Sultanate of Oman
Ministry of Education
Al Batinah North Governorate
Hind bint Al-Muhallab Basic
Education School (Grades 5–10)

A Comparative Analytical Study of Greywater Treatment Results Using Moringa Aloe vera

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Table of Contents

Abstract

With the increasing pressure on freshwater resources in arid and semi-arid regions, the reuse of non-conventional water sources has become a vital necessity to ensure water sustainability. Greywater, which is generated from domestic activities such as washing and bathing, represents a promising alternative water resource; however, its direct reuse is limited due to its physical and chemical characteristics. Consequently, there is a growing need for low-cost, environmentally friendly treatment methods that can improve greywater quality and enable its safe reuse.

This study aims to investigate the effectiveness of powdered Moringa oleifera leaves as a natural treatment agent for improving the quality of greywater. The research focuses on assessing changes in key physicochemical parameters, including turbidity, pH, salinity, and dissolved oxygen, and evaluating the potential of Moringa as a sustainable alternative to conventional chemical treatment methods.

1. Do Moringa Aloe vera leaves have a measurable impact on the physicochemical properties of greywater?
2. Can Moringa Aloe vera leaves be utilized as a sustainable natural water purification agent?

To answer these research questions, the study was conducted in two main stages.

The first stage involved reviewing relevant scientific literature and identifying appropriate water-quality assessment protocols in accordance with the GLOBE Program. Greywater samples were collected from a single source, and baseline measurements of turbidity, pH, salinity, and dissolved oxygen were recorded.

The second stage consisted of an experimental application in which powdered Moringa leaves were added to the greywater samples. The same water-quality parameters were measured after treatment, and the results were compared with the pre-treatment values to evaluate the effectiveness of the natural treatment process.

The results demonstrated that the addition of powdered Moringa leaves significantly improved greywater quality by reducing turbidity, adjusting pH toward neutral levels, decreasing salinity, and increasing dissolved oxygen concentration. These findings indicate that Moringa oleifera represents an effective, sustainable, and eco-friendly solution for greywater treatment, particularly in water-scarce regions, and supports its potential application in sustainable water-resource management and reuse practices.

Key Terms

Greywater: Wastewater generated from domestic activities such as washing, bathing, and laundry, excluding sewage. Greywater contains relatively low levels of contaminants compared to blackwater and can be treated and reused for non-potable purposes such as irrigation and environmental applications.

Moringa oleifera:A natural plant known for its water-purification properties. Its leaves and seeds contain bioactive compounds that act as natural coagulants and antimicrobial agents, making it effective in improving water quality and reducing turbidity.

Turbidity:A measure of water clarity that indicates the presence of suspended particles which scatter light. High turbidity reflects poor water quality and is commonly expressed in Nephelometric Turbidity Units (NTU).

pH:A logarithmic scale used to measure the acidity or alkalinity of water. Maintaining a pH close to neutral is essential for water stability and suitability for reuse.

Salinity: The concentration of dissolved salts in water, typically expressed in parts per million (ppm). Elevated salinity can negatively affect soil properties and plant growth when water is reused for irrigation.

Dissolved Oxygen (DO): The amount of oxygen dissolved in water, measured in milligrams per liter (mg/L). Higher dissolved oxygen levels indicate improved water quality and enhanced suitability for environmental and agricultural reuse.

Introduction and Literature Review

The Sultanate of Oman, like many arid regions, faces increasing pressure on freshwater resources due to low rainfall, high evaporation rates, and growing water demand. This situation has led to the depletion of conventional water sources, particularly groundwater, highlighting the need for sustainable and alternative water-management solutions (World Health Organization, 2015).

Greywater, generated from domestic activities such as washing, bathing, and laundry, represents a significant non-conventional water resource. Although it is less polluted than blackwater, untreated greywater often exhibits high turbidity, unstable pH, elevated salinity, and low dissolved oxygen levels, which limit its direct reuse and may negatively affect soil and plant health (Arab Journal of Water Sciences, 2018).

Conventional greywater treatment methods rely on chemical and energy-intensive processes, prompting increased interest in natural, low-cost treatment alternatives (Al-Sayed, 2018). In this context, Moringa oleifera has been widely recognized for its natural water-purification properties. Previous studies have shown that Moringa leaves and seeds effectively reduce turbidity, improve water clarity, and stabilize pH, making them a sustainable alternative to chemical coagulants (Abdulrahman, 2015).

Several studies have confirmed the effectiveness of Moringa-based treatments in enhancing greywater quality and supporting its reuse for irrigation and environmental purposes, particularly in water-scarce regions (Al-Otaibi, 2020). Accordingly, the present study investigates the effectiveness of powdered Moringa oleifera leaves in improving key physicochemical properties of greywater, contributing to sustainable water-resource management in arid environments.

Research Methods

This study used an experimental approach to evaluate the effect of powdered Moringa oleifera leaves on greywater quality. Three greywater samples were collected from a single source, and turbidity, pH, salinity, and dissolved oxygen were measured before and after treatment in accordance with the GLOBE Program Water Protocols. Average values were calculated to compare pre- and post-treatment results, allowing assessment of the effectiveness of Moringa leaf powder as a natural method for improving greywater quality.**Scientific Interview**

Research Procedures

The study was conducted according to the following structured steps:

(1) Reviewing relevant literature from available books at the Learning Resource Center and reliable online scientific sources.
(2) Developing a detailed research plan and establishing a timeline for its implementation.

(3) Employing an experimental research design to evaluate the effect of Moringa leaf powder on greywater quality.
(4) Collecting, organizing, and recording experimental data and observations in tabulated form.
(5) Entering the collected data into the program's designated online platform.
(6) Analyzing and discussing the results, including graphical representation of the data.
(7) Drawing conclusions and formulating recommendations based on the findings.

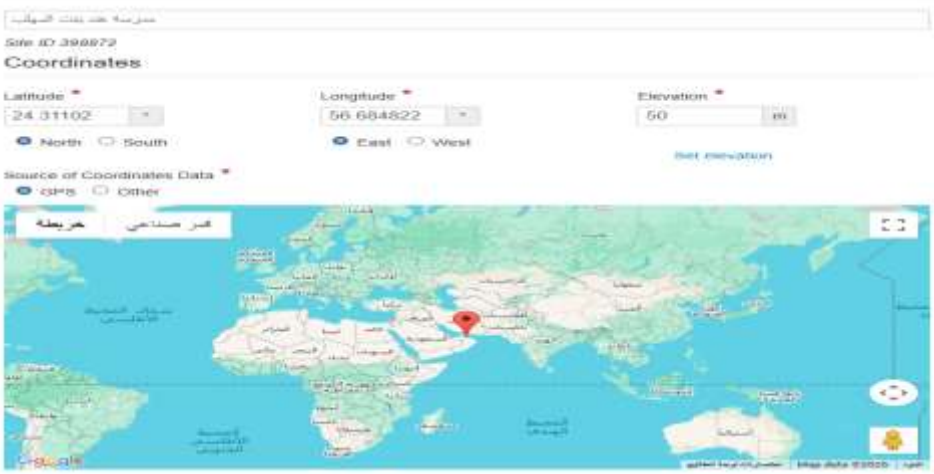
Research Plan and Implementation Timeline

No.	Student Name	Task	Date of Implementation
1	Ajnan khlifa Alquri Maysa Sultan Alesaii	Selection of the research topic	November 2025
2	Mira Omar Al-Yhyai Fadwa Saif Al-Issaei	Collecting information about the research topic from various sources	November 2025
3	Mira Omar Al-Yhyai Fadwa Saif Al-Issaei	Collection of Moringa tree leaves	November 2025
4	Mira Omar Al-Yhyai Fadwa Saif Al-Issaei	Practical implementation and result documentation	November 2025 — December 2025 — January 2026
5	Mira Omar Al-Yhyai Fadwa Saif Al-Issaei	Observing the results, recording them, and entering the data on the website	November 2025 — December 2025
6	Mira Omar Al-Yhyai Fadwa Saif Al-Issaei	Writing the research report and interpreting the results	January 2026

Table 1: Research Implementation Steps

Study Location

The research was conducted in the North Al Batinah region, characterized by a hot and humid climate, specifically within Hind bint Al-Muhalib School.



Identification of the Protocols Used in the Study

In this study, the Water Protocol will be employed to measure the pH, salinity, turbidity, and dissolved oxygen content of the water samples.

Identification of the Instruments and Tools Required for Conducting the Study

Several instruments will be used to measure soil properties as well as plant characteristics. Table (2) presents the most important of these instruments and their respective uses.

Equipment	Equipment Image	**Purpose / Use**
pH Meter		Measures the acidity or alkalinity of water
Salinity and Conductivity Meter		Determines water salinity and electrical conductivity
Turbidity Meter		Assesses water clarity and light transmission
Dissolved Oxygen Meter		Measures the concentration of dissolved oxygen in water

Table 2: Instruments and Tools Required for Conducting the Study

Data Collection and Analysis

Readings were taken from three greywater samples obtained from the same source. The water quality parameters were measured before and after the addition of powdered Moringa Aloe vera leaves. The measurements included pH, salinity, turbidity, and dissolved oxygen. Subsequently, the average

values of the readings were calculated to assess the effect of Moringa leaf powder on greywater properties.

	Before Addition				After Addition			
	1	2	3	**Average**	1	2	3	**Average**
Turbidity (NTU)	36	34	35	35	10	11	9	10
pH	6	6.2	6	6	7	7.1	6.9	7
Dissolved Oxygen (mg/L)	4.6	4.4	4.5	4.5	6.8	6.9	6.7	6.8
Salinity (ppm)	125	118	120	120	101	105	98	100

Study of Greywater Properties Before and After Using Moringa Extract

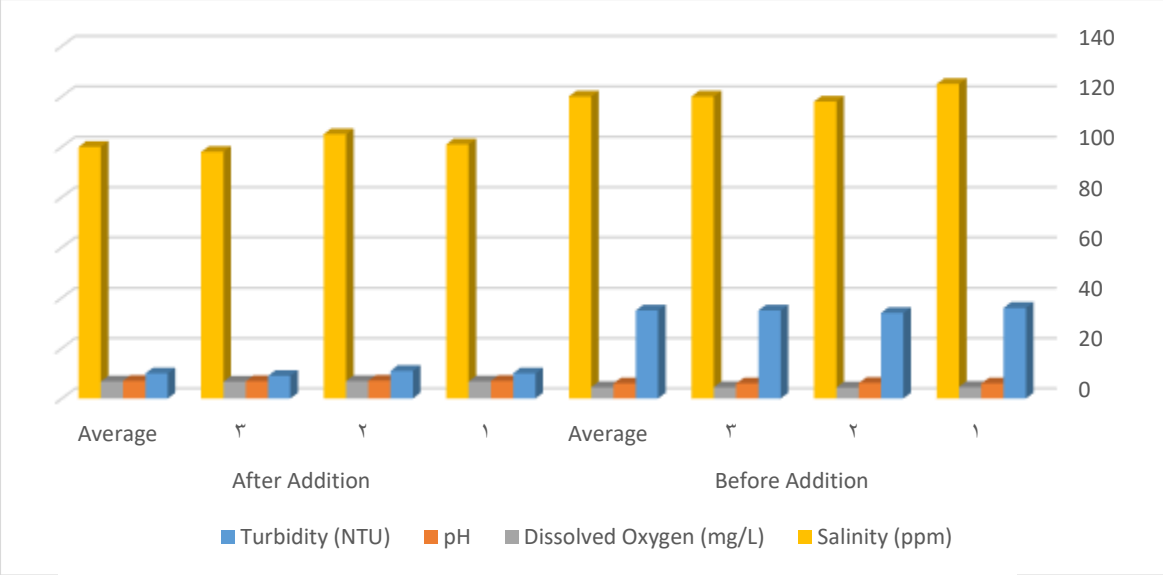


Figure 1: Water Properties Before and After Using Moringa Extract

"Table 3 and Figure 1 show a decrease in salinity and acidity, and an increase in transparency and dissolved oxygen levels.

Data Entry Documentation

Documentation of Data Entry on the GLOBE Website (www.globe.gov)

Results Analysis and Discussion

Based on the practical experiments and the readings in Table 1 and Figures 1 and 2, it can be concluded that adding Moringa leaf extract to greywater improves its quality and properties as follows:

Improved water transparency: Turbidity decreased significantly from an average of 35.0 NTU to 10.0 NTU, indicating the ability of Moringa to settle suspended particles.

- pH adjustment: The pH increased closer to neutral, enhancing water stability and reducing its acidic effect.

- Reduced water salinity: A slight decrease in salinity was observed, from an average of 121.0 ppm to 101.0 ppm, which may contribute to improved water quality for various uses.

- Increased dissolved oxygen: Dissolved oxygen concentration increased, improving water quality for irrigation or environmental reuse.

Conclusion

We praise Allah for the successful completion of this study, in which we employed practical experimentation following the protocols of the GLOBE program. The study demonstrated that powdered Moringa leaves are an effective and environmentally friendly method for treating greywater, helping to reduce turbidity, improve pH, decrease salinity, and increase dissolved oxygen. Further studies are recommended on a larger scale to determine the optimal doses and reaction times to achieve maximum benefits.

Commercial Applications of Layered soil

The use of Moringa oleifera as a natural treatment agent for greywater presents significant commercial potential in several sectors. In agriculture, treated greywater can be reused for irrigation, reducing dependence on freshwater resources and lowering operational costs, particularly in arid and water-scarce regions. This application is especially suitable for small farms, greenhouses, and school or community gardens.

In the environmental sector, Moringa-based greywater treatment systems can be commercially developed as low-cost, eco-friendly filtration units for households, schools, and public facilities. These systems can be marketed as sustainable water-reuse solutions that align with environmental regulations and sustainability goals.

Additionally, powdered Moringa leaves can be commercially packaged and sold as a natural water-treatment product for use in decentralized water-treatment systems, emergency situations, and rural areas lacking access to advanced treatment infrastructure. The simplicity of the treatment process and the availability of Moringa plants further enhance its commercial viability.

Overall, the commercial application of Moringa in greywater treatment supports sustainable water management practices while offering cost-effective and environmentally responsible solutions suitable for both domestic and small-scale commercial use.

References

(1) Abdulrahman, A. (2015). Use of Moringa in Water Purification. Journal of Environmental Sciences.

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(3) Al-Otaibi, K. (2020). Water Purification Techniques Using Natural Plants. Arab Academic Publishing House.

(4) Arab Journal of Water Sciences. (2018). Greywater Treatment and Reuse Practices in Arid Regions. Arab Journal of Water Sciences.

(5) World Health Organization (WHO). (2015). Guidelines for the Safe Use of Wastewater, Excreta and Greywater. World Health Organization, Geneva.

GLOBE Badges

I AM A GLOBE RESEARCHER

This badge is earned because the study was conducted using official GLOBE Program protocols for soil, water, and land cover, with systematic data collection, analysis, and documentation in accordance with GLOBE scientific standards.

I AM A PROBLEM SOLVER

This badge is earned because the study addresses a real environmental challenge related to water scarcity and soil salinity in arid environments by proposing and experimentally validating a soil model that improves water retention and reduces irrigation demand

I AM A COLLABORATOR

This badge is earned because the study was conducted through collaboration with a STEM professional and under academic supervision, integrating expert input, guidance, and cooperative effort throughout the research process.