



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 6, June 2025

Treatment of Domestic Wastewater by using Natural Coagulants

Gayatri A. Bahire*, Tejaswini D Kadam**

Assistant professor, Department of Civil Engineering, PRMCEAM, Badnera, India

Assistant professor, Department of Civil Engineering, PRMCEAM, Badnera, India

ABSTRACT: Water is very important for life, but it is becoming harder to get because of growing cities, more people, and pollution. With the rise in domestic wastewater and lack of proper treatment facilities, there is need for the sustainable and eco-friendly treatment methods. A Conventional chemical coagulants in wastewater treatment are much costly and produce toxic substances and harmful for environment. So the natural coagulants offer sustainable, biodegradable, and cost effective alternative especially where resources are limited. Based on findings domestic grey wastewater containing dishwashing waste and food residues was collected from household. Their initial parameters COD, BOD, Turbidity, Temperature were carried out. The natural coagulants were prepared by shade dried for 4 to 5 days to remove moisture, then grinded in mixer grinder, and sieved with mesh size 212 μ m to gain required particle size, and then after, jar tests were conducted with selected dosages of 5, 10, 15, 20, and 25g/L. Parameters such as turbidity, pH, COD, BOD, and DO were measured after using coagulants. The result showed that among other two coagulants, activated charcoal showed the best performance, reducing turbidity by 72.34%, COD by 50.55%, and BOD by 54.45%, along with improving the DO levels. Pomegranate peel was found to be most effective for correcting pH. The study concludes that natural coagulants are a low-cost, and ecofriendly solution for wastewater treatment, especially in rural and resource-limited areas, and they have strong potential for use in small-scale water purification systems.

KEYWORDS: Cognitive Radio, Spectrum Sensing, Efficient Communication, System Security.

I. INTRODUCTION

Water is an essential element for all life on Earth, playing an important role in maintaining ecosystems, supporting human health, and enabling economic development. Water is also essential for drinking, agriculture, sanitation, and industrial activities. Every living organism, from the simplest microorganism to complex human societies, relies on water to function. Water conservation is critical to sustaining life on Earth, as freshwater is a limited and precious resource. While water covers about 70% of the Earth's surface, only a small fraction is fresh and readily available for human consumption, agriculture, and industrial purposes. Domestic wastewater, also known as sewage or household wastewater, originates from everyday activities in households. It consists of two main fluxes: one is grey water which comes from wash basins, laundry washing, dishwashing, showers, baths etc., and second one is black water which comes from toilets flushing and urinals. The composition of grey water includes detergents, soap residues, oils and greases, hairs and skin particles whereas Blackwater includes urine, pathogens and bacteria, nutrients (nitrogen phosphorus), toilet paper and solids. Domestic wastewater carries a variety of contaminants, including pathogens, organic matter, nutrients like phosphate and nitrogen, and home chemicals, even though its concentrations of pollutants are usually lower than those of industrial wastewater. If these pollutants are not well handled, even minute concentrations can have a big, long-lasting effect on the ecosystem. With rapid expansion of cities and domestic water supply, quantity of grey wastewater is increasing in the same proportion.

The per capita wastewater generation by the class-I cities and class-II towns, representing 72% of urban population in India, has been estimated to around 98 LPCD while that from the National Capital Territory Delhi alone (discharging 3,663 MLD of wastewaters, 61% of which is treated) is over 220 LPCD. As per CPCB estimates, the total wastewater generation from Class I cities and Class II towns in the country is around 35,558 and 2,696 MLD respectively. While, the installed sewage treatment capacity is just 11,553 and 233 MLD, respectively thus, overall analysis of water resources indicates that in coming years, there will be a twin edged problem to deal with reduced fresh water availability and increased wastewater generation due to increased population and industrialization. In India, there are

234-Sewage Water Treatment plants (STPs). In class-I cities, oxidation pond or Activated sludge process is the most commonly employed technology, covering 59.5% of total installed capacity. Series of Waste Stabilization Ponds technology is also employed in 28% of the plants, though its combined capacity is only 5.6%. Therefore, it becomes crucial to promote decentralized and natural wastewater treatment solutions, especially in semi-urban and rural areas. Integrating eco-friendly and cost-effective methods like natural coagulants can bridge the treatment gap. Strengthening policies and increasing investments in wastewater management infrastructure will be essential to ensure sustainable water resources for the future.

II. MATERIAL AND METHODS

2.1 Working Principle of Coagulation and Flocculation

Coagulation in water treatment involves the addition of a coagulant, usually a chemical like aluminium sulphate (alum) or ferric chloride, to water containing suspended particles, colloids, and impurities. These particles typically have negative surface charges, causing them to repel each other and remain dispersed in the water. When the coagulant is added, it dissociates into positively charged ions, which neutralize the negative charges on the particles, destabilizing them. As a result, the particles lose their repulsive forces and start to come together, forming small aggregates known as micro-flocs. These micro-flocs are the first step in the coagulation process, and while they may not be large enough to settle out on their own, they are now prepared for further aggregation during the subsequent flocculation process. Coagulation is crucial for improving water clarity, reducing turbidity, and making it easier to remove contaminants through sedimentation or filtration. Flocculation is the process that works after coagulation in water treatment and plays a key role in the removal of suspended particles and contaminants from water. After coagulation has neutralized the charges on the particles, flocculation promotes the formation of larger particles known as flocs, through gentle stirring or mixing. During flocculation, chemicals known as flocculants often polymers such as polyacrylamides may be added to enhance the process. These flocculants help by either neutralizing remaining charges or acting as "bridging agents" that connect small particles and micro-flocs together and bind into larger, more stable aggregates. These larger flocs are denser and can be more easily separated from the water through sedimentation, where they settle to the bottom, or through filtration, where they are physically removed.

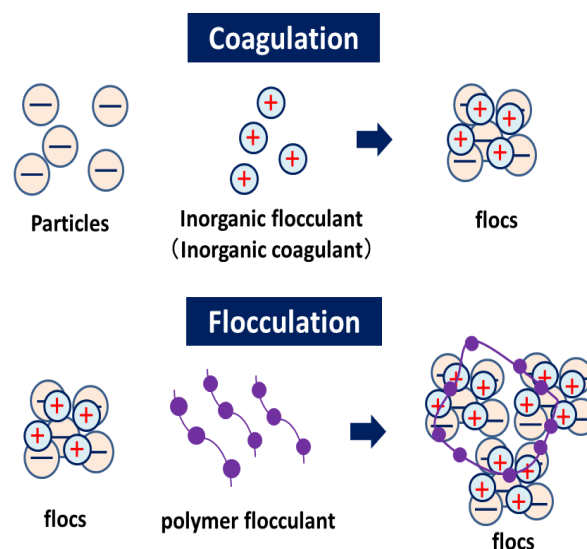


Figure 2.1 Coagulation and Flocculation Process

2.2 Types of Coagulants

- i **Artificial coagulants:** These are chemically manufactured substances used in water and wastewater treatment to enhance the removal of suspended particles and contaminants.
- ii **Natural coagulants:** Natural coagulants are substances derived from natural sources, such as plants, animals, or minerals, used to promote coagulation in water treatment processes.

ii Natural coagulants: Natural coagulants are substances derived from natural sources, such as plants, animals, or minerals, used to promote coagulation in water treatment processes.

2.2.1 Types of Natural Coagulants

i. Animal Based Coagulants:

Animal-based coagulants are substances derived from animal by-products or components that are used to aid in the coagulation process for water or wastewater treatment. These coagulants typically contain proteins and enzymes that can neutralize the charges on suspended particles in water.

ii. Plant Based Coagulants:

Plant-based coagulants are natural substances derived from various plants that are used in the coagulation process to purify water by removing suspended particles, organic matter, and other impurities. Unlike chemical coagulants like alum or ferric chloride, plant-based coagulants are biodegradable, environmentally friendly, and non-toxic. These coagulants are extracted from different parts of plants, including seeds, peels, and leaves, and contain bioactive compounds like proteins, polysaccharides, tannins, and phenolic substances that aid in the coagulation and flocculation process.

2.3 Preparation of Pomegranate & Banana coagulant:

Before converting the raw materials into powder form, the collected peels were washed several times with tap water and followed by distilled water to remove dust, dirt, sugars, oils, and any residual food particles that may present on the surface. This step is crucial to avoid growth of unwanted microbes during drying, bad odour, inaccurate test results due to the presence of external organic matter, and contamination that can interfere with the natural properties of coagulants and reduce its effectiveness. The washed material then cut into small pieces and then the peels were subjected to a two-stage drying process. In the first stage, they were shade-dried for 4 to 5 days at room temperature to gradually reduce the moisture content and make sure that the existing bioactive compounds present in the material should not affect and reduce. Direct exposure to sunlight can degrade the active compounds in the coagulant, reducing its effectiveness. Sun-drying involves high temperatures and UV rays, which can affect the chemical properties of the coagulant. In the second stage, the partially dried peels were placed in a hot air oven at 60°C for 6 to 8 hours to ensure complete moisture removal. This step is crucial to enhance the shelf life of the coagulant and prevent microbial contamination during storage.

Once the drying process was complete and the peels became crisp and brittle, they were grounded into a fine powder using a mixer grinder. The ground material was then passed through a sieve with a mesh size of 212 microns (μm) to obtain a uniform powder with consistent particle size. This sieving step helps eliminate any larger, unprocessed particles that might interfere with the efficiency of the treatment. Ensuring uniformity also contributes to reproducibility of results in experimental testing. This uniform particle size is crucial because it enhances the interaction between the coagulant particles and the impurities present in the wastewater. Smaller and consistent particles provide a greater number of active sites for adsorption and chemical reactions, thereby improving the overall efficiency of the coagulation process. Additionally, controlled particle size ensures better dispersion of the coagulant in the solution, leading to more effective floc formation and faster settling of suspended solids.

2.4 Preparation of Activated Charcoal

The process of preparation of Activated charcoal begins by selecting dry, hardwood material ensuring that it produce dense charcoal with high carbon content. The wood is then first chopped into small, uniform pieces and then subjected to carbonization which is a thermal decomposition process carried out in the absence or limited presence of oxygen (Awaal Musa et al., 2020). To perform small-scale or on-site pyrolysis, a required size of drum was used for pyrolyzing the wood and small holes were made for limited supply of oxygen for partial combustion. The holes were also necessary so that when the internal temperature rises, volatile gases are released and burn off through the vents. The temperature was nearly between 200°C to 600°C.

When the smoke emission decreases or stops, it indicates that the pyrolysis is completed. The drum was allowed to cool naturally, and the material which was obtained is Activated charcoal. Now, before grinding and converting the charcoal into fine powder, nearly 10% of phosphoric acid (H_3PO_4) was applied to increase the surface area and enhancing the absorption efficiency of charcoal. The enhanced porosity and increased surface area of the activated charcoal were expected to significantly improve its performance in adsorbing impurities from domestic wastewater. The material was

then washed with distilled water properly and then dried completely, grinded into fine powder passing through the sieve of mesh size 212 microns (μm). Then it got ready to use in the test works

III. RESULT AND DISCUSSION

3.1 The effects of Pomegranate, Banana & Charcoal powder on wastewater sample are shown below.

Table 3.1 Effect of Coagulant Dosage on Turbidity

Initial Readings of wastewater (NTU)	Coagulant Dosage in (g/L)	Final Readings (Pomegranate) (NTU)	Final Readings (Banana) (NTU)	Final Readings (Charcoal) (NTU)
94	5	81	78	75
94	10	58	51	44
94	15	64	33	26
94	20	77	40	38
94	25	112	98	47

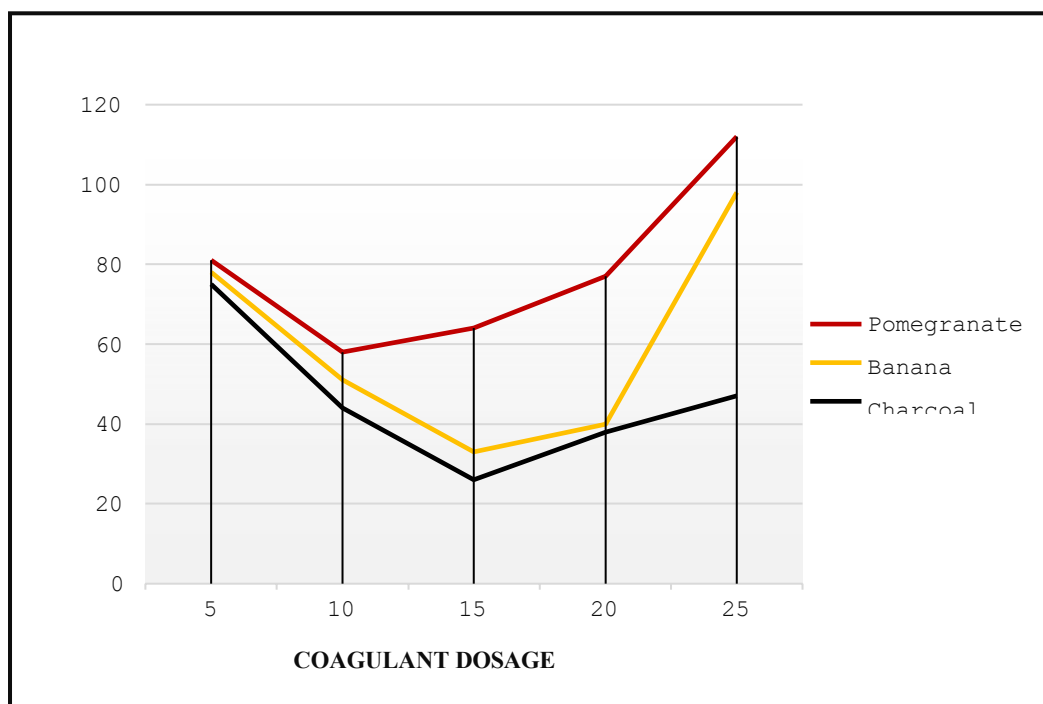


Figure 3.1 Effect of Coagulant Dosage on Turbidity

The initial turbidity of the wastewater was recorded as 94 NTU before treatment. As the dosage of the coagulants increases, the final turbidity readings changed accordingly, showing varying effectiveness of each coagulant. It was observed that, by addition of pomegranate on different dosage, the optimum dosage was 10g among other dosages which shows turbidity reduction of 58 NTU, it means that the removal efficiency of pomegranate on 10g of optimum dosage is 38.29%. Apart from that, the optimum dosage of banana for turbidity reduction was 15g, with removal efficiency of 64.89%. On the other hand, charcoal showed the removal efficiency of 72.34% (Turbidity reduction - 26NTU) on 15g of optimum dosage. The removal efficiency of pomegranate, banana & charcoal is 38.29%, 64.89% & 72.34% respectively on varying dosage. It was concluded that among all three coagulants, Charcoal showed highest turbidity reduction and gave better result in treatment in this test. It was also observed that, increasing the dosage of coagulants from 15 to 25g, the results got affected which means it leads to overdosing. For ex. turbidity increased drastically from 58 to 112 NTU on further addition of 15g of pomegranate dosage, indicating that overdosing caused re-stabilization of particles or introduced additional organic matter that worsened water clarity.

Table 3.2 Effect of Coagulant Dosage on PH

Initial Readings of wastewater (NTU)	Coagulant Dosage in (g/L)	Final Readings (Pomegranate) (NTU)	Final Readings (Banana) (NTU)	Final Readings (Charcoal) (NTU)
9.21	5	8.21	8.57	7.98
9.21	10	7.05	7.94	7.00
9.21	15	7.52	7.56	6.43
9.21	20	8.30	8.61	6.40
9.21	25	9.45	8.70	6.87

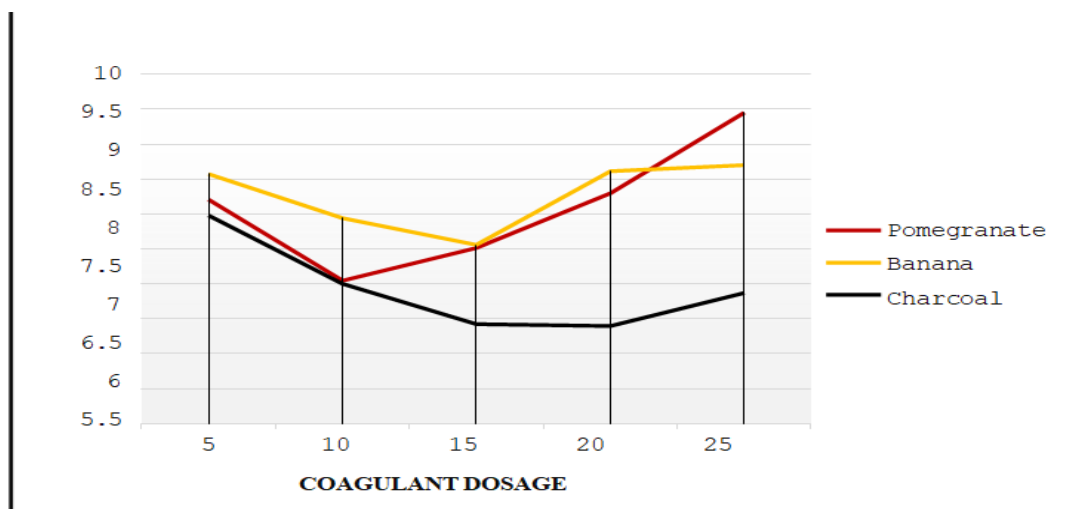


Figure 3.2 Effect of Coagulant Dosage on PH

The initial reading of pH of the wastewater was recorded as 9.21, which means the nature of wastewater is moderately alkaline (basic). It means that the wastewater sample contains presence of soaps, detergents, or cleaning agents, etc. The variation is shown in **Figure 3.2**. According to the test, it was observed that pH of water changes from addition of different dosages from 5 to 25gms. The optimum dosage of pomegranate was carried out to be 10g achieving pH of 7.05 which is nearly a pH of drinking water of 7 (neutral). The optimum dosage of banana was 15g achieving pH of 7.56. The result of banana compared to pomegranate was comparatively low in pH test, despite being effective, it was less efficient than pomegranate due to its mildly alkaline nature. Apart from that, the optimum dosage of charcoal was 20g achieving pH 6.40. It was concluded that among the three, pomegranate peel showed the most effective pH reduction, achieving a nearly neutral pH of 7.05 at 10g of optimum dosage, which is ideal for water reuse, even though charcoal reduced pH more, it overcorrected, pushing the water toward acidic, which is not desirable for reuse or discharge. Because the goal is not just to reduce pH, the goal is to bring it close to neutral (pH 7) within the safe range (6.5 – 8.5). Hence, pomegranate peel emerges as a more balanced and efficient coagulant for pH correction. This highlights its potential for sustainable and safe domestic wastewater treatment applications.

Table 3.3 Effect of Coagulant Dosage on BOD

Initial Readings of wastewater (NTU)	Coagulant Dosage in (g/L)	Final Readings Pomegranate (NTU)	Final Readings Banana (NTU)	Final Readings Charcoal (NTU)
119	5	97.2	93.2	74.1
119	10	87.7	81	54.2
119	15	86	74.6	68.9
119	20	64.8	77	68.2
119	25	69.3	84	70

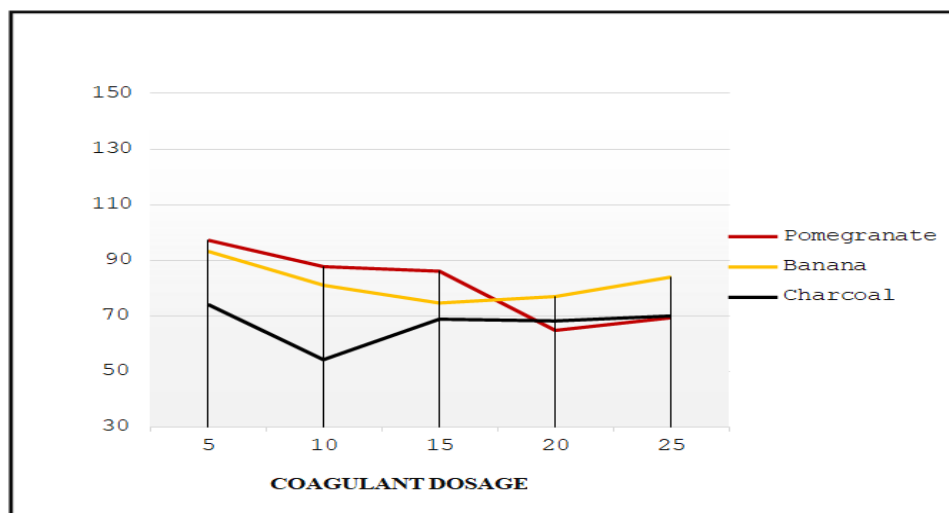


Figure 3.3 Effect of Coagulant Dosage on BOD

The initial BOD value of the wastewater sample was recorded at 119 mg/L, indicating a significant presence of biodegradable organic matter. High BOD levels signify that a large amount of dissolved oxygen is required by aerobic microorganisms to break down the organic pollutants, which poses a serious threat to aquatic life if discharged untreated. For pomegranate peel, the lowest BOD reading was 64.8 mg/L at a dosage of 20 g/L, indicating a removal efficiency of approximately 45.5%. Banana peel showed its best result at 15 g/L dosage, achieving a BOD reduction to 74.6 mg/L with a 37.3% removal efficiency. Activated charcoal, however, exhibited the most significant reduction at a dosage of 10 g/L, bringing the BOD down to 54.2 mg/L achieving 54.45% removal efficiency. This indicates that activated charcoal not only performed best but also required a lower dosage to achieve maximum efficiency. Hence, among the three, activated charcoal is the most efficient coagulant for BOD reduction in domestic wastewater treatment.

Table 3.4 Effect of Coagulant Dosage on DO

Initial Readings of wastewater (NTU)	Coagulant Dosage in (g/L)	Final Readings Pomegranate (NTU)	Final Readings Banana (NTU)	Final Readings Charcoal (NTU)
3.8	5	4.1	4.3	5.0
3.8	10	4.7	4.6	5.3
3.8	15	3.5	5.0	5.1
3.8	20	4.0	3.4	6.2
3.8	25	3.0	2.9	4.8

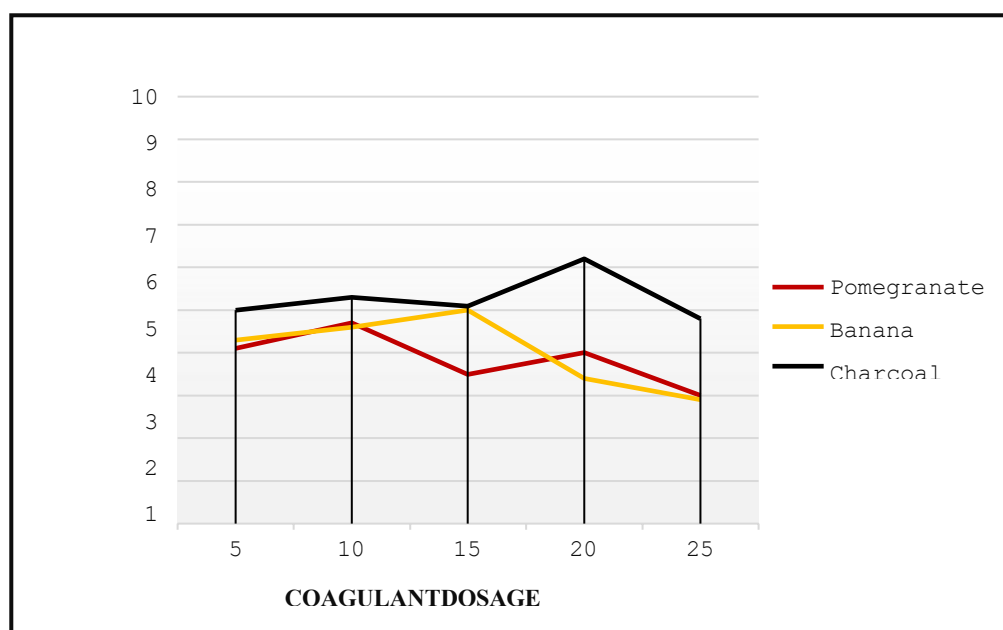


Figure 3.4 Effect of Coagulant Dosage on DO

The Table 3.4 showing the Initial and Final Dissolved Oxygen (DO) levels of wastewater after treatment with coagulants. The initial DO of the wastewater was recorded at 3.8 mg/L, which is relatively low and indicates a high oxygen demand from organic pollutants and limited oxygen availability for aquatic organisms. Improving DO levels in treated wastewater is crucial as it supports aquatic life and reflects better water quality. For pomegranate peel, the highest DO level was observed at a dosage of 10 g/L, reaching 4.7 mg/L, indicating an increase of approximately 23.7%. However, at higher dosages like 25 g/L, the DO dropped to 3.0 mg/L. Banana peels showed its peak DO improvement at 15 g/L, achieving 5.0 mg/L, which reflects an increase of 31.58% from the initial value. This indicates effective pollutant removal and improved oxygen balance up to an optimum dosage, beyond which the performance started to decline (e.g. 2.9 mg/L at 25 g/L), again likely due to excess organic load. Activated charcoal consistently showed better result from both pomegranate and banana peels across all dosages. The highest DO value was recorded at 20 g/L, reaching 6.2 mg/L, which is an impressive 63.2% increase over the initial value. Even at lower dosages like 10 g/L and 15 g/L, DO levels remained above 5.0 mg/L, demonstrating its superior oxygen enhancing capability.

3.2 Removal Efficiencies on optimum dosages

Removal efficiency of Pomegranate, Banana & Charcoal powder on wastewater is shown on given table

Table 3.5 Removal Efficiency

Test Parameter	Initial Value	Coagulant	Optimum Dosage (g/L)	Final Value	Removal Efficiency
Turbidity (NTU)	94	Pomegranate Peel	10	58	38.29% Reduction
		Banana Peel	15	33	64.89% Reduction
		Activated Charcoal	15	26	72.34% Reduction
pH Correction	9.21	Pomegranate Peel	10	7.05	Near neutral
		Banana Peel	15	7.56	Mildly alkaline
		Activated Charcoal	20	6.40	Overcorrected (Acidic side)
BOD (mg/L)	119	Pomegranate Peel	20	64.8	45.5% Reduction
		Banana Peel	15	74.6	37.3% Reduction
		Activated Charcoal	10	54.2	54.45% Reduction (Highest)
DO (mg/L)	3.8	Pomegranate Peel	10	4.7	23.7% Increase
		Banana Peel	15	5.0	31.58% Increase
		Activated Charcoal	20	6.2	63.2% Increase (Highest)

IV.CONCLUSION

The experimental analysis, test results & all graphical comparisons clearly shows that activated charcoal gave the best results compared to pomegranate and banana peels. It performed the best in removing turbidity (72.34%), reducing COD (50.55%) and BOD (54.45%), and improving dissolved oxygen (DO) levels by 63.2%, which means the water became much cleaner for non-potable uses. Although pomegranate peel was best at adjusting the pH closer to neutral, the slightly acidic effect of charcoal can be easily corrected, making it more useful overall.

It was also concluded that, at higher dosages like 25g, the coagulants did not show better performance. The results became less effective because of problem of overdosing. When too much coagulant is added, instead of helping the particles in the water to floc together and settle, it can actually destabilize the floc particles. Also, it was observed that after adding 15g and 20g dosages, the turbidity increased to some extent, it means that adding more coagulant can make the water cloudy again. Similarly, at 25g dosage, DO levels also dropped, indicating a decline in water quality. So based on the experimental observations, the most effective dosages for best results were within 10g to 20g, depending on the coagulant. This range provided optimum performance without overdosing and helped in achieving better water quality.

The filtered or treated grey water can be reuse for non-potable purposes such as gardening, irrigation, cleaning, toilet flushing, vehicle washing, small scale firefighting, & construction works,

The use of this plant based waste materials as coagulants not only treating wastewater effectively but also reducing organic waste that would otherwise be discarded. This helps turn waste into something useful, turning kitchen and agricultural waste into a valuable input for water purification.

REFERENCES

- [1] Shivani Yadav, Farhan Khan, Kaminee Rathod **“Household Wastewater treatment using Activated Charcoal”** International Journal For Multidisciplinary Research, E-ISSN: 2582-2160, Volume 6, Issue 5, Sept-Oct 2024.
- [2] Chanchal Rajput **“Analysis of Waste Water Treatment”** International Journal of Humanities Social Science and Management (IJHSSM), Volume 4, Issue 1, Jan-Feb 2024.
- [3] P H Tjahjanti1, Iswanto, M F Luliefan, A Fahrudin, R R Ernanda **“The Analysis of Banana Peels are used as Water Purifying Materials”** Journal Of Physics: Conference Series, Department of Mechanical Engineering, Universitas Muhammadiyah Sidoarjo, Kampus 2 Jalan Raya Gelam nomer, Indonesia, 2021.
- [4] Samia Ben-Ali **“Application of Raw and Modified Pomegranate Peel for Wastewater Treatment: A Literature Overview and Analysis”** International Journal Of Chemical Engineering, Volume 2021, Article ID 8840907, 19 Page, Department of Chemical Engineering, 2021.
- [5] Awwal Musa, Sani Saleh, Kasim Mohammed, Yahaya Hassan Labaran **“Evaluation of Potential Use of Charcoal as a Filter Material in Water Treatment”** International Research Journal of Engineering and Technology, Volume 7, Issue 5, May 2020.
- [6] Ekta Banik & Rishav Singh **“Analysis of Wastewater Treatment in India”** A Blind Review & Referred Quarterly International Journal, ISSN: 2250-1940, Volume 8, Issue 27, Department of Civil Engineering (Dream Institute of Technology) Thakurpukur, B.H. Road, Kolkata- 700104, Apr-June 2020.
- [7] Abraham Francics.A, Thenmozhi.R, Sivakumar.M, Sivakumar.K, Sasikumar.G, Thamaraimuthuayyanraj.S **“Waste Water Treatment Unit Using Activated Charcoal”** International Research Journal of Engineering and Technology, e-ISSN: 2395-005, Volume: 05 Issue: 03, Mar-2018.
- [8] Atif Khan, Hassan Jived Naqvi, Shabana Afzal, Shaista Jabeen, Misbah Iqbal **“Efficiency Enhancement of Banana Peel for Waste Water Treatment through Chemical Adsorption”** Pakistan Academy of Sciences, ISSN: 2518-4245, August 2017.
- [9] Jabbar H. Al-Baidhani & Azhar Hadi Jassim Al-Khafaji **“Using of Coagulation Process of Pomegranate Peels for the Tertiary Treatment of Wastewater”** International Journal of Applied Engineering Research ISSN 0973-4562, Volume 12, Number 24, 2017.
- [10] Aakanksha Darge, S.J. Mane **“Treatment of Industrial Wastewater by using Banana Peels and Fish Scale”** International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064, Volume 4 Issue 7, July 2015.

- [11] Anand Patel, Dolly Sharma, Pushpak Kharkar, Dr. Dhiraj Mehta, “Application of Activated Carbon In Wastewater Treatment” International Journal of Engineering Applied Sciences and Technology, Volume 3, Issue No. 2455-2143, Page 63-66, April 2019.
- [12] Rana Khankishiyeva, Leyla Maharramova, Aydan Musayeva “Ecofriendly Purification of Heavy Metal Contaminated Wastewater Using Pomegranate Peel and Chitosan Derived Flocculant” Bio Web of Conferences 85, 2023.
- [13] Mohmmad Ahmed Hamdan, Esraa Taha Sublaban “Wastewater Treatment Using Activated Carbon Produced From Oil Shale” Journal of Ecological Engineering, ISSN 2299-8993, 2023.
- [14] Jimoh Abdulfatai, Abdulkareem Ambali Saka, Ayo Samuel Afolabi, “Development of Absorbent From Banana Peels for Wastewater Treatment”, Applied Mechanics and Materials, Volume 248, Page no. 310-315, 2017.



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details