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# A Review on Moringa oleifera Seeds as Natural Coagulant for Sustainable Wastewater Treatment

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**ABSTRACT**

This review explains how *Moringa oleifera* seeds can be used as a natural coagulant for cleaning wastewater. Studies show that Moringa seeds can remove color, oil, and organic pollutants from different types of wastewater. They work well in a wide pH range (3–11) and need very small doses for clear water. The seeds contain proteins that help particles stick together and settle. Simple processing methods like oil removal and salt extraction make the coagulant more effective. Compared to chemicals like alum, Moringa is safer, biodegradable, and cost-effective. It also reduces harmful residues. However, challenges include sludge handling and standardizing extraction methods. Overall, Moringa seeds are a promising eco-friendly option for water treatment.

**Keywords:** *Moringa oleifera; natural coagulant; turbidity removal; wastewater treatment; eco-friendly; sludge; sustainability*

## 1. Introduction

Clean water is essential, but chemical coagulants used in treatment plants can cause health and environmental problems. They also produce non-biodegradable sludge. Natural coagulants like *Moringa oleifera* seeds are safe, biodegradable, and easily available. This review looks at how Moringa seeds work, their efficiency, and their benefits compared to chemical coagulants.

## 2. How Moringa Works

Moringa seeds have proteins that carry a positive charge. These proteins attract and bind with negatively charged particles in water, making them clump together and settle. Removing oil from seeds and using salt during extraction improves their performance.

## 3. Methods Used in Studies

Researchers tested Moringa seeds on different wastewaters using jar tests. They measured turbidity, color, COD (organic load), and oil removal. Some studies used raw seed powder, while others used processed seeds (oil removed and salt extracted).

## 4. Results from Different Wastewaters

- **Textile Dye Water:** Removed about 95% of dye at normal pH (4–9).
- **Slaughterhouse Wastewater:** Reduced COD by up to 64% using 3–7 g/L of seed powder.
- **Oily Steelworks Wastewater:** Removed about 95% oil and 90% turbidity; worked well across pH 3–11.
- **Low-Turbidity Water:** Needed only 0.4 mg/L of processed Moringa to remove 96% turbidity.
- **Lake Water:** New method achieved 95% turbidity removal with just 0.7 mg/L of coagulant.

## 5. Key Factors

- **pH:** Works best in acidic to neutral water; still effective up to pH 11.
- **Dose:** Very low doses for clear water; higher doses for polluted water.
- **Settling Time:** 15–120 minutes depending on water type.
- **Processing:** Oil removal and salt extraction improve efficiency.

## 6. Sludge

Moringa produces biodegradable sludge, which is easier to manage than chemical sludge. However, sometimes the volume is higher than alum sludge.

## 7. Sustainability

Moringa is eco-friendly, cheap, and locally available. It reduces chemical use and harmful residues. Using seed cake after oil extraction adds value and supports a circular economy.

## 8. Limitations

- Need standard methods for extraction and dosing.
- Possible organic matter in treated water if crude extracts are used.
- Large-scale application needs more research.

## 9. Conclusion

*Moringa oleifera* seeds are a safe and effective alternative to chemical coagulants. They work well for different wastewaters, need small doses, and are environmentally friendly. With proper processing and standardization, Moringa can be widely used for sustainable water treatment.

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