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Physicochemical Characteristics of River Water and its Treatment Technology Using Moringa Seeds as A Coagulant

KEYWORDS: Moringa oleifera, River water, Coagulation, Antimicrobial agent, physicochemical parameter

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ABSTRACT *"Water Quality" is used to define the physical and chemical characteristics by which one evaluates the acceptability of water. The high cost of treated water makes most people in the rural communities to resort to readily available water sources which are normally of low quality exposing them to waterborne diseases. Present research work deals with the applicability of the coagulation-flocculation process using Moringa oleifera seeds as natural absorbent and environmentally friendly antimicrobial agent for purification of Nagavali river water for drinking purpose. In present study various doses of Moringa oleifera seed powder like 50, 100 and 150 mg/l were taken and checked for the efficiency dose on raw river water. After treatment of water samples with Moringa oleifera seed powder were analyzed for different physicochemical parameters like pH, turbidity, total dissolved solids (TDS), electrical conductivity, hardness, alkalinity and chlorides. All parameters were reduced with increased dose of Moringa oleifera seed powder except alkalinity and pH. Application of this low cost Moringa oleifera seeds is recommended for eco-friendly, nontoxic, simplified water treatment where rural and peri-urban people living in extreme poverty are presently drinking highly turbid and microbiologically contaminated water.*

Introduction

India has 16% of the world's population and 4% of its fresh water resources. Estimates indicate that surface and ground water availability is around 1,869 billion cubic meters (BCM). Of this, 40 percentages is not available for use due to geological and topographical reasons. Around 4,000 BCM of fresh water is available due to precipitation in the form of rain and snow, most of which returns to the seas via rivers. Eighty nine percent of surface water use is for agricultural sector and 2% and 9% respectively are used by the industrial and domestic sector. The average availability of water remains more or less fixed according to the natural hydrological cycle but the per capita availability reduces steadily due to an increasing population. A country is said to be water stressed when the per capita availability of water drops below1700 cu. m/person/year. It is expected that by around 2020, India will be a water stressed state with per capita availability declining to1, 600 cu.m/person/year. In this situation technology on water treatment is an essential role of environmental and basic scientist of the country towards development. Searching of safe drinking water remains a global problem and it is expected to rise with population growth and environmental changes. Scientist in many parts of the world has made it a priority to develop practical and appropriate approaches to improve access to clean water.

Chemical coagulants like Aluminum sulphate (alum), $FeCl_2$ are used in municipal drinking water treatment plant for purification process. This excess use of amount of chemical coagulants can affect human health e.g. Aluminum has also been indicated to be a causative agent in neurological diseases such as pre-senile dementia [1]. Presently there are no appropriate low-cost technologies available for removal of several commonly present river water contaminants. River 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. 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. One of these alternatives is Moringa oleifera (M. oleifera) seeds. 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. According to Suleyman et.al [1], hardness removal efficiency of Moringa oleifera was found to increase with increasing dosage. M.oleifera seeds act as a natural absorbents and antimicrobial agent. Its seed contain 1% active polyelectrolyte's that neutralize the negative charged colloid in the dirty water. This protein can therefore be a nontoxic natural polypeptide for sedimentation of mineral particles and organics in the purification of drinking water. M. oleifera seeds are also acting as antimicrobial agent against variety range of bacteria and fungi [2]. The seed contain number of benzyl isothiocyanate and benzyl glucosinolate which act as antibiotic [3]. The use of natural materials of plant origin to clarify turbid water is not a new idea [4-7] and cited by Madsenet et al. [2] in 1987. According to Amagloh and Amos Benang [8], at 95.0% confidence level, there was significant difference among all the treatments at the varying loading dose concentrations on the pH. The treatments gave a range of 7.2 to 7.9 which falls within the reduced as the concentrations of the dosing solutions were increased. The reverse was observed with the Moringa treatment. Among all the plant materials that have been tested over the years, powder processed from the seeds from Moringa oleifera has been shown to be one of the most effective as a primary coagulant for water treatment and can be compared to that of alum a conventional chemical coagulant [9]. It was inferred from their reports that the powder has antimicrobial properties. A general rule of thumb is that powder from one Moringa kernel to two liters of water is a good amount when water is slightly turbid, and to one liter when water is very turbid [10]. The seeds and powder can be stored but the paste needs to be fresh for purifying the water.

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Material and Methods

A good quality dried Moringa oleifera (drumsticks) were selected and wings and coat from seeds were removed. Fine powder was prepared by using mortar and pestle and this powder was directly used as coagulant. Water samples for study purpose were collected from Nagavali River, Srikakulam, and Andhrapradesh. Treatment to water was given by directly using seed powder. The water quality parameters were checked before and after treatment. Doses of seed powder i.e. 50, 100 and 150 mg/l were selected for treatment by supporting table of Micheal Lea Clearing house, Low cost water treatment technologies for developing countries, Ottawa, Canada (Table 1).

The coagulant was mixed with drinking water sample and kept on the shaker for 45 min at 110 - 120 rpm. The settling time was 1 - 2 hours (depending on the water turbidity). After sedimentation, supernatant of treated water was used for test. The water quality parameters were checked for physicochemical as per standard methods [11] before and after the treatment. The efficiency dose of M. oleifera seed powder was determined. Samples were collected from river water and analyzed for physicochemical parameters as per standard methods [12].

Table 1: Dose range of M. oleifera seed powder given by Micheal Lea clearing house, Low cost water treatment technologies for developing countries, Ottawa, Canada.

Sr. No.	Raw Water Turbidity (NTU)	Dose Range of M. oleifera Seeds Powder (mg/l)
1	<50	50
2	50-150	100
3	>150	200

Results and Discussion

For the water samples were collected from Nagavali River, srikakulam, Andhra Pradesh, following drinking water quality parameters were analyzed before and after the treatment of various doses of Moringa oleifera seed powder. The Methods used for physicochemical study of water are listed in the Table 2 and the results obtained on the river water before and after treatment were reported in the Table 3.

Table 2: **Methods used for physicochemical study of river water.**

Sr. No.	Parameters	Method
Physical Parameters		
1	pH	pH meter
2	Turbidity	Nephelometer
3	TDS	Conductivity meter
4	Color	Visually
5	Electrical conductivity	Conductivity meter
6	Odor	Manually
Chemical Parameters		
7	Hardness	Titration
8	Alkalinity	Titration
9	Chloride	Titration

Table 3: Physicochemical characters of Nagavali River water before and after treatment with various doses of M. oleifera seed powder.

Sr. No.	Parameters	Before treatment	After treatment of water sample at various doses of Moringa seed powder			WHO/ USPH Standards
		0 mg/l	50 mg/l	100 mg/l	150 mg/l	
1	pH	7.69	7.10	7.30	7.40	6.5-8.5
2	Turbidity (NTU)	13.6	4.0	3.8	3.5	5
3	TDS (mg/l)	336	249	222	217	500
4	Color	Faint brown	colour-less	colour-less	colour-less	colour-less
5	Odour	None	None	None	None	None
6	Electrical Conductivity (µS/cm)	648	482	430	420	
7	Hardness(mg/l)	210	130	120	115	500
8	Alkalinity (mg/l)	62.5	45.5	46.0	47.0	200
9	Chloride	25.02	14.0	12.0	11.0	250

a. Analysis on Physical Parameters

pH

The presences of pH in river water samples before and after treatment were given in Figure 1(A) for analysis. Present study, treatment of M. oleifera seed powder was given to river water samples in different doses. During the analysis, it was observed that after treatment with Moringa seed powder; pH was decreased at 50 and 100 dose, but it was partially increased at 150 mg/l dose. After treatment the range of pH was 7.10 - 7.40 and within the WHO limit. The recommended acceptable range of pH for drinking water specified by WHO is between 6.0 and 8.5. The pH increases with increasing concentrations of the Moringa as coagulant. It was reported that the action of M. oleifera as a coagulant lies in the presence of water soluble cationic proteins in the seeds. This suggests that in water, the basic amino acids present in the protein of Moringa would accept a proton from water resulting in the release of a hydroxyl group making the solution basic [13]

Turbidity

The presences of turbidity in river water samples before and after treatment were given in Figure 1(B) for analysis. The initial turbidity observed was 14.6 NTU in river water which was beyond the limits of WHO standards. It was observed that the use of Moringa oleifera seed powder showed decrease in turbidity of ground water with increased dose at 50, 100 and 150 mg/l respectively. Residual turbidity reduces below 5 NTU. Due to this there was an improvement in the flock size and flock settled rapidly. The overdosing resulted in the saturation of the polymer bridge sites and caused restabilization of the destabilized particles due to insufficient number of particles to form more inter-particle bridges. The high positive charge and small size suggest that the main destabilization mechanism may could be adsorption and charge neutralization. This was also reported by Madsen et al. [2], 1987 and found that 90-99% of turbidity was removed by using Moringa seed powder.

Total Dissolved Solids (TDS)

The presences of TDS in river water samples before and after treatment were given in Figure 1(C) for analysis. The initial TDS was 336 mg/l. After the treatment M. oleifera seed powder, the total solids and total dissolved solids were reduced from river water. The range of total dissolved solids range was 217-249 mg/l. These were present within the limit according to WHO standards. M. oleifera is known to be a natural cationic polyelectrolyte and flocculent with a chemical composition of basic polypeptides with molecular weights ranging from 6000 to 16,000 daltons, containing up to six amino acids of mainly glutamic acid, methionine and arginine.

Electrical Conductivity

The presences of electrical conductivity in river water samples before and after treatment were given in Figure 1(D) for analysis. Before the treatment M. oleifera seeds electrical conductivity is 648µS/cm. After the treatment M. oleifera seed powder, the electrical conductivity was reduced from river water. The range of electrical conductivity range was 420-482 µS/cm. These were present within the limit according to WHO standards.

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Colour

The initial brown colour of ground water was completely removed after treatment of M. oleifera seed powder. The M. oleifera seeds show absorbent properties. Good clarification is obtained if a small cloth bag filled with the powdered seeds of the Moringa is swirled round in the turbid water.

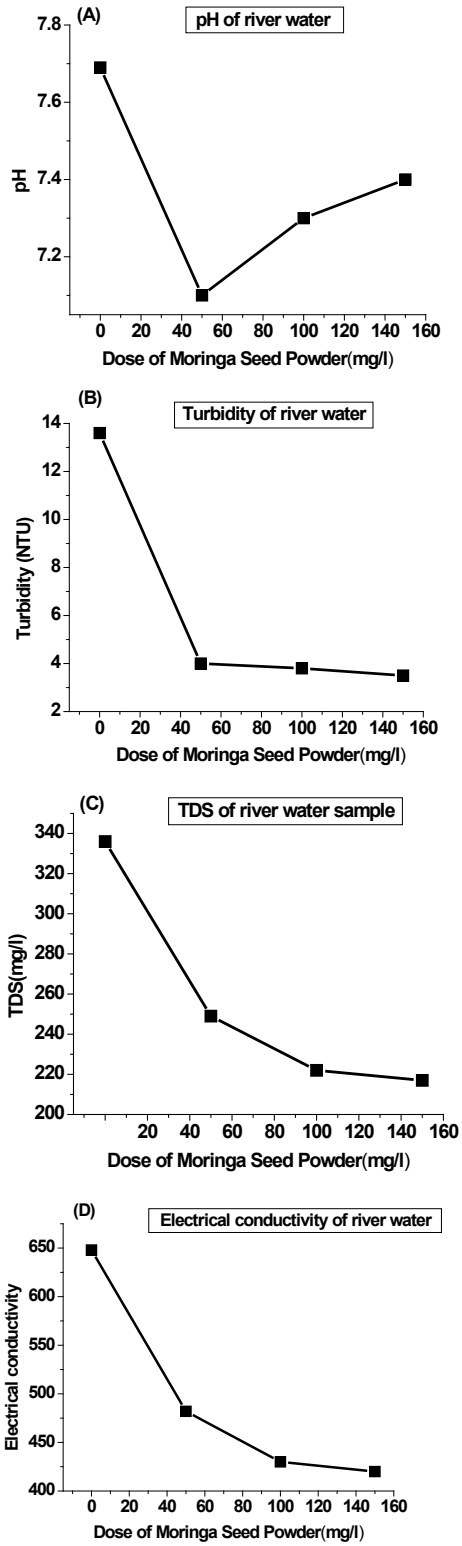


Figure 1: Physical parameters of river water before and after treatment of M. oleifera seed powder: (A) pH, (B) Turbidity, (C) TDS and (D) Electrical conductivity.

b. Analysis on Chemical Parameters

Hardness

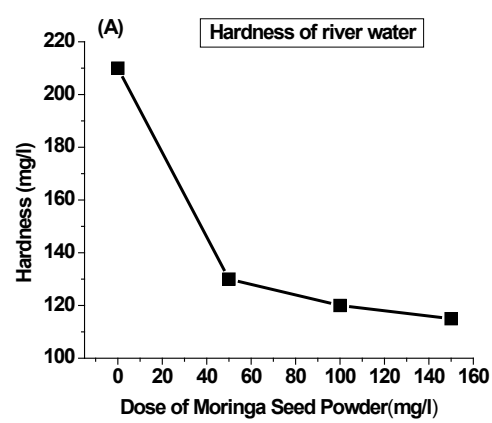
The presences of hardness in river water samples before and after treatment were given in Figure 2(A) for analysis. Hardness was 210 mg/l for river water sample. It was observed that hardness of water is decreased with increased dose of Moringa seed powder at 50, 100 and 150 mg/l of ground water. Hardness range was 115 - 130 mg/l and within the limit of WHO standards. As a polyelectrolyte, it may therefore be postulated that M. oleifera removes hardness in water through adsorption and inter-particle bridging. According to Suleyman [1] as a polyelectrolyte it may therefore be postulated that M. oleifera removes hardness in water through adsorption and inter-particle bridging. Secondly, with the observation that light, slow-settling solids/flocks were formed and precipitation reaction lead to the conversion of soluble hardness-causing ions to insoluble compounds would also be a good prediction of the reaction mechanism. The higher value for the surface water and groundwater samples is due to the fact that they contain hardness due to calcium, magnesium and other hardness-causing substances. This implies that as the number of hardness increases, the required dosage of Moringa oleifera seed powder increases.

Alkalinity

The presences of alkalinity in river water samples before and after treatment were given in Figure 2(B) for analysis. Alkalinity during the present research work was observed to be 62.5mg/l for river water. At various doses of M. oleifera seed powder, it was observed that the alkalinity reduced after the treatment at 50 mg/l dose. But at higher dose of 100 and 150 mg/l of Moringa seed, the alkalinity was slowly increased. The alkalinity was present in the range of 45.5 -47.0 mg/l which was within limits of WHO standards. The slight decrease in alkalinity and pH of all water samples may be due to precipitation of insoluble products of the reaction between the M. oleifera and the hardness-causing ions similar to precipitation softening using lime/soda ash. The M. oleifera seed extract appears to have natural buffering capacity. The precipitates (solids / flocks) were light and did not settle easily. The chemical constituent of the precipitate is however not known. It was also confirmed that alkalinity reduction in the coagulation of water sources using M. oleifera seeds [8].

Chloride

The presences of chloride in river water samples before and after treatment were given in Figure 2(C) for analysis. The chlorides were present 25.02 mg/l in the river water samples. It was observed that Moringa seed treatment with chloride ions reduces the chloride level, because cations from the seed attract negatively charged chloride ions present in ground water and neutralize the chlorides and therefore chloride ions range between 11-14 mg/l in river water samples which is within standard limit.



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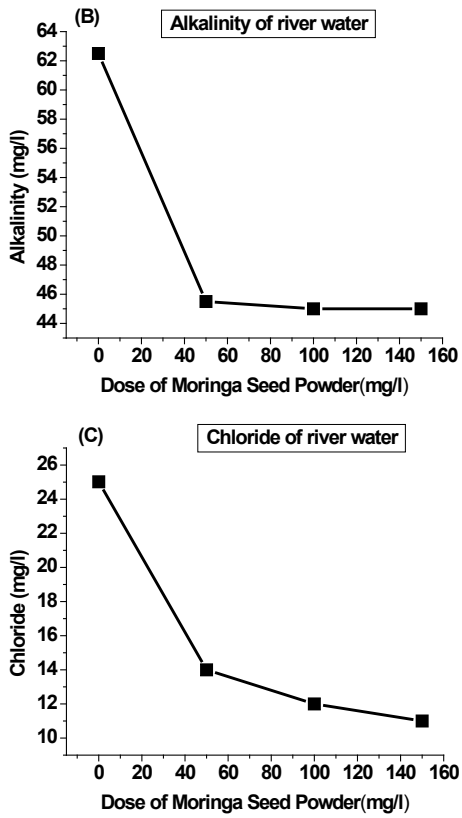

Figure 2: Chemical parameters of river water before and after treatment of M. oleifera seed powder: (A) Hardness, (B) Alkalinity, and (C) Chloride.

Conclusions

Scarcity of water both in quantity and quality, posses a significant threat to the current and future well beings of the people in the country especially for people in rural sector. Low cost treatment of water provides solution to all related issues to access the clean water for poor people in rural areas. M. oleifera seeds acts as a natural coagulant, flocculent, absorbent for the treatment of drinking water. It reduces the total hardness, turbidity, alkalinity, TDS and chloride after the treatment providing safe drinking water to rural population is the major challenge for a district administration. It could be possible by having the water treatment technology using M. oleifera coagulant solution. The low cost water treatment using M. oleifera seeds in the form of water soluble extract suspension results an effective purification agent for highly turbid and untreated pathogenic water. Efficient reduction on high turbidity produces an aesthetically clear supernatant. Applications of this low cost treatment technology at rural and urban people living in extreme poverty are leads to provide solution for drinking the highly turbid and micro biologically contaminated water.

REFERENCE

1. Suleyman, A. M., & Lilian, M. E. (1995). Moringa oleifera seeds for softening hard water. Wat. Res., 29(4), 1099-1105. | 2. Madsen, M., Schlundt, J., & Omer, E. F. (1987). Effect of water coagulation by seeds of M. oleifera on bacterial concentration. J. Trop. Med. Hyg., 1, 90-109. | 3. Eilert, U., Wolters, B., & Nahrstedt. (1981). the antibiotic principle of using Moringa oleifera and Moringa stenopetalla. Plant medical, 42 (1), 55-61. | 4. Bina, B., Mehdinejad, M. H., Gunnel, D., Guna, R. M. N., & Attar, H. M. (2010). Effectiveness of Moringa oleifera coagulant protein as natural coagulant aid in removal of turbidity and bacteria from turbid waters, World Academy of Science, Engineering and Technology, 67. | 5. Folkard, G., & Sutherland, T. (2001). The use of Moringa oleifera as a natural coagulant for water and waste water treatment, Department of engineering, University of Leicester, UK. | 6. Kawo, A. H., & Daneji, I. A. (2011). Bacteriological and physcio - chemical evaluation of water treated with seed powder of moringa oleifera lam. Bayero J. Pure and Applied Scie., 4(2), 208-212. | 7. Adejumo, M., Oloruntoba, E. O., & Sridhar, M. K. C. (2013). Use of moringa oleifera (lam.) seed powder as a coagulant for purification of water from unprotected sources in nigeria. European Scientific Journal, 9, 24. | 8. Amagloh F. K., & Benang A. (2009). Effectiveness of Moringa oleifera seeds as a coagulant for water purification, University for Development Studies, Faculty of Applied Sciences, Department of Applied Chemistry and Biochemistry, Navrongo, Ghana. | 9. Kumar, S. P., Mishra, D., Ghosh, G., Panda, C., & Medicinal, S. (2010). Uses and pharmacological properties of Moringa oleifera. Internat. J. Phytomedi., 2, 210-216. | 10. Amagloh & Benang (2009). Effectiveness of Moringa oleifera seeds as a coagulant for water purification, University for Development Studies, Faculty of Applied Sciences, Department of Applied Chemistry and Biochemistry, P.O. Box 24, Navrongo, Ghana. | 11. Srivastava, A., Mittal, D., Sinha, I., Chakravarty, I., & Raja, R. B. (2011). Study of Adsorption Isotherms for the reduction of basic dyes in effluent water using Moringa oleifera seeds, Anna. Biolog. Resea., 2(2), 227-238. | 12. Maithi, S. K. (2004). Handbook of methods in environmental studies vol.1: water and waste water analysis, second edition, published by ABD publisher, Jaipur - 302015. | 13. Olayemi, A. B., & Alabi, R. O. (1994). Studies on traditional water purification using M. oleifera seed, African study monographs, 15, 101-109. |