reduction of TSS (95.7%), turbidity (77.8%), BOD (33.3%), alkalinity (25%) and COD (62.3%) while plantain peel coagulant proved to be more effective in the reduction of TS (76%), turbidity (77.8%) and pH (40.4%). Based on these results, papaya seeds observed to be more effective in the treatment of wastewater.

***Corresponding author**

Jeje JO, Department of Civil Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria.

Received: October 16, 2023; **Accepted:** October 19, 2023; **Published:** October 27, 2023

Keywords: Papaya Seeds, Physicochemical Properties, Coagulant, Wastewater, Oxidation Pond

Introduction

Rapid industrialization has posed many threats to the environment due to the wastewater generated from various industrial processes. Indiscriminate disposal of this wastewater, with or without an appropriate level of treatment, can cause water and land pollution [1]. Pollution of water sources due to the dumping of untreated wastewater and chemical waste directly into rivers, lakes, and drains has been of great concern over the last few decades. Unlike organic wastes, heavy metals are non-biodegradable and they can accumulate in living tissues, causing various diseases and disorders such as cancer; therefore, their removal is required before discharge into water bodies [2]. Decontamination of toxic pollutants from water poses a challenging problem, and therefore a wide range of approaches have been explored for their removal.

The potential environmental and human health hazards associated with the use of chemical coagulants have necessitated the use of natural coagulants for industrial wastewater treatment. Attention is being focused on the development of low-cost adsorbents for the treatment of wastewater containing heavy metals [1,3]. The search for low cost, non-toxic and easily available adsorbents have led to the investigation of agricultural waste materials as potential adsorbents. Biochar, the carbon-rich product obtained from the pyrolysis of plant-based materials, has shown some agronomical and environmental benefits [4]. Plant waste such as banana peels and papaya seeds has been found to possess the ability to remove turbidity, heavy metals, and bacteria from contaminated water.

In addition to the surprisingly inventive uses of plantain peels, which include polishing silverware, leather shoes, and the leaves of houseplants, scientists have also included the use of plantain peel as a natural coagulant for the treatment of water. The peel of plantains constitutes 40% of the total weight of fresh plantains. Plantain peels contain sulfur, nitrogen, carboxylic acid, and other atoms that function pretty much the same way magnets do in terms of attracting heavy metals [5]. These molecules do not affect human health. This is great news since heavy metals are one of the biggest problems in terms of water contamination. Plantain peels are very attractive as water purifiers because of their low cost and because they do not have to be chemically modified in order to work [6,7].

According to Papaya seeds work as coagulants due to the presence of positively charged proteins that bind with negatively charged particles (silt, clay, bacteria, toxins, etc.), allowing the resulting flocs to settle and obtain clear water (adsorption and charge neutralization) [8]. Also, papaya seed powder has the ability to join with solids in water and settle to the bottom. Papain (Papaya proteinase) is the important protein present, which contains 345 amino acid residues and consists of a single sequence of propertied and mature peptides. Papaya seeds have also been used to treat water with fecal bacteria [9,10].

Materials and Methods

Description of the Study Area

The study area, Obafemi Awolowo University, is located in Ile-Ife, Osun State, Nigeria, with a population of over 35,000 people. It is bounded by a latitude of 7.5165°N and a longitude of 4.5286°E.

The institution is built on about 5,000 acres (20 km^2) on a site comprising 13,000 acres (53 km^2) of university owned land.

Sample Collection and Preparation

Most of the materials used were obtained from places within and outside Obafemi Awolowo University, Ile-Ife, Osun State, where they are readily available. Wastewater sample was collected from the OAU stabilization ponds (Figure 1), plantain peel was obtained from the popular AP filling station in Ile-Ife, while papaya seeds was obtained within Obafemi Awolowo University campus.

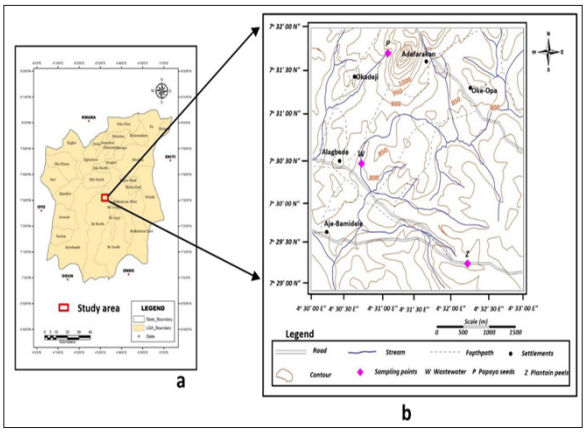

Figure 1: OAU Stabilization Ponds

The plantain peel was diced and washed thoroughly with distilled water to remove any external dirt. The washed pieces of plantain peel were then sundried for three weeks until required moisture content is achieved and the dried peels (Figure 2) were then grinded to a fine powder using a mortar and pestle and then sieved with 1.18 mm IS sieve size to remove the bigger particles, and then stored in an airtight container, while papaya seeds (Figure 3) were crushed into powder form using mortar and pestle.

The general wastewater quality parameters; alkalinity, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Solids (TS), total suspended solid (TSS) and turbidity were measured and their results recorded prior to the application of the prepared natural coagulants. About 500 ml of the wastewater samples was divided and put into six clean white plastic containers with 25 ml of coagulants prepared from banana peel and papaya seed powder in 1 %, 2 % and 3 % added to the wastewater samples contained in the plastic containers (Figure 4) and the mixture stirred rapidly for 60 seconds and then slowly for two minutes. The treated wastewater samples were then allowed to settle for 24 hours before measured the wastewater parameters. Calculations were carried out to obtain the results of each quality parameter. The results obtained in this stage were compared and analyzed.

Figure 2: The Sun-Dried Plantain Peels

Figure 3a: Dried Papaya Seeds

Figure 3b: Grinded Papaya Seeds

Figure 4: The Prepared Natural Coagulants of Plantain Peel and Papaya Seed

Results and Discussion

Table 1 shows the physicochemical characteristics of wastewater before and after treatment with varying concentration of plantain peels coagulant of 5,000 mg/l, 10,000 mg/l, and 15,000 mg/l respectively. While Table 2 shows the physicochemical characteristics of wastewater before and after treatment with varying concentration of papaya seeds coagulants of 5,000 mg/l, 10,000 mg/l, and 15,000 mg/l respectively.

The 5000 mg/L of both coagulants which showed more effective removal of turbidity and TSS, it is observed that both coagulants were effective and reduced the initial values of the measured parameters to meet the WHO standard except for BOD. Nevertheless, the concentration of 15,000 mg/L showed significant reduction in the BOD. Therefore, higher coagulant dosage or concentration is required to remove significant BOD from wastewater. Figures 5 and 6 showed the percentage removal efficiency of plantain peels and papaya seeds coagulants respectively.

Table 1: Physico-Chemical Characteristics of The Wastewater Before and After Treatment with Plantain Peels Coagulant

Parameters	Raw wastewater	Coagulant			WHO standards
		5,000 mg/l	10,000 mg/l	15,000 mg/l	
BOD (mg/L)	234.00	168.00	144.00	48.00	60.00
COD (mg/L)	160.00	70.00	80.00	110.00	150.00
Turbidity (NTU)	9.00	2.00	3.00	4.00	10.00
Alkalinity (mg/L)	88.00	85.00	75.00	77.00	600.00
Total solid (mg/L)	500.00	120.00	160.00	20.00	1200.00
TSS (mg/L)	940.00	120.00	160.00	140.00	200.00
pH	4.70	6.60	6.60	6.70	6-9

Table 2: Physico-chemical Characteristics of the wastewater before and after treatment with papaya seed coagulant

Parameters	Raw wastewater	coagulant (mg/l)			WHO standards
		5000	10000	15000	
BOD (mg/L)	234.00	156.00	162.00	108.00	60.00
COD (mg/L)	160.00	60.00	110.00	120.00	150.00
Turbidity (NTU)	9.00	2.00	5.00	8.00	10.00
Alkalinity (mg/L)	88.00	66.00	68.00	66.00	600.00
Total solid (mg/L)	500.00	180.00	260.00	220.00	1200.00
TSS (mg/L)	940.00	40.00	20.00	100.00	200.00
pH	4.70	6.50	6.50	6.30	6-9

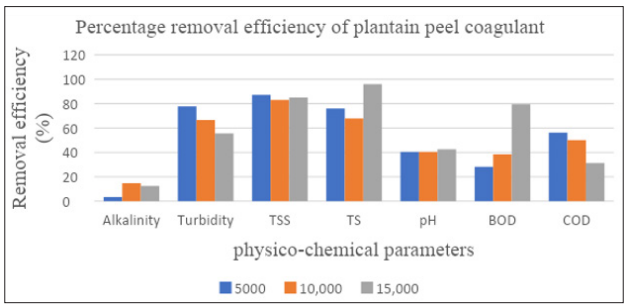

Figure 5: Percentage Removal Efficiency of Plantain Peel Coagulant

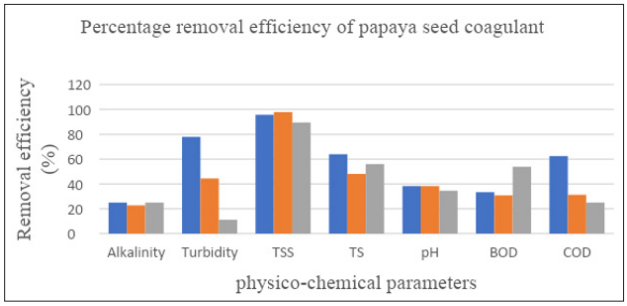

Figure 6: Percentage Removal Efficiency of Papaya Seed Coagulant

Conclusion

Considering the turbidity removal, it can be concluded that the coagulant concentration of 5000 mg/L gave the best performance for both plantain peel and papaya seeds coagulants. Comparing the results and taking the concentration of 5000 mg/L as the most effective for both coagulants, all the results are within the WHO standard except for BOD results which required higher concentration or dosage of coagulant for significant removal. Papaya seeds coagulants was observed to be more effective in the reduction. Based on these results, Papaya seeds can be said to be more effective than plantain peels coagulant.

References

1. Abdulfatai J, Saka A A, Afolabi A S (2012) Development of Adsorbent from Banana peel for Wastewater Treatment. Applied Mechanics and Materials 248: 310-315.
2. George D, Chandran A J (2018). Coagulation Performance Evaluation of Papaya Seed for Purification of River Water, Int. J. Latest Technol. Eng 7: 50-66.
3. Maurya S, Daverey A (2018) Evaluation of plant based natural coagulants for municipal wastewater treatment, 3 Biotech 8: 1-4.
4. Chitra D, Muruganandam L (2019) Performance of natural coagulants on greywater treatment. Recent wInnov. Chem. Eng 13: 81-92.
5. Zaidi N S (2019) Potential of Fruit Peels in Becoming Natural Coagulant for Water Treatment. International Journal of Integrated Engineering 11: 140-150.
6. Maquet C (2020) Wastewater reuse: a solution with a future. The Journal of Field Actions 22: 64-69.
7. Joaquin A A, Nirala G, Kanakasbai R (2021) Response Surface analysis for Sewage Wastewater Treatment using Natural Coagulant. Pol. J. Environ. Stud 30: 1215-1225.
8. Vigneshwarak S, Karthikeyan P, Sirajudhen P (2020) Optimisation of sustainable Chitosan/Moringa Olifeira a coagulant aid for the treatment of Synthetic turbid water – A Systemic Study. Environ. Chem. Ecotoxicol 2: 132-140.
9. Gautam S, Saini G (2020) Use of Natural Coagulant for Industrial wastewater Treatment. Glob. J. Eviron. Sci. Manage 6: 553-578.
10. Elsayed E, El-Den A A, Elkady M, Zaatout A (2020) Comparison of Coagulant Performance Using Natural Coagulant against Traditional Ones. Sep. Sci.Technol 56: 1779-1787.