AJES ASIAN JOURNAL OF ENVIRONMENTAL SCIENCE ■ VOLUME 7 | ISSUE 2 | DECEMBER, 2012 | 167-171

RESEARCH ARTICLE

Effectiveness of *Moringa oleifera* as natural coagulant aid for waste water treatment of dairy industry

■ **KOKILA PARMAR, YOGESH DABHI, RINKU PATEL AND SARJU PRAJAPATI**

Article **C**hronicle :
Received :
06.08.2012;
Revised :
02.09.2012;
Accepted :
22.10.2012

SUMMARY : *Moringa oleifera* (MO) is a multipurpose, medium or small-sized tree, from regions of north west India and indigenous to many parts of Asia, Africa, and South America. Its pods have been employed as an inexpensive and effective sorbent for the removal of organics, and coagulant for water treatment. It is a non-toxic natural organic polymer. The main objective of this work was to use the MO seeds as a natural adsorbent for the treatment of dairy industry wastewater (DIW). Seeds of the plant species *Moringa oleifera* contain natural polyelectrolyte which can be used as coagulants to clarify turbid waters. The best removal was observed at pH 7.0-9.0 for all turbidities. Turbidity removal efficiency was resulted between 75.29 per cent to 85.88 per cent, BOD removal 60.17 per cent and COD removal 40.15 per cent by *Moringa oleifera* coagulant protein as coagulant aid. At 9.0 pH TDS reduction was 16.17 per cent with dose of 100 mg/l of *Moringa oleifera* seed. The antimicrobial effect of the coagulant showed that a reduction in the microbial load was 94.05 per cent. It is concluded that the MO seeds have the potential to be used in the dairy industry waste water treatment in an efficient way and with low cost.

HOW TO CITE THIS ARTICLE : Parmar, Kokila, Dabhi, Yogesh, Patel, Rinku and Prajapati, Sarju (2012). Effectiveness of *Moringa oleifera* as natural coagulant aid for waste water treatment of dairy industry. *Asian J. Environ. Sci.,* **7** (2): 167-171.

Key **W**ords :
BOD, COD, Dairy industry waste water, fecal coli forms, Heterotrophic bacteria, *Moringa oleifera*, TDS, Turbidity

Author for correspondence :
KOKILA PARMAR
Department of Chemistry, Hemchandracharya North Gujarat University, PATAN (GUJARAT) INDIA
Email: drkap_chem@yahoo.com

See end of the article for **Coopted authors'**

Many coagulants are widely used in conventional water treatment processes, based on their chemical characteristics. These coagulants are classified into inorganic, synthetic organic polymers and natural coagulants. The two most commonly used primary coagulants are aluminum and iron salts (Okuda *et al.*, 1999). In recent years, there has been considerable interest in the development of natural coagulants such as *Moringa oleifera* (MO) and *Chitosan*. By using natural coagulants, considerable savings in chemicals and sludge handling cost may be achieved (Diaz *et al.*, 1999) MO is among the 14 species of trees that belong to the family Moringaceae (Folkard *et al.*, 1999). MO seed kernels are biological coagulant consisting of significant quantities of low molecular weight water-soluble proteins, which in solution carry an overall positive charge. MO coagulant is safe and very effective in removing impurities.

Turbidity and colour removal is one of the important steps in a water treatment process, which is generally achieved using coagulants. Wastewater treatment methods include precipitation, coagulation/flotation, sedimentation, filtration, membrane process, electrochemical techniques, ion exchange, biological process, and chemical reactions. Each method has its own merits and limitations in applications because of their cost. Presently, there is an increasing trend to evaluate some indigenous cheaper materials for the removal of these pollutants and pesticides from aqueous solutions. A large number of cheaper materials including industrial and agricultural wastes have been used to remove different pollutants from the industrial effluents for their safe disposal into the biosphere (Akhtar *et al.*, 2009). The major concern in the use of seed extracts for water treatment applications is the residual organic seed material that will be present in the finished water. MO is organic and biodegradable. If the particulates are removed and the sludge that is generated is proven to be non-hazardous by analysis, then this sludge may be used as a fertilizer and/or soil conditioner after stabilization (Bhuptawat *et al.*, 2007). If MO is proven to be active, safe and inexpensive, it is possible to use it widely for drinking water and wastewater treatment. MO may become one of the cash products bringing more economic benefits for the producing countries. Our recent efforts have been focused on the coagulation process with MO for wastewater treatment. We are now reporting an improved preparative strategy aimed at a much effective and cheaper product that can remove turbidity, COD and BOD from DIW components. MO seed has been widely studied for the extraction of an active compound, used in coagulation/flocculation processes (Gassenschmidt *et al.*, 1995; Bhatia *et al.*, 2007) as well as for the adsorption of different compounds in biosorption processes. Some studies used the MO as adsorbent for the removal of organic pollutants (Akhtar *et al.*, 2007) and metals (Sharma *et al.*,2006; Bhatti *et al.*, 2007) from aqueous solutions, but no previous work has appeared concerning the removal of dairy industry wastewater (DIW) components, like proteins, lipids and carbohydrates, using MO pods. The present communication deals with the sorption of DIW components onto cost-effective MO. The main objectives of the present work are to investigate the coagulant potential of MO for the removal of organics—DIW components from aqueous media over a wide pH range along with other parameters affecting the coagulant process. Data have been analyzed by a statistical model. A kinetic study of the sorption process has also been made. This may lead to a better understanding of the coagulant process and demonstrate its utility in the pre-concentration of organics from DIW samples. It is a well established fact as proven in several publications that the quality parameters of drinking water include its turbidity, conductivity, pH and microbial load. The main objective of this study is to confirm the effectiveness of powder processed from *M.oleifera* seeds as water coagulant.

EXPERIMENTAL METHODOLOGY

Sample preparation:

The wastewater was collected from the discharge unit(digester inlet) of the Dudhsagar dairy, Mehsana (N.G.), India. Sample was collected in clean glass or plastic stoppard bottle made of neutral glass or polyethylene carboy with a minimum of 2 litres. The wastewater sample used for BOD determinations were collected directly into dark bottles.

Preparation of coagulant:

Moringa oleifera seeds were dried in oven at 40 ^{0}C temp. Seeds were powered and sieved through a 150 μm sieve. Two gram of powder was soaked in distilled water, blended and the volume was made up to 100 ml. As a preservative, 0.5 ml HCl was added per 100 ml solution. This suspension was used for the coagulation study.

Turbidity measurement:

This was carried out based on Nepholometric method. This method on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the intensity of scattered light, the higher turbidity. Formazin polumer was used as the primary standard reference suspension is defined as 4000 NTU. Turbidity meter calibration followed the manufacturer's operating instruction. Calibrated the instrument by using distilled water taking in standard test tube by adjusting zero reading. Fixed the range to be used. For reading measurement, water sample was taken in a standard test tube, put into turbidity directly from instrument scale. The instrument of turbidity meter should be warmed by starting switch before 15 to 20 minutes.

Electrical conductivity:

The electrical conductivity of water samples was measured using digital conductivity meter, systronics, M-306. This is the direct reading instrument of routine measurement of conductivity. The reading displayed by the instrument in the unit of micro-siemens/cm was noted down.

pH measurement:

The pH of the sample was read using a calibrated Crison pH meter Basic C20. A volume of 200 ml of the supernatants obtained from the beakers containing the treatments was measured into a beaker. The pH meter probe was then inserted making sure it did not touch the beaker. The pH reading was then taken from the LCD display after it had stabilized.

Measurement of COD:

COD was determined by closed reflux, titrimetric method. This procedure is applicable to COD values between 40 and 400 mg/l. Higher values are obtained by dilution. Alternatively use higher concentrations of dichromate digestion solution to determine greater COD values. COD values of 100 mg/l or less can be obtained by using a more dilute dichromate digestion solution or a more dilute FAS tartan.

EXPERIMENTAL FINDINGS AND DISCUSSION

In the present work, *Moringa oleifera* seed solution was used as solo coagulant for the treatment of the dairy waste water. According to Table 1 and Fig.1 the optimal dosage of *Moringa oleifera* seed suspension for coagulation

Table 1: Determination of optimum dosages of *Moringa oleifera* seed in turbidity

Dosage (mg/l)	Residual turbidity (NTU)	% Turbidity removal
25	4.2	75.29
50	3.7	78.23
100	2.4	85.88
125	2.6	84.70
150	3.9	77.05
200	4.0	76.47

Table 2: Effect of setting time in residual turbidity

Setting times in minutes	% Residual turbidity (NTU)
30	3.5
45	2.4
60	4.8

Table 3: Determination of optimum dosages of *Moringa oleifera* seed in COD removal

Dosage (mg/l)	Residual COD (mg/l)	% COD removal
25	1040	30.50
50	960	33.33
100	880	38.88
150	960	33.33
200	1040	30.55
300	1120	22.22

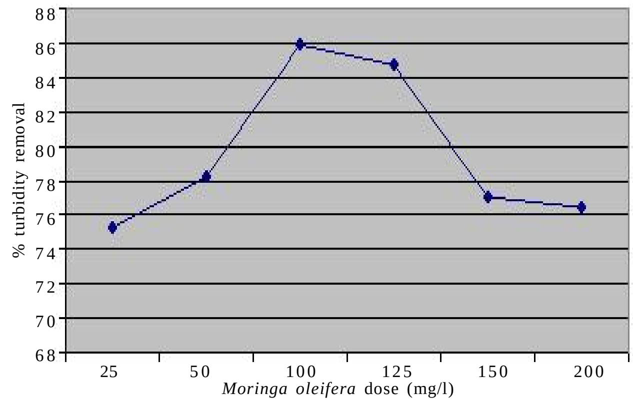

Fig. 1: Effect of *Moringa oleifera* on turbidity removal

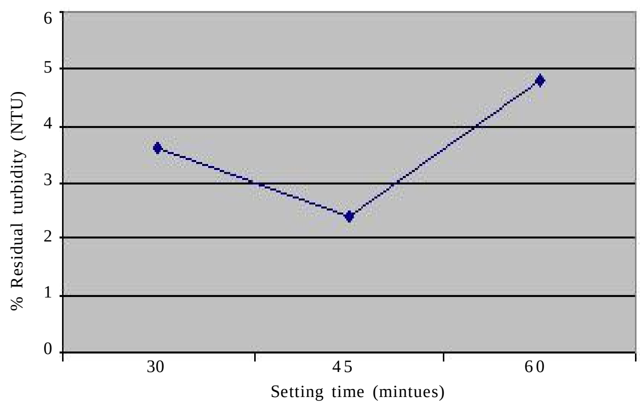

Fig. 2: Effect of setting time

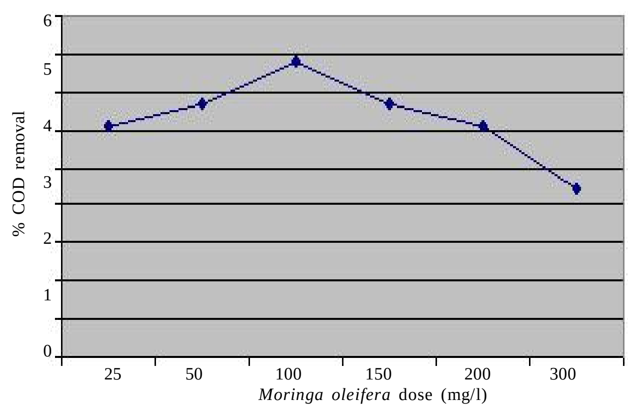

Fig. 3: Effect of *Moringa oleifera* on COD removal

flocculation of dairy waste water was between and 100 and 125 mg/l. The turbidity, after treatment was around 2.4 to 2.6 even at optimal conditions. If the dosage is too high there is a risk that the turbidity rises above the original turbidity. Once the coagulant and its dosages were selected the setting time for coagulation varied between 30-150 minutes at a particular dosage and at a particular pH. Obviously the purification increased with prolonged settling time but Fig. 2 shows that already after 45 minutes the water was relatively clean. 45 minutes was a reasonable long settling time (Table 2).

The reduction in turbidity using *Moringa oleifera* was 75.29 – 85.88 per cent (25-100 mg/l. dose). This is similar to the settling of particulate and suspended matter observed in the controlled experiment. This reduction in turbidity is also comparable to those achieved by natural coagulant like *M.drouhardii*, *M. stenopetala* and *M. peregrine* seeds as reported by Jahn (1986).

Moringa oleifera seed is pH neutral and does not change the pH in the water. The dairy waste water when treated with dose of 100 mg/l has resulted in COD values of the waste water 880 mg/l in the pH range of 9.0 as shown in Fig. 3 and Table 3.

The dairy waste water when treated with M.O. seeds dose of 100 mg/l has resulted in BOD values of the waste water 418 mg/l in the pH range was of 7.0- 9.0 as shown in Fig. 4 and Table 4. Maximum 60.17 per cent BOD removal was obtained by the treatment with optimum dose of 100 mg/l of M.O. seed.

Fig. 5, Table 5 and 7 showed the variations and change in TDS and conductivity of the clarified effluent. A maximum

Table 4: Determination of optimum dosages of *Moringa oleifera* seed in BOD removal

Dosage (mg/l)	Residual BOD (mg/l)	% BOD removal
25	557	40.61
50	510	51.28
100	418	60.17
150	448	57.21
200	603	42.40
300	731	30.27

Table 5: Determination of optimum dosages of *Moringa oleifera* seed in TDS values

Dosage (mg/l)	TDS at pH (7.0) (mg/l)	TDS at pH (9.0) (mg/l)
25	2400	2900
50	2700	2850
100	2600	2800
150	2720	2930
200	2840	2980
300	2860	3020

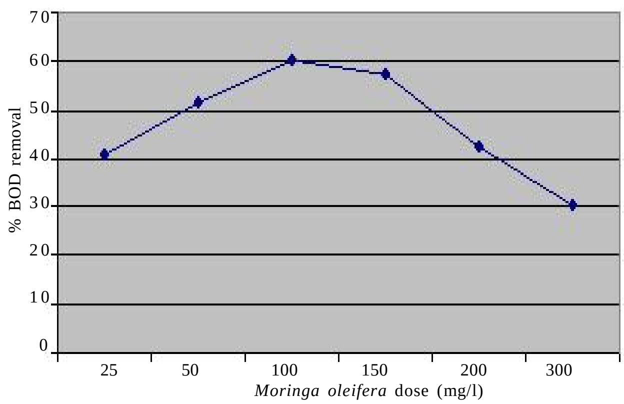

Fig. 4: Effect of *Moringa oleifera* on BOD removal

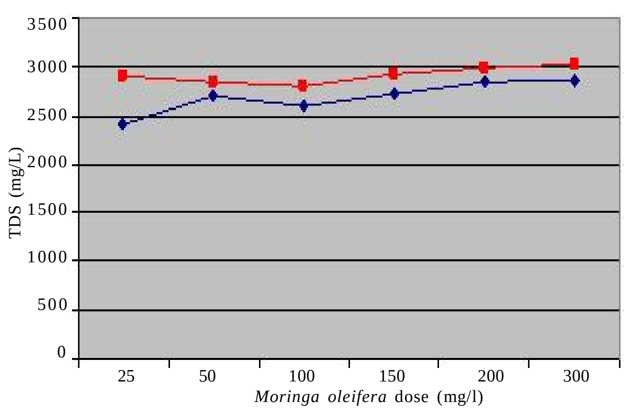

Fig. 5: Variation in TDS with *Moringa oleifera*

Table 6: Determination of optimum dosages of *Moringa oleifera* seed on heterotrophic bacteria

Initial (cfu/ml)	Final (cfu/ml)	% Reduction
3.73×10^4	3.56×10^4	94.05

Table 7: Effect of various optimum dosages of *Moringa oleifera* seed dose on electrical conductivity

Dosage (mg/l)	Conductivity (μs/cm)
25	8500
50	8400
100	8000
150	8100
200	8600
300	8800

of 23.52 per cent reduction in TDS was observed at pH 7.0. at 9.0 pH this reduction was 16.17 per cent with the dose of 100 mg/l of *Moringa oleifera* seed.

The anti microbial effect of the coagulant is shown in Table 6. The result indicate reduction in the microbial load of the waste water sample by 94.05 per cent for 1 hour interval after treatment.

The results of the present study are important in liquid waste and effluent remediation. So, to achieve a considerable remediation of liquid waste and effluent, there has been a reduction in microbial diversity and population. On the over all analysis, the *Moringa oleifera* seeds left the water clear, reduced the turbidity almost 100 per cent and 99.50-100 per cent removal of fecal coli forms, respectively.

Coopted Authors' :

RINKU PATEL AND SARJU PRAJAPATI, Department of Chemistry, Hemchandracharya North Gujarat University, PATAN (GUJARAT) INDIA

YOGESH DABHI, Vasana Science College, AHMEDABAD (GUJARAT) INDIA

REFERENCES

Akhtar, M., Iqbal, S., Bhanger, M.I., Zia-Ul-Haq, M. and Moazzam, M. (2009). Sorption of organophosphorous pesticides onto chickpea husk from aqueous solutions. *Colloids & Surfaces B: Biointerfaces*, **69**: 63–70.

Akhtar, M., Moosa, Hasany S., Bhanger, M.I. and Iqbal, S. (2007). Sorption potential of *Moringa oleifera* pods for the removal of organic pollutants from aqueous solutions. *J. Hazardous Materials*, **141**(3): 546–556.

Bhatia, S., Othman, Z. and Ahmad, A.L. (2007). Pretreatment of palm oil mill effluent (POME) using *Moringa oleifera* seeds as natural coagulant. *J. Hazardous Materials*, **145**(1–2):120–126.

Bhatti, H.N., Mumtaz, B., Hanif, M.A. and Nadeem, R. (2007). Removal of Zn (II) ions from aqueous solution using *Moringa oleifera* Lam. (horseradish tree) biomass. *Process Biochem.*, **42**:547–553.

Bhuptawat, H., Folkard, G. K. and Chaudhari, S. (2007). Innovative physico-chemical treatment of wastewater incorporating *Moringa oleifera* seed coagulant. *J. Hazardous Materials*, **142**(1-2) : 477–482.

Diaz, A., Rincon, N., Escorihuela, A., Fernandez, N., Chacin, E. and Forster, C.F. (1999). A preliminary evaluation of turbidity removal by natural coagulants indigenous to Venezuela. *Process Biochemis.*, **35**: 391-395.

Folkard, G.K., Sutherland, J. and Shaw, R. (1999). Water clarification using *Moringa oleifera* seed coagulant, Intermediate Technology Publications, LONDON (UNITED KINGDOM). pp. 109-112.

Gassenschmidt, U., Jany K.D., Tauscher, B. and Niebergall, H. (1995). Isolation and characterization of a flocculating protein from *Moringa oleifera* Lam. *Biochimica et Biophysica Acta,* **1243** : 477–481.

Okuda, T., Baes, A.U., Nishijima, W. and Okada, M. (1999). Improvement of extraction method of coagulation active components from *Moringa oleifera* seed. *Water Res.,* **33**(15): 3373–3378.

Jahn, S.A.A. (1986). The tree that purifies water, *Unasylv,* **38**: 23-28.

Sharma, P., Kumari, P., Srivastava, M.M. and Srivastava, S. (2006). Removal of cadmium from aqueous system by shelled *Moringa oleifera* Lam. seed powder. *Bioresource Technol.*, **97**(2): 299–305.

****
******