A comprehensive study on evaluating the efficacy of natural coagulants and sand bed filtration in removing pollutants from surface water quality.

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APPROVAL

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DECLARATION

It is hereby declared that this thesis/project report, in whole or in part, has not been submitted elsewhere for the award of any Degree or Diploma.

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We thank our family and teachers for their support and belief in us.

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All glory to Almighty Allah, by his graciousness we were able to finish our research objective. We are grateful to Allah, who is most merciful and compassionate.

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ABSTRACT

In the quest for sustainable water treatment methods, this comprehensive study evaluates the efficacy of natural coagulants and sand bed filtration in removing pollutants from surface water. The environmental hazards associated with synthetic coagulants have prompted the investigation into natural alternatives. This research focused on the coagulation efficiency of Moringa oleifera seeds, cactus opuntia, and chitosan due to their abundant availability and biodegradability.

Experiments were conducted to compare the turbidity, total dissolved solids (TDS), chemical oxygen demand (COD), and microbial contamination levels before and after applying these natural coagulants. Subsequently, sand bed filtration was employed as a secondary treatment to further purify the water. The study's findings indicate that certain natural coagulants significantly reduce turbidity and COD levels, with a notable decrease in TDS and microbial counts.

Moreover, when combined with sand bed filtration, these coagulants demonstrated a synergistic effect, leading to an even greater reduction in pollutants. The results suggest that the integration of natural coagulants with sand bed filtration could serve as an effective and environmentally friendly approach to improving surface water quality. This method holds promise for application in regions lacking access to advanced water treatment facilities, providing a cost-effective and accessible solution for clean water.

Keywords: Sustainable water treatment, natural coagulants, sand bed filtration, surface water quality, pollutants removal, Moringa oleifera, cactus opuntia, chitosan, turbidity, total dissolved solids (TDS), chemical oxygen demand (COD), microbial contamination, biodegradability, synergistic effect.

1 CHAPTER ONE INTRODUCTION

1.1 Background

Water pollution has become a critical environmental issue, with surface water bodies being particularly vulnerable to contamination from industrial discharges, agricultural runoff, and improper waste management. The presence of pollutants in water not only degrades ecosystems but also poses significant health risks to humans and animals. Traditional water treatment methods often rely on chemical coagulants, such as alum and polyacrylamides, which are effective in removing suspended particles but have drawbacks including potential toxicity and secondary pollution.

The pursuit of eco-friendly and sustainable water treatment alternatives has led researchers to explore natural coagulants. These substances, derived from plants or other natural sources, offer a promising solution due to their biodegradability and lower environmental impact. Among the various natural coagulants studied, Moringa oleifera seeds have gained attention for their coagulation properties. The seeds contain proteins that can neutralize charges on suspended particles, facilitating aggregation and subsequent removal.

Chitosan, a derivative of chitin found in crustacean shells, is another biopolymer that has been investigated for its ability to remove contaminants from water. Its positive charge allows it to bind with negatively charged particles such as heavy metals and dyes, making it an effective coagulant. However, the performance of these natural coagulants can vary based on factors such as water pH and temperature.

Sand bed filtration complements the use of natural coagulants by providing a physical barrier that filters out remaining particulates. The simplicity and low cost of sand filtration make it an attractive option for communities with limited resources. When used in conjunction with natural coagulants, sand bed filtration can enhance the overall effectiveness of the treatment process.

Despite the potential benefits of natural coagulants and sand bed filtration, there is a need for comprehensive studies to evaluate their efficacy in various conditions. This research aims to fill that gap by conducting a systematic study on the removal of pollutants from surface water using these sustainable methods. By analyzing key water quality indicators before and after treatment, the study will provide valuable insights into the practical application of natural coagulants and sand bed filtration in improving water quality.

The findings of this research could have significant implications for environmental engineering and public health. By demonstrating the effectiveness of eco-friendly water treatment methods, this study could encourage their adoption in regions affected by water pollution. Moreover, it could contribute to the development of guidelines for implementing natural coagulants and sand bed filtration in water treatment facilities.

In conclusion, the background for this research highlights the urgency of addressing water pollution through sustainable methods. Natural coagulants and sand bed filtration present viable options for reducing pollutants in surface water, offering hope for cleaner water bodies and healthier ecosystems.

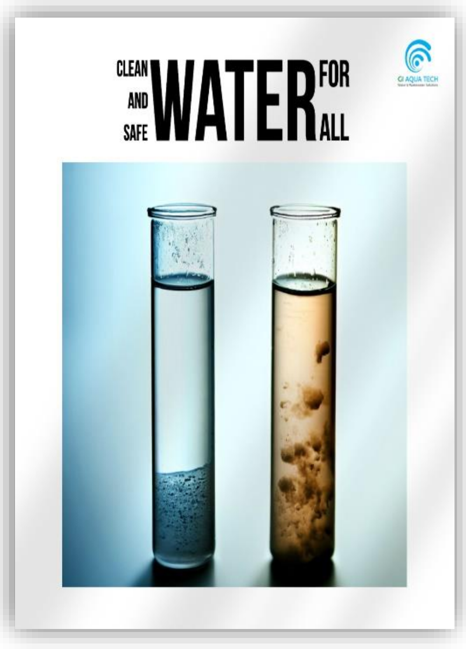
1.2 Problem Statement

Bangladesh, a country crisscrossed by rivers, faces significant challenges in managing its water resources due to rampant industrialization, inadequate waste disposal, and extensive use of agrochemicals. The resultant contamination of surface water with organic pollutants, heavy metals, and microbial pathogens poses severe risks to public health and the environment. The existing water treatment infrastructure in Bangladesh is often overwhelmed or non-existent in rural areas, leading to reliance on untreated surface water for daily needs.

The conventional use of chemical coagulants in water treatment raises concerns about residual toxicity and long-term ecological impacts. Moreover, the import dependency for these chemicals adds economic strain. There is an urgent need for cost-effective, sustainable, and locally available water treatment solutions that can be implemented at scale across diverse geographic and socio-economic settings within Bangladesh.

This research addresses the critical problem of improving surface water quality in Bangladesh by evaluating the efficacy of natural coagulants and sand bed filtration. These methods not only promise to mitigate the environmental footprint of water purification but also align with the country's pursuit of sustainable development goals. The study aims to provide a scientific basis for adopting such eco-friendly practices in Bangladesh's water treatment protocols, potentially transforming the landscape of public health and environmental conservation.

1.3 Purpose and Objectives



- To evaluate the effectiveness of various natural coagulants (NCs) for removing pollutants from surface water compared to aluminum sulfate coagulation

- To assess the performance of sand bed filtration in removing pollutants from water pre-treated with NCs.

1.4 Scope of the Study

The scope of this study encompasses a comprehensive evaluation of natural coagulants and sand bed filtration for treating surface water in Bangladesh. The research focuses on the following areas:

1. **Selection of Natural Coagulants**: Identifying locally available natural coagulants that are both effective in pollutant removal and feasible for use in Bangladesh's socio-economic context.
2. **Laboratory Experiments**: Conducting controlled experiments to determine the optimal conditions under which these natural coagulants perform best in terms of water purification.

3. **Field Trials**: Implementing field trials to test the scalability and practicality of using natural coagulants and sand bed filtration in real-world settings across various regions of Bangladesh.
4. **Water Quality Analysis**: Utilizing a range of water quality parameters to evaluate the treatment efficacy, with a focus on parameters most relevant to Bangladesh's pollution issues.
5. **Environmental and Economic Assessment**: Considering the environmental sustainability and economic viability of adopting these methods as standard practice for water treatment in Bangladesh.

The study will not delve into the molecular mechanisms of coagulation or the detailed chemical analysis of natural coagulants. Instead, it will concentrate on their practical application and effectiveness in improving water quality within the specific context of Bangladesh's environmental challenges.

1.5 Chapter Breakdown of the Thesis

Six chapters have been logically assigned to this topic. Every chapter has a title and a subtitle that give enough context to support the complete framework. The ensuing synopsis provides a logical synopsis of the full thesis in reverse chronological order.

Chapter 1: Introduction

A lengthy introduction that serves as the foundation for the entire thesis is presented in the first chapter. In addition to presenting the study's background and motivation, this chapter also highlights the problem statement, the study's applicability given the time and place, and its goals, objectives, and scope—basically laying the groundwork for the remaining research.

Chapter 2: Literature Review

To clarify the research question at hand and how it pertains to the specified industry, a thorough literature study is included in the second chapter. This helps to identify any research gaps. This chapter offers insights into the research that has previously been done on the topic thus far as well as how other writers have tackled the problem in their own investigations.

Chapter 3: Study Area and Data Collection

The potential research locations to guarantee the most representative response are covered in the third chapter. This section includes a brief summary of the various data gathering techniques, as well as how the data was processed and filtered to emphasize the information pertinent to the study.

Chapter 4: Methodology

The methods employed in this study to assess the validity and reliability of the findings are briefly discussed in the third chapter. This chapter includes an overview of all the strategies and explains why the chosen method was chosen to depict the best-case scenario results.

Chapter 5: Analysis and Results

The results are presented succinctly, impartially, and logically in the fourth chapter. Graphs, charts, and tables have also been included to offer a more comprehensive perspective based on the condensed observations.

Chapter 6: Conclusion and Recommendations

The last chapter summarizes the main conclusions of the study and suggests some tenable policy ramifications. This chapter also considers the study's shortcomings and makes recommendations for future research avenues that might expand on its results.

2 CHAPTER TWO LITERATURE REVIEW

2.1 Literature Review on Rice Husk Ash

The literature review was conducted to establish context, provide background information, and set the stage for the research. It aimed to identify gaps by finding areas that have not been explored and justifying the need for the current study. Additionally, it sought to support the methodology by comparing and contrasting with previous methods and reinforcing the chosen approach. Lastly, it aimed to strengthen credibility by demonstrating familiarity with the existing body of work and enhancing the research's credibility.

The selection of research papers for a literature review in environmental engineering is typically guided by specific criteria to ensure relevance and quality. Key points to consider include relevance, where papers should be directly related to the research topic and contribute meaningful insights or data. Methodology is another critical criterion, as the research methods used in the papers should be sound and appropriate for the topic. Quality is essential, with a preference for peer-reviewed papers published in reputable journals or conferences. Recency is also important, with recent papers often preferred to reflect the current state of research. The Table 1 presents a summary of various studies investigating the use of rice husk and its ash as natural coagulants in wastewater treatment. The primary objective of these studies was to evaluate the effectiveness of rice husk and rice husk ash in improving water quality through different methods and under various conditions.

The first study by Anjitha et al. (2016) investigated the use of rice husk and rice husk ash as natural coagulants. The study employed a dosage range of 0.2g to 1g and settling durations between 15 to 30 minutes. The findings revealed a significant reduction in turbidity, with rice husk ash being more effective than rice husk. However, the study's limitation was its focus on these specific coagulants without comparing them to others. The conclusion highlighted the effectiveness of rice husk and rice husk ash, with the latter being superior for turbidity removal. In the second study by Benson et al. (2019), the treatment efficiency of rice husk on wastewater was assessed with dosages ranging from 5 g/L to 25 g/L and settling durations from 24 to 72 hours. The study demonstrated effective reduction in BOD, turbidity, alkalinity, and hardness, emphasizing that both dosage and duration impacted the results. A notable limitation was the lack of specific coagulant/material information. The conclusion indicated that rice husk is an effective adsorbent, with an optimal duration of 48 hours for the best results. Priya et al. (2020) demonstrated the green synthesis of copper nanoparticles using rice husk ash in their study. The dosage ranged from 5% to 15%, with a settling duration of 1 hour. The findings showed a significant improvement in water quality parameters, identifying rice husk ash copper nanoparticles (Rha-cunps) as potential nanosorbents. Despite the significant improvements, the study noted limitations similar to its findings. The conclusion affirmed that Rha-cunps are effective, meet standard limits, and hold potential for safe discharge. Tsamo et al. (2021) compared the coagulation performance of rice husk, cypress leaves, and eucalyptus leaves powders with that of alum. Although the study did not specify the dosage, it used a settling duration of 1 hour. The results indicated varying degrees of effectiveness among the biomass powders, with rice husk being the most efficient. This study, however, mirrored its findings as its limitation. The conclusion suggested that biomass powders, particularly rice husk, are comparable to alum, with rice husk being the most efficient.

In summary, these studies collectively illustrate the potential of rice husk and its ash, as well as other biomass materials, in wastewater treatment. The findings consistently support the efficacy of rice husk and rice husk ash in reducing turbidity and other water quality parameters, with specific studies highlighting their advantages over conventional coagulants like alum. However, limitations such as the lack of broader comparisons and specific material information indicate areas for further research.

Table 1 Rice Husk Ash Previous Studies

Article name	Objective	Dosage	Settling durations	Findings	Limitations	Conclusion	Reference
Comparative study using rice husk and its ash as natural coagulants in waste water treatment	Investigate rice husk and rice husk ash as natural coagulants.	0.2gm to 1 gm	15 minutes to 30 minutes	Significant reduction in turbidity; rice husk ash more effective.	Focus only on specific coagulants; no comparison with others	Rice husk and rice husk ash are effective; ash is superior for turbidity removal.	Anjitha et al. (2016)
Treatment efficiency of rice husk on waste water	Assess treatment efficiency of rice husk on wastewater.	5 g/l to 25 g/l	24 hours to 72 hours	Effective reduction in bod, turbidity, alkalinity, and hardness; dosage and duration impact	Lack of specific coagulant/material information.	Rice husk is an effective adsorbent; optimal duration is 48 hours.	Benson et al. (2019)
Combating water quality in domestic wastewater treatment using biowaste material with green synthesis of nanoparticles	Demonstrate green synthesis of copper nanoparticles with rice husk ash.	5% to 15%	1 hour	Significant improvement in water quality parameters; rhacunps are potential nano sorbents.	Significant improvement in water quality parameters; rhacunps are potential nano sorbents.	Rha-cunps are effective; meets standard limits; potential for safe discharge.	Priya et al. (2020)
Comparing the coagulation performance of rice husk, cypress leaves, and eucalyptus leaves powders with that of alum	Compare coagulation performance of biomass powders with alum.	N/a	1 hour	Varying degrees of effectiveness; rice husk most efficient.	Varying degrees of effectiveness; rice husk most efficient.	Biomass powders are comparable to alum; rice husk is the most efficient.	Tsamo et al. (2021)

2.2 Literature Review on Biochar

The Table 2 provides a concise overview of studies focused on the use of biochar and its modifications for various environmental applications, particularly in water treatment and soil improvement. Li et al. (2019) explored the use of Fe-Mn binary oxides modified biochar for the degradation of naphthalene. Using a dosage of 1 g/L, the study found high efficiency, stability, and reusability of the biochar. However, a limitation noted was the lack of investigation into long-term stability. The study concluded that this approach is promising for water treatment applications. Cui et al. (2021) investigated the effects of biochar and effective microorganisms on the growth of Sesbania cannabina and soil quality in the coastal saline-alkali soil of the Yellow River Delta, China. The findings indicated improved plant growth and soil fertility. The limitation was the focus on specific soil and plant species and not exploring long-term effects. The conclusion was that biochar and effective microorganisms are effective for mitigating soil salinity and improving soil quality. Ye et al. (2019) developed a biochar-based nanocomposite with improved graphitization for efficient photocatalytic activity driven by visible light. Using K2FeO4 at a dosage of 0.15 g/L, the study found improved photocatalytic activity but noted limited testing. The limitation was an incomplete assessment of the photocatalytic activity. The conclusion suggested that the nanocomposite is promising for water remediation by combining adsorption and photocatalysis. Zhang et al. (2020) evaluated biochar and its modifications for the removal of ammonium, nitrate, and phosphate from water. The study found effective removal of these nutrients but lacked specific coagulant/material information. The conclusion indicated that biochar is promising for nutrient removal from water. These studies collectively highlight the potential of biochar and its modifications for environmental applications, particularly in water treatment and soil quality improvement. Despite some limitations, the findings support the efficacy and promise of biochar in various contexts.

Table 2: Biochar Previous Studies

Article name	Objective	Dosage	Settling durations	Findings	Limitations	Conclusion	Reference
Degradation of naphthalene with magnetic bio-char activate hydrogen peroxide: synergism of bio-char and femn binary oxides	Explore femn binary oxides modified biochar for naphthalene degradation.	Fe-mn/biochar 1 g/l	Not mentioned	High efficiency, stability, and reusability.	Lack of long-term stability investigation.	Promising for water treatment applications.	Li et al. (2019)
Biochar and effective microorganisms promote sesbania cannabina growth and soil quality in the coastal saline-alkali soil of the yellow river delta, china	Investigate biochar and effective microorganisms on plant growth and soil quality.	Not mentioned	Not mentioned	Improved plant growth and soil fertility.	Lafocus on specific soil and plant species, no long-term effects explored.	Effective for mitigating soil salinity and improving soil quality.	Cui et al. (2021)
Facile assembled biochar-based nanocomposite with improved graphitization for efficient photocatalytic activity driven by visible light	Develop biochar-based nanocomposite for efficient photocatalytic activity.	(k2fe04) used 0.15 g/l	Not mentioned	Improved photocatalytic activity but limited testing.	Incomplete assessment of photocatalytic activity.	Promising for water remediation, combining adsorption and photocatalysis.	Ye et al. (2019)
Evaluating biochar and its modifications for the removal of ammonium, nitrate, and phosphate in water	Evaluate biochar and modifications for nutrient removal.	Not mentioned	Not mentioned	Effective removal of ammonium, nitrate, and phosphate.	Lack of specific coagulant/material information.	Promising for nutrient removal from water.	Zhang et al. (2020)

2.3 Literature Review on Moringa oleifera

Table 3 summarizes studies on the use of Moringa oleifera as a natural coagulant for water treatment. Oluwasanya et al. (2023) examined the effectiveness of kenaf fibers and moringa seeds for treating turbid water using dosages of 0 to 50 grams. The study found that this combination effectively treated high turbidity, but did not compare with other coagulants. Ng et al. (2021) aimed to optimize Moringa oleifera extract as a coagulant in water treatment. Despite unspecified dosages and settling durations, it proved effective but lacked long-term stability analysis. Vijayaraghavan et al. (2011) demonstrated the green synthesis of copper nanoparticles with rice husk ash, finding significant water quality improvements, though focused only on this specific nanoparticle. Shan et al. (2017) assessed Moringa oleifera seeds for wastewater treatment, finding them effective in reducing turbidity and BOD while increasing conductivity and TDS. This study lacked dosage details but showed the seeds' potential in treating wastewater and removing heavy metals. In summary, Moringa oleifera is shown to be an effective natural coagulant, with further research needed for long-term stability and broader comparisons**.**

Table 3: Moringa oleifera Previous Studies

Article name	Objective	Dosage	Settling durations	Findings	Limitations	Conclusion	Reference
Turbid water treatment with kenaf (hibiscus cannabinus) fibers and moringa seeds (moringa oleifera): an application of nature-based solutions	To explore the effectiveness of kenaf fibers and moringa seeds as nature-based solutions in treating turbid water.	0, 20, 30, 40, and 50 gm	Nil	The study focused on the use of kenaf fibers and moringa seeds as upregulates for turbid surface water treatment in a specific location	Focus only on specific coagulants; no comparison with others	The study concluded that the combination of kenaf fibers and moringa seed powder showed effectiveness in treating high turbid water	Oluwasanya et al. (2023)
Utilization of moringa oleifera as natural coagulant for water purification	The study aimed to determine the optimum conditions for using mo extract as a coagulant and flocculant in water treatment processes.	Haftendorn (2000)	Nil	Nil	The limitations of the study include the lack of investigation into the long-term stability and effectiveness of moringa oleifera	Effective for mitigating soil salinity and improving soil quality.	Ng et al. (2021)
Application of plant-based coagulants for waste water treatment	Demonstrate green synthesis of copper nanoparticles with rice husk ash.	5% to 15%	1 hour	Significant improvement in water quality parameters; rhacunps are potential nano sorbents.	Focus only on rice husk ash-copper nanoparticles.	Rha-cunps are effective; meets standard limits; potential for safe discharge	Vijayaraghavan et al. (2011)
The use of moringa oleifera seed as a natural coagulant for wastewater treatment and heavy metals removal.	Compare coagulation performance of biomass powders with alum.	Not mentioned	1 hour	Varying degrees of effectiveness; rice husk most efficient.	It effectively reduced turbidity and BOD while improving DO levels in treated water.	There were slight increases in conductivity, total dissolved solids (tds), and salinity after treatment	Shan et al. (2017)

2.4 Literature Review on Okra Seeds

Table 4 summarizes studies on the use of okra seeds as a natural coagulant for water treatment. Raji et al. (2016) tested okra seed extract for surface water treatment, finding that 300 mg/L effectively removes turbidity, meeting WHO standards for eco-friendly water treatment in developing nations. The study concluded okra seeds are a green solution but recommended further research on other contaminants. Ahirwar et al. (2021) explored okra seed extract for treating Turag River water. Using 6 ml per 1000 ml of raw water with a 30-minute settling duration, the study achieved a 58.74% reduction in turbidity and improvements in various water quality parameters. The conclusion highlighted okra extract as cost-effective and sustainable, though more research is needed for comparisons and wider applicability. Mishra et al. (2017) compared okra seeds to chemical coagulants, using dosages of 150 to 250 mg/L. The study found okra extract effective in water treatment, requiring pH adjustment and producing less sludge than alum. It concluded that okra seeds are a cost-effective, eco-friendly alternative, although further investigation into factors like cost and scalability is necessary. Jatav et al. (2016) assessed okra seed extract for surface water treatment, finding that a 200 mg/L dosage efficiently removes turbidity within 30 minutes, comparable to alum's performance. The study emphasized okra extract as a cost-effective alternative to alum, but noted the need for further research on other contaminants and long-term stability. In summary, these studies consistently demonstrate okra seeds' potential as an effective, eco-friendly, and cost-efficient coagulant for water treatment, with recommendations for additional research on broader applications and long-term effects.

Table 4: Okra Seeds Previous Studies

Article name	Objective	Dosage	Settling durations	Findings	Limitations	Conclusion	Reference
Assessment of coagulation efficiency of okra seed extract for surface water treatment	Study tests okra seed extract for water treatment, finding optimal dosage and ph for efficient turbidity removal.	300 mg/l.	Not mentioned	Okra seeds at 300 mg/l meet who standards for eco-friendly water treatment in developing nations	Okra seeds: green solution for water treatment, effective at diverse doses and ph levels.	Okra seeds at 300 mg/l meet who standards for eco-friendly water treatment in developing nations; more research needed for contaminants.	Raji et al. (2016)
Coagulation efficiency of okra seeds extract for the narmada river water	Study aims to explore okra seed extract as a natural coagulant for treating turag river water.	6ml/1000ml of raw water.	30 minutes.	Okra extract (6 ml/1000 ml) cuts turag river water turbidity by 58.74%, improving ph, alkalinity, hardness, fluorides, total dissolved solids, iron, and chloride.	Study solely examines okra seed extract as a coagulant for turag river water, lacking comparison to other coagulants and limiting generalizability.	Okra extract (6 ml/1000 ml) reduces turbidity, cost-effective and sustainable; needs more research for comparisons and wider use.	Ahirwar et al. (2021)
Okra seeds: an efficient coagulant.	Study explores okra seeds as a natural water coagulant, comparing effectiveness to chemicals.	150 mg/l to 250 mg/l	Not mentioned	Okra extract, effective in water treatment like alum, improves with higher doses, requires ph adjustment, and yields less sludge, suggesting management benefits.	This study solely examines okra seed extract's coagulation effectiveness for water treatment, overlooking factors like cost, availability, and scalability.	Okra seed extract: cost-effective, eco-friendly water treatment at 150-250 mg/l doses, ph adjustment crucial, less sludge than alum.	Mishra et al. (2017)
Coagulation efficiency of okra seed extract for surface water treatment.	Study objective: assess okra seed extract as a natural coagulant for surface water treatment, determining optimal dosage for turbidity removal.	Not mentioned	30 minutes.	Okra seed extract, at 200mg/l dosage, efficiently removes water turbidity in 30 minutes, comparable to alum's performance..	Study limits: sole focus on okra seed extract as a turbidity coagulant, neglecting other contaminants and long-term stability.	Okra extract (200mg/l) effectively removes water turbidity, showing potential as a cost-effective alternative to alum in surface water treatment.	Jatav et al. (2016)

2.5 Conclusion

- **Literature Review Insights**
    - The studies reviewed focus on natural coagulants like rice husk ash and okra seeds, comparing their effectiveness with traditional coagulants in water

treatment. Key findings suggest rice husk ash and okra seeds are promising alternatives for turbidity removal.

- **Relevance to Bangladesh**
  - Given the significant water quality issues in Bangladesh, particularly arsenic contamination, these natural coagulants offer a sustainable and cost-effective solution for improving water safety and accessibility.
- **Study Impact**
  - The research contributes to the global effort to address the safe water crisis by providing viable methods for water purification using locally available materials, which is crucial for countries facing water scarcity and pollution.
- **Conclusions Drawn**
  - The study concludes that natural coagulants, especially rice husk ash, have a high potential for use in water treatment processes, offering an eco-friendly alternative to chemical coagulants like alum.

This study is particularly impactful for Bangladesh, where access to safe drinking water is a critical issue. The use of natural coagulants could revolutionize water treatment practices, making them more environmentally sustainable and accessible to communities in need. The findings are a step forward in addressing the global water crisis and highlight the importance of localized solutions in environmental engineering.

3 CHAPTER THREE DATA COLLECTION AND FILTER PREPARATION.

3.1 Introduction

In the quest to enhance the quality of surface water, the exploration of sustainable and efficient treatment methods remains a pivotal challenge. This chapter delves into the systematic approach employed to collect relevant data and the rigorous methodologies applied to assess the efficacy of various natural coagulants and sand bed filtration. Our study is anchored on the premise that environmentally friendly solutions can significantly improve water quality, thereby addressing the pressing safe water crisis in regions like Bangladesh.

We commence with a detailed description of the coagulant preparation processes for Okra seeds, Biochar, Moringa seeds, and Rice Husk Ash, elucidating the meticulous steps taken to ensure consistency and reliability in our experiments. Following this, we outline the construction and grading of the sand bed filters, which play a crucial role in the subsequent filtration stage.

The study areas, primarily the Buriganga and Turag Rivers, were selected based on their varying levels of pollution and representativeness of common water quality issues. We present the parameters tested, including pH, turbidity, and biochemical oxygen demand (BOD), among others, and compare them against established environmental standards.

Our methodology section provides a transparent view of the experimental design, including the dosage selection for each coagulant, the settling durations, and the specific conditions under which each test was conducted. By presenting this information, we aim to furnish a replicable framework that can be utilized by fellow researchers and practitioners in the field of water treatment.

In summary, this chapter serves as a cornerstone for understanding the empirical efforts undertaken to contribute to the domain of water purification, with a focus on sustainable practices that align with global environmental goals.

3.2 Study Area and Data

3.2.1 Study Area

The study area section of the current page discusses two rivers in Bangladesh:

Buriganga River: The figure below provides a detailed analysis of various water quality parameters for the Buriganga River, such as pH, color, iron content, total suspended solids (TSS), total dissolved solids (TDS), electrical conductivity (EC), dissolved oxygen (DO), salinity, turbidity, chemical oxygen demand (COD), and biochemical oxygen demand (BOD). These parameters are compared against the Environmental Conservation Rules (ECR) standards for 2023.

Turag River: Similar to the Buriganga River, the Turag River's water quality is assessed based on the same set of parameters and compared with the ECR 2023 standards. The results indicate the current state of water quality and the extent of pollution in these rivers. subsequent analysis of the coagulation process's impact on improving water quality. This section is crucial as it sets the baseline for evaluating the effectiveness of natural coagulants in treating water from these rivers. The data serves as a reference point for the collection of sample water.

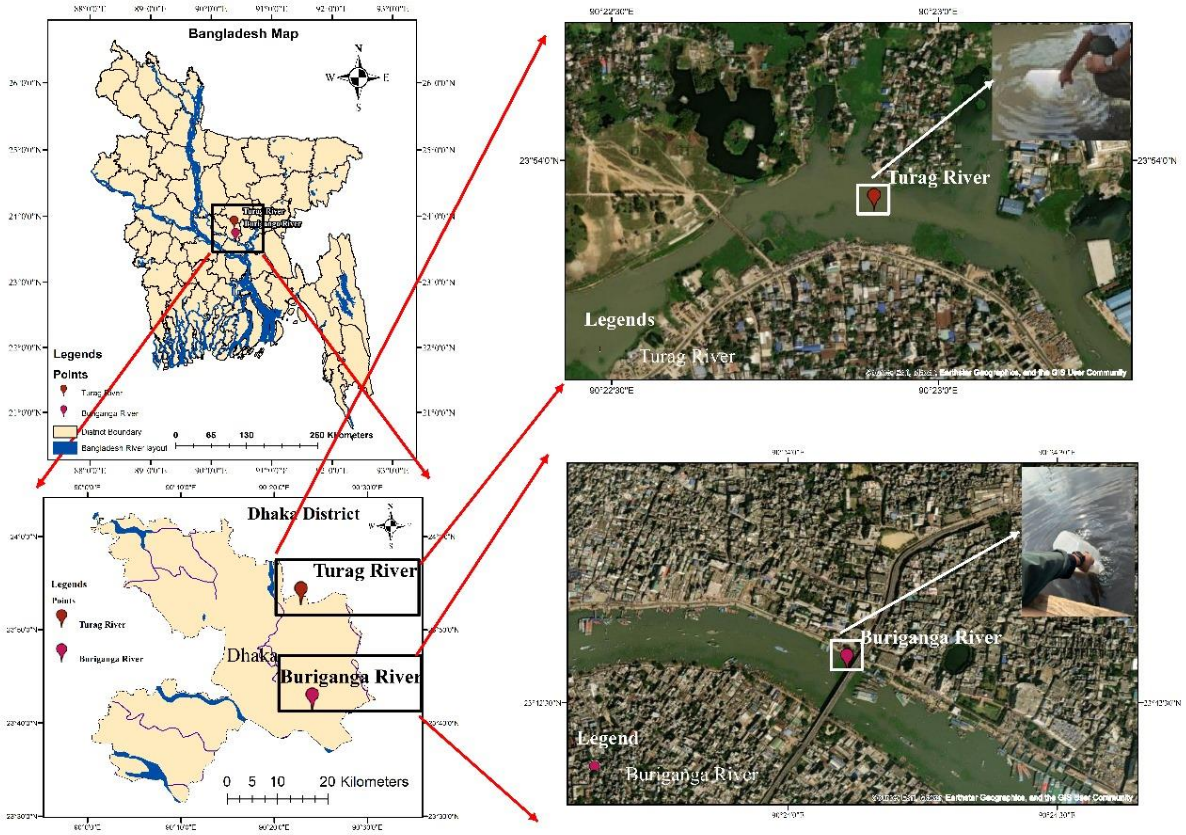


Figure 1: Data Collection Locations

3.2.2 Data

Water was collected from the pointed locations:

Turag River Coordinates: 23.8989962, 90.3816981

Buriganga River Coordinates: 23.7096681, 90.4018348

3.3 Filter Preparation Overview

The filter preparation process is a critical step in ensuring the effectiveness of natural coagulants in water treatment. The procedure involves selecting appropriate materials and sizes to construct a filter that can efficiently remove pollutants from water pre-treated with natural coagulants.

3.3.1 Materials Selection

Sieves: ASTM standard sieves with sizes 9.5, 4.75, 2.36 stone, and 1.18, 600-micron sand are used.

Filter Media: The choice of filter media is crucial for the filtration process. The media must be clean, uniform, and of the right size to ensure proper filtration.

Grading and Layering

The filter media are carefully graded and layered according to their sizes. The larger stones are placed at the bottom, followed by smaller stones and finally sand at the top. This gradation helps in trapping different sizes of particles effectively.

Table 5: Sieve Analysis

Sieve . opening (mm)	Wt of Sieve	Sieve + Material Retained	Wt. of material (gm)	Percent Retain (Stone)	Cumulative Percent (Stone)	Percent Finer (Stone)
37.5	0	0	0	0.00%	0.00%	100.00%
20	0	0	0	0.00%	0.00%	100.00%
9.5	273.22	424.9	151.68	12.25%	12.25%	87.75%
4.75	346.46	709.82	363.36	29.35%	41.60%	58.40%
2.36	322.98	725.27	402.29	32.49%	74.09%	25.91%
1.18	319.72	469.19	149.47	12.07%	86.17%	13.83%
0.6	313.47	450.74	137.27	11.09%	97.26%	2.74%
0.3	289.69	315.43	25.74	2.08%	99.33%	0.67%
0.15	293.17	300.65	7.48	0.60%	99.94%	0.06%
0.075	288.73	289.49	0.76	0.06%	100.00%	0.00%
			1238.05			

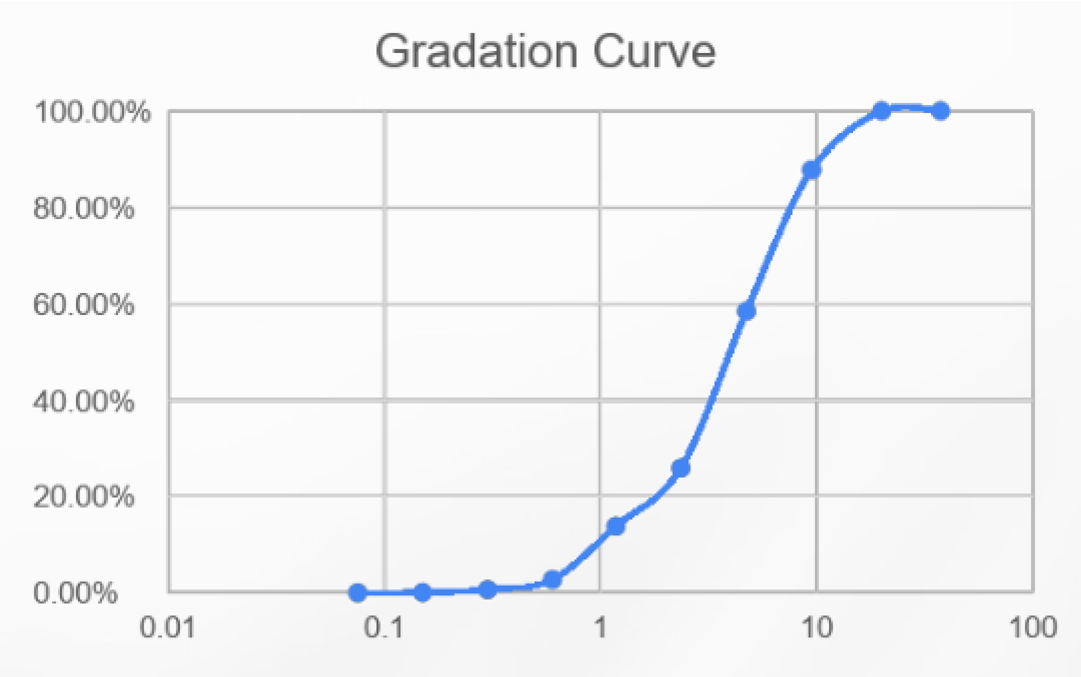


Figure 2: Filter Gradation Curve

Quality Control

Throughout the filter preparation process, quality control measures are taken to ensure that the filter media are free from contaminants and are of the specified quality.

Final Assembly

The prepared filter media are then assembled into the filtration system, ready for the water treatment process.

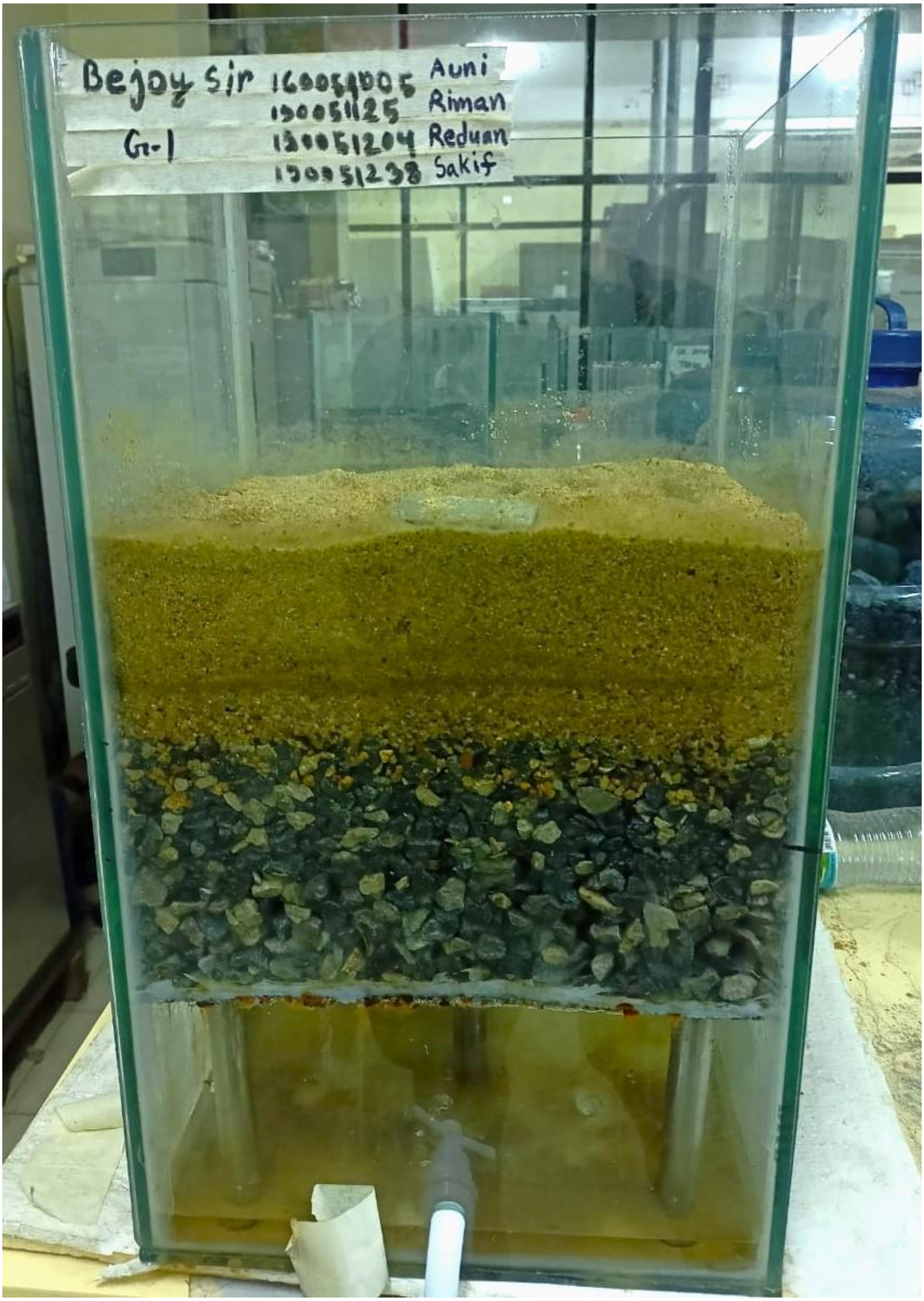


Figure 3: Filter

Figure 4: Filter Making

Figure 5: Sieve Analysis

Figure 6: Sand used in Filter

4 CHAPTER FOUR METHODOLOGY

4.1 Different Coagulant Preparation & Filter making.

4.1.1 Coagulant Preparation of Okra Seeds

The process began with purchasing Okra seeds from the market, followed by washing them to remove dust and impurities. After cleaning, the seeds were sun-dried on foil paper using a temperature-controlled machine to ensure proper drying. Once dried, the seeds were ground using a spice grinder. The final step involved performing a sieve analysis, where the ground seeds were passed through a 200-mesh sieve to achieve the desired fineness.

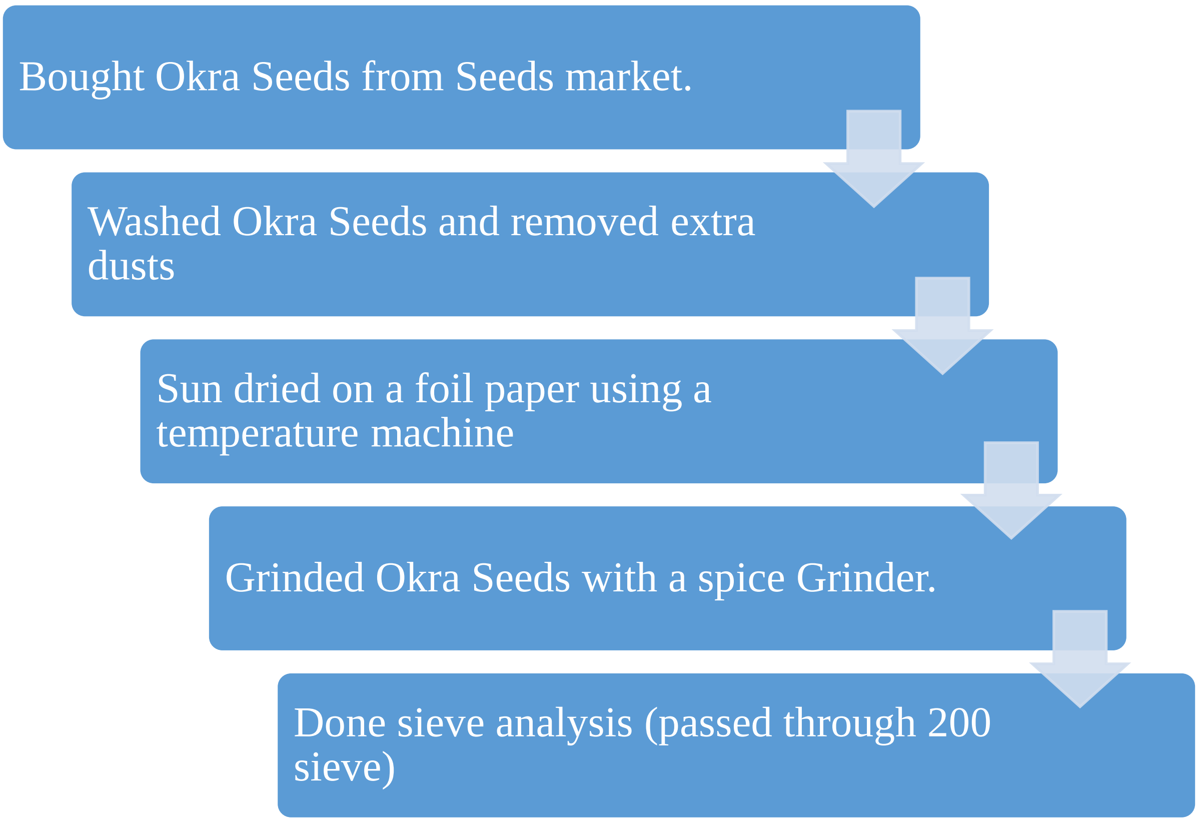


Figure 7: Coagulant Preparation of Okra Seeds

4.1.2 Coagulant Preparation of Biochar

The process started with purchasing biochar for coagulant preparation. A drying stand was then constructed, and the necessary preparations were made for drying the coagulant. The biochar underwent a 4-hour sun drying process, during which the temperature was carefully monitored.

Finally, the dried biochar was sieved using an ASTM 200 sieve to achieve the appropriate particle size for the coagulant.

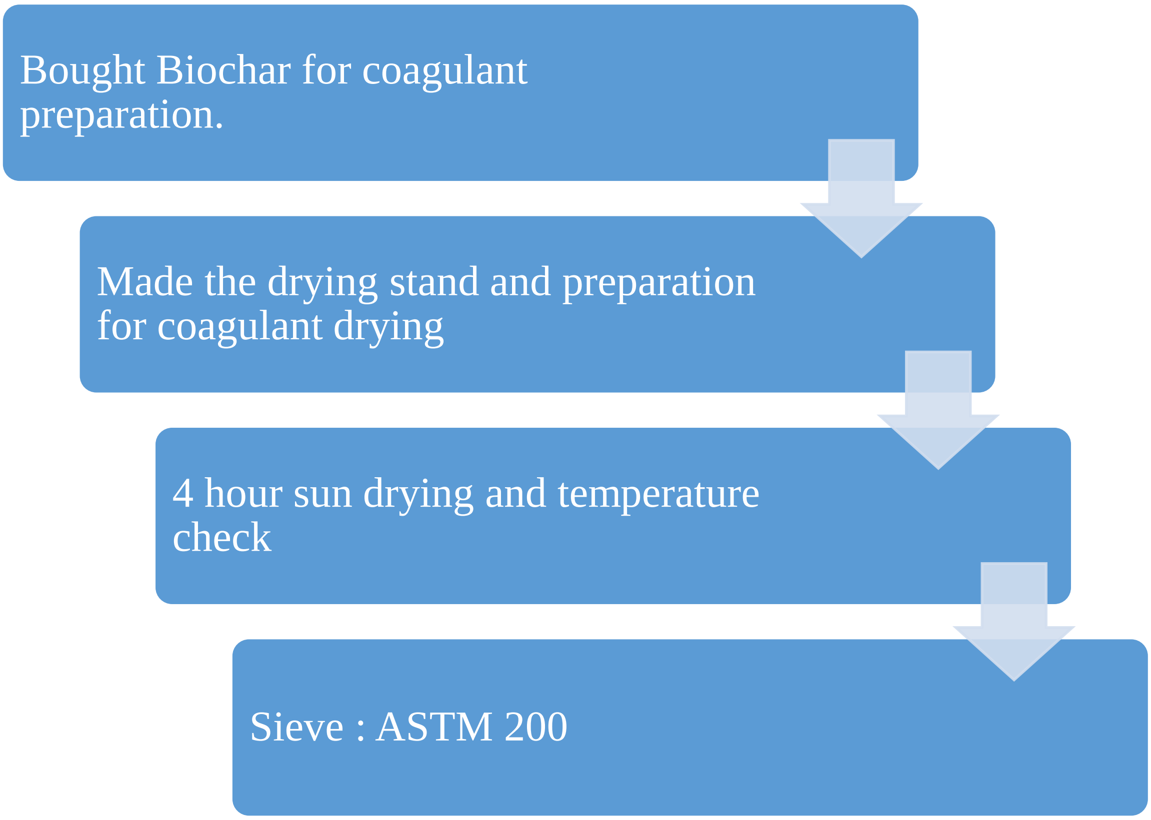


Figure 8: Coagulant Preparation of Biochar

4.1.3 Coagulant Preparation of Moringa Seeds

The process began with purchasing Moringa seeds from the market, followed by washing them to remove dust and impurities. The seeds were then sun-dried for 4 hours on foil paper using a temperature-controlled machine to ensure they were thoroughly dried. After drying, the seeds were ground using a spice grinder. Finally, the ground Moringa seeds were passed through a 100-mesh sieve during the sieve analysis to achieve the desired fineness.

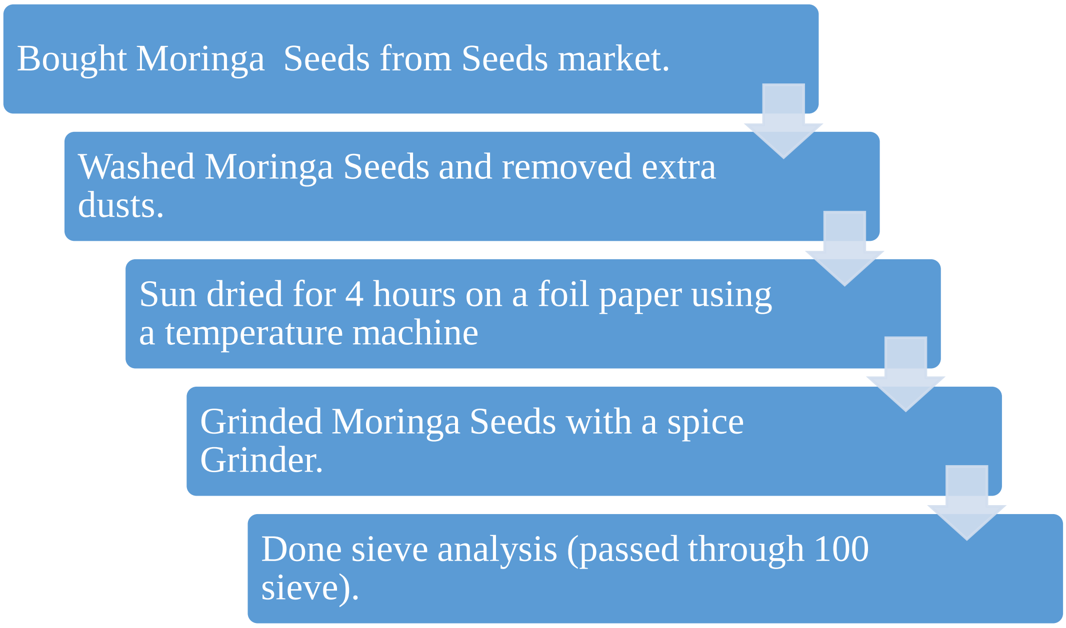


Figure 9: Coagulant Preparation of Moringa Seeds

4.1.4 Coagulant Preparation of Rice Husk Ash

The process started with constructing a low-cost incinerator using sustainable materials. Rice husk was then purchased from a local farmer's market. The rice husk was burned to produce rice husk ash, which was intended for use as a coagulant. The resulting ash was then sieved using an ASTM 200 sieve to ensure the appropriate particle size for the coagulant.

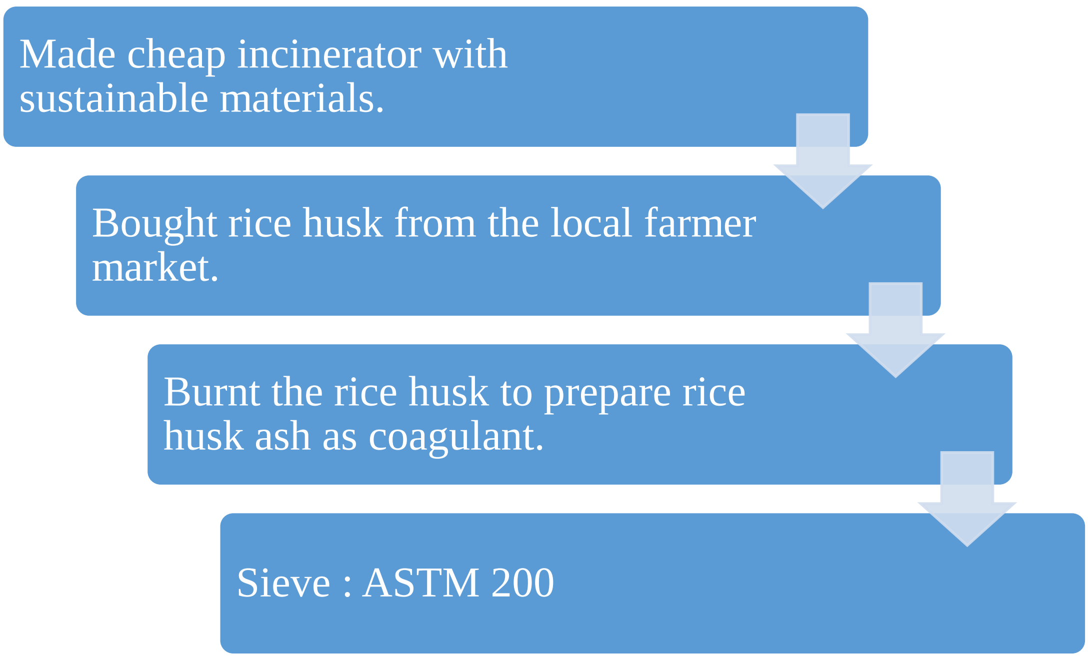


Figure 10: Coagulant Preparation of Rice Husk Ash

5 CHAPTER FIVE COAGULANT PREPARATION, PARAMETER, JAR TEST & RESULT ANALYSIS

5.1 Introduction

Chapter Four of the thesis presents a detailed exploration of the preparation methods for various natural coagulants, the parameters involved in assessing water quality, and the jar test procedures used to analyze the effectiveness of these coagulants in treating surface water. This chapter is crucial as it lays the groundwork for understanding how different coagulants are prepared and evaluated, providing insight into their potential for practical application in water treatment. The results obtained from the jar tests are instrumental in determining the efficiency of each coagulant, guiding the selection of the most suitable natural coagulant for improving water quality. The chapter's comprehensive analysis aims to contribute to the field of water treatment by offering sustainable and eco-friendly alternatives to traditional chemical coagulants.

5.2 Coagulant Preparation.

Rice Husk Ash

The preparation of rice husk ash as a coagulant, as described in the current page, involves several steps:

Sourcing Rice Husk: The rice husk is obtained from the local farmer market.

Figure 11: Ruce Husk

Incinerator Construction: A cost-effective incinerator is constructed using sustainable materials.

Figure 12: Incineration Construction

Ash Production: The rice husk is burned in the incinerator to create rice husk ash.

Figure 13: Ash Production

Sieving: The resulting ash is then sieved using an ASTM 200 sieve to ensure uniform particle size.

Figure 14: Coagulant Sieving

This process is part of a study on evaluating the efficacy of natural coagulants for water treatment. Rice husk ash is one of the materials being tested for its ability to remove pollutants from surface water.

Okra Seeds:

The preparation of okra seed's extract as a coagulant, as described in the current page, also involves several steps:

Sourcing Okra Seeds: The okra seeds are collected from local seed market located in Siddikbazar.

Figure 15: Okra Seeds

Washing: The seeds are washed with water to remove extra dusts from it.

Sun Drying Okra Seeds: A frame was prepared with woods and set a tin and a foil paper on it to sun dry the seeds. Also measured the temperature with a machine.

Figure 16: Sun Drying

Grinding Okra Seeds: Then the Okra seeds are grinded using a spice grinder. Made as powder as possible for better coagulant result.


Figure 17: Grinding

Sieve Analysis: The powdered okra seed’s extract is then sieved using as ASTM 200 sieve to ensure uniform particle size. Thus, the coagulant is prepared.


Figure 18: Sieve Analysis of Okra

Okra Seeds Extract is very effective in removing pollutants from surface water.

Biochar:

The preparation of Biochar as a coagulant, as described in the current page, also involves several steps:

Sourcing Biochar: The Biochar is obtained from the local market.

Figure 19: Biochar

Sun Drying Biochar: A frame was prepared with woods and set a tin and a foil paper on it to sun dry the seeds. Also measured the temperature with a machine.

Figure 20: Sun Drying of Biochar

Sieve Analysis: After sun dried, the Biochar is then sieved using an ASTM 200 sieve to ensure uniform particle size.

Figure 21: Sieve Analysis of Biochar

Biochar is also very effective in removing pollutants from surface water.

Moringa Oleifera:

The preparation of Moringa Oleifera Seed's Extract as a coagulant, as described in the current page, also involves several steps:

Sourcing Moringa Seeds: The Moringa seeds are collected from local seeds market.

Figure 22: Moringa Seeds

Washing Moringa Seeds: The Moringa seeds are washed with water to remove extra dusts from it.

Sun Drying Moringa Seeds: A frame was prepared with woods and set a tin and a foil paper on it to sun dry the moringa seeds. Also measured the temperature with a machine.

Figure 23: Sun Drying of Moringa Seeds

Figure 24: Sun Drying of Moringa Seeds

Grinding Moringa Seeds: Then the Moringa seeds are grinded using a spice grinder. Made as powder as possible for better coagulant result.

Figure 25: Grinding Moringa Seeds

Sieve Analysis: The powdered Moringa seed’s extract are then sieved using as ASTM 200 sieve to ensure uniform particle size.

Figure 26: Sieve Analysis of Moringa Seeds

Moringa Seed's Extract is very effective in removing pollutants from surface water. Which is also sourced from many research paper.

5.3 Parameter Test:

The Parameter Test section of the presentation focuses on assessing the quality of water from two rivers, the Buriganga and Turag, by measuring various water quality parameters. Here's a brief overview:

Test Parameters: The study measures pH, color, iron content, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Solids (TS), Electrical Conductivity (EC), Dissolved Oxygen (DO), salinity, turbidity, Chemical Oxygen Demand (COD), and Biochemical Oxygen Demand (BOD).

Standards & Results: Each parameter is tested against the Environmental Conservation Rules (ECR) standards for 2023. The results show compliance or deviation from these standards, indicating the water's quality.

River-Specific Findings: For the Buriganga River, parameters like color and turbidity exceed the standard values, suggesting pollution issues. In contrast, the Turag River shows better DO levels but higher turbidity, indicating different contamination sources.

Coagulant Testing: The study also includes tests using natural coagulants like Okra Seeds and Rice Husk Ash to treat the water, aiming to improve its quality by reducing pollutants.

This section is crucial for understanding the effectiveness of natural coagulants in water treatment and the current state of water quality in these rivers.

5.4 Buriganga River Parameter Test

The table summarizes the results of a water quality assessment for the Buriganga River, comparing the findings against the Environmental Conservation Rules (ECR) of 2023. The pH level of the river, at 7.38, falls comfortably within the acceptable range of 6.5 to 8.5, indicating a balanced acidity. However, the color of the water presents a significant concern, with a value of 327 Pt-Co far exceeding the standard of 15 Pt-Co, pointing to severe discoloration likely due to pollution.

Iron levels in the water are relatively low, measuring 0.32 mg/L, which is well below the permissible limit of 1 mg/L, suggesting minimal contamination from iron. Conversely, the Total Suspended Solids (TSS) slightly surpass the acceptable limit, with a value of 107 mg/L compared to the standard of 100 mg/L, indicating some particulate matter presence. On a positive note, the Total Dissolved Solids (TDS) are well within the allowable limit at 222 mg/L, compared to a standard of 2100 mg/L.

Other parameters, such as Total Solids (TS), Electrical Conductivity (EC), and salinity, lack specified standards for comparison, but their values of 329 mg/L, 459 μs/cm, and 0.22%, respectively, provide baseline data for further monitoring. The Dissolved Oxygen (DO) level is notably high at 7.97 mg/L, exceeding the minimum requirement of 5 mg/L, which is a positive indicator of water quality and aquatic health.

However, turbidity poses a significant issue, with a measurement of 73.4 NTU, dramatically higher than the standard of 10 NTU, signaling high levels of suspended particles that could affect water clarity and quality. Despite these concerns, the Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) levels are within acceptable limits, at 57 mg/L and 29 mg/L, respectively, suggesting that organic pollution is manageable.

Overall, the Buriganga River exhibits a mix of compliance and concern in its water quality, with notable issues in color and turbidity that warrant immediate attention to reduce pollution and improve the river's health.

Table 6: Buriganga River Parameter Test

Test	Standard Value (ECR, 2023)	Test Result
pH	6.5-8.5	7.38
Color (Pt-Co)	15	327
Iron (mg/L)	1	0.32
TSS (mg/L)	100	107
TDS (mg/L)	2100	222
TS (mg/L)	Not specified	329
EC (µs/cm)	Not specified	459
DO (mg/L)	≥5	7.97
Salinity (%)	Not specified	0.22
Turbidity (NTU)	10	73.4
COD (mg/L)	200	57
BOD (mg/L)	30	29

5.5 Turag River Parameter Test

The table presents the results of a water quality analysis for the Turag River, comparing the outcomes with the standards set by the Environmental Conservation Rules (ECR) of 2023. The pH level of 7.62 falls within the acceptable range of 6.5 to 8.5, indicating that the river's acidity is within the normal limits. However, the color measurement at 378 Pt-Co is significantly higher than the standard of 15 Pt-Co, suggesting substantial discoloration, likely due to pollution.

Iron concentration is relatively low, with a result of 0.31 mg/L, which is well within the permissible limit of 1 mg/L, indicating minimal iron contamination. The Total Suspended Solids (TSS) are measured at 60 mg/L, comfortably below the standard of 100 mg/L, reflecting lower levels of particulate matter. Similarly, the Total Dissolved Solids (TDS) are 465 mg/L, well within the allowable limit of 2100 mg/L, indicating acceptable levels of dissolved substances in the water.

While the values for Total Solids (TS), Electrical Conductivity (EC), and salinity—measured at 525 mg/L, 778 µs/cm, and 0.38%, respectively—lack specific standard comparisons, they provide essential data points for understanding the river's overall water quality. However, a major concern arises with the Dissolved Oxygen (DO) level, which is critically low at 1.66 mg/L, far below the minimum requirement of 5 mg/L. This low DO level suggests poor oxygenation, which could severely impact aquatic life in the river.

Turbidity, measured at 29.6 NTU, exceeds the standard limit of 10 NTU, indicating a significant presence of suspended particles that could affect water clarity and quality. Despite these issues, the Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) levels are relatively low at 42 mg/L and 33 mg/L, respectively, with COD well within the acceptable limit of 200 mg/L, though BOD slightly exceeds the standard of 30 mg/L. This suggests moderate organic pollution, though it remains a concern.

In summary, while the Turag River shows compliance with several water quality standards, critical issues such as high discoloration, low dissolved oxygen, and elevated turbidity highlight the need for urgent interventions to improve the river's health and sustain its aquatic life.

Table 7: Turag River Parameter Test

Tests	Standard Value (ECR, 2023)	Test Result
pH	6.5-8.5	7.62
Color (ptCo)	15	378
Iron (mg/L)	1	0.31
TSS (mg/L)	100	60
TDS (mg/L)	2100	465
TS (mg/L)	Not specified	525
EC (µs/cm)	Not specified	778
DO (mg/L)	≥5	1.66
Salinity (%)	Not specified	.38
Turbidity (NTU)	10	29.6
COD (mg/L)	200	42
BOD (mg/L)	30	33

5.6 JAR TEST

The section on jar tests from the current page discusses:

- **Jar Test Procedure**: It outlines the procedure for conducting jar tests using four different natural coagulants: Rice Husk, Moringa Oleifera, Biochar, and Okra Seeds.

The tests aim to evaluate the effectiveness of these coagulants in treating water from the Buriganga and Turag Rivers.

- **Dosage and Duration**: Details are provided on the specific dosages of coagulants used for each river and the duration for which the tests were conducted, ranging from 2 to 24 hours.
- **Test Results**: The results section compares the performance of each coagulant in improving various water quality parameters such as pH, turbidity, total suspended solids (TSS), and others.
- **Effectiveness of Coagulants**: The conclusion highlights the effectiveness of natural coagulants in removing pollutants from surface water and their potential as sustainable alternatives to traditional coagulation methods.

5.6.1 Dosage Selection of Coagulants:

The tables present the dosage selection for various coagulants used in water treatment for the Buriganga and Turag Rivers. The coagulants considered are Rice Husk, Moringa Oleifera, Biochar, and Okra Seeds, with dosages measured in grams. The goal is to identify the most effective dosage for each coagulant in treating the respective river water.

For the Buriganga River, the dosage of each coagulant varies significantly.

- **Rice Husk**: The dosage starts from 0.02 grams and increases progressively to 0.12 grams.
- **Moringa Oleifera**: The dosage ranges from 0.05 grams to 0.17 grams.
- **Biochar**: The required dosage is notably higher, starting at 3 grams and reducing to 0.5 grams as the concentration increases, indicating a strong initial dose is needed.
- **Okra Seeds**: The dosage starts at 0.05 grams and increases to 0.17 grams, showing a steady increment similar to Moringa Oleifera.

This table suggests that Biochar requires a larger initial quantity compared to the other coagulants, but as the dosage increases, its required amount decreases more sharply, which may indicate its effectiveness at higher concentrations.

Table 8: Dosage Selection (Coagulant in gm) of Buriganga River

Rice Husk	Moringa Oleifera	Biochar	Okra Seeds
0.02	0.05	3	0.05
0.04	0.07	2	0.07
0.06	0.08	1.5	0.09
0.085	0.13	1	0.12
0.1	0.15	0.8	0.15
0.12	0.17	0.5	0.17

For the Turag River, the coagulant dosages also show variability, though with some differences compared to the Buriganga River.

- **Rice Husk**: The dosage begins at a lower 0.01 grams and increases more steeply, reaching up to 1.01 grams, which is a significant jump compared to its usage in the Buriganga River.

- **Moringa Oleifera**: The dosage is similar to that used in the Buriganga River, ranging from 0.05 grams to 0.19 grams.

- **Biochar**: Here, the dosage starts at 2 grams and decreases to 0.3 grams, following a pattern similar to its use in the Buriganga River but with generally lower amounts.

- **Okra Seeds**: The dosage progression is also similar to the Buriganga River, ranging from 0.05 grams to 0.17 grams.

In this table, the dosage of Rice Husk is notably higher for the Turag River than for the Buriganga River, indicating that a higher quantity is necessary for effective coagulation.

Biochar again requires a higher initial dosage but decreases more sharply as concentration increases, consistent with its performance in the Buriganga River.

Table 9: Dosage Selection (Coagulant in gm) of Turag River

Rice Husk	Moringa Oleifera	Biochar	Okra Seeds
0.01	0.05	2	0.05
0.02	0.07	1.5	0.07
0.04	0.09	1	0.09
0.06	0.15	0.8	0.12
0.08	0.17	0.5	0.15
1.01	0.19	0.3	0.17

Comparative Analysis

Comparing both tables, we observe that the required dosage for each coagulant varies depending on the river, with Rice Husk showing the most significant difference between the two rivers. Moringa Oleifera and Okra Seeds have relatively consistent dosages across both rivers, indicating similar effectiveness in different water bodies. Biochar stands out as requiring higher initial dosages but becoming more effective at lower quantities with increased concentration.

These dosage selections are crucial for optimizing water treatment processes, ensuring that the appropriate amount of each coagulant is used to achieve the best water quality outcomes for each specific river.

5.7 Buriganga River Parameter Test with Coagulants

The table outlines the effects of different coagulants—Okra, Rice Husk Ash, Biochar, and Moringa Oleifera—on the water quality of the Buriganga River over varying retention times. The raw water's pH started at 7.38, and most coagulants caused slight fluctuations, with Moringa Oleifera and Biochar generally maintaining stable pH levels. A significant reduction in watercolor was observed, especially with Okra and Rice Husk Ash, which effectively reduced the color after 24 hours, demonstrating their efficiency in treating discoloration.

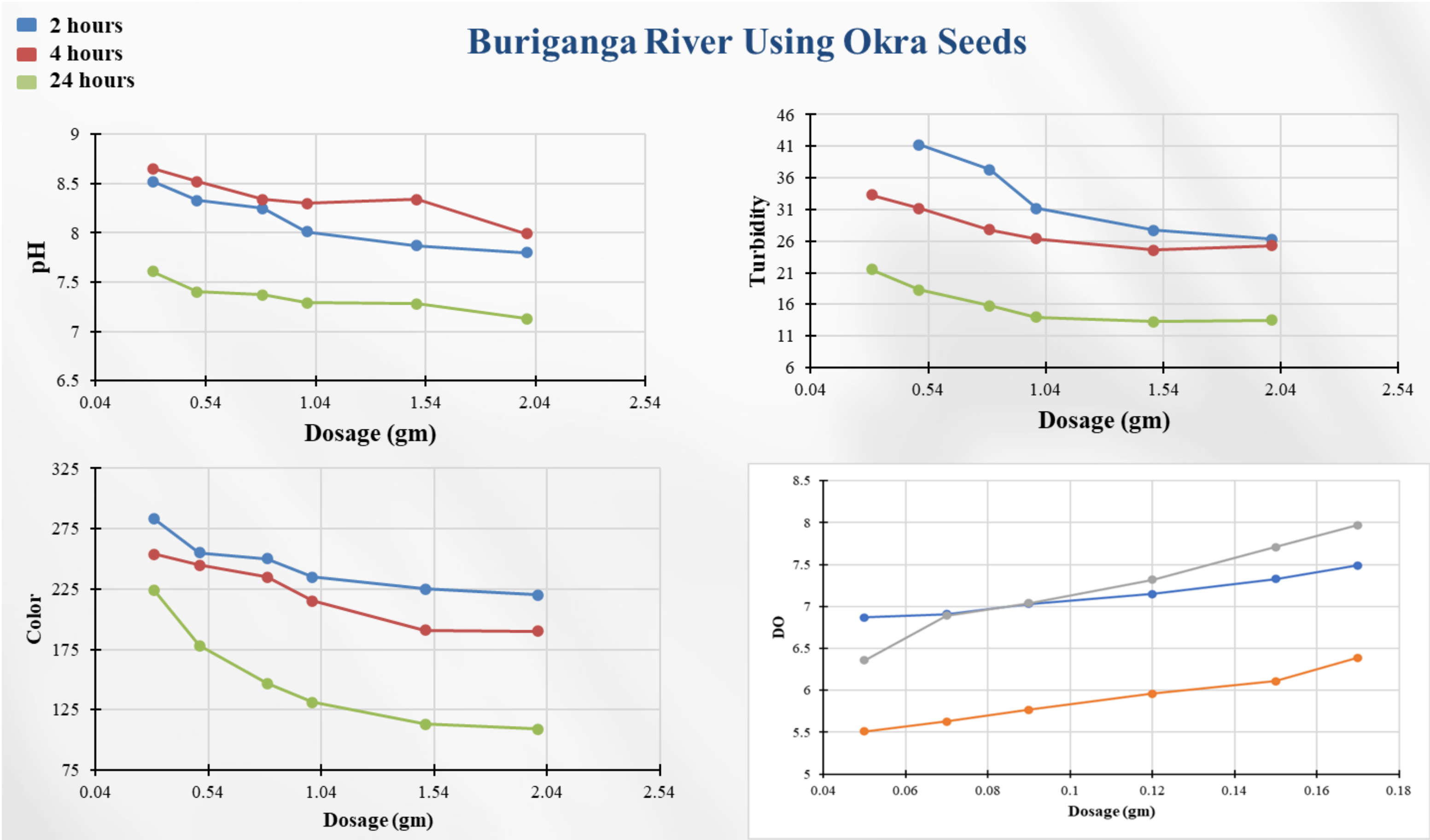
Iron levels in the water were generally reduced by the coagulants, with Okra showing the most significant reduction over time. Total Suspended Solids (TSS) were notably decreased, especially with Okra and Rice Husk Ash, which brought TSS down to minimal levels after 24 hours, indicating their strong potential in removing particulate matter. The Total Dissolved Solids (TDS) and Total Solids (TS) showed slight variations, with Biochar increasing these levels initially but stabilizing later.

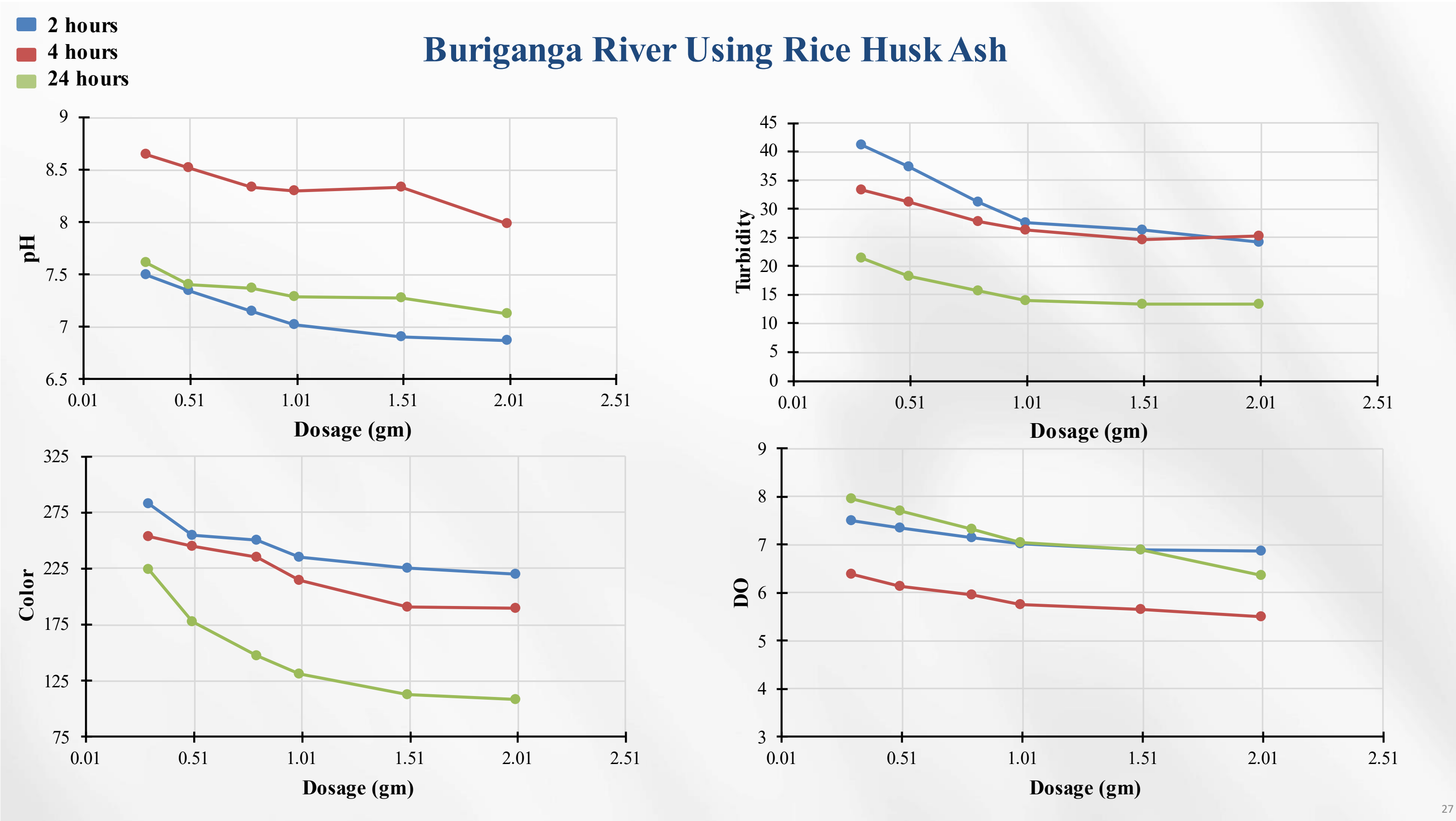
Electrical Conductivity (EC) and salinity remained relatively stable across the treatments, with minor fluctuations observed. However, the Dissolved Oxygen (DO) levels were significantly impacted by Biochar, which reduced DO levels, while other coagulants maintained them closer to the initial values. Turbidity was effectively reduced by Okra, which brought it down to a low level, demonstrating its effectiveness in clearing suspended particles from the water.

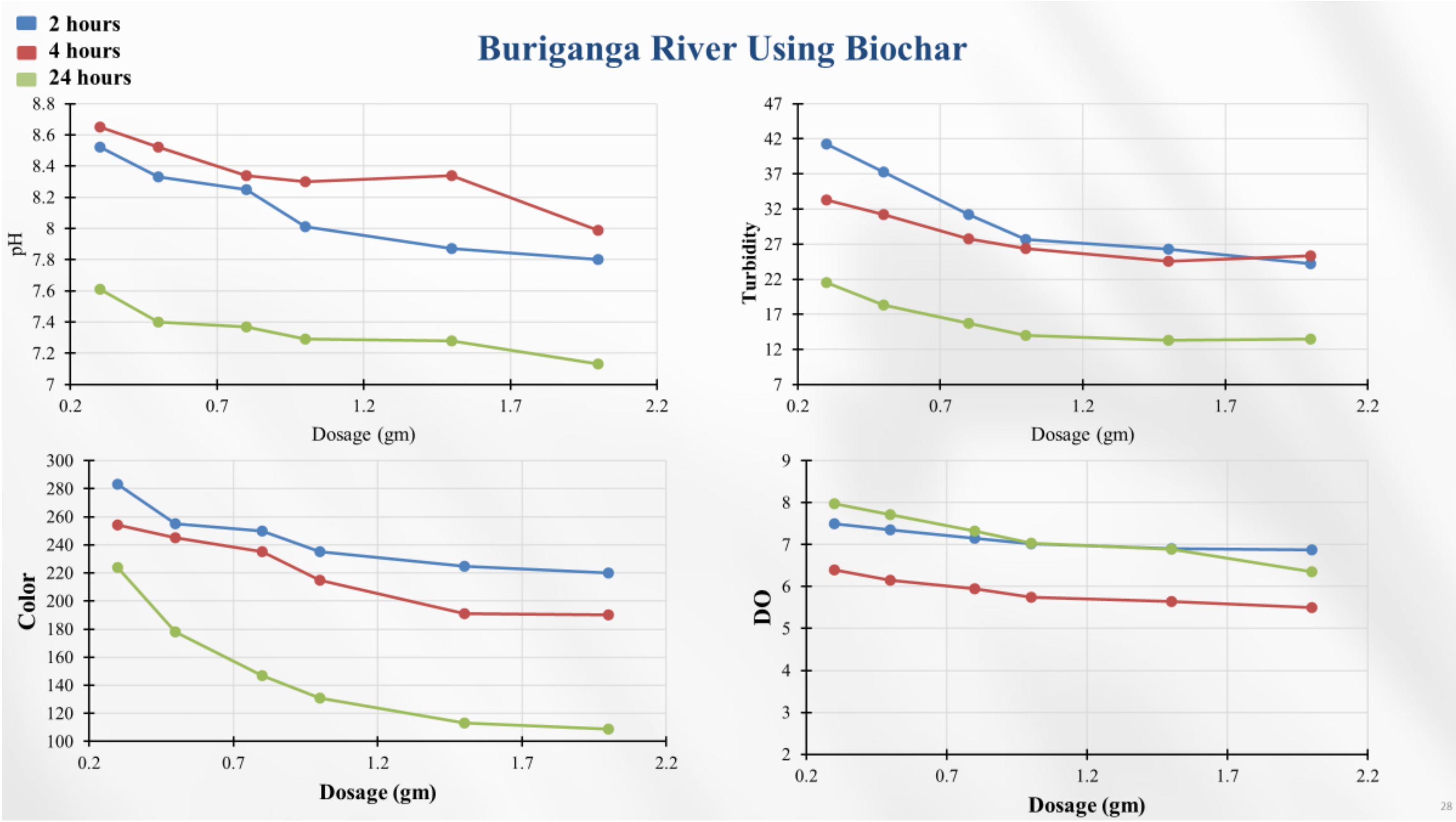
Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) were significantly reduced by all coagulants, with Okra and Moringa Oleifera performing particularly well in decreasing these values, indicating their ability to lower organic pollutants. Overall, Okra and Rice Husk Ash emerged as the most effective coagulants, consistently improving water quality across multiple parameters, while Biochar, though effective in some areas, required careful management due to its initial impact on certain parameters.

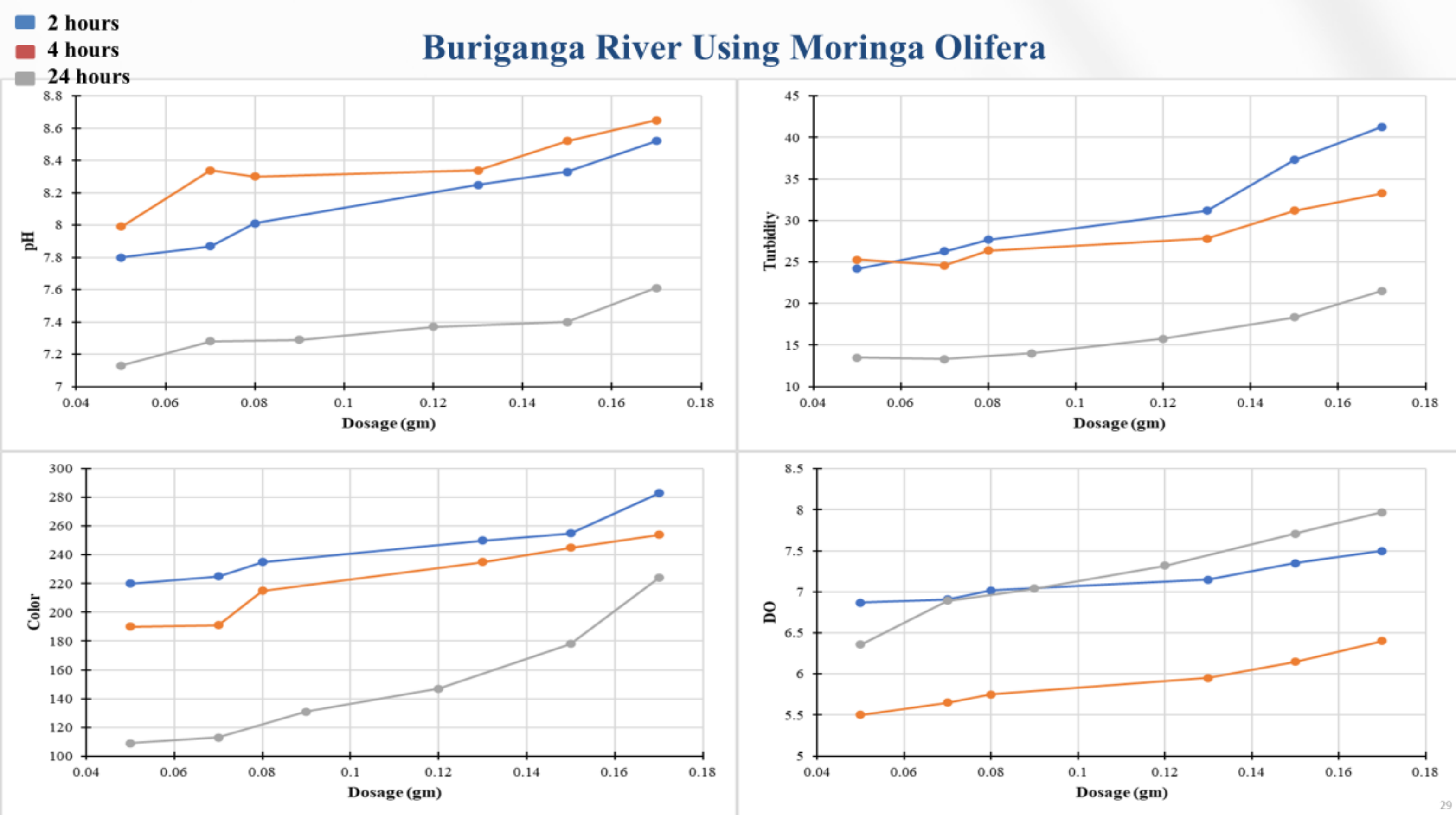
Table 10: Buriganga River Parameter Test with Coagulants

Parameters	Raw Water	Okra (0.025 gm/100mL)			Rice Husk Ash (0.0425gm/100ml)			Biochar (0.035gm/100mL)			Moringa Oleifera (0.025gm/100mL)		
		Retention Time			Retention Time			Retention Time			Retention Time		
		2 hr	4 hr	24 hr	2 hr	4 hr	24 hr	2 hr	4 hr	24 hr	2 hr	4 hr	24 hr
pH	7.38	7.8	8.03	7.28	7.15	7.28	7.11	7.43	7.81	7.57	7.9	8.04	7.29
Color (ptCo)	327	219	201	113	102	100	96	243	203	106	220	202	114
Iron (mg/l)	0.32	0.41	0.43	0.15	0.52	0.55	0.42	2.44	0.76	0.24	0.42	0.44	0.16
TSS (mg/l)	107	38	32	29	15	14	14	93	53	43	39	33	28
TDS (mg/l)	222	225	244	228	260	241	234	233	279	231	226	245	227
TS (mg/l)	329	263	276	257	273	255	243	326	332	274	264	277	255
EC (ms/cm)	459	454	493	438	536	516	511	479	417	429	455	494	438
DO (mg/l)	7.97	6.87	5.63	6.89	7.21	6.39	7.11	3.4	3.1	4.7	6.85	5.65	6.89
Salinity (%)	0.22	0.22	0.24	0.21	0.26	0.23	0.22	0.49	0.23	0.24	0.23	0.25	0.21
Turbidity (NTU)	73.4	24.2	24.7	13.3	7.35	27.9	15.75	65.1	43.7	20.3	24.2	24.8	13.2
COD (mg/l)	57	110	10	84	113	19	18	53	37	43	111	11	85
BOD (mg/l)	29	24	17	12	23	15	13	29	20	18	23	16	13


2 hours
4 hours
24 hours
Buriganga River Using Okra Seeds
pH
Dosage (gm)
Turbidity
Dosage (gm)
Color
Dosage (gm)
DO
Dosage (gm)


2 hours
4 hours
24 hours
Buriganga River Using Rice Husk Ash
pH
Dosage (gm)
Turbidity
Dosage (gm)
Color
Dosage (gm)
DO
Dosage (gm)
27


Buriganga River Using Biochar
2 hours
4 hours
24 hours
pH
8.8
8.6
8.4
8.2
8
7.8
7.6
7.4
7.2
7
0.2
0.7
1.2
1.7
2.2
Dosage (gm)
Turbidity
47
42
37
32
27
22
17
12
7
Color
300
280
260
240
220
200
180
160
140
120
100
DO
9
8
7
6
5
4
3
2
Dosage (gm)
28


Buriganga River Using Moringa Olifera
2 hours
4 hours
24 hours
pH
Turbidity
Color
DO
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
Dosage (gm)
45
40
35
30
25
20
15
10
8.5
7.5
6.5
5.5
29

5.8 Turag River Parameter Test with Coagulants

The table provides an analysis of the water quality of the Turag River after treatment with different coagulants—Okra, Rice Husk Ash, Biochar, and Moringa Oleifera—over various retention times (2 hours, 4 hours, and 24 hours). The results highlight the effectiveness of these coagulants in modifying several key water quality parameters.

Initially, the raw water's pH was 7.38. Treatment with the coagulants caused variations in pH, with Moringa Oleifera and Biochar generally increasing the pH to levels above 8.0, suggesting that these coagulants can significantly alter the water's acidity. The color of the water, initially 327 ptCo, was substantially reduced by all coagulants, with Okra and Biochar showing the most pronounced reductions, bringing the color down to around 100-120 ptCo after 24 hours.

Iron levels, which were 0.32 mg/L in the raw water, showed slight increases with some coagulants, particularly Biochar and Moringa Oleifera, but remained within acceptable ranges. Okra and Rice Husk Ash were more effective at reducing iron content over time. Total Suspended Solids (TSS) were effectively reduced by all coagulants, with Okra reducing TSS to as low as 19 mg/L after 24 hours, demonstrating its efficiency in removing particulate matter. Total Dissolved Solids (TDS) and Total Solids (TS) saw increases after treatment, particularly with Rice Husk Ash, which led to significant rises in TDS and TS, indicating that while effective in some areas, it may contribute to increased dissolved and total solids in the water. Electrical Conductivity (EC) followed a similar trend, with significant increases observed, particularly after treatment with Rice Husk Ash and Biochar.

Dissolved Oxygen (DO) levels, initially 7.97 mg/L, were generally maintained or slightly increased by the coagulants, with Moringa Oleifera showing the most consistent improvement in DO levels, reaching up to 8.76 mg/L after 24 hours. This indicates that the coagulants, particularly Moringa Oleifera, can enhance the oxygenation of the water, which is beneficial for aquatic life.

Salinity remained relatively stable, with slight increases observed across the board, particularly with Rice Husk Ash, which increased salinity to around 0.39-0.43%. Turbidity, initially high at 73.4 NTU, was significantly reduced by all coagulants, with Okra and Moringa Oleifera performing particularly well, reducing turbidity to as low as 12.7 NTU after 24 hours.

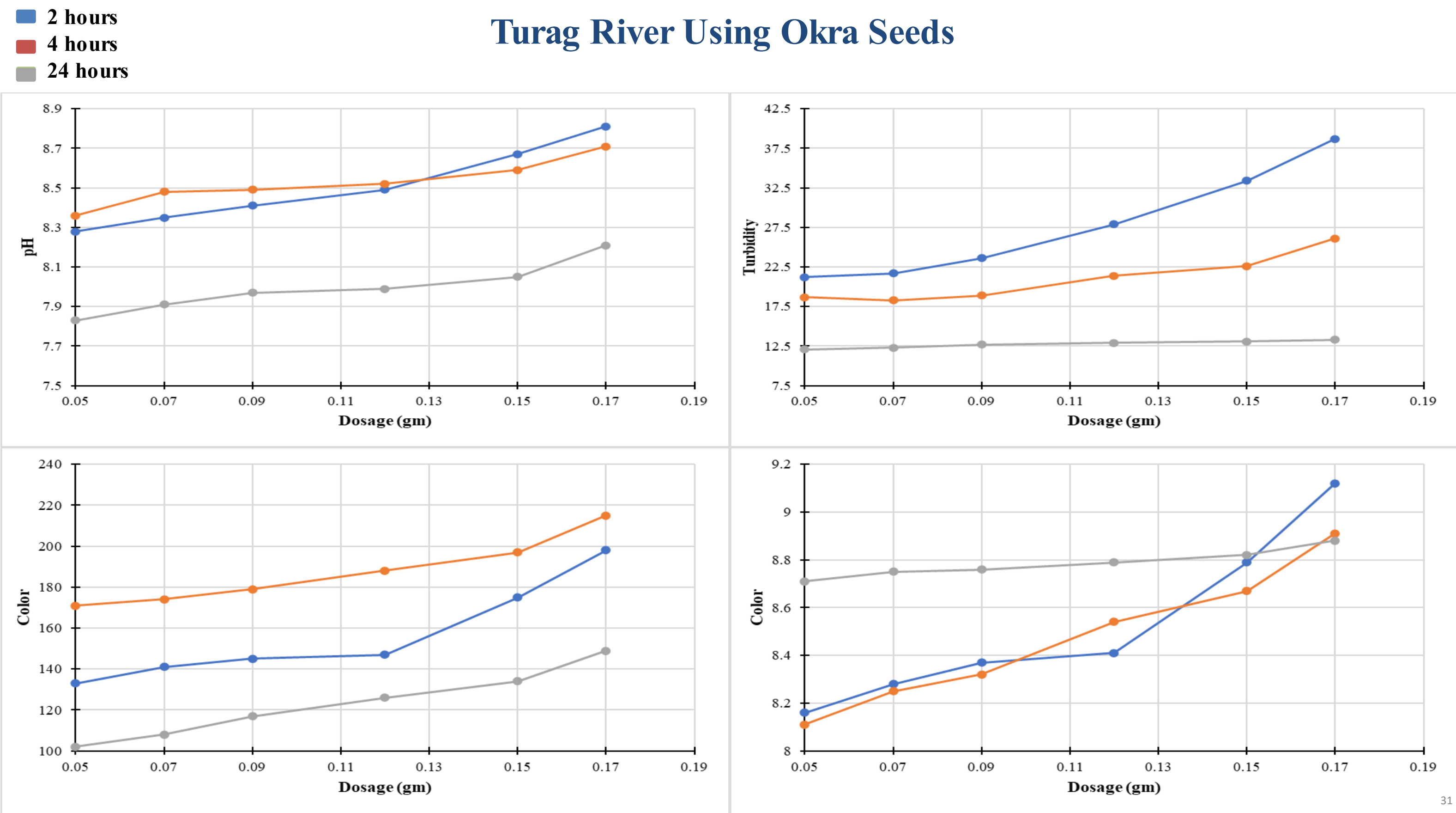
Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) both saw reductions across treatments. COD, initially 57 mg/L, was effectively reduced by Okra and Rice Husk Ash, with Okra bringing COD down to 10 mg/L after 24 hours. BOD also decreased, with all coagulants showing similar reductions to around 12 mg/L after 24 hours, indicating effective removal of organic pollutants.

Table 11: Turag River Parameter Test with Coagulants

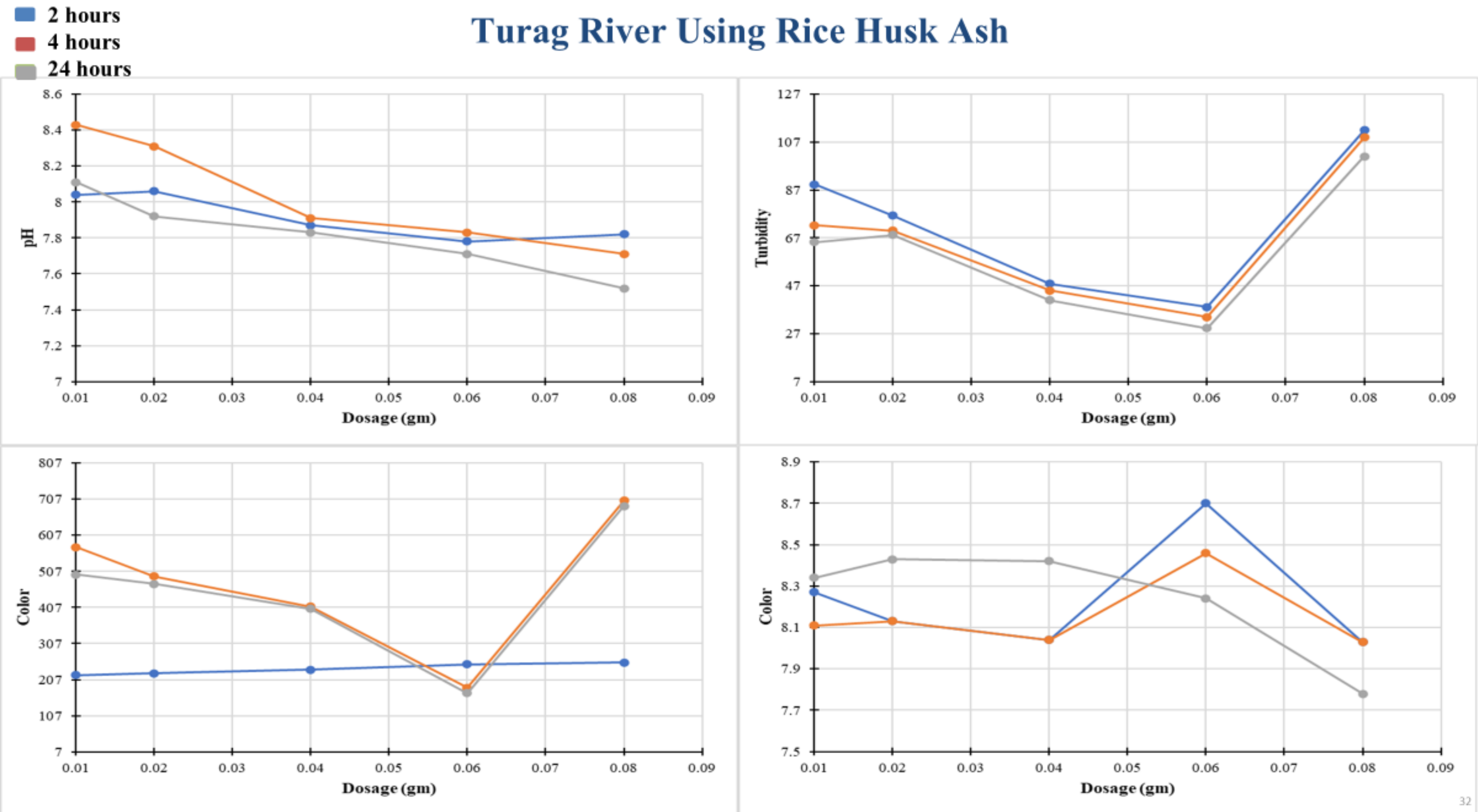
Parameters	Raw Water	Okra (0.025 gm/100mL)			Rice Husk Ash (0.0425gm/100ml)			Biochar (0.035gm/100mL)			Moringa Oleifera (0.025gm/100mL)		
		Retention Time			Retention Time			Retention Time			Retention Time		
		2 hr	4 hr	24 hr	2 hr	4 hr	24 hr	2 hr	4 hr	24 hr	2 hr	4 hr	24 hr
pH	7.38	7.8	8.03	7.28	7.78	8.81	8.13	8.43	8.40	8.13	8.4	8.48	7.50
Color (ptCo)	327	219	201	113	199	183	120	187	176	105	146	174	118
Iron (mg/l)	0.32	0.41	0.43	0.15	0.48	0.45	0.34	0.49	0.47	0.27	0.42	0.16	0.65
TSS (mg/l)	107	38	32	29	23	18	19	42	41	19	19	28	43
TDS (mg/l)	222	225	244	228	398	431	485	342	339	369	378	375	367
TS (mg/l)	329	263	276	257	421	449	426	384	380	388	395	406	415
EC (ms/cm)	459	454	493	438	726	837	796	696	656	651	702	773	752
DO (mg/l)	7.97	6.87	5.63	6.89	7.42	7.45	7.54	7.5	7.6	7.7	8.37	8.26	8.76
Salinity (%)	0.22	0.22	0.24	0.21	0.40	0.43	0.39	0.36	0.37	0.36	0.37	0.39	0.37
Turbidity (NTU)	73.4	24.2	24.7	13.3	38.20	35.5	13.30	42.1	38.2	13.6	24.5	18.4	12.7
COD (mg/l)	57	110	10	84	34	30	22	34	30	21	75	120	65
BOD (mg/l)	29	24	17	12	14	14	12	14	13	12	14	18	12

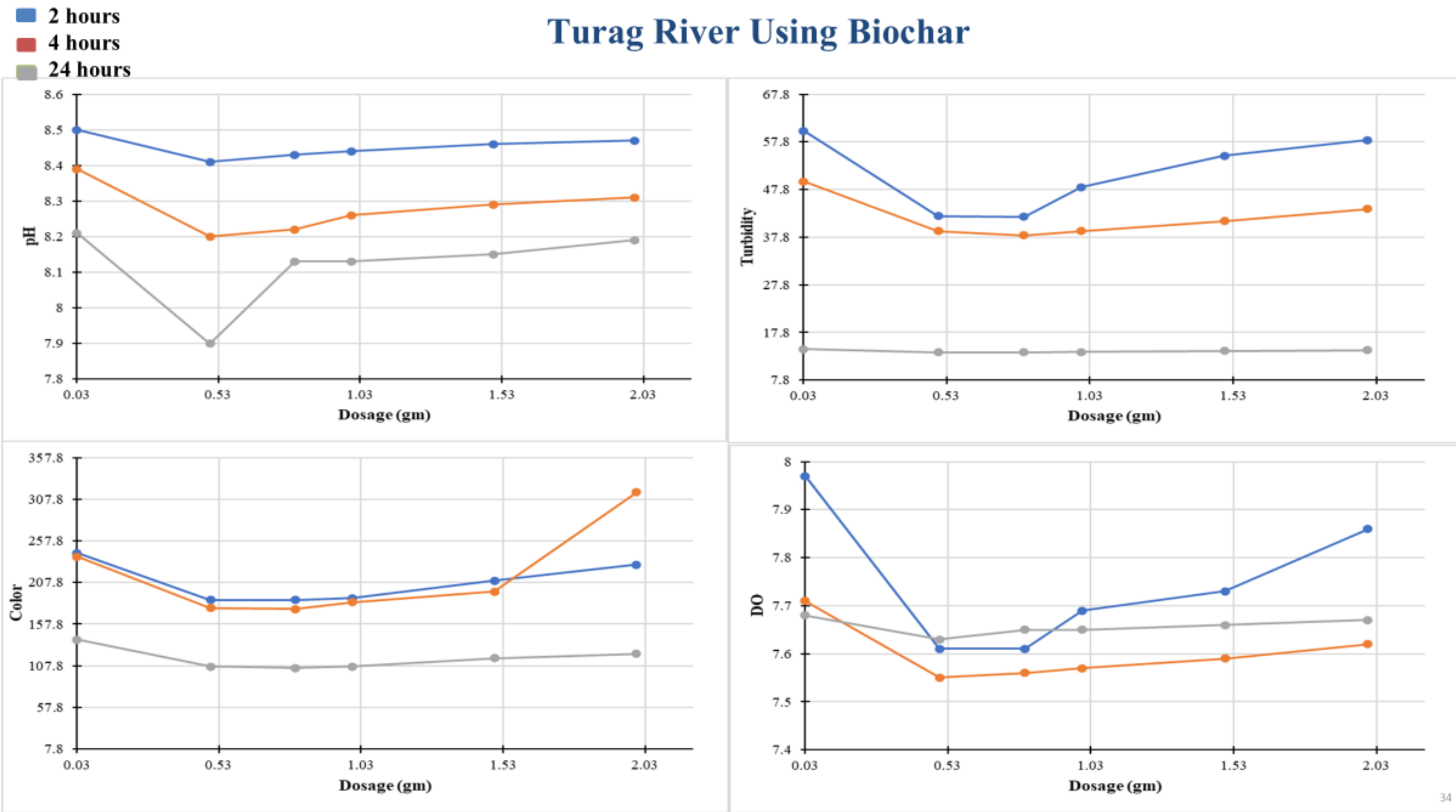
In summary, the coagulants effectively improved several water quality parameters in the Turag River. Okra and Moringa Oleifera were particularly successful in reducing color, turbidity, COD, and BOD while maintaining DO levels. However, Rice Husk Ash and Biochar, though effective in some areas, tended to increase TDS, TS, and EC, requiring careful consideration of these trade-offs.

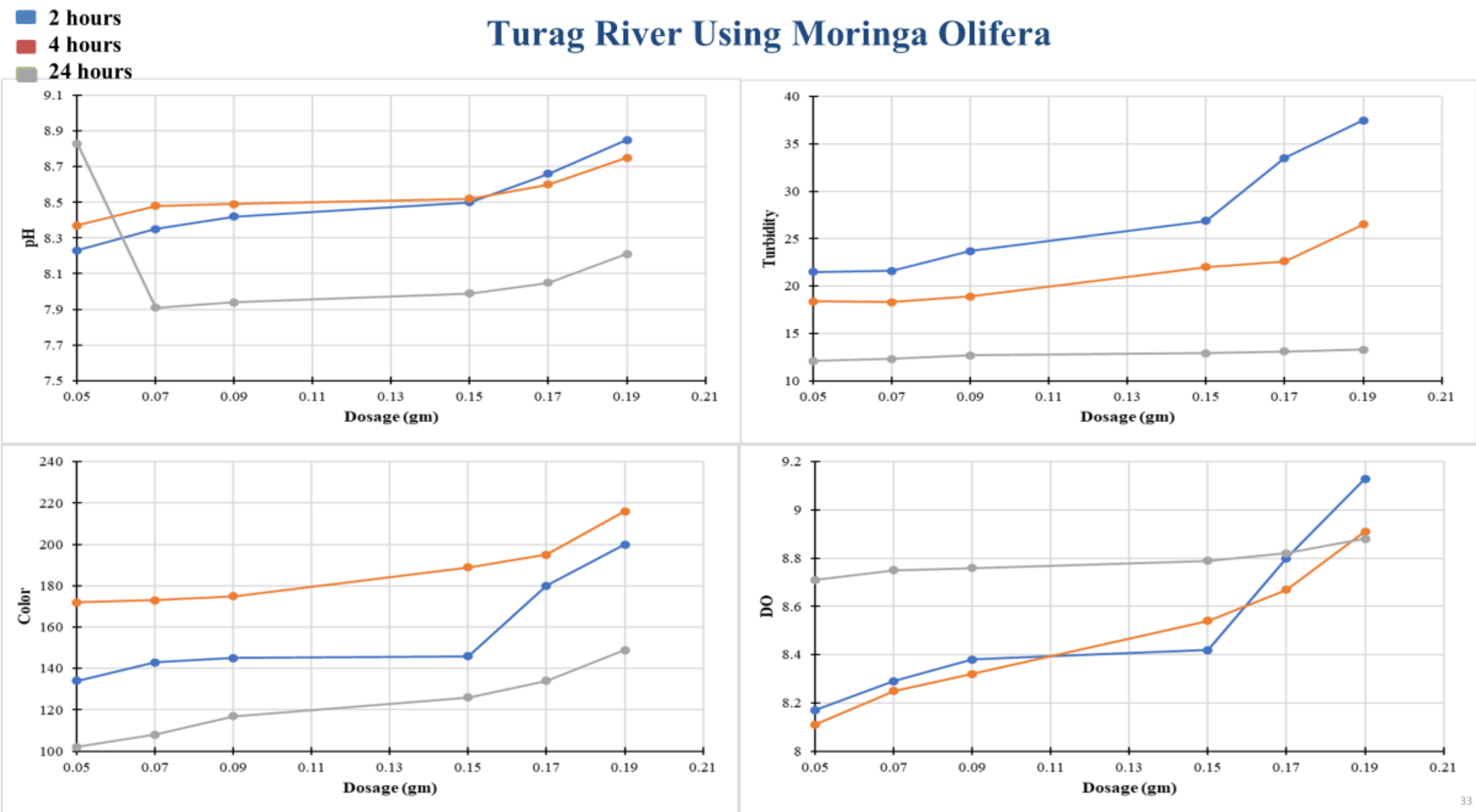
Turag River Using Okra Seeds



Turag River Using Rice Husk Ash




2 hours
4 hours
24 hours
Turag River Using Biochar
pH
Dosage (gm)
Turbidity
Dosage (gm)
Color
Dosage (gm)
DO
Dosage (gm)
0.03
0.53
1.03
1.53
2.03
34


2 hours
4 hours
24 hours
Turag River Using Moringa Olifera
pH
Dosage (gm)
Turbidity
Dosage (gm)
Color
Dosage (gm)
DO
Dosage (gm)
0.05
0.07
0.09
0.11
0.13
0.15
0.17
0.19
0.21
33

6 CHAPTER FIVE CONCLUSION AND RECOMMENDATIONS

As we approach the culmination of this rigorous investigation into the viability of natural coagulants (NCs) for water purification, it is imperative to reflect on the insights garnered from the extensive research and experimentation conducted. The journey embarked upon in this thesis was driven by the pressing need for sustainable and environmentally friendly water treatment solutions, particularly in the context of Bangladesh's water crisis. The exploration of NCs, including rice husk ash, Moringa oleifera seeds, biochar, and okra seeds, has not only illuminated their potential as viable alternatives to conventional chemical coagulants but also underscored their compatibility with existing water treatment methodologies.

The empirical data presented in this study, derived from meticulous testing and analysis, has demonstrated the efficacy of these NCs in reducing key pollutants from the Buriganga and Turag rivers—two vital water bodies that have been the focus of our research. Through a series of jar tests and parameter evaluations, we have observed that NCs can indeed match, and in some instances surpass, the pollutant removal capabilities of traditional coagulants like aluminum sulfate. This finding is not only significant for the field of environmental engineering but also for communities grappling with water quality issues.

Moreover, the integration of sand bed filtration with NC pre-treatment has revealed a promising synergy, enhancing the overall quality of treated water. This integrated approach serves as a testament to the importance of combining various treatment methods to achieve optimal results. As we delve into the conclusion, we will synthesize the key findings, discuss the implications of our research, and chart a course for future studies that can build upon the foundation laid by this work.

In essence, the conclusion will encapsulate the transformative potential of NCs in revolutionizing water treatment practices, offering a beacon of hope for regions afflicted by water pollution. It is a narrative of innovation, sustainability, and the relentless pursuit of solutions that align with the principles of environmental stewardship.

- **Effectiveness of Natural Coagulants**: The study found that various natural coagulants were effective in removing pollutants from surface water and could be superior to traditional coagulants like aluminum sulfate.
- **Sand Bed Filtration Performance**: Sand bed filtration, when used after natural coagulant pre-treatment, showed promising results in further purifying the water.
- **Integrated Treatment Approaches**: The research highlights the importance of combining natural coagulants with other treatment methods like sand bed filtration for effective water treatment.
- **Future Research Directions**: The future research directions suggested by the study are:
    - **Integration with Other Methods**: Investigate how natural coagulants and sand bed filtration can be integrated with other water treatment technologies, such as UV disinfection or membrane filtration.
    - **Comparison Studies**: Compare the efficiency of natural coagulants with conventional chemical coagulants under various water conditions.
    - **Combined Coagulant Effects**: Explore the combined effects of using multiple coagulants to enhance the removal efficiency of pollutants from water.

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