

"Evaluation of Physico - Chemical Characteristics of Water Treated With Moringa Oleifera Seed as A Coagulant for Purification of River Water"



Environment

KEYWORDS : Moringa oleifera, River water, Pathogenic water, Physical parameters, Chemical parameters.

ALLU UDAYASRI

Department of Chemistry, ADITYA Institute of technology and management, Tekkali - 532201, India.

MALLA RAMANAIAH

Department of Chemistry, ADITYA Institute of technology and management, Tekkali - 532201, India.

Dr. B.B.V. SAILAJA

Assistant Professor, Dept. of Inorganic and Analytical Chemistry, School of Chemistry, Andhra University, Visakhapatnam - 530003, India.

ABSTRACT

The present work was carried out to confirm the effectiveness of seed powder extracted from Moringa oleifera seeds which are commonly available in most rural communities. The main objective of this work is to evaluate the some physicochemical parameters and efficiency of a natural absorbent from Moringa oleifera seeds in treating river water. During this study, Vamsadhara river water samples were collected for treatment by Moringa seeds powder, resulting in an effective natural clarification agent for highly turbid and untreated pathogenic water. Various doses of Moringa seed powder viz. 50, 100 and 150 mg/l were taken and checked for the efficiency dose on raw river water. After treatment of seed powder with water samples were analyzed for different physical parameter like pH, Turbidity, TDS and electrical conductivity and chemical parameters like Hardness, Alkalinity and Chlorides. All parameters were reduced with increasing dose of 50, 100 and 150 mg/l seed powder respectively (except alkalinity and pH). Application of this low cost Moringa oleifera seeds is recommended for simplified, eco-friendly and nontoxic water treatment where rural and peri-urban people living in extreme poverty presently drinking highly turbid and microbiologically contaminated water.

Introduction

About 1.3 billion people still lack safe drinking water and more than 6 million children die from diarrhea in developing countries every year [1]. Only 61% of people in developing countries are estimated to have access to a potable water supply, greater in urban than rural areas, and 36% to sanitation, greater in urban than in rural areas (WHO, 1998). However, in many parts of the world river water which is used for drinking purposes can be highly turbid. The turbidity is conventionally removed by treating the water with expensive chemicals, many of which are imported at great cost and these are frequently unavailable. Large water treatment centres to the water purification by adding coagulants to the water such as aluminium sulphate (alum) [2].

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 [3]. 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.* [3], 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 [4]. The seed contain number of benzyl isothiocyanate and benzyl glucosinolate which act as antibiotic [5]. The use of natural materials of plant origin to clarify turbid water is not a new idea [6-9] and cited by Madsenet *et al.* [4] in 1987. According to Amagloh and Amos Benang [10], 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 [11]. 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 [12]. The seeds and powder can be stored but the paste needs to be fresh for purifying the water.

In view of the reported potentials of the seeds of M. oleifera, it is still pertinent to conduct further investigation on the coagulation and flocculation activity of M. oleifera seed powder (MOSP) using water source such as the Vamsadhara River with the objective of assessing the potential of M. oleifera seed in reducing some physicochemical parameters from river water.

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 Vamsadhara 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 [13] 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 [14].

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

Sr. No.	Raw Water Turbidity (NTU)	Dose range (seeds/liter)	Dose Range of MOSP (mg/l)
1	<50(low)	1 seed/4 liters	50
2	50-150(medium)	1 seed/2 liters	100
3	150-250(high)	1 seed/liter	200
4	>250(extreme)	2 seeds/liter	400

Results and Discussion

For the water samples were collected from Vamsadhara River, srikakulam, Andhra Pradesh, following drinking water quality parameters were analyzed before and after the treatment of various doses of MOSP. 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: Effect of treatment with MOSP on the physico-chemical characteristics of water before and after 3 hours of treatment.

Sr. No.	Parameters	Before treatment	After treatment of water sample at various doses of MOSP			WHO/USPH Standards
		0 mg/l	50 mg/l	100 mg/l	150 mg/l	
Physical parameters						
1	pH	8.25	7.01	6.99	7.10	6.5-8.5
2	Turbidity (NTU)	15.0	4.3	3.9	3.4	5
3	TDS (mg/l)	222	170	154	143	500
4	Color	Faint brown	colorless	colorless	colorless	colorless
5	Electrical Conductivity (µS/cm)	430	330	300	280	
6	Odour	None	None	None	None	None
Chemical parameters						
7	Hardness(mg/l)	215	180	170	165	500
8	Alkalinity (mg/l)	125	80	65	69	200
9	Chloride	15.01	10.0	8.0	5.0	250

a. Analysis on Physical Parameters

pH

The presences of pH in river water samples before and after treatment were given in Figure 1 for analysis. Present study, treatment of MOSP was given to river water samples in different doses. The initial pH observed was 8.25 in river water. 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 6.99-7.10 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 [15].

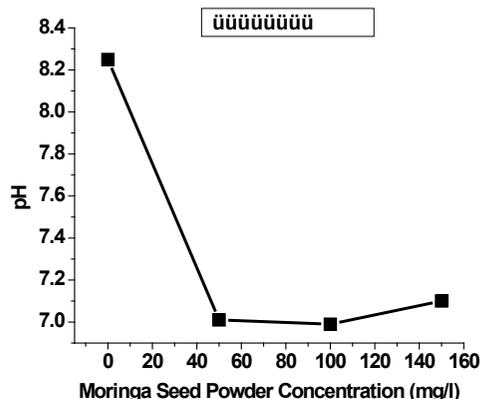


Figure 1: Variation in pH with *M. oleifera* seed powder coagulant dose.

Turbidity

The presences of turbidity in river water samples before and after treatment were given in Figure 2 for analysis. The initial turbidity observed was 15.0 NTU in river water which was beyond the limits of WHO standards. It was observed that the use of MOSP showed decrease in turbidity of ground water with increased dose at 50, 100 and 150 mg/l respectively. Residual turbidity reduces below 5.0 NTU. Due to this there was an improvement in the flock size and flock settled rapidly. The over-dosing 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.* [4], 1987 and found that 90-99% of turbidity was removed by using Moringa seed powder.

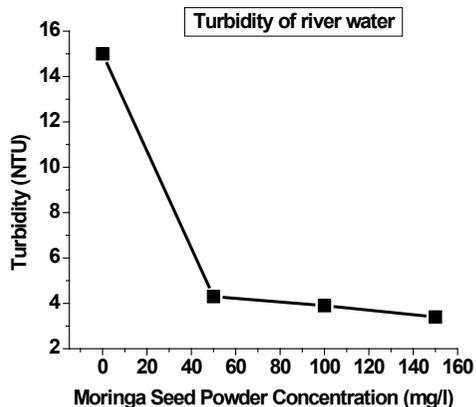


Figure 2: Variation in Turbidity with *M. oleifera* seed powder coagulant dose.

Total Dissolved Solids (TDS)

The presences of TDS in river water samples before and after treatment were given in Figure 3 for analysis. The initial TDS was 222.0 mg/l.

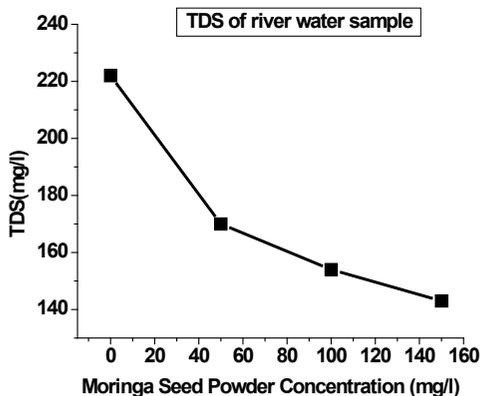


Figure 3: Variation in TDS with *M. oleifera* seed powder coagulant dose.

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 143.0-170.0 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 4 for analysis. Before the treatment *M. oleifera* seeds electrical conductivity is 430µS/cm. After the treatment *M. oleifera* seed powder, the electrical conductivity was reduced from river water. The range of electrical conductivity range was 280-330µS/cm. These were present within the limit according to WHO standards.

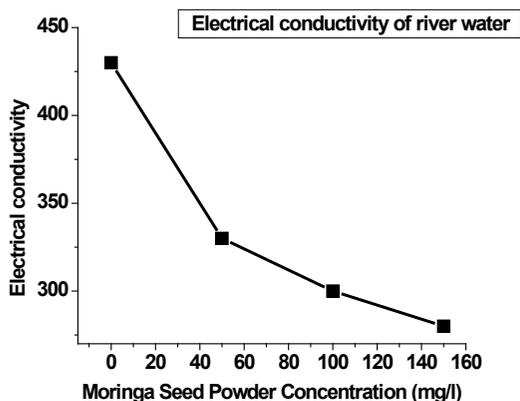


Figure 4: Variation in Electrical Conductivity with *M. oleifera* seed powder coagulant dose.

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.

a. Analysis on Chemical Parameters

Hardness

The presences of hardness in river water samples before and after treatment were given in Figure 5 for analysis. Hardness was 215 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 165-180 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 [3] 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.

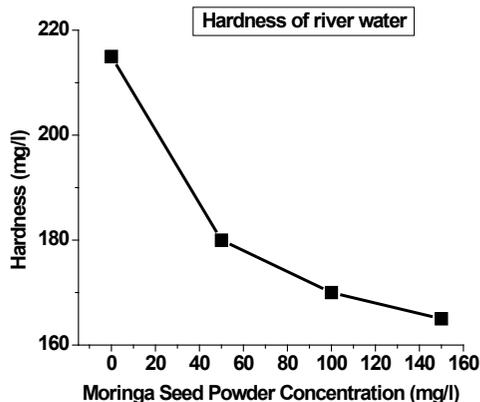


Figure 5: Variation in Hardness with *M. oleifera* seed powder coagulant dose.

Alkalinity

The presences of alkalinity in river water samples before and after treatment were given in Figure 6 for analysis. Alkalinity during the present research work was observed to be 125 mg/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 65-80 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 [10].

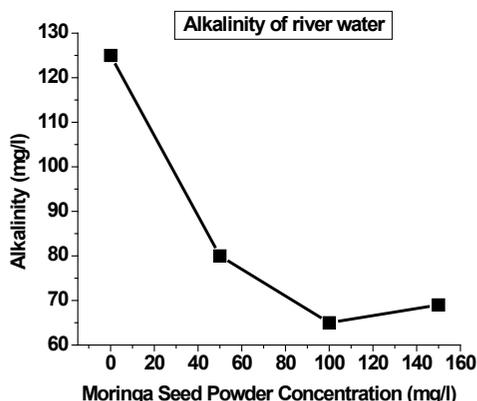


Figure 6: Variation in Alkalinity with *M. oleifera* seed powder coagulant dose.

Chlorides

The presences of chloride in river water samples before and after treatment were given in Figure 7 for analysis. The chlorides were present 15.01 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 5.0-10.0 mg/l in river water samples which is within standard limit.

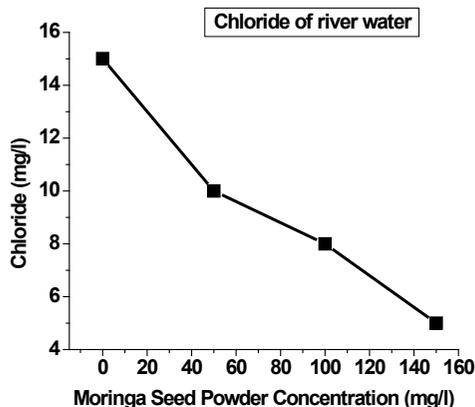


Figure 7: Variation in Chloride with *M. oleifera* seed powder coagulant dose.

Conclusions

Water is essential for human life. Potable water should be free from contaminants. *M. oleifera* seed have been shown to be a potential substitute for chemicals used in water treatment. *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. This study revealed that treating highly turbid and contaminated raw water with *M. oleifera* seed powder and further filtration using a matured simple household sand filter is viable for household/community use. This method does not alter the basic mineral composition of the water thus keeping the original appearance and taste. There is need to promote this simple technology, which can provide potable water economically and in culturally acceptable terms.

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