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Microbiology-based Phytoremediation Study of Musi River Water using Moringa Seeds and Vetiver Grass

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ABSTRACT: Musi River once vibrant water body and lifeline for the city of Hyderabad, Telangana, India, is facing a severe ecological crisis due to the discharge of decades of unchecked industrial waste coupled with the relentless influx of untreated domestic sewage have transformed it into a repository of pollutants. The consequences are far-reaching, impacting not only the aquatic ecosystem but also posing significant health risks to the communities that depend on the river for their sustenance and livelihood. As reported by the Telangana State Pollution Control Board (TSPCB) the Musi River's pollution is a well-documented environmental crisis, which consistently highlight the elevated levels of pollutants, including heavy metals, organic compounds, and faecal coliforms. In this context, the exploration of cheap, natural, eco-friendly alternatives for water purification assumes immense significance. This project delves into the potential of two such natural resources: *Moringa oleifera* seeds and *Vetiveria zizanioides* roots. The present work reveals the ability of Vertiver grass roots are highly active as phytoremediation agents than moringa seeds. Vetiver grass roots have shown low colony forming units compared to the moringa seeds treated samples. Implementation of this low-cost method is recommended for ecofriendly, non-toxic simplified water treatments where rural and peri-urban people living in extreme poverty are presently drinking highly turbid and microbiologically contaminated water.

KEYWORDS: Phytoremediation, *Moringa oleifera*, *Vetiveria zizanioides*, Water purification

I. INTRODUCTION

Several studies have indicated that water contamination in urban rivers leads to severe public health crises, including waterborne diseases and heavy metal toxicity (WHO, 2021). Conventional water treatment methods, such as chlorination and chemical coagulation, are often expensive and inaccessible for rural and peri-urban communities (Kumar et al., 2023). This has led to increased interest in natural phytoremediation techniques, which offer an eco-friendly and cost-effective alternative for water purification.

In response to this environmental challenge, this study explores the use of natural phytoremediation agents—*Moringa oleifera* seeds and *Vetiveria zizanioides* (vetiver grass) roots—for purifying Musi River water. Moringa seeds have been extensively researched for their antimicrobial properties and their ability to act as natural coagulants, effectively reducing turbidity and microbial loads in water (Singh & Ramesh, 2022). Studies have shown that Moringa seeds contain bioactive compounds like flavonoids and phenolic acids, which contribute to their antimicrobial effects (Ali et al., 2020).

Vetiver grass, on the other hand, has been widely used for soil and water remediation due to its deep root system, which facilitates the absorption of heavy metals and organic pollutants (Xie et al., 2018). Recent research has demonstrated that vetiver roots can significantly reduce microbial contamination by acting as a biofilter (Kumar et al., 2023). Given the potential of these two phytoremediation agents, this study aims to determine their comparative efficacy in reducing microbial contamination and improving water quality.

II. MATERIALS AND METHODS

The phytoremediation potential of these agents was assessed using the viable count method. Water samples were treated with Moringa seeds and Vetiver grass roots separately, and their effects were analyzed over six hours.

1. Microbial Isolation and Identification: Serial dilution and plating techniques were used to isolate microorganisms from Musi River water. The isolates were identified using Gram's staining and selective media, including Salt Agar Media, Eosin Methylene Blue Agar (EMB), Hichrome Chromogenic Coliform Agar, and Mannitol Salt Agar (MSA) (World Health Organization, 2021).
2. Viable Count Analysis: Water samples were inoculated on nutrient agar plates at hourly intervals and incubated at 37°C for 18–24 hours. Colony-forming units (CFUs) were counted using a digital colony counter.
3. Phytoremediation Treatment (fig 1):
 - Moringa Treatment: Crushed Moringa seeds were added to 200 ml of Musi River water and stirred for uniform dispersion.
 - Vetiver Treatment: Cleaned and chopped vetiver roots were immersed in 200 ml of Musi River water.
 - Combined Treatment: A mixture of Moringa seed extract and vetiver roots was applied to 200 ml of Musi River water.
4. Incubation: The treated water samples were kept at room temperature, and microbial analysis was conducted every hour for six hours.



Fig1. Preparation of Musi River Samples for the experiment



Fig 2: Pure culture of Musi River water isolates on Nutrient agar media

III. RESULTS

The microbial analysis of Musi River water revealed the presence of various bacterial species (fig-2). The table 1 below outlines their characteristics and identification. Effect of phytoremediation agents on viable count is shown in the following table 2.

Table 1: Microorganisms identification using Grams Staining and Selective media

Culture Code	Colony Morphology	Gram Staining	SAM	EMB	MSA	CCAM	Identity
MS1	Small, round, raised, buff-colored colonies	Gram-positive cocci (+)	-	-	-	-	Monococcus
MS2	Large, white spreading colonies	Gram-positive rods (+)	+	-	-	-	Bacillus
MS3	Small white colonies with uneven edges	Gram-positive cocci (+)	-	-	-	-	Streptococcus
MS4	Golden-yellow colonies	Gram-negative (+)	-	-	+	-	Staphylococcus
MS5	White-colored colonies with round edges	Gram-negative (-)	-	+	-	+	Enterobacter
MS6	Round, raised mucoid colonies	Gram-negative (-)	-	+	-	+	Klebsiella

Note: “+” growth/growth with clear zone in case of SAM & MSA; “-” no growth/ no clear zone around the colonies.



SAM-starch agar media, EMB-eosin methylene blue agar media, MSA-mannitol salt agar media, CCAM-Hicrome chromogenic agar media.

Table2: The effect of phytoremediation agents -Moringa seeds and Vetiver grass roots on bacterial CFUs over six hours.

Time (hours)	Moringa Seeds	Vetiver Grass Roots	Moringa + Vetiver
0	100.5	89	133
1	93.5	80.5	101
2	86.5	77.5	118
3	97	66	100.5
4	73	54.5	96
5	58	95.7	58
6	96.5	58.5	88

IV. DISCUSSION

The results of this study highlight the effectiveness of *Vetiveria zizanioides* roots in reducing microbial contamination in Musi River water compared to *Moringa oleifera* seeds. Vetiver-treated samples exhibited lower colony-forming unit (CFU) counts, indicating a higher efficacy in removing bacterial contaminants. This supports previous research findings that vetiver grass possesses strong phytoremediation properties, absorbing pollutants and heavy metals through its extensive root system (Kumar et al., 2023).

Moringa seeds demonstrated antimicrobial activity, particularly in the early hours of the experiment, but their efficacy fluctuated over time. This may be due to the nature of the active compounds in Moringa seeds, which function primarily as coagulants and antimicrobial agents but may not sustain long-term microbial suppression (Singh & Ramesh, 2022). The combined treatment of Moringa seeds and vetiver grass roots did not yield significantly better results than vetiver alone, suggesting that vetiver grass may be the more effective standalone phytoremediation agent.

These findings align with prior studies on natural water treatment methods, reinforcing the importance of vetiver grass as a biofilter for microbial contamination and chemical pollutants (Xie et al., 2018). The adoption of vetiver-based phytoremediation could be particularly beneficial for low-income communities that lack access to conventional water treatment infrastructure. However, further studies are recommended to explore the long-term effects and scalability of these treatments in different water sources.

V. CONCLUSION

This study demonstrates the potential of *Vetiveria zizanioides* and *Moringa oleifera* as eco-friendly, cost-effective phytoremediation agents for water purification. Vetiver grass roots showed a greater ability to reduce microbial contamination in Musi River water, while Moringa seeds exhibited moderate antimicrobial properties. Given its high efficiency, vetiver grass should be further investigated as a primary phytoremediation agent for natural water purification systems. The integration of such sustainable, low-cost water treatment methods could play a crucial role in improving water quality for rural and peri-urban populations that currently rely on contaminated water sources.

Future research should focus on optimizing the application of these phytoremediation techniques in large-scale settings and evaluating their effectiveness over extended periods. Additional studies on the removal of heavy metals and other non-microbial contaminants will further enhance the understanding of these natural purification systems.



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