Potentials of *Moringa oleifera* seed in water treatment

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Abstract

In order to meet the standards set by the World Health Organization for drinking water, it is necessary to treat water and remove contaminants and bacteria. A research study conducted in Bumsa Ward, located in the Gulani Local Government Area of Yobe State, Nigeria utilized a suspension made from *Moringa oleifera* seeds as an agent for coagulation and softening during groundwater treatment. The experiment involved examining multiple sites within this area using established laboratory techniques to assess the physical and chemical properties of water samples. Different concentrations of *Moringa oleifera* seed suspension were created and employed as a means of purifying the water. Analysis revealed that turbidity levels ranged between 108 NTU to 126 NTU when observing these water samples' physicochemical characteristics. The findings indicate that the samples exhibit high levels of cloudiness with moderate levels of TDS, ranging from 75.25 to 125.61 mg/L. The pH values for the water samples range between 6.7 and 6.8. Both samples are transparent, tasteless, and odorless. The results demonstrate that varying concentrations of Moringa seed suspension have a significant impact as both a coagulating and softening agent.The use of seed suspension decreases turbidity in groundwater by up to 82% and reduces its hardness by up to 42% after exposure for a duration of 90 minutes.Hence,Moringa seeds suspension can be considered an effective natural solution for reducing turbidity and softening water quality

Keywords: Moringa oleifera, Coagulant, bacteria, Physico-chemical, Water.

Introduction

Water is a vital resource for human existence. Population growth, economic progress, and industrial expansion have led to a rise in the consumption of freshwater as well as substantial misallocation of this invaluable resource (Fito et al., 2017). The scholars demonstrate that advancements in societal production and consumption patterns have caused a dramatic surge in domestic waste generation (Hermawan, 2018). This waste, along with effluents from various sources, contributes to the pollution and degradation of natural and surface water bodies. As a result, water contamination has become a major concern (Omelych et al., 2021).

Effluents from diverse origins compromise the quality of natural and surface water by being carried or released into rivers, carrying harmful chemical compounds that contribute to significant water pollution. Among these sewage materials, those involved in the process of oxidation lead to the degradation of water and oxygen levels, thereby elevating the chemical oxygen demand in bodies of water. This underscores the pressing requirement for effective wastewater treatment to mitigate the influence of these pollutants on aquatic ecosystems and protect both human well-being and the environment. In order to address the growing issue of water pollution caused by industrial activities, proper wastewater treatment methods must be implemented (Dhiman et al., 2016).Moringa seed has emerged as a viable solution for wastewater treatment, as it has been extensively studied since the nineteenth century (Abdi et al., 2022). Furthermore, the contamination of water resources by industrial and urbanization activities has resulted in a scarcity of fresh water supply for approximately 80% of the world's population (Nabi & Bari, 2023). Therefore, it is crucial to invest in advanced wastewater treatment technologies like using moringa seed in order to ensure the availability of clean and safe water for both present and future generations (Abdi et al., 2022).Thus, moringa seed emerges as a promising and efficient method for wastewater treatment due to its cost-effectiveness, high removal efficiency, and limited reliance on chemical reagents . Given its simplicity and cost-effectiveness, the commonly utilized coagulation and flocculation process is a crucial stage in water and wastewater treatment. Researchers have discovered Moringa oleifera seed is a natural coagulant that has shown promise in water purification and wastewater treatment. This ingredient, supported by various studies (Alo et al., 2012; Bina et al., 2010; Eman et al., 2014; Shan et al., 2017), offers several advantages as it is safe for human consumption and does not pose significant drawbacks. By incorporating Moringa oleifera seed into water treatment processes, it is possible to effectively remove turbidity, heavy metals, bacteria such as Escherichia coli, algae, and surfactants (Jagaba, 2018). Furthermore, the cationic proteins present in Moringa oleifera seed have been identified as the active components responsible for its effectiveness in water treatment .Using Moringa oleifera seeds as a natural coagulant in water treatment and wastewater treatment processes has been extensively studied by researchers, who have found it to be one of the most effective options, particularly in rural communities where access to conventional water treatment methods may be limited (Odika et al., 2020).In addition to its efficacy in water treatment, the availability of Moringa oleifera seed may be a potential challenge for widespread implementation (Domingues et al., 2020). However, given its origins in India, the availability of Moringa oleifera seed may be limited in other parts of the world. However, efforts are being made to overcome this constraint and explore alternative sources or develop technologies for wider accessibility of Moringa oleifera seed in water treatment.By utilizing these treatment methods, the water quality can be improved, ensuring the protection of public health and the environment.

Materials and Methods

Study Area and Sample Collection Sites

Bumsa Ward, of Gulani Local Government Area of yobe is located at longitude 11°00´11E and latitude 11°001′40N north with a total land area of about 2,090 km^2, situated in the Northeastern part of Nigeria. The state lies mainly in the dry savannah belt as a result it is dry and hot for most part of the year except in the southern part of the state which has a mild climate (W, Lagu, 2016).

Collection and Preparation of the Seeds of *M. Oleifera*

The fresh and matured seeds of *M. oleifera* were obtained from Farms in Gulani. The seeds authentication was established at by a botanist with the aid of treatise or regional flora (Dutta, 1979) and by comparison with herbarium sheets of the authentic species.The representative sample of the seeds were kept at the Natural Herbarium of Department of biological science, Yobe State University. Seeds were separated manually from each pod. The husks from the seeds will be shelled and the kernels ground with electronic mill (Straub Model E4 grinding mill).

Water Sampling

The collected water samples from different sites in Gulani metropolis were labeled A to E and transported to the microbiology laboratory at Yobe State University for further analysis, following standard methods as outlined by the APHA, 2008

Physico-chemical Analysis

The physico-chemical tests included the determination of Total Dissolved Solid,pH, Conductivity, using the standard methods methods described by Ademoroti, 2008

Bacteriological Analysis

The method used to determine the number of colonies formed (cfu/ml) on plate count agar was the pour-plate technique (Chakraborty et al., 2021). Additionally, the number of coliforms and fecal coliforms in the water samples was determined using the nine-tube, three-dilution (multiple tube fermentation) technique. Confirmatory tests were then conducted on positive Most Probable Number tubes to confirm the presence of E. coli. The isolates were further characterized through biochemical tests, including gram staining, citrate utilization, indole production, urease, and other tests.

Results and Discussion

Table 1 shows the results of a bacterial load count prior to treatment with M. olifera seed. Samples A and B with dilution factors 10-1 and 10-3 have bacterial loads of 80 and 71 cfu/ml, respectively, and the estimated bacterial colonies detected were 1610-1. The bacterial load is so high that the plate cannot be counted, and this is referred to as Too numerous to count (TNTC), whereas at 10-3 the bacterial load was counted as 74, and the estimated colonies were 14.210-1 Sample D, in 10-1 and 10-3, shows the density of the bacterial load that could not be counted on a plate, and this is also referred to as TNTC

Sample	Dilution factor (df)	Number of colonies	Estimated colonies (cfu/ml)
Anguwan Sarki	10^{-1}	80	16×10^{-1}
	10^{-3}	71	14.2×10^{-1}
Tike	10^{-1}	TNTC	0
	10^{-3}	74	1.48×10^{-1}
Tashan Mota	10^{-1}	55	1.1×10^{-1}
	10^{-3}	41	8.2×10^{-2}
Bulama Audu	10^{-1}	TNTC	0
	10^{-3}	TNTC	0
Kasuwa	10^{-1}	TNTC	0
	10^{-3}	TNTC	0

KEYS: TNTC= Too numerous to count
CFU= colony forming Unit
DF= Dilution Factor

: Shows the Result of Bacterial Load Count After Treatment

The efficiency of M. olifera seed in water filtration is shown in Table 2. The results show that the coagulant dosage was quite successful in suppressing some of the microorganisms found in the water samples. The results show that the dilution factors 10-1 and 10-3 reduced the bacterial load using 1.5g and 2.0g of coagulant dose as purifier, respectively, and that the lower concentration coagulant dose of 1.5 and 2.0 reduced the bacterial load to a reasonable level with less estimated colonies of 2.0×101, 1.4×101, and 0.6×101 . The coagulant dose only reduced the bacterial load to a limited degree but did not suppress the bacterial load in all concentrations except 2.0g of coagulant dose in the Tashan Mota sample. This demonstrates that increasing the coagulant dose inhibits bacterial burden. The bacterial load in the Bulama Audu sample was drastically reduced at 0.5g, 1.0, and 1.5, but at 2.0, the bacterial load was abolished by the action of the coagulant dosage.

Sample	Dilution factor (df)	Concentration of coagulant dose (g)	Number of colonies	Estimated colonies (cfu/ml)
Anguwan Sarki	10^{-1}	0.5	10	2.0×10^{1}
		1.0	7	1.4×10^{1}
		1.5	3	0.6×10^{1}
		2.0	0	0
Anguwan Sakri	10^{-3}	0.5	8	1.6×10^{3}
		1.0	5	1.0×10^{3}
		1.5	5	0.6×10^{3}
		2.0	3	0
Tike	10^{-1}	0.5	8	1.6×10^{3}
		1.0	5	1.0×10^{3}
		1.5	5	0.6×10^{3}
		2.0	3	0
Tike	10^{-3}	0.5	9	1.8×10^{3}
		1.0	8	1.6×10^{3}
		1.5	5	1.0×10^{3}
		2.0	5	1.0×10^{3}
Tashan Mota	10^{-1}	0.5	9	1.5×10^{1}
		1.0	7	1.4×10^{1}
		1.5	7	1.4×10^{1}
		2.0	5	1.0×10^{1}
Tashan Mota	10^{-3}	0.5	7	1.4×10^{2}
		1.0	7	1.4×10^{1}
		1.5	6	1.2×10^{1}
		2.0	3	0.6×10^{1}
Bulama Audu	10^{-1}	0.5	11	2.2×10^{1}
		1.0	11	2.2×10^{1}
		1.5	9	1.5×10^{1}
		2.0	7	1.4×10^{1}
Bulama Audu	10^{-3}	0.5	9	1.8×10^{3}
		1.0	8	1.6×10^{2}
		1.5	5	1.0×10^{2}
		2.0	5	1.0×101
Kasuwa		0.5	9	1.8×10^{3}

	1.0	8	1.6×10^2
	1.5	5	1.0×10^2
	2.0	5	1.0×101
Kasuwa	0.5	9	1.8×10^3
	1.0	8	1.6×10^2
	1.5	5	1.0×10^2
	2.0	5	1.0×101

KEYS: TNTC= Too numerous to count
CFU= colony forming Unit
DF= Dilution Factor

Table 3 shows the conductivity, total dissolved solids, and pH values of all the water samples collected before purification. Anguwan Sarki shows the highest TDS of 0.56ppm, with EC conductivity 0.42ppm, and a pH value of 6.7, followed by Tike 0.47ppm TDS (ppm), EC Conductivity 340 and the pH value was 6.7, followed by Tashan Mota Sample with 0.34 TDS (ppm), EC Conductivity of 248 and the pH value of 6.6, while Bulama Audu Sample 2 had 0.25ppm TDS, 184 EC conductivity and pH value of 6.4 and finally Kasuwa Sample had 0.051ppm TDS, 365 EC conductivity and pH value of 6.4.

Before Treatment

Sample	TDS (ppm)	EC Conductivity ums	pH value
Anguwan Sarki	0.56	403	6.7
Tike	0.47	340	6.7
Tashan Mota	0.34	248	6.6
Bulama Audu	0.25	184	6.4
Kasuwa	0.51	365	6.4

After Treatment

This table result shows that the coagulant dose increases the turbidity and conductivity. Various research shows that the coagulant dose usually leads to an increase in the aforementioned parameters. Anguwan sarki shows the highest TDS of 0.62ppm, with EC conductivity of 442 and a pH value of 8.2, followed by Kasuwa with 0.54 TDS (ppm), EC Conductivity 397 and a pH value was 7.0, followed by Tike Sample with 0.51 TDS (ppm), EC Conductivity of 370 and the pH value of 6.6, while Bulama Audu Sample had 0.38ppm TDS, 283 EC conductivity and pH value of 5.7 and finally Tasha Mota Sample had 0.30ppm TDS, 226 EC conductivity and pH value of 7.5.

Sample	TDS (ppm)	EC Conductivity ums	pH value
Anguwan Sarki	0.62	442	8.2
Tike	0.51	370	6.6
Tashan Mota	0.30	226	7.5
Bulama Audu	0.38	283	5.7
Kasuwa	0.54	397	7.0

Table 4: Shows the coagulaant dose, TDS, conductivity and pH values after treatment

Sample	Coagulant dose (g)	TDS (ppm)	EC Conductivity ums	pH value
Anguwan Sarki	0.5	0.62	442	8.2
	1.0	0.67	478	7.1
	1.5	0.76	543	6.5
	2.0	0.83	595	5.7
Tike	0.5	0.51	370	6.6
	1.0	0.53	384	6.2
	1.5	0.61	437	5.4
	2.0	0.65	453	6.0
Tashan Mota	0.5	0.30	226	7.5
	1.0	0.45	322	6.1
	1.5	0.54	405	5.5
	2.0	0.63	447	6.4
Bulama Audu	0.5	0.38	283	5.7
	1.0	0.46	334	6.2
	1.5	0.57	409	6.0
	2.0	0.69	492	5.3
Kasuwa	0.5	0.54	397	7.0
	1.0	0.56	385	6.0
	1.5	0.50	359	6.9
	2.0	0.64	471	6.8

Well, water in the study area is mostly shallow and the soil texture is categorically loose which permits the movement of materials through the soil, human activities in the study area contaminate the groundwater sources and are likely to contribute to high levels of faecal coliforms. Although it has been reported that indicator and pathogenic bacteria are efficiently retained in soils and are detected at only low levels in groundwater under field conditions (Liu, 2004; Alhajjar et al., 2010), other studies have found that heavy rainfall promotes the movement of bacteria and other inorganic contaminants through soil (Zyman and Sorber, 2003; Nikolaidis et al., 2011). It is therefore clear that should the groundwater be qualified as drinking water, it must be fully treated, and the surface waters must be protected from pollutants accordingly.

Related research conducted by Urifo et al., (2014) shows that M. olifera seed powder decreased turbidity and conductivity with decreased coagulant dose and the turbidity increased with an increase in coagulant dose, but after treatment purified with protein powder M. olifera seed there was a decrease in turbidity with increase dosage of coagulant from 30g 50g. However, this research work conforms with the work of Oladuro (2007), the findings reveal that M. Olifera seed extract efficiently precipitated about 90% of the bacteria and 99% of coliforms, this was an indication of the seed's potential to coagulate and clarify the water body. Madsen et al., (1997) also reported that 90% reduction in the bacterial load of water treated with moringa seed paste. The result obtained reveals that M. olifera seed has high efficacy in water purification because it drastically reduces the bacterial load in the water samples at low concentrations of the coagulant doses 1.0g, 1.5, and 2.0g respectively. This shows that the higher the coagulant dose the lower the bacterial load. The conductivity, turbidity, and pH slightly increase because of the density and sweet taste of the M. olifera seed. The Moringa is a multipurpose tree with significant economic and societal value that is grown in almost every developing country. In addition to treating wastewater, its nutritional and medicinal applications are very effective. The study proved that the use of Moringa seed powder in the reduction of color, turbidity, and pH is highly effective. From the results obtained in this research work, it is concluded that Moringa olifera seed is effective in water treatment and purification for public consumption. The use of Moringa seed powder should be employed in water purification, especially in rural areas where there is a scarcity of pipe-borne water.

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