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# A Comparative Study of Plant-Based Coagulants for Water Purification: Performance and Sustainability

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**ABSTRACT:** Water purification remains a critical global challenge, particularly in developing regions where access to clean water is limited. Traditional chemical coagulants, while effective, pose environmental and health risks. This research paper compares the performance and sustainability of various plant-based coagulants in water purification. The study evaluates the efficacy of Moringa oleifera, Opuntia spp., and Cicer arietinum in reducing turbidity and improving water quality. Additionally, it examines the environmental impact, cost-effectiveness, and potential health benefits of using plant-based coagulants. The findings highlight the promising potential of plant-based coagulants as sustainable alternatives to chemical coagulants in water treatment.

## I. INTRODUCTION

Access to clean water is essential for human health and development. Conventional water treatment methods often rely on chemical coagulants like aluminum sulfate (alum) and ferric chloride to remove impurities and suspended particles. However, these chemicals have drawbacks, including environmental pollution, high costs, and potential health risks. Plant-based coagulants have emerged as sustainable alternatives due to their biodegradability, low toxicity, and availability. This research explores the performance and sustainability of three plant-based coagulants: Moringa oleifera, Opuntia spp. (prickly pear cactus), and Cicer arietinum (chickpea).

## II. LITERATURE REVIEW

### Chemical Coagulants

Chemical coagulants such as alum and ferric chloride are widely used in water treatment for their effectiveness in coagulating and removing suspended particles. However, the drawbacks associated with chemical coagulants include:

1. **Residual Chemicals:** Chemical coagulants can leave harmful residues in treated water, posing health risks.
2. **Environmental Impact:** The production and disposal of chemical coagulants can lead to environmental pollution.
3. **Cost:** Chemical coagulants can be expensive, especially for communities with limited financial resources.

### Plant-Based Coagulants

Plant-based coagulants offer an eco-friendly and cost-effective alternative to chemical coagulants. Key advantages include:

1. **Biodegradability:** Plant-based coagulants are biodegradable and do not leave harmful residues.
2. **Sustainability:** These coagulants are derived from renewable resources and have a lower environmental impact.
3. **Cost-Effectiveness:** Many plant-based coagulants are readily available and inexpensive.

### Moringa Oleifera

Moringa oleifera, also known as the drumstick tree, has been extensively studied for its coagulation properties. The seeds contain water-soluble proteins that can neutralize the charges of suspended particles, facilitating their removal. Research has shown that Moringa oleifera is effective in reducing turbidity and removing pathogens from water.

### Opuntia spp.

Opuntia spp., commonly known as prickly pear cactus, is another promising plant-based coagulant. The mucilage extracted from Opuntia spp. has been found to be effective in coagulating suspended particles in water. The plant's ability to thrive in arid regions makes it a sustainable option for water purification in drought-prone areas.

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**Cicer Arietinum**

Cicer arietinum, commonly known as chickpea, has been explored for its coagulation properties. The seeds contain proteins and polysaccharides that can act as natural coagulants. While less studied than Moringa oleifera and Opuntia spp., chickpea has shown potential in reducing turbidity and improving water quality.

## III. METHODOLOGY

**Materials**

The materials used in this study include:

- **Plant-Based Coagulants:** Moringa oleifera seeds, Opuntia spp. mucilage, and Cicer arietinum seeds.
- **Synthetic Turbidity Water:** Prepared using kaolin to simulate surface water with varying turbidity levels.
- **Laboratory Equipment:** Jar test apparatus, pH meter, turbidity meter, and other standard lab equipment.

**Preparation of Coagulant Solutions**

1. **Moringa Oleifera:** Dried seeds were crushed into a fine powder. A stock solution was prepared by dissolving a known quantity of the powder in distilled water and stirring for 30 minutes. The solution was then filtered to remove any insoluble material.
2. **Opuntia spp.:** Mucilage was extracted from fresh cactus pads by blending with distilled water and filtering the mixture to obtain a clear solution.
3. **Cicer Arietinum:** Dried seeds were soaked in water for 24 hours, followed by blending and filtration to obtain a coagulant solution.

**Experimental Procedure**

1. **Jar Test Experiments:** Jar tests were conducted to evaluate the coagulation efficiency of the plant-based coagulants. Synthetic turbid water samples were prepared with initial turbidity levels ranging from 50 to 500 NTU (Nephelometric Turbidity Units). The following parameters were varied during the experiments:
   - **Coagulant Dosage:** Different dosages of the coagulant solutions were added to the water samples.
   - **Contact Time:** The mixture was stirred at varying speeds and durations to determine the optimal contact time.
   - **pH Levels:** The pH of the water samples was adjusted to study the effect on coagulation efficiency.
2. **Measurement of Turbidity:** After coagulation and sedimentation, the turbidity of the treated water was measured using a turbidity meter. The percentage reduction in turbidity was calculated for each coagulant.

## IV. RESULTS AND DISCUSSION

**Coagulant Dosage**

The efficiency of turbidity reduction was dependent on the dosage of the plant-based coagulants. Optimal dosages were identified for each coagulant, beyond which no significant improvement in turbidity reduction was observed. The optimal dosages were as follows:

- **Moringa Oleifera:** 100 mg/L
- **Opuntia spp.:** 200 mg/L
- **Cicer Arietinum:** 150 mg/L

**Contact Time**

Optimal contact time is crucial for effective coagulation. The jar test results indicated that a contact time of 30 minutes was sufficient for all three coagulants to achieve significant turbidity reduction. Longer contact times did not yield additional benefits, suggesting that the coagulation process reaches equilibrium within this period.

**pH Levels**

The pH of the water samples was found to influence the coagulation efficiency of the plant-based coagulants. The optimal pH range for effective coagulation was identified as 6.5 to 8.5 for all three coagulants. Outside this range, the turbidity reduction efficiency decreased, highlighting the importance of pH adjustment in the coagulation process.

**Comparison of Coagulation Efficiency**

The performance of the plant-based coagulants in reducing turbidity was compared. The results indicated that Moringa oleifera achieved the highest turbidity reduction, followed by Opuntia spp. and Cicer arietinum. The average turbidity reduction percentages were:

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- **Moringa Oleifera:** 85%
- **Opuntia spp.:** 75%
- **Cicer Arietinum:** 65%

**Environmental and Health Benefits**

The use of plant-based coagulants offers several environmental and health benefits over conventional chemical coagulants:

1. **Reduced Chemical Residues:** Plant-based coagulants do not leave harmful residues in treated water, unlike alum, which can introduce residual aluminum.
2. **Lower Sludge Production:** The biodegradable nature of plant-based coagulants results in less sludge production, reducing disposal challenges.
3. **Sustainability:** Plant-based coagulants are derived from renewable resources, providing a sustainable source of natural coagulants.

**Sustainability Analysis**

**Environmental Impact**

The cultivation and use of plant-based coagulants have a lower environmental impact compared to the production and disposal of chemical coagulants. Plants like Moringa oleifera and Opuntia spp. can be grown in a variety of climates, often requiring minimal agricultural inputs. This reduces the carbon footprint associated with their production and transportation.

**Cost-Effectiveness**

Plant-based coagulants are generally more cost-effective than chemical coagulants. Moringa oleifera seeds, for example, are inexpensive and widely available in many developing countries. The low cost of these coagulants makes them accessible to communities with limited financial resources, improving access to clean water.

**Health Benefits**

Using plant-based coagulants eliminates the risk of chemical residues in treated water. This is particularly important in regions where people are exposed to waterborne diseases and chemical contaminants. The absence of harmful chemicals ensures that treated water is safe for consumption and reduces health risks associated with chemical coagulants.

## V. CONCLUSION

The study demonstrates that plant-based coagulants are effective and sustainable alternatives to chemical coagulants for water purification. Moringa oleifera, Opuntia spp., and Cicer arietinum all show significant potential in reducing turbidity and improving water quality. Among the three, Moringa oleifera exhibited the highest coagulation efficiency, followed by Opuntia spp. and Cicer arietinum.

The environmental, economic, and health benefits of using plant-based coagulants make them a viable option for water treatment, particularly in developing regions. Further research could focus on optimizing the extraction and application methods of these coagulants, as well as exploring their combined use with other natural or chemical coagulants to enhance overall water treatment efficiency.

## REFERENCES

1. Ali, E. N., Muyibi, S. A., Salleh, H. M., Alam, M. Z., & Salleh, M. R. M. (2010). Moringa oleifera Seeds as a Natural Coagulant for Water Treatment. **International Journal of Environmental Science and Technology, 7(4)**, 775-780.
2. Folkard, G. K., & Sutherland, J. P. (2002). Development of a Naturally Derived Coagulant for Water and Wastewater Treatment. **Water Science and Technology: Water Supply, 2(5-6)**, 89-94.
3. Jahn, S. A. A. (1988). Using Moringa Seeds as Coagulants in Developing Countries. **Journal of the American Water Works Association, 80(6)**, 43-50.
4. Ndabigengesere, A., & Narasiah, K. S. (1998). Quality of Water Treated by Coagulation Using Moringa oleifera Seeds. **Water Research, 32(3)**, 781-791.

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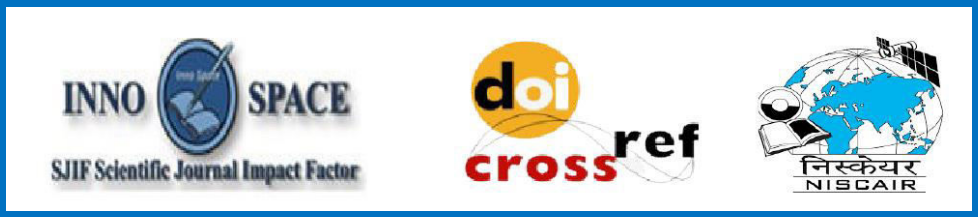
5. Ghebremichael, K. A., Gunaratna, K. R., Henriksson, H., Brumer, H., & Dalhammar, G. (2005). A Simple Purification and Activity Assay of the Coagulant Protein from Moringa oleifera Seed. **Water Research, 39(11)**, 2338-2344.
6. Sutherland, J. P., & Folkard, G. K. (2001). The Use of Natural Coagulants in Water Treatment. **Waterlines, 20(3)**, 12-14.
7. Miller, S. M., Fugate, E. J., Craver, V. O., Smith, J. A., & Zimmerman, J. B. (2008). Toward Understanding the Efficacy and Mechanism of Opuntia spp. as a Natural Coagulant for Potential Application in Water Treatment. **Environmental Science & Technology, 42(12)**, 4274-4279.
8. Muyibi, S. A., & Evison, L. M. (1995). Moringa oleifera Seeds for Softening Hard Water. **Water Research, 29(4)**, 1099-1105.
9. Bhuptawat, H., Folkard, G. K., & Chaudhari, S. (2007). Innovative Physico-Chemical Treatment of Wastewater Incorporating Moringa oleifera Seed Coagulant. **Journal of Hazardous Materials, 142(1-2)**, 477-482.
10. Anwar, F., Latif, S., Ashraf, M., & Gilani, A. H. (2007). Moringa oleifera: A Food Plant with Multiple Medicinal Uses. **Phytotherapy Research, 21(1)**, 17-25.
11. Madsen, M., Schlundt, J., & Omer, E. F. (1987). Effect of Water Coagulation by Seeds of Moringa oleifera on Bacterial Concentrations. **Journal of Tropical Medicine and Hygiene, 90(3)**, 101-109.
12. Okuda, T., Baes, A. U., Nishijima, W., & Okada, M. (2001). Coagulation Mechanism of Salt Solution-Extracted Active Component in Moringa oleifera Seeds. **Water Research, 35(3)**, 830-834.
13. Katayon, S., Noor, M. J. M. M., Asma, M., Ghani, L. A. A., Thamer, A. M., Azni, I., Ahmad, J., Khor, B. C., & Suleyman, A. M. (2006). Effects of Storage Conditions of Moringa oleifera Seeds on its Performance in Coagulation. **Bioresource Technology, 97(13)**, 1455-1460.
14. Mangale, S. M., Chonde, S. G., & Raut, P. D. (2012). Use of Moringa oleifera (Drumstick) Seed as Natural Absorbent and an Antimicrobial Agent for Ground Water Treatment. **Research Journal of Recent Sciences, 1(3)**, 31-40.
15. Eman, N. A., Salleh, M. R. M., & Hamid, R. (2011). The Potential of Natural Coagulants for Water and Wastewater Treatment. **Management of Environmental Quality: An International Journal, 22(3)**, 347-355.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