Utilization of Organic Seed Base for Sustainable Water Purification Biosorbet Technology

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ABSTRACT

This project seeks to achieve this by creating a new biosorbent that does not use chemicals in water treatment. Such a system has great appeal in rural settings and in industrial utilization for easy water purification, lowering the cost of operations. The tablets also significantly decreased the levels of hardness (by 11.8%), calcium (by 34.3%), magnesium (by 24.5%), cadmium (by 96%), and iron (by 65.9%). While the microbial analysis of water treated with Moringa and Jujube seed tablets showed significant quality improvements. Initially, the water had high microbial counts TAPC at 2.50 x 10^3 cfu/mL, SSC at 7.5 x 10^2 cfu/mL, ECC at 1.1 x 10^3 cfu/mL, FC at 9.0 x 10^2 cfu/mL, and CC at 470 MPN/100mL. Post-treatment, TAPC fell to 1.0 x 10^1 cfu/mL, SSC to 0.1 x 10^1 cfu/mL, ECC and FC to 0 cfu/mL, and CC to 0 MPN/100mL, showcasing the tablets effectiveness in reducing microbial contamination and making the water safer for consumption. Remarkable results are obtained from a qualitative phytochemical examination of water treated with a mixture of Jujube (Ziziphus jujuba) seed and Moringa oleifera. Alkaloids, flavonoids, saponins, steroids, glycosides, and proteins are all present in moringa seeds, but tannins are absent. Notably, tablets effectively reduced the contaminated water pH level from 3.94 to 7.13. These substances have antibacterial qualities and aid in the coagulation and flocculation of suspended particles. Renowned for their antibacterial and antifungal properties, 4-(αL- rhamnopyranosyloxy) benzyl isothiocyanate and niazimioin are important active ingredients. The synergy between these seeds improves the removal of waterborne pathogens and organic impurities, making the combined treatment more effective than Moringa alone.

Keywords: Biosorbent Tablets, Eco- Friendly Filtration, Environmental Sustainability, Seed Derived Material, Water Treatment.

INTRODUCTION

Water is viral for life and yet its scarcity and contamination are serious global issues (Fewtrell *et al*. 2005). Contaminated water is one the major cause of water borne diseases such as cholera, typhoid and dysentery, which kill thousands of people around the world every day, particularly children (Xu *et al*. 2019). Biosorption offers an ecofriendly alternative, utilizing natural materials like agriculture waste, plants & microorganisms (Alo *et al*. 2012). Natural biosorbent, such as moringa oleufer and zizyphus moaurtiana (jujube) seeds, show promise as sustainable solution (Li *et al*. 2007). Rich in bioactive compounds, that purify water by binding pollutants and heavy metals (Suarez *et al*. 2003).

AIMS & OBJECTIVE

- To improve water quality by utilizing waste material
- To reduce the operational steps and costs associated with traditional wastewater treatment plants through the implementation of biosorbent technology.

METHODOLOGY

Plant Material Collection

The raw material such as Moringa oleifera seeds, Zizyphus mauritiana (jujube seed) & binders are sourced from nearby markets.

Product Development

In product development, the seeds are first dried at 85°C for 3 hours in an oven. Once dried, they are ground into a powdered form and sieved through a 60 mesh size stainless steel sieve. The powdered material is then weighed along with the binders prepared for tablet formation. All ingredients are mixed uniformly before being transferred to a tablet compressing machine, where they are compressed into tablets. The finished tablets are collected and stored at a temperature of 20-25°C.

Proximate Analysis of Product

The moisture content of the tablet was determined using the AACC Method 4415.02 through oven drying at 100°C for 3 hours (Brabec *et al*., 2018). Fat content was analyzed by AOAC Method 948.22, while protein content was estimated using Kjeldahl's method (AOAC 981.10). Ash content, measured as inorganic residue, was determined by burning the sample at 550°C using AOAC Method 942.05. Carbohydrates were calculated as the difference: 100 - % moisture - % protein - % lipid - % mineral. The pH of treated and untreated water samples was measured using AOAC Method 973.41, and conductivity was assessed with ASTM D4519-10 using Conductivity Probes. Total Dissolved Solids (TDS) were measured via the Gravimetric Method (ASTM D5907), while water hardness was determined using AOAC 973.52B with the EDTA titration method. Iron was estimated using Flame Atomic Absorption (ASTM D1068A), and calcium and magnesium were analyzed by titration and atomic absorption spectrometry (ASTM D511-08).

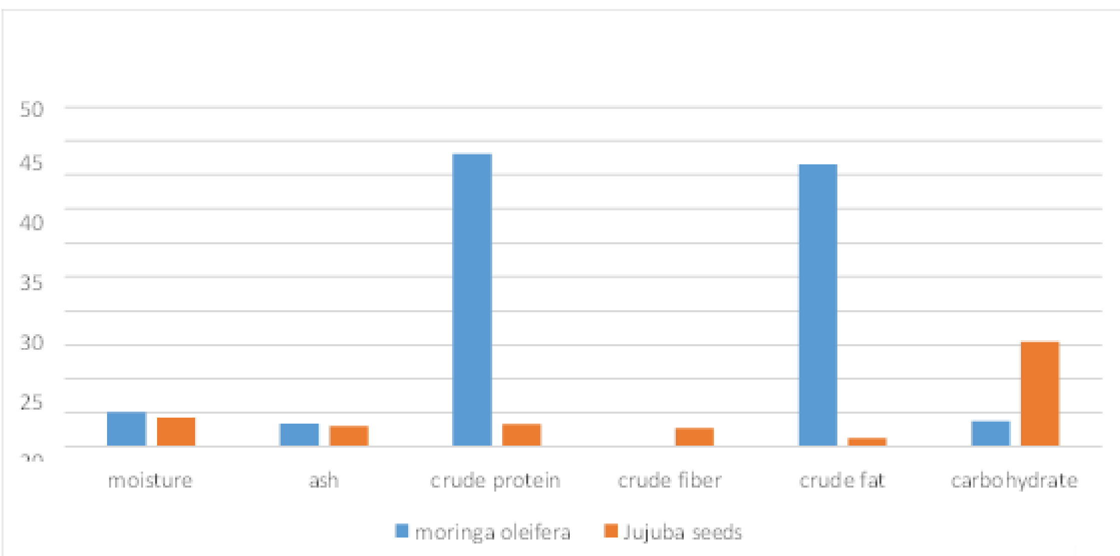

Figure 1. Proximate analysis moringa & jujubee seeds

Microbial Analysis of Product

Microbial analysis such as TAPC, SSC, EEC, FC, CC is done by the method according to AOAC Official Method 966.23 (AOAC, 2019) & APHA Standard Methods 9260 (APHA, 1998).

Phytochemical Analysis of Product

Phytochemical analysis of the sample was conducted following standard procedures.

Figure 2. Phytochemical Tests.

RESULT & DISCUSSION

The study revealed that the tablet had proved to be effective as a surface water purification agent (Mangale *et al*., 2012). This showed the potential and efficacy of the seeds to improve the bacteriological and physicochemical qualities of surface water (Ahluwalia & Goyal, 2007).

Table 1: Physiochemical Analysis of Treated and Untreated.

Testing	Untreated Water	Treated with Moringa Seed	Treated with Jujube Seed	Treated with tablet
Ph	3.94	6.90	6.6	7.13
Conductivity (µs/cm)	263	219	215	426
TDS (mg/l)	175	144	136	281
Hardness (mg/l)	50.124	25.21	15.29	44.2
Magnesium (mg/l)	16.703	14.927	15.53	20.8
Calcium (mg/l)	22.581	13.939	0.0368	30.33
Iron (mg/l)	0.229	0.057	0.01	0.078
Cadmium (mg/l)	0.05	0.01	--	0.001

Table 2. Microbial Analysis of Water Before and After Treatment with Tablet.

TABLET	TAPC (cfu/mL)	SSC (cfu/mL)	ECC (cfu/mL)	FC (cfu/mL)	CC (MPN/100mL)
Before Treatment	2.50 x 10^3	7.5 x 10^2	1.1 x 10^3	9.0 x 10^2	470
After Treatment	1.0 x 10^1	0.1x 10^1	0	0	0

The microbial analysis of water treated with Moringa and Jujube seed tablets showed remarkable improvements in water quality. Moringa and Jujube seed tablets demonstrated exceptional antimicrobial properties, significantly reducing microbial contamination in water (Ndabigengesere *et al*., 1995). These findings underscore the potent efficacy of the seed tablets in purifying water and safe for consumption.

Qualitative phytochemical analysis of tablets. The analysis of Moringa oleifera seed powder revealed the presence of alkaloids, flavonoids, saponins, steroids, glycosides, and proteins, while tannins were absent. These phytochemicals contribute to Moringa's ability to settle flocs and exhibiting antimicrobial properties (Eilert *et al*., 1981). The antibacterial and antifungal capabilities of bioactive chemicals found in moringa seeds include 4- (αL-rhamnopyranosyloxy) benzyl isothiocyanate, niazimicin, pterygospermin, benzyl isothiocyanate, and 4-(α-L-rhamnopyranosyloxy) benzyl glucosinolate. On the other hand, compounds found in abundance in jujube seeds, such as flavonoids, triterpenoids, and saponins, have antibacterial, anti- inflammatory, and antioxidant properties (Dalen *et al*., 2009).

The combination of Moringa and Jujube seeds likely enhances the overall efficacy of the water purification process.

CONCLUSION

The study found that tablets containing Moringa oleifera and Jujube seeds are quite effective in purifying surface water. The tablets drastically decreased microbial burden, hence improving bacteriological and physicochemical water quality. The pH scaled from 3.94 to 7.13, while hardness, calcium, magnesium, cadmium, iron, and chloride levels all decreased significantly. Microbial examination revealed a 99.9% reduction in overall plate counts and eliminated E. coli and coliform pathogens completely. Both seeds included phytochemicals such as alkaloids, flavonoids, and saponins, which improved antibacterial capabilities and made the water safe to consume.

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