ISSN : 2249 - 8877 Volume 3 Issue 1

Trade Science Inc.

Research & Reviews On Polymer

Full Paper

RRPL, 3(1), 2012 [17-22]

Reduction of turbidity from water using *Lathyrus sativus* and *Pisum sativum* seed powder as natural coagulants and coagulant aids

Md.Alamgir Hossain[1], Md.Asrafuzzaman[2], A.N.M.Fakhruddin[2*]

[1]Microbiology and Chemical Division, Dhaka Water Supply and Sewerage Authority (DWASA), Asad Gate, Mohammadpur, Dhaka-1207, (BANGLADESH)

[2]Department of Environmental Sciences, Jahangirnagar University, Savar, Dhaka-1342, (BANGLADESH)

E-mail : a.fakhruddin2@mail.dcu.ie

Received: 26th July, 2011 ; Accepted: 26th August, 2011

ABSTRACT

Surface water pollution in and around the Dhaka city, especially the waters of the peripheral rivers has been threatening the supply of potable water to the city dwellers. The pollution problem was found stringent during dry season. During dry season there was increasing trends of turbidity from 2006 to 2010 in Buriganga River. Dry season average turbidity level of Buriganga River was found 119 NTU. Traditional coagulants and coagulant aid, like alum and polyacryl amide were not sufficient to treat highly polluted water. A conventional jar test apparatus was employed for the tests. Seed powder of *Lathyrus sativus* and *Pisum sativum* were used as natural coagulants and alum as synthetic coagulant in this study. Seed powder of *Lathyrus sativus* and *Pisum sativum* were also used separately with suspension of alum as coagulant aid for reduction of turbidity and to lower the dose of alum and polyacryl amide (PAA) was used as chemical coagulant aid in this study to reduce turbidity. The tests were carried out, using artificial turbid water to represent wide range of turbid water. Seed powder of *L. sativus* and *P. sativum* could effectively replace synthetic coagulant aid polyacryl amide. Using these natural coagulant aids, suitable, alternative and environment friendly options for water treatment would be achieved.

KEYWORDS

Lathyrus sativus;
Pisum sativum;
Seed powder;
Natural coagulants;
Turbidity.

INTRODUCTION

More than 80% of people in Bangladesh lack clean, safe water because most household and industrial wastes are dumped directly prior any treatment into natural water bodies such as rivers, ponds and canals, which threaten the supply of safe drinking water, pose severe public health and rapid increase in the water borne diseases[1]. People of the capital city depend on the supply of drinking water and sanitation services provided by Dhaka Water Supply and Sewerage Authority (DWASA). With the rapid urbanization and migration from rural areas there is a tremendous load on water consumption in the city[2]. Eighty four percent of the total supply of DWASA comes from ground level. At present, DWASA is dependent more on the surface

water than the ground water due to over extraction and insufficient infiltration of ground water[3]. For surface water the citizen of Dhaka city is mainly dependent on peripheral rivers namely Buriganga, Turag, Balu and Sitalakhya. The water condition of the surface water of Dhaka region has become highly polluted due to indiscriminate discharge of untreated waste from tannery, textile and other industries, municipal waste into water bodies, poor drainage system, population increasing and urban encroachment, river bank erosion. During dry season, the water level of the peripheral rivers of Dhaka decreased to an alarming level that makes the pollution in concentrated condition which makes it untreatable condition. Commonly used chemicals are for various treatment units are synthetic organic and inorganic substances. In most of the cases these are expensive since it require higher dose and do not show cost effective and many of the chemicals are also associated with human health and environmental problems[4-6].

Natural organic polymers have been used in India, Africa and China as effective coagulants and coagulant aids at high water turbidities. They may be produced from plants seeds, leaves and roots[7]. These natural organic polymers are interesting because comparative to the use of synthetic organic polymers containing acrylamide monomers, no human health danger and the cost of these natural coagulants would be less expensive over to the conventional chemicals like since it is locally available most rural communities of Bangladesh. A number of effective coagulants from plant origin have been identified, such as Nirmali[8], Okra[9], red bean, sugar and red maize[10] *Moringa oleifera*[11], *Cactus latifera* and seed powder of *Prosopsi juliflora*[12].

The objectives of the present study were to reduce the level of turbidity from water using locally available natural coagulant and coagulant aids and to find out natural coagulant aids alternative to synthetic polymer.

MATERIALS AND METHODS

Preparations of coagulant and coagulant aid stock solutions

Stock solution of alum

The aluminum sulphate (alum) [$Al_2(SO4)_3 \cdot 18H_2O$] used in this study was supplied by Dhaka Water Supply and Sewerage Authority (DWASA), Bangladesh. A 1% solution of alum (1 g of alum in 99 ml water) in tap water was made. Then the required concentrations were used as different coagulant dosages.

Stock solution of poly acryl amide (PAA)

Poly acryl amide (PAA) was used in this study was also supplied by Dhaka Water Supply and Sewerage Authority (DWASA), Bangladesh. A 1% solution of PAA (1 g of PAA in 99 ml water) in tap water was made. Then the required concentrations were used for different dosages as coagulant aids.

Stock solution of pulse (dal)

Locally available pulse namely, *Lathyrus sativus* (local name khesari), and *Pisum sativum* (local name anchor or boot) were selected for the study. Powder of *Lathyrus sativus* and *Pisum sativum* were bought from local market of Dhaka city. Then the experiments using these pulses were carried out in two ways. One was the direct use of the seed powder at different concentrations for different turbidity. Fresh solutions were prepared daily and kept refrigerated to prevent any ageing effects (such as change in pH, viscosity and coagulation activity). Solutions were shaken vigorously before use.

Preparation of synthetic water

Synthetic turbid water for the jar tests was prepared by adding clay materials to tap water. About 30 g of the clay materials was added to 1 liter of tap water. The suspension was stirred for about 1 hour to achieve a uniform dispersion of clay particles. Then it was allowed to settle for at least 24 hours for complete hydration of the clay materials. The suspension of synthetic turbid water was added to the sample water to achieve the required turbidity just before coagulation.

Jar test operations

A Completely Randomized Design was used for this experiment. The treatments given were the varying concentrations of alum, pulse seeds and the control. Each treatment conducted on the response of turbidity. The experiment was carried out in a jar test operations (Figure 1). A conventional jar test apparatus was used in the experiments to coagulate sample of synthetic turbid water and river water by using some coagulants

and coagulant aids. It was carried out as a batch test, accommodating a series of six beakers together with six-spindle steel paddles. Besides, the sample water was adjusted from the initial pH by adding acid or base. Before operating the jar test the sample were mixed homogenously. Then, the samples ought to be measured for turbidity. Sometimes the concentrations were kept constant as a means of control concentration and sometimes there were replica of concentration to understand the errors. The whole procedures in the jar test were conducted in different rotating speed. After the desired amount of coagulants was added to the suspensions, the beakers were agitated at various mixing time and speed, which consist of rapid mixing (200-250 rotation per minute, rpm) for 1-3 minutes and slow mixing (30-40 rpm) for 12-15 minutes. After the agitation being stopped, the suspensions were allowed to settle for 20-30 minutes. Finally, a sample was withdrawn using a pipette from the middle of supernatant for turbidity. All tests were performed at an ambient temperature in the range of 26 - 32°C and for different turbid ranges-higher (90-120) NTU, medium (40-50) NTU and lower (25-35) NTU. In the experiment, the study was conducted by varying a few experimental parameters, which were coagulant dosage, mixing time in order to study their effect in flocculation and obtain the optimum condition for each parameter.

Filtration

For this study fine tissue or soft cotton cloth were used as filtrating agent.

Figure 1 : Jar test operations for high turbid water

Measurement of turbidity

Turbidity is one of the important aesthetic properties of potable water and it is also very useful in defining drinking water quality. Turbidity was measured by using turbidity meter (Model-2100 P, HACH, USA). The amount of light angles by the turbidity particles is determined, as a determination of the turbidity in the sample and finally expressed as Nephelemetric Turbidity Units (NTUs). In a Turbidity meter, the sample was filled into a sample cell and put into the cell holder for measurement.

RESULTS AND DISCUSSION

Changing pattern of turbidity in buriganga river during 2006 to 2010

Trend of turbidity level in the water of Buriganga River during dry season of different years is presented in Figure 2. It was found from the Figure that the turbidity level was increasing gradually from 2006 to 2010. The average value of turbidity in the dry season (March-May) of 2006 was 78.3 NTU, whereas it was 119 NTU in 2010[13]. If this trend continues the turbidity level will touch around 170.5 NTU up to the 2015. Similar increasing trend of turbidity during dry season near Hazaribagh, Swarighat and Chandnighat point of Buriganga river was also observed[14]. The study revealed that, the higher value of turbidity in water was due to addition of suspended silt and clay particles along with organic matter. The sources of organic and microbial pollutants present in the water were also responsible for higher turbidity and in addition, the presence of streamer and engine boats used for conveying commercial raw materials were partially responsible for higher turbidity. River bank erosion, sedimentation and interaction of industrial effluents were also responsible for importing turbidities materials during the dry season. On the other hand, during rainy season, the river water gets diluted and the particulate matters responsible for turbid water flow. The increasing concern is being voiced for turbidity reduction of the peripheral rivers of Dhaka city has incited growing awareness of the need for more effective, easier, cheaper and environment friendly.

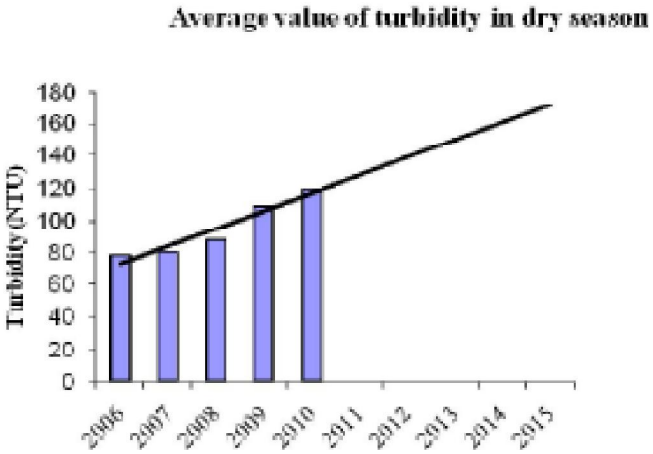

Figure 2 : Gradual increase of turbidity in the water of Buriganga river during dry season.

Reduction of turbidity using seed powder of natural coagulants

For higher turbid water a study using 1% solution of pulse seed powder (*Lathyrus sativus* and *Pisum sativum*) and 1% solution of alum were also used as coagulating agents. Turbidity was measured after coagulation-flocculation and after filtration. TABLE 1 shows the results of different doses of alum, *Lathyrus sativus* and *Pisum sativum* for the turbidity of 95.6 NTU in jar test. 20, 30 and 40 mg/l dose were used in three beakers for study for all coagulants. For 20 mg/l dose, turbidity reduced to 8, 8.9, and 10.8 NTU for alum, *Lathyrus sativus* and *Pisum sativum* respectively. After filtration, it was 1.7, 2.1 and 2.5 NTU respectively. For 30 mg/l dose, turbidity reduced to 6, 6.7 and 9.4 NTU for alum, *Lathyrus sativus* and *Pisum sativum* respectively. After filtration, it was 1.4, 1.5 and 2.2 NTU respectively. And for 40 mg/l dose, turbidity reduced to 7, 6.6 and 11 NTU for alum, *Lathyrus sativus* and *Pisum sativum* respectively. After filtration, it was 1.5, 1.5 and 2.5 NTU respectively. Hence among the natural coagulants, *Lathyrus sativus* showed an excellent performance for turbidity reduction.

In Figure 3 and 4 results of using *Lathyrus sativus* for high and medium turbid water are presented. It was found from Figures that seed powder of *Lathyrus sativus* was effective for the reduction of tubidity. After filtration its all results complies with the Bangladesh Drinking Water Standard[16] and drinking water standard by[15]. Use of these natural coagulants powder will be easy, handy, cheap and available. So it might be an excellent option for water clarification in remote areas and for household water treatment.

TABLE 1 : A comparative result of turbidity reduction using different coagulants after dosing and filtration

Dose (mg/l)	Raw water turbidity (NTU)	Turbidity after dosing (NTU)			Turbidity after filtration (NTU)		
		Alum	*L. sativus*	*P. sativum*	Alum	*L. sativus*	*P. sativum*
20	95.6	8	8.9	10.8	1.7	2.1	2.5
30	95.6	6	6.7	9.4	1.4	1.5	2.2
40	95.6	7	6.6	11	1.5	1.5	2.5

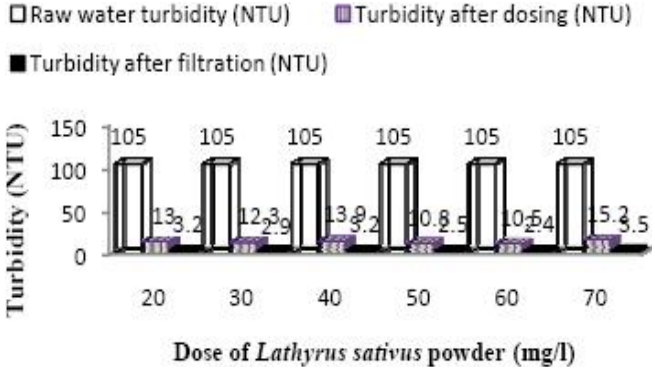

Figure 3 : Reduction of turbidity using powder of *Lathyrus sativus* (for higher turbid water).

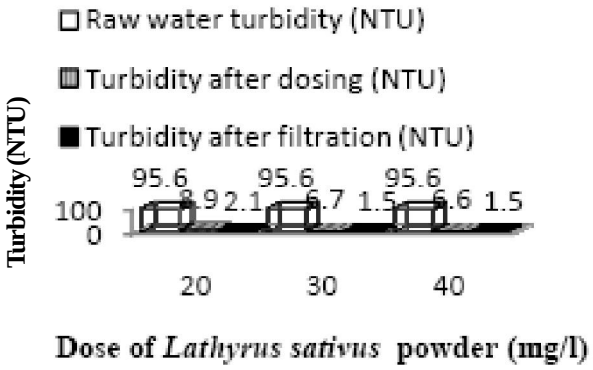

Figure 4 : Turbidity reduction using powder of *Lathyrus sativus* for medium turbid water.

Use of natural coagulants as coagulant aids for the reduction of turbidity as means of chemical coagulant dose reduction

Polyacryl amide (PAA) is a very well known coagulant aids largely used in water treatment applications. It is used to clarify highly turbid water. Using pulse (*Lathyrus sativus)* in combination with alum might do the same job as PAA done. A comparative result using *Lathyrus sativus* seed powder and PAA in combination with alum are represented in the TABLE 2 and 3.

The raw water was highly turbid (214 NTU). Alum individually reduced turbidity for different doses are presented in TABLE 2. In its 40 mg/l dose, its turbidity reduction capacity was found good. Thus 40 mg/l dose of alum was kept as control dose for alum to show the effects of coagulant aids. After using 40 mg/l of alum and 5-15 mg/l of PAA and *Lathyrus sativus* powder, the turbidity was found significantly lower than alum can individually reduce (TABLE 3). And the result of turbidity after dosing with alum and *Lathyrus sativus* was lower than the PAA and alum. So, *Lathyrus sativus* powder might be used as natural coagulant aids for water clarification purpose. Previous study[17] showed that, extract of *Moringa oleifera* seed could respectively remove turbidities of 98, 97, 89 and 55 percent in optimum concentration 10-30 (mg/l) and the optimum concentration of 20-30 mg/l with the optimum pH of 8. Another study using chitosan (a natural coagulant) as coagulant aids significantly reduced the required dose of primary coagulant to about 50-87.5% in optimum condition[18].

Similar study conducted using guar gum (a natural coagulant) as flocculant aid and showed; guar gum may be used along with alum to reduce the raw water turbidity from 26.5 to 1.0 NTU and concluded that guar gum can be used as a safer alternative to Polyacryl amide (PAA) in water treatment for drinking and food processing purposes[19]. So using *Lathyrus sativus* as coagulant aid- in combination with alum might have significantly reduced the amount of alum and thus it would make the treatment process cost effective.

TABLE 2 : Reduction of turbidity using alum for higher turbid water

Jar No.	Raw water turbidity (NTU)	Alum dose (mg/l)	Turbidity after dosing (NTU)
Jar 1	214	30	12
Jar 2	214	40	11.5
Jar 3	214	50	11.4
Jar 4	214	60	10.7
Jar 5	214	70	10.4
Jar 6	214	80	10.9

TABLE 3 : Reduction of turbidity using alum with Polyacryl amide (PAA) and powder of *Lathyrus sativus* for higher turbid water

Jar No.	Raw Water turbidity (NTU)	Alum Dose (control) (mg/l)	Dose of *Lathyrus sativus* powder (mg/l)	Dose of PAA (mg/l)	Turbidity after dosing (NTU)
Jar 1	214	40	5	0	5.8
Jar 2	214	40	10	0	4.6
Jar 3	214	40	15	0	4.2
Jar 4	214	40	0	5	2.4
Jar 5	214	40	0	10	1.5
Jar 6	214	40	0	15	5.4

CONCLUSIONS

During dry season its turbidity level of Buriganga River was found high (average 119 NTU). Traditional coagulants and coagulant aid, like alum and polyacryl amide were not sufficient to treat highly polluted water. Seed powder of *L. sativus* and *P. sativum* could effectively replace synthetic coagulant aid polyacryl amide. Using these natural coagulant aids, suitable, alternative and environment friendly options for water treatment would be achieved.

REFERENCES

[1] D.J.Gomes; Waterborne Illness, A Real Disaster In Bangladesh. In: Japan-Bangladesh Joint International Conference on Microbiology Education & The Prospect of Japanese Collaboration in Education and Research (December 27), **(2005)**.

[2] A.R.Khan; Increasing Environmental Pollution in Dhaka City and Plans for Control, In: Souvenir on The Occasion of the World Environment Day, June 2000, 84-90, Department of Environment, Ministry of Environment and Forest, Government of Bangladesh, **(2000)**.

[3] M.Shamsuzzoha; Seminar Paper on, Water Supply and Sanitation in Dhaka City, Role of Concerned Authorities, Organized by Dhaka Diploma Engineers Association, 1-10 (2003).

[4] D.R.Crapper, S.S.Krishnan, A.J.Dalton; Science, **180(4085)**, 511-513 **(1973)**.

[5] H.M.Christopher, P.S.Michael, G.G.Doyale; Toxicology and Applied Pharmacology, **131**, 119-129 **(1995)**.

[6] R.C.Kaggwa, C.I.Mulaleo, P.Denny, T.O.Okurut; Water Res., **35(3)**, 795-807 **(2001)**.
[7] S.Kawamura; J.Am.Water Works Assoc., **83(10)**, 88-91 **(1991)**.
[8] P.N.Tripathi, M.Chaudhuri, S.D.Bokil; Indian Journal Environ.Health, **18**, 272-281 **(1976)**.
[9] A.A.Al-Samawi, E.M.Shokralla; J.Environ.Sci.Health, Part A, Environ.Sci.Eng.Toxic Hazard.Subst.Control **8**, 1881-1897 **(1996)**.
[10] K.R.Gunaratna, B.Garcia, S.Andersson, G.Dalhammar; Water Science and Technology, Water Supply, **7(5/6)**, 19 **(2007)**.
[11] S.A.A.Jahn; Journal American Water Works Association, **80(6)**, 43-50 **(1988)**.
[12] A.Diaz, N.Rincon, A.Escorihuela, N.Fernandez, E.Chacin, C.F.Forster; Process Biochem., **35(3-4)**, 391-395 **(1999)**.
[13] DWASA Unpublished Results, Dhaka Water and Sewage Treatment Authority **(2010)**.
[14] A.Gulshan; Determination of the Present Status of Buriganga River Water on the Basis of Some Selected Water Quality Parameters, Project Report, Department of Environmental Sciences, Jahangirnagar University, Savar, Dhaka, Bangladesh, 38-55 **(2008)**.
[15] WHO, Guideline for drinking-water quality (electronic resources): incorporating first addendum. Vol. 1, Recommendations, 3rd edition, available in online at: http://www.who.int/ water_sanitation_health/ dwq/ gdwq0506.pdf **(2006)**.
[16] ECR, Environmental Conservation Rules, Department of Environment, Ministry of Environment and Forest. People's Republic of Bangladesh **(1997)**.
[17] M.Yarahmadi, M.Hossieni, B.Bina, M.H.Mahmoudian, A.Naimabadie, A.Shahsavani; World Applied Sciences Journal, **7(8)**, 962-967 **(2009)**.
[18] M.H.Mehdinejad, B.Bina, M.Nikaeen, H.M.Attar; J.Food, Agriculture & Environment, **7(3&4)**, 845-850 **(2009)**.
[19] B.S.Gupta, E.A.Jubilant; Eur.Food Res.Technol., **221**, 746-751 **(2005)**.