



School of Engineering Technology Annual International Conference (SAINCONF)



Application of Banana Peel Powder as Natural Coagulant in the Treatment of Grey Water

Abass A. OLATUNJI*, Ayokunle O. FAMILUSI, Ibrahim O. LAMIDI, Joel O. OLUSAMI
and Damilola A. OGUNDARE

Department of Civil Engineering, Federal Polytechnic Ede, Nigeria.

* olatunji.abass@federalpolyede.edu.ng; (Phone Number: +2348068782879)

Abstract: Water is essential not only for survival but also contributes immeasurably to the quality of our lives. Coagulation is an effective, simple and widely practiced water treatment method. However, the usage of chemical coagulant poses detrimental effect on living organisms and human health as well as producing large amount of sludge. This study describes the utilization of banana peel powder (BPP) as natural coagulant in the treatment of grey water. The grey water samples were collected from two different households namely RW1 and RW2. Banana (*Musa Acuminata*) peels were washed, ground into fine powder and sieved to a particle size of 75 μm . X-Ray Fluorescence (XRF) of the BPP was also done to determine its chemical composition. About 2.5 g of BPP was added to 1 litre of grey water sample and the sample was coagulated. After the sedimentation, the samples were filtered using sterilized muslin cloth, and the supernatant was collected and taken to the laboratory for analysis. The BPP reduced the turbidity of both RW1 and RW2 to 40 NTU and 65 NTU from 800 NTU and 1650 NTU respectively. It increased the values of dissolved oxygen from 0.06 mg/L to 0.8 mg/L for RW1 and from 0.04 mg/L to 0.7 mg/L for RW2. It also reduced the concentrations of total alkalinity, total dissolved solids (TDS), total suspended solids (TSS), chloride ions and chemical oxygen demand (COD) in the grey water. The BPP was found to be rich in silica, potassium, calcium, and belongs to alkaline group and potassium alum category of alum. The BPP was found to be a good natural coagulant for grey water treatment.

Keywords: Banana Peel, Bio-coagulant, Coagulation, Grey Water, Natural Coagulant.

1. Introduction

As it is widely used in many productive sectors, including industry, agricultural production, livestock, and urban supplies, water is one of the key determinants for economic development globally (Natarajan *et al.*, 2018). In agricultural nations, rapid industrialization, financial development, and population growth have resulted in unexpected water shortages in urban areas (Priyatharishini *et al.*, 2019). The population is growing swiftly, which in turn increases the need for water, but overuse is also causing a steady fall in ground and surface water levels. Water supply options are being sought, and wastewater treatment and reuse is one popular option (Subashree *et al.*, 2017). By adjusting the electrostatic charges of particles suspended in water, the chemical water treatment process known as coagulation removes solids from water. Coagulants are the substances utilized in the coagulation process, and they can be made of metals, synthetic materials, or biopolymers (Bradley, 2022).

The outer layer of a banana has been transformed into a natural coagulant. The banana (*Musa Acuminata*) tree can only produce fruit in clusters of roughly three to twenty hands once in a lifetime, which results in enormous amounts of biomass waste being produced from the tree globally (Priyatharishini *et al.*, 2019). The capacity for water use and wastewater generation in residence sectors have significantly risen over the previous few decades. One of the most important sanitation systems is wastewater treatment. To achieve environmental consistency and resource reutilization, effective municipal wastewater resource treatment and pollution management are required (Natarajan *et al.*, 2018). Coagulation and flocculation is the most preferred method for treating wastewater out of the many available options. This procedure is frequently used since it is affordable, dependable, easy to use, and is thought to be a low-energy method (Oladoja, 2015).

The consequences of wrong wastewater management can be rather severe. The current global crisis may have an impact on future water demand exploitation unless sophisticated goals are incorporated into the wastewater management process. The growing issues around the world have the potential to have devastating effects on the environment, ecological sustainability, human health, the food supply chain, economic performance, and the well-being of all living things (Jones *et al.*, 2017). Banana peels are the most widely utilized adsorbent because they are readily available, easy to process, and produce excellent results, according to studies that have shown that a variety of adsorbents can be employed for wastewater treatment (Atif *et al.*, 2017). Despite this, such treatment creates disposal issues because the sludge produced as a result of the use of aluminum salts runs the danger of building up in the environment (Priyatharishini *et al.*, 2019). Organic polymers like acrylamide also have a carcinogenic and neurotoxic effect, and the answer to these issues is the substitution of metal and coagulants with natural coagulants which are more environmentally friendly (Priyatharishini *et al.*, 2019).

In order to remediate heavy metal ions from aqueous solution at a cheap cost, green adsorbents made from agricultural waste, residue, and by-products are being investigated (Amit *et al.*, 2022). Tons of banana peels were thrown out and put in the garbage as useless materials, and it is highly important, if not absolutely necessary, to discover uses for these peels as waste management is currently becoming a very serious environmental problem. According to Subashree *et al.* (2017), these waste peels are inexpensive, non-hazardous, and environmentally benign biomaterials that can be employed as adsorbents in wastewater treatment. According to Atif *et al.* (2017), banana peels can remove a wide range of contaminants from wastewater, including biological waste, heavy metals, carcinogenic substances, and different colours from textiles and other sources.

Throughout the world, banana peel is rich in low molecular weight and organic compounds such as pectin molecules, chlorophyll pigments, cellulose, and hemicellulose. Banana peels are a good source of galacturonic acid, pectin (10–21%), lignin (6–12%), cellulose (7.6–9.6%), and hemicelluloses (6.4–9.4%) all over the world, according to experimental evidence (Priyatharishini *et al.*, 2019). Black water and grey water are two categories for domestic wastewater. Gray water comes from showers, wash basins, and floor washing, while black water comes from toilets or sewage (Fahad *et al.*, 2019). Agricultural waste products have been investigated as prospective adsorbents as a result of the search for inexpensive and easily accessible adsorbents. There are numerous technologies in use to treat wastewater, and in this study, an effort has been made to look at the use of low-cost adsorbents derived from banana peels to treat grey water.

2. Materials and Method

2.1 Materials

Grey water samples were collected from two different student residences in Ogberin, Ede Osun, State Nigeria. The first sample was taken from the washing machine outlet and was designated

RW1, while the second sample was taken from the kitchen's sink outlet and was marked RW2. Bananas (*Musa Acuminata*) were purchased from the Oje market in Ede, Osun State.

2.2 Methods

Preparation of natural coagulant from banana peel

The method outlined by Zurina *et al.* (2014) was used to prepare the coagulant. The banana peels were thoroughly cleaned with distilled water to get rid of any pollutants before being sliced into small pieces that were between 0.5 and 1 cm in size. Next, the peels were sun-dried for seven days. The dried banana peels were then ground into fine powder and sieved with a 75 μ m sieve.

Coagulation of grey water

A 1 litre sample of grey water (RW1) was mixed with 2.5 g of banana peel powder (BPP) and swirled using a stirrer. To achieve consistent mixing during the flocculation process, the mixture was mixed quickly for 4 minutes and slowly for 15 minutes. The mixture was then allowed to settle for 1 hour to allow for sedimentation. Following sedimentation, the samples were filtered through a muslin cloth that had been sterilized, and the supernatant was transferred to the lab for examination. For RW2, the process was repeated.

3. Results and Discussion

3.1 The X-Ray Fluorescence (XRF) Analysis of Banana Peel Powder

The high concentration of silicon oxides (SiO_2 at 23.72 %), as demonstrated by the X-Ray Fluorescence analysis of banana peel powder in Table 1, indicates that it will be only marginally successful in the treatment of wastewater. If titanium dioxide (TiO_2) and aluminum oxides (Al_2O_3), which are the main oxides that improve wastewater treatment, had high percentages as well, it would have been the ideal coagulant. The powder's highest CaO content of 29.90 % demonstrates its high lime content and alkaline group membership. The potassium alum category of alum is indicated by the presence of 23.22 % K_2O . All of these oxides will improve this bio-coagulant's ability to treat wastewater.

Table 1: XRF Analysis of Banana Peel Powder

SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	P_2O_5	K_2O	MnO	Na_2O	MgO	CL
23.72	4.33	3.65	2.14	29.90	6.84	23.22	1.45	0.40	4.02	0.33

3.2 Physical Analysis of the Samples

Both samples (RW1 and RW2) had an unpleasant taste and odour, and both of the BPP-treated samples (TW1 and TW2) maintained this unpleasantness after treatment. RW1 and RW2 had pH values of 6.5 and 7.4 respectively before treatment, whereas TW1 stayed the same and TW2 dropped to 6.8. All of the numbers fall within the WHO's 6.5 to 8.5 range.

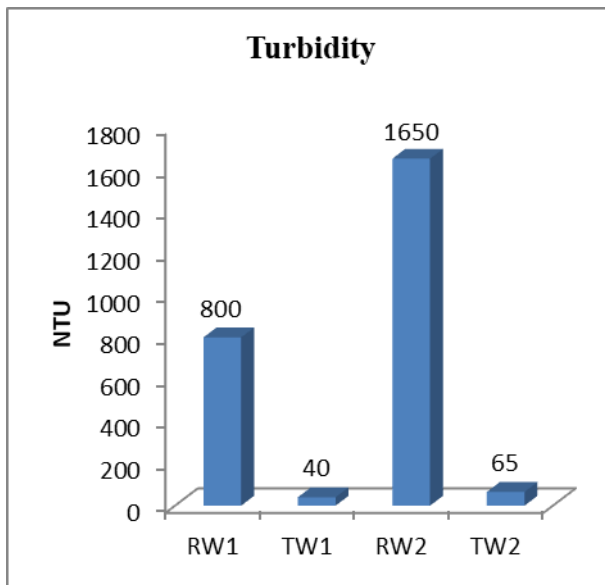


Fig. 1: Turbidity Result

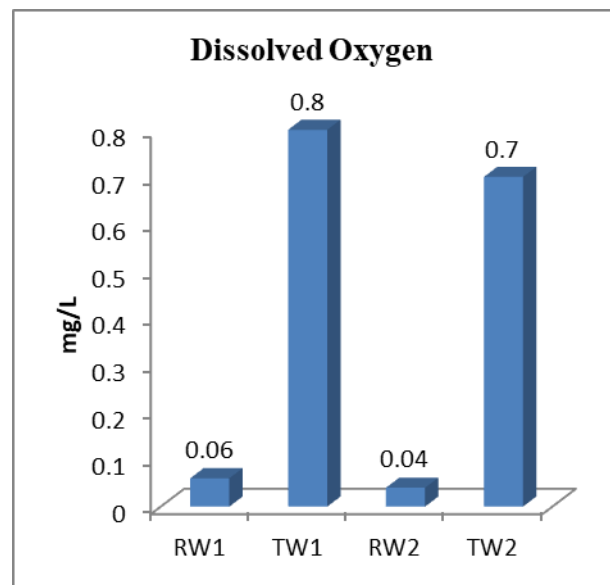


Fig. 2: Dissolved Oxygen

As demonstrated in Fig. 1, BPP was successful in removing turbidity because it lowered sample 1 (RW1) from 800 NTU to 40 NTU. Sample 2 (RW2)'s concentration was lowered from 1650 NTU to 65 NTU. This is consistent with the findings of Priyatharishini *et al.* (2019), who came to the conclusion that BPP is a viable option for reducing turbidity in wastewater.

Both samples' temperatures increased slightly from 25.3°C and 25.2°C to 25.4°C and 25.6°C, respectively. This might be related to treatment that involves agitating the samples with a stirrer.

3.3 Chemical Analysis Result

Table 2 displays the results of the chemical analysis performed on the grey water samples before and after treatment. For sample 1 and 2, Total Alkalinity concentration decreased from 1001 mg/L and 1220 mg/L to 660 mg/L and 890 mg/L, respectively. Both readings, however, exceeded the NESREA threshold of 150 mg/L.

Since a higher dissolved oxygen concentration is associated with less or no pollution, Fig. 2 demonstrated effectiveness with dissolved oxygen as it increased RW1 from 0.06 mg/L to 0.8 mg/L. Similar to RW1, RW2 increased from 0.04 mg/L to 0.7 mg/L.

Table 2: Results of Chemical Analysis on the Samples

Parameter (mg/l)	RW1	TW1	RW2	TW2
Total Alkalinity	1001	660	1220	890
Total Dissolved Solids (TDS)	322.00	118.00	404.00	193.00
Total Suspended Solids (TSS)	3.647	2.231	2.867	1.567
Chloride ions	126.00	30.00	235.00	80.00
Chemical Oxygen Demand (COD)	6.00	0.00	6.00	0.00
Silica	0.40	1.80	0.78	3.10
Potassium	1.70	4.30	2.40	6.20
Calcium ions	26.40	28.80	27.00	29.50
Fluoride	0.00	0.88	0.00	1.05

RW = Before Treatment, TW = After Treatment

TDS of RW1 decreased from 322 mg/L to 118 mg/L and that of RW2 decreased from 404 mg/L to 193 mg/L after treatment with BPP. All TDS values were below the 2000 mg/L established by FEPA and the 500 mg/L set by NESREA.

As RW1 and RW2 values decreased from 3.647 mg/L and 2.867 mg/L to 2.231 mg/L and 1.567 mg/L, respectively, the BPP also lowered some of the TSS. These are all below the standard limit of 25 to 30 mg/L. For both samples, there was a decrease in the amounts of chloride ions.

Because there were no chemical oxidants present in the BPP (Olatunji *et al.*, 2022), the presence of COD in the samples was completely eliminated, demonstrating the effectiveness of the BPP in lowering COD in water.

Silica, potassium, and calcium ion concentrations were found to have somewhat increased; this is not surprising given that the chemical composition of BPP indicates larger percentages of those elements from the XRF result in Table 1.

The increase in fluoride concentrations for RW1 and RW2 from 0.00 mg/L to 0.88 mg/L and 1.05 mg/L, respectively, shows that BPP is a good candidate if water fluoride levels need to be raised.

4. Conclusion and Recommendations

The findings of this study demonstrate the viability of using locally accessible banana peel as a natural coagulant in the treatment of grey water. Turbidity, Total Alkalinity, TDS, TSS, Chloride ions, and COD in grey water were all significantly reduced by the banana peel powder. The BPP can add fluoride to water if necessary and is effective at removing COD. It has higher percentage of silica, potassium and calcium and thus slightly increased their concentrations. It is rich in lime and belongs to alkaline group and potassium alum category of alum. In order to determine its ideal alum dosage, additional research should be done at various dosages and pH, and its usefulness in removing metal should also be examined.

References

- Amit, K. T., Romsha, S., Ravi, T. P. and Vinayak, P. (2022). Green Adsorbents for the Removal of Heavy Metals from Wastewater: A Review. *MaterialsToday Proceedings*. Vol 57, Part 4, page 1468-1472. <https://doi.org/10.1016/j.matpr.2021.11.373>
- Atif, K., Hassan, J. N., Shaqbana, A., Shaista, J., Misbah, I. and Iram, R. (2017). Efficiency Enhancement of Banana Peels for Wastewater Treatment through Chemical Adsorption. *Physical and Computational Sciences*. Vol 54: Pp 329-335
- Bradley, E. (2022). Wastewater Coagulation. Retrieved May 25, 2022, from <https://www.dober.com/water-treatment/resources/wastewater-coagulation>
- Fahad, A., Mohamed, R. M. S., Radhi, B. and Al-Sahari, M. (2019). Wastewater and Its Treatment Techniques: An Ample Review. *Indian Journal of Science and Technology*. 12 (25), Pp 1-13. DOI:10.17485/ijst/2019/v12i25/146059

- FEPA – Federal Environmental Protection Agency. (1991). National Environmental Protection (Effluent Limitation) Regulations. *Effluent limitation guidelines in Nigeria for all categories of industries*.
- Jones, D. L., Freeman, C. and Sanchez-Rodriguez, A. R. (2017). Wastewater Treatment. *Encyclopedia of Applied Plant Science*. Vol 3, Pp 352-362. DOI:10.1016/B978-0-12-394807-6.00019-8
- Natarajan, R., Al Fazari, F. and Al-Saadi, A. (2018). Municipal Wastewater Treatment by Natural Coagulant Assisted Electrochemical Technique Parametric Effects. *Environmental Technology & Innovation*. Vol 10, Pp: 71-77. <https://doi.org/10.1016/j.eti.2018.01.011>
- NESREA - National Environmental Standards and Regulations Enforcement Agency. (2009). National Environmental (Food, Beverages and Tobacco Sector) Regulations, 2009. *Effluent Limitation Standards for Food, Beverages and Tobacco Sector*. Printed and Published by The Federal Government Printer, Abuja, Nigciv FGP106/102009/1,000 (OL 59).
- Oladoja, N. A. (2015). Headway on Natural Polymeric Coagulants in Water and Wastewater Treatment Operations: An Ample Review. *Journal of Water Process Engineering*. Vol 6, 82-90 doi: <https://doi.org/10.1016/j.jwpe.2015.04.004>
- Olatunji, A.A., Olomo, R.O., Adegbenle, B.O., Lamidi, I.O., and Surajudeen, M. K. (2022). Impact of Abattoir Effluent Discharged on Surface Water Quality in Ede Metropolis. *4th School of Engineering Technology Annual International Conference (SAINCONF)*, 1(1): 9-16.
- Priyatharishini, M., Mokhtar, N. M. and Kristanti, R. A. (2019). Study on the Effectiveness of Banana Peel Coagulant in Turbidity Reduction of Synthetic Wastewater. *International Journal of Engineering Technology and Sciences* 6:1 pg: 82–90. DOI: <http://dx.doi.org/10.15282/ijets.6.1.2019.1007>
- Subashree, R., Surya, P. N. and Anusha, G. (2017). Treatment of Wastewater using Banana and Lemon Peels as Adsorbents. *International Journal of Engineering Technology Science and Research (IJETSR)*, Vol 9.
- WHO - World Health Organization. (2011). *Guidelines for drinking water quality*, 4th ed. <http://www.who.int> (accessed on 10/09/2023)
- Zurina, A. Z., Mohd Fadzli, M., and AbdulGhani, L. A. (2014). Preliminary Study of Rambutan (Nephelium Lappaceum) Seed as Potential Bio-coagulant for Turbidity Removal. *Advanced Materials Research*, 917, 96–105. <https://doi.org/10.4028/www.scientific.net/amr.917.96>