

“Can a simple natural seed – Moringa oleifera replace costly chemicals in water purification?”

National Science Fair Synopsis

Level : *Middle*

Category: *Environmental Science*

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Grade : *VII*

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Introduction

Water that contains disease-causing organisms is unsafe for humans. Today, protecting health and the environment has increased the need for safe and effective water disinfection.

Many methods are used, such as precipitation, incineration, electro-deionization, flocculation, coagulation, reverse osmosis, ion-exchange, membrane filtration, UV radiation, advanced oxidation, and biological treatment. However, these methods often face problems like high cost, limited efficiency, and negative environmental impacts.

Presently there are no appropriate low-cost technologies available for removal of several commonly present groundwater contaminants. Fluoride is one such compound that is widely present in groundwater worldwide. Exposure to fluoride in Drinking water has a number of adverse effects on human health Including crippling skeletal fluorosis that is a significant cause of morbidity in a number of regions of the world.

Ground water is polluted due to industrial effluents and municipal waste in Water bodies. In rural and undeveloped countries people living in extreme poverty are presently drinking highly turbid and Microbiologically contaminated water. Because they lack Knowledge of proper drinking water treatment and they cannot afford costly chemical coagulants.

One of the most important steps in water and wastewater treatment is coagulation and flocculation. Coagulants neutralize charges on tiny suspended particles, forming larger clumps (agglomerates). Flocculation makes these clumps heavier, helping them settle faster. Common coagulants include iron salts, aluminium, lime, magnesium carbonate, and polymers such as PAC and polyferric sulfite.

To overcome chemical Coagulant problems it is necessary to increase the use of natural coagulants for drinking water treatment. Naturally occurring

Coagulants are usually presumed safe for human health. Some Studies on natural coagulants have been carried out and various Natural coagulants were produced or extracted from Microorganisms, animals or plants.

Problem

While effective, **chemical coagulants can cause serious issues**. For example, *aluminium-based coagulants have been linked to Alzheimer's disease, and flocculants can create alkaline water, toxic sludge, and incomplete removal of harmful substances*. These methods are also too costly for many developing nations.

Fluoride is one such compound that is widely present in groundwater worldwide. High levels of fluoride in drinking water can harm human health, causing skeletal fluorosis, a condition that can lead to bone pain, deformities, and disability.

Need for Natural purifier

Because of these drawbacks, there is a growing demand for natural **coagulants and flocculants**.

Using natural coagulants can be a safer alternative to chemical coagulants for water treatment. These natural coagulants come from plants, animals, or microorganisms and are considered safer for human health. Researchers are exploring their potential for purifying drinking water.

Coagulants (Natural)

Definition:

Natural coagulants are substances from plants, animals, or minerals that help neutralize the charge of tiny suspended particles in water — making them clump together.

How they work:

They contain proteins or polysaccharides that carry a positive charge, which attracts the negatively charged dirt particles in water.

Examples: Moringa oleifera seeds – contain cationic (positively charged) proteins that act just like chemical coagulants (e.g., alum).

Flocculants (Natural)

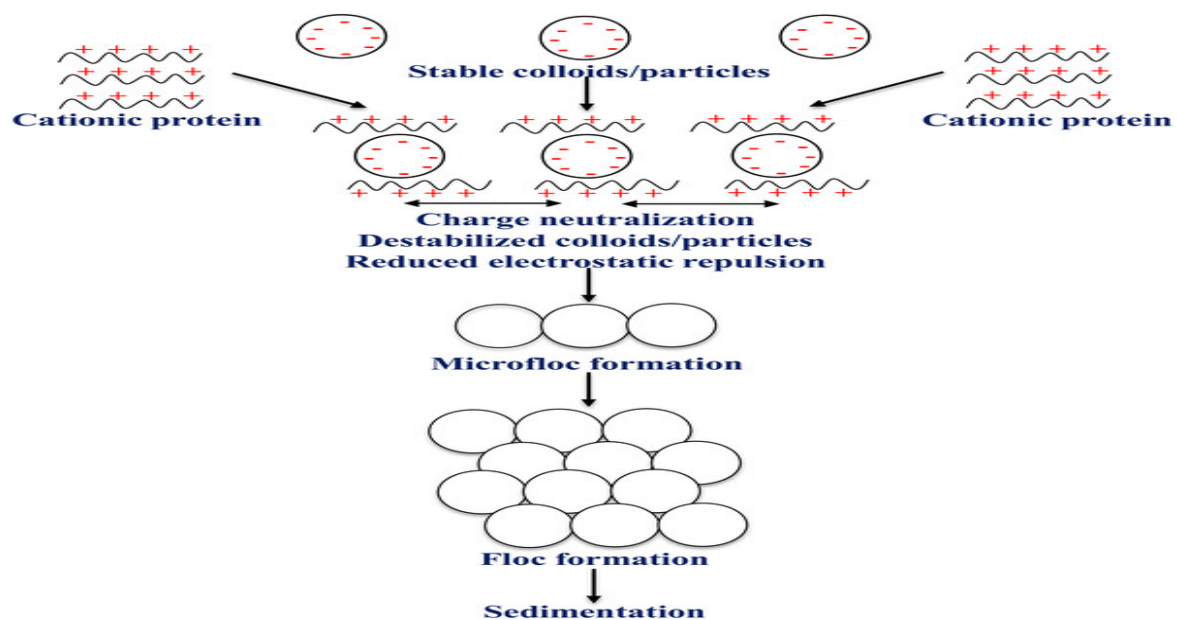
Definition:

Natural flocculants help join those small clumps formed by coagulants into bigger, heavier flocs that can easily settle down or be filtered out.

How they work:

They act like bridges — connecting small clumps to form larger flocs, often using long-chain molecules such as natural polymers.

They are low-cost, safe, widely available, easy to use, and environmentally friendly. Natural coagulants produce much less sludge—up to five times lower—and this sludge is biodegradable. This makes them a promising ***solution for affordable and sustainable water purification.***



Water Treatment with Moringa



Moringa oleifera (MO), also known as **horseradish** or **drumstick tree**, is one of the most effective **natural primary coagulants for water treatment**, comparable to alum. It grows abundantly in tropical and subtropical regions such as India, Sri Lanka, Africa, Burma, Central and South America, Singapore, Mexico, and Southeast Asia.

Earlier studies have found Moringa to be non-toxic and recommended it for use as a coagulant in Developing countries. The use of Moringa has an added advantage over the chemical treatment of water because it is biological and has been reported as edible.

Every part of the tree is useful, but the seeds are especially important. The powdered seeds are non-toxic and reduce water turbidity, pH, suspended particles, and hardness. Their action is due to cationic proteins with a low molecular mass and an isoelectric point >10 . These proteins, rich in glutamate, arginine, proline, histidine, and glutamine residues, neutralize

charges, destabilize colloids, and promote adsorption, bridging, and charge neutralization.

In addition, MO seeds show antioxidant and antimicrobial properties, which help in bacterial removal. Because of these active phytochemicals, Moringa seeds are highly effective in purifying drinking water, murky river/pond water, and industrial wastewater.

Moringa Seeds → Cationic Proteins → Amino Acids → Mechanisms → Effects → Result (Clean & Safe Water)

Mechanistic Pathway of Water Purification Using Moringa oleifera Seeds

The seeds of Moringa oleifera are the key component used for water purification. They contain water-soluble proteins, oils, and other natural compounds.

Cationic Proteins

Inside the seeds are **cationic (positively charged) proteins** — mainly small polypeptides. These proteins are responsible for the **coagulating and flocculating** properties of Moringa.

They carry a positive charge, which is crucial for interacting with negatively charged impurities in water (like clay, silt, and bacteria).

Amino Acids :Those proteins are made of amino acids that determine their charge and behavior in water. Certain ***amino acids (like arginine and lysine) carry positive charges, giving the overall protein its cationic nature.***

That's why the proteins can bind effectively to the negatively charged particles — electrostatic attraction happens here.

Mechanisms

Two key mechanisms occur:

- **Coagulation:** The cationic proteins **neutralize the charge** of suspended particles, breaking their stability.
- **Flocculation:** Once destabilized, the proteins **bridge between particles, forming large, heavy flocs** that settle easily.

This dual mechanism allows Moringa to act both as a coagulant and flocculant

Effects

- ❖ Turbidity decreases drastically (up to 99% in some cases).
- ❖ Bacterial count reduces significantly due to protein–cell wall interaction.
- ❖ Water pH remains stable.
- ❖ Sludge produced is biodegradable and less toxic.



Literature Review / Ongoing research

- A study on “Sustainable wet-spun cellulose-Moringa oleifera composite fibres for potential water purification” investigated composite fibres made from moringa seed powder embedded in cellulose, optimized for heavy-metal ion removal.
- Research titled “Investigating the effectiveness of a simple water-purifying gadget using Moringa oleifera seeds as the active beads” developed a low-cost device combining moringa seed powder with charcoal and cotton wool, and tested microbial load reduction in real-world river samples.
- Another recent work “Evaluation of Moringa oleifera seeds as a natural solution in comparison to alum for combatting common aquatic pathogenic bacteria by coagulation and antibacterial action” looks at how moringa seeds may reduce pathogenic bacteria compared with traditional coagulants.

Hypothesis

“Can a simple natural seed- Moringa oleifera replace costly chemicals in water purification?”

Materials Required

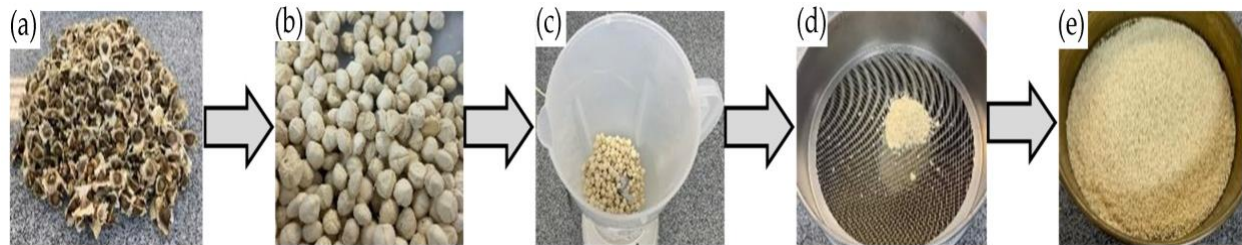
- Moringa oleifera seeds (drumstick seeds)
- Dirty/turbid water samples (from pond or prepared by mixing soil in water)

- Beakers or clear plastic bottles (for holding water samples)
- Mortar and pestle /mixer grinder (to crush seeds)
- Clean cloth or muslin (for filtering)
- Measuring spoon and cup (to measure seed powder and water)

Methodology

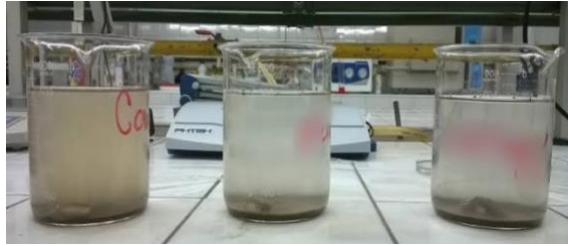
.i) *Preparation of Moringa Seed Powder*

- ❖ Remove the shells from the Moringa seeds to obtain the white kernels.
- ❖ Dry the kernels completely (sun-dry or air-dry).
- ❖ Grind them into a fine powder using a grinder or mortar and pestle. And a sieve if needed.



ii) *Treatment of Water Samples*

- ❖ Take equal amounts of turbid/dirty water in 4 beakers (e.g., 500 ml each).
- ❖ Label them as:
 - Control (No treatment) (CO – No MO)
 - Sample 1 (e.g., 0.5 g Moringa powder)
 - Sample 2 (e.g., 1 g Moringa powder)
 - Sample 3(e.g., 1.5 g Moringa powder)
- ❖ Mix the Moringa seed powder with a small amount of clean water to make a paste/slurry.
- ❖ Add this paste into the respective beakers and stir well for about 5–10 minutes.



iii) Flocculation and Sedimentation

- ❖ Leave the treated water undisturbed for 1 hour.
- ❖ Observe the formation of flocs (clumps of dirt and impurities) at the bottom.
- ❖ After sedimentation, I will carefully decant (pour out) the clear water from the top into another clean container.

iv) Observation and Testing

I will compare the clarity of water in each beaker.

Note down:

- Turbidity (clearer or still cloudy?).
- Color changes.
- Odor differences.

Data analysis

The experiment was conducted to study how different amounts of moringa seed powder affect the purification of turbid water. The results show that as the quantity of moringa powder increased, the water became clearer and the turbidity level decreased. This indicates that moringa seeds act as a natural coagulant, helping suspended particles to settle at the bottom. The control sample remained cloudy, while the treated samples showed visible improvement in water clarity, with the best result observed in the sample containing the highest amount of moringa powder.

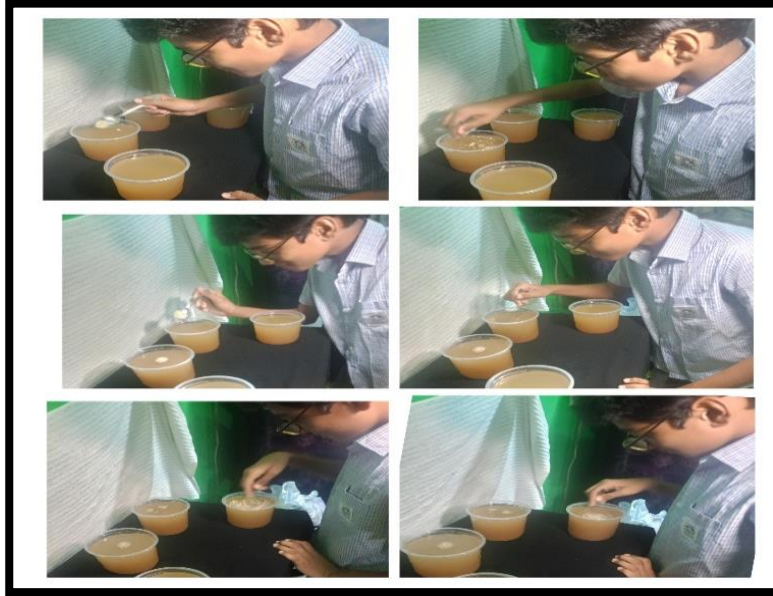
Recording Observation

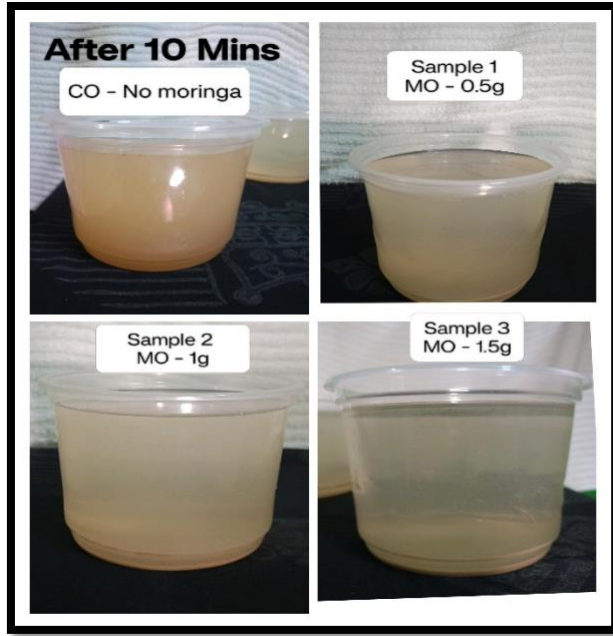
Tabulation

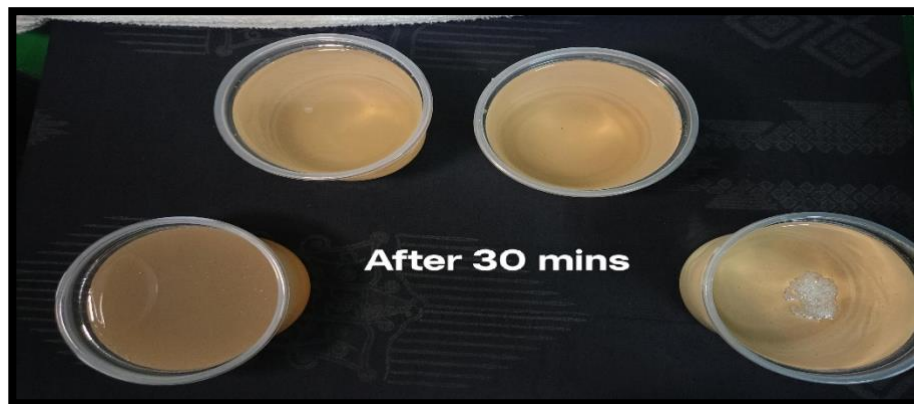
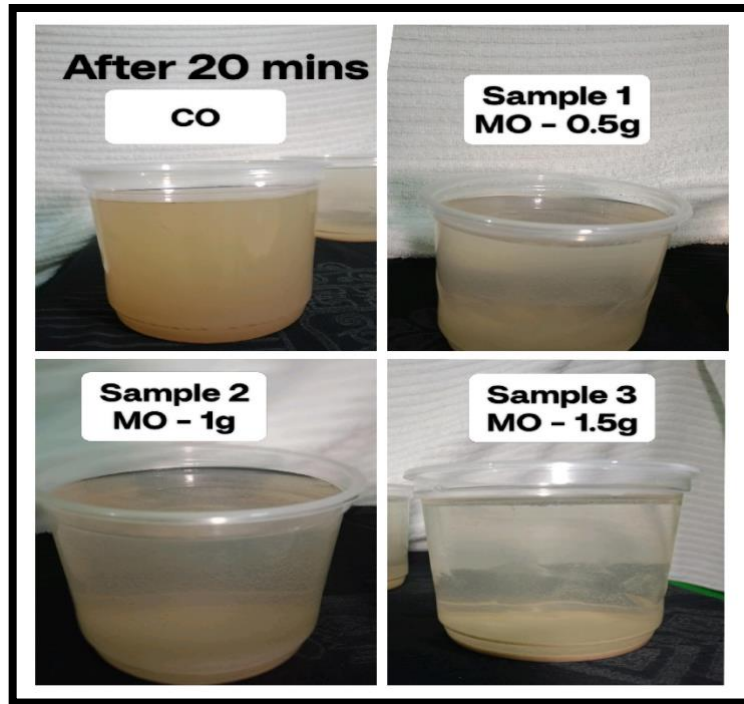
Table showing Effect of Moringa seed dosage on water turbidity.

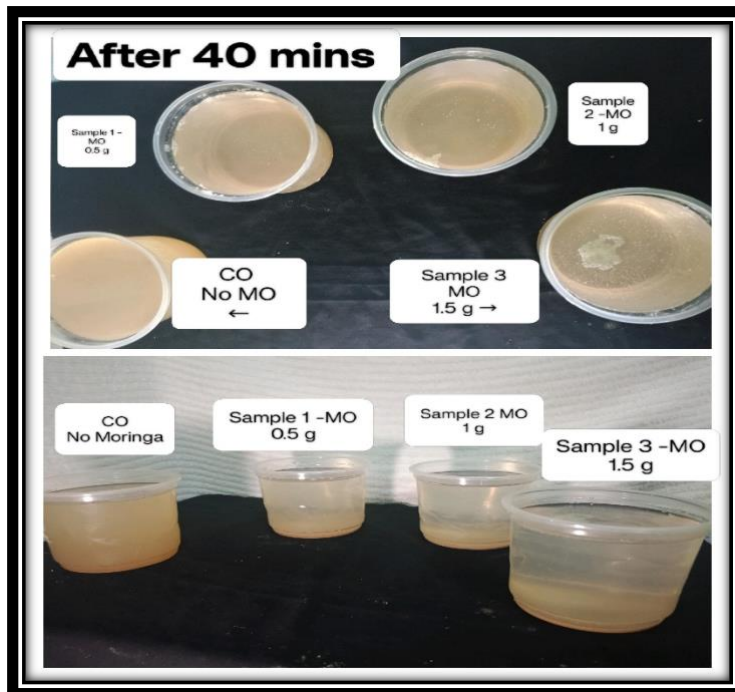
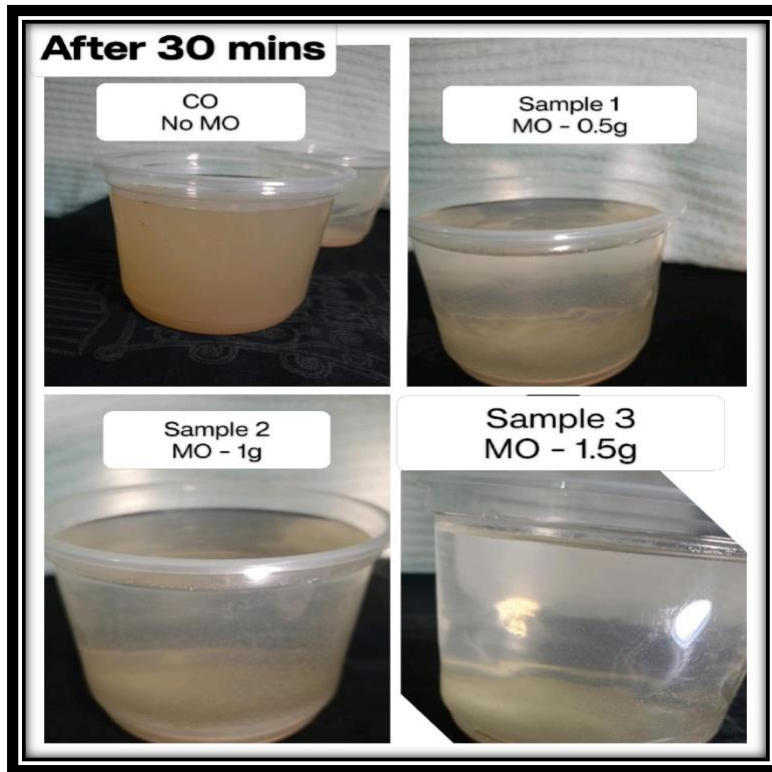
Showing Effect of Moringa Seed Dosage on Water Turbidity							
Sample	Amt of Moringa Powder	Time (min) Allowed for Sedimentation	Water Clarity	Turbidity level	Floc Formation	Colour change	Observation
1.Control	No Mo	60	Very Cloudy	unclear	No flocs	Muddy brown	No change — water remained cloudy.
2.Sample 1	0.5 g	60	Semi Clear	hazy	Moderate flocs	Pale yellow	Colour changed from muddy brown to pale yellow
3.Sample 2	1g	60	Clear	Mostly clear	Heavy settling	colourless	Top layer became clear, showing good water quality.
4.Sample 3	1.5 g	60	transparent	clear	Thick residue at the Bottom	colourless	Water turned from cloudy to clear with large flocs settling.

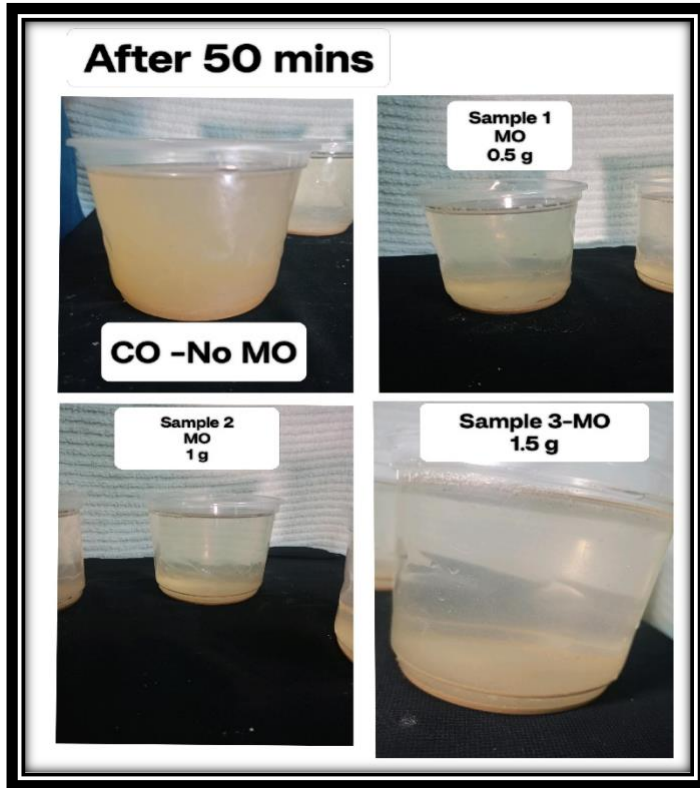
Visual Records

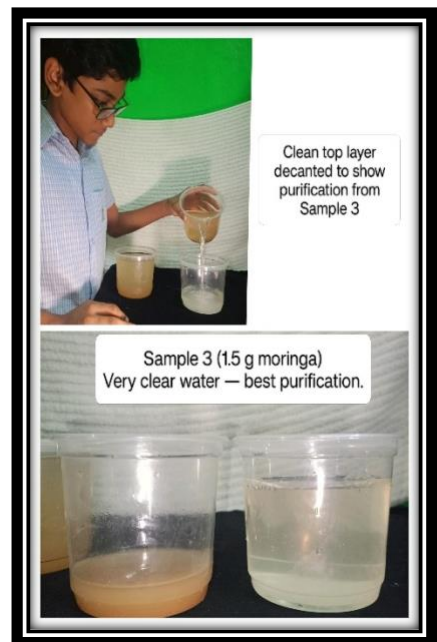
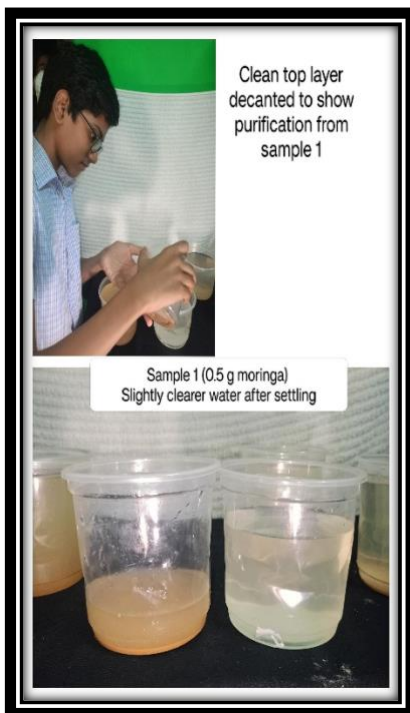
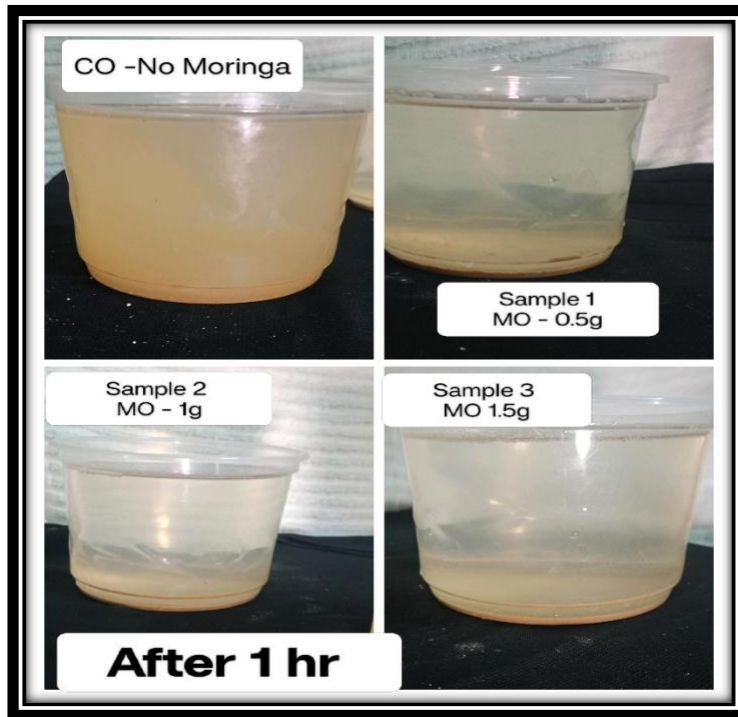


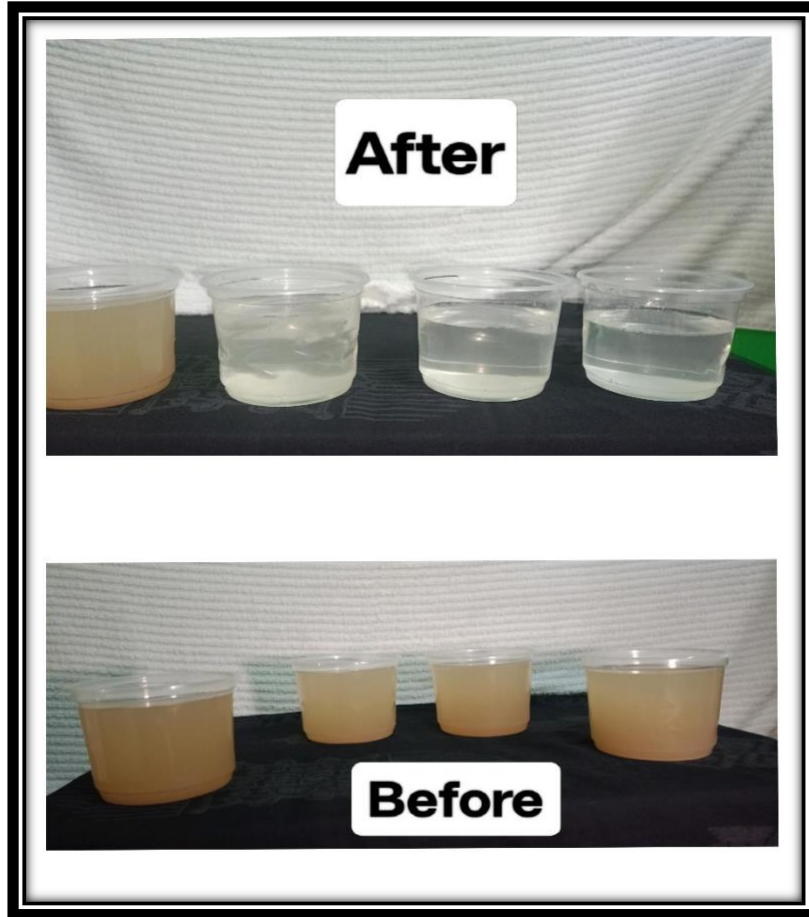




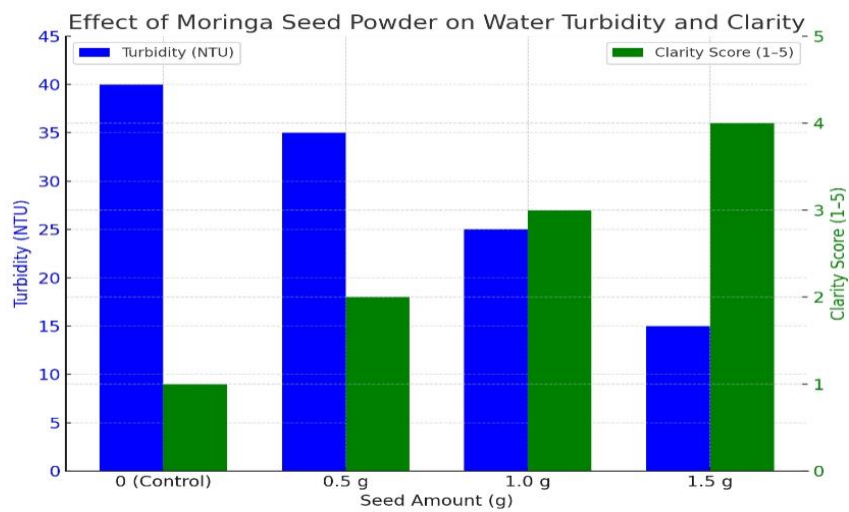








Graphical Representation



As the amount of Moringa seed powder increases, turbidity decreases (water becomes clearer), while clarity score increases, showing that higher seed amounts improve water purification.

Analysis of pH Stability After Treatment

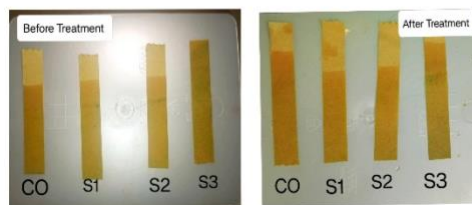
The pH test results showed no major difference between the water samples before and after treatment with Moringa seed powder. This indicates that Moringa acts as a natural coagulant without significantly changing the acidity or alkalinity of the water. The purification process mainly occurs through flocculation, where positively charged proteins in the seeds attract suspended particles, helping them to settle. Since this is a physical rather than a chemical process, the hydrogen ion concentration remains stable, keeping the pH nearly neutral. The orange colour observed was due to natural pigments from the moringa seeds and not a change in water pH



pH Observation



pH observation



Conclusion

The present study demonstrates that *Moringa oleifera* seed powder can effectively reduce the turbidity of contaminated water through natural coagulation and sedimentation.

As the dosage of moringa powder increased, the water became progressively clearer, indicating its potential as a sustainable and eco-friendly coagulant.

The experiment demonstrated that *Moringa oleifera* seed powder effectively reduced the turbidity of contaminated water, producing a visibly clearer final sample. The pH of the treated water remained nearly unchanged, staying around 6 to 7, which indicates that *Moringa* acts as a **natural coagulant without significantly altering the water's acidity or alkalinity**. The orange tone observed in the pH strips was consistent before and after treatment, confirming pH stability.

Although bacterial growth reduction was not directly tested in this study, **several scientific references support *Moringa's* antimicrobial potential. According to Lea (2010) and Ndabigengesere et al. (1995), proteins in *Moringa* seeds possess antibacterial properties that can reduce microbial contamination.** Therefore, based on these studies, *Moringa* seed powder can be considered a safe, **eco-friendly, and cost-effective natural purifier, suitable for improving water quality in rural and low-resource areas.**

Future Improvements

To make *Moringa* seed treatment more efficient and widely applicable as an alternative to chemical coagulants, several improvements can be made. First, large-scale extraction and purification of the active cationic proteins from

Moringa seeds can enhance performance and ensure consistency in results. Developing standardized **dosage guidelines for different water types and levels of turbidity** would also make the method more reliable. Additionally, **combining Moringa powder with solar disinfection or sand filtration** could improve bacterial removal and overall safety. Promoting community-based cultivation and seed processing units can make this treatment sustainable and affordable for developing regions. With further research and proper implementation, Moringa-based purification can become a **global, eco-friendly solution** to replace chemical coagulants like alum.

References

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