

Studies on Nirmali Seed Extract as Coagulant Aid

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SUMMARY

The extract of an indigenous natural source of poly-electrolyte, known as "Nirmali seeds" has been found to be effective in small doses as an aid in the coagulation of turbid waters by metal coagulants. The extract is observed to (i) improve floc size and clarification, (ii) bring about reduction in the dose of metal coagulant required, (iii) remove efficiently the colouring bodies from water, (iv) overcome the interference of phosphate on coagulation of water by alum and (v) broaden the pH range of coagulation by alum, thereby increasing the flexibility of pH control.

In the present paper, the authors propose to describe the experiments carried out by them on these seeds, and discuss the results obtained, particularly the effect of various factors like pH, prechlorination, etc. on the efficiency of the extract as an aid in coagulation. Nirmali seed extract compared favourably with the other imported cationic poly-electrolytes such as Nalco 600 and Magnifloc 990.

1. INTRODUCTION

The use of natural and synthetic poly-electrolytes as coagulants and coagulant aids is perhaps one of the most significant recent developments in water treatment technology. The radically different behaviour of the poly-electrolytes as compared with the metal coagulants used in conventional water treatment plants may have a marked effect on future plant design.

"Poly-electrolyte" is a term that has been used prominently for several

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years to classify high molecular weight, water soluble organics that have many charged sites in water solution². The feature common to both natural and synthetic poly-electrolytes is the presence in the molecule of recurring units containing ionizable groups³. An understanding of the action of poly-electrolytes in flocculation was evolved from a number of investigations of the interaction of various polymeric flocculants with pure clay suspensions^{4,5} and slimes^{7,8}.

One source of a natural poly-electrolyte of local origin is the seed of *strychnos potatorum*, Linn, commonly known as clearing nut or 'nirmali seed.' *Strychnos potatorum* is one of the group of trees which grows profusely in various parts of India and South-East Asia. Subbaramaiah and Sanjiv Rao⁹ found from electrophoretic measurements that the paste of the seed carried a weak negative charge and the seed contained albumin and strychnine. Later work has shown that clearing nuts contained brucine, and not strychnine, and the former has been demonstrated not to aid coagulation. Haskar and Kendurkar¹⁰ have reported the presence of complex polysaccharides in the seed containing galacto-mannan residues, similar to those found in guar gum. Sen and Bulusu¹¹ showed the extract of nirmali seed to be effective as coagulant and coagulant aid in producing well defined floc with rapid settling characteristics at all pH values of naturally occurring turbid water. The pilot plant studies carried out by Bulusu and Sharma¹² conclusively proved the efficacy of nirmali seed extract as an aid to alum.

In this paper the results of the Jar tests conducted in a more comprehensive manner to study the turbidity and colour removal effectiveness of nirmali

seed extract plants under prechlorination using upper reported. Th with other i trolytes like 990.

2. MATERIALS

The tests were conducted in upper lake, different turbidities dispersing time from the bed used in these fresh conditions. Water extracted by taking one in 200 ml. of high speed in minutes. The litre and was decomposition of concentration (gr. l.l). This calculated as per litre of

Jar tests were conducted electrically on turbidimeter 20 mm viewniquettes used v Turbidity Methods.¹³

EXPERIMENTAL

3. NIRMALI SEED EXTRACT AS AN AID TO ALUM

In a series of Jar tests, the effectiveness of the extract as an aid to alum, ferric sulphate was studied. Doses of the extract for coagulation at different turbidities were compared with those of the metal coagulant. The results are given in Table 1.

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seed extract as an aid to metal coagulants under varying conditions of pH, prechlorination, flocculation time etc. using upper Bhopal Lake Water, are reported. The extract was compared with other imported cationic poly-electrolytes like Nalco 600 and Magnilloc 990.

2. MATERIALS AND METHODS

The tests were run on raw water from upper lake, Bhopal. Water samples of different turbidities were prepared by dispersing the clay and silt obtained from the bed of the lake. Nirmali seed used in these studies was obtained in a fresh condition from the local market. Water extract of the seed was prepared by taking one gram of the powdered seed in 200 ml. of water and mixing it at a high speed in a food blender for 10 minutes. The extract was made upto 1 litre and was preserved from bacterial decomposition by the addition of 1 ml. of concentrated hydrochloric acid (Sp. gr. 1.1). The dosage of the extract was calculated as milligram of seed material per litre of sample.

Jar tests were conducted with an electrically operated jar test machine, turbidimeter using glass tubes of 50 and 20 mm viewing depths. Analytical techniques used were those given in Standard Turbidity was measured in Hellige Methods.¹³

EXPERIMENTAL

3. NIRMALI SEED EXTRACT AS AN AID TO METAL COAGULANTS:

In a series of experiments the effectiveness of the extract as an aid to the conventionally used metal coagulants like alum, ferric chloride and ferrous sulphate was studied. Firstly, the optimum doses of the metal coagulants required for coagulating waters of different turbidities were determined. Then, the dose of the metal coagulant was reduced to $\frac{1}{2}$ to $\frac{1}{3}$ of the optimum dose and varying doses of the extract were added as an aid. Jar tests were conducted as shown in Table 1.

Similar tests were carried out using FeCl_3 and FeSO_4 . It was found that nirmali seed extract serves as an effective aid to all the conventional metal coagulants. A dose of 1 to 2 mg/l of the extract reduced the amount of metal coagulant required to $\frac{1}{3}$ to $\frac{1}{2}$ without affecting the efficiency of turbidity removal. It was further found that when nirmali seed extract is used as an aid (a) the floc formed was strong and not easily broken up in turbulent flow, and (b) the floc was coarse and settled quickly. The floc formation was more rapid. Further experiments were conducted using alum as prime coagulant and extract as an aid.

4. EFFECT OF pH ON NIRMALI SEED EXTRACT AS AN AID

The pH of raw turbid water was varied from 3 to 11 by the addition of requisite amounts of mineral acid and alkali.

The extract broadened the pH range of coagulation by alum, thereby increasing the flexibility of pH control. Flocs formed by alum and the extract in the pH range 3-11 were large and settled equally rapidly. The settling rate was found to be not affected by the hydrogen-ion concentration of the raw water in the above range. At pH values less than 7 and greater than 9, there was significant deterioration in the quality of floc formed when alum alone was used as coagulant.

5. EFFECT OF PRE-CHLORINATION:

In many water works when treating raw water of low quality, pre-chlorination of water is resorted to before it enters the flocculation chamber. It was therefore felt necessary to study the influence of pre-chlorination on the effectiveness of the Nirmali seed extract as an aid to alum.

Chlorine doses upto 10 mg/l were found to have no adverse effects on the coagulation by alum and the extract. On the other hand, chlorine had a beneficial effect. This finding is particularly interesting in view of the observation made by Pressman¹⁴ that poly-electrolytes of

the polyamine type were adversely affected by normal Calcium hypochlorite doses of 11 mg/l available chlorine, while the poly-electrolytes of poly-quaternary ammonium type were unaffected.

6. EFFECT OF FLOCCULATION TIME AND SETTLING TIME:

In another series of experiments, flocculation time and settling time were varied from 10 to 60 min. and 2 to 15 min. respectively, keeping the mixing rate constant (60 rpm).

An increase in flocculation time upto 30 min caused a general decrease in resi-

dual turbidity of settled water. Further increase in flocculation time decreased the efficiency of coagulation. The optimum flocculation time is in the range of 20 to 30 min.

As the settling time was increased upto 15 min the final turbidity progressively decreased. However, the removal of a major portion of the turbidity took place in the first 10 min. Further experiments showed that the size and settleability of flocs were affected by the ionic concentration of water. Flocs were ill-formed in a poorly mineralised water.

Table 1.
Effectiveness of Nirmali Seed extract as an aid to alum.

Turbidity (Mg/l)	F.T.* (Min)	S.T.* (Min)	Jar No.	1	2	3	4	5	6			
2200	20	10	Alum	20	30	40	50	60	80			
			RT*	80	40	30	20	10	27			
			Alum	20	20	20	20	20	20			
			Ext.	0	0.5	1	2	3	4			
			RT	80	20	14	12	12	11			
			Alum	15	15	15	15	15	15			
			Ext.	0	0.5	1	2	3	4			
			RT	200	25	22	20	16	9			
			1100	20	10	Alum	10	15	20	25	30	40
						RT	60	45	15	10	8	8
						Alum	15	15	15	15	15	15
						Ext.	0	0.25	0.51	1	2	3
RT	45	35				18	11	10	9			
Alum	10	10				10	10	10	10			
Ext.	0	0.25				0.5	1	2	3			
RT	60	42				24	12	10	9			
500	20	10				Alum	5	10	15	20	25	30
						RT	80	38	20	6	6	8
						Alum	5	5	5	5	5	5
						Ext.	0	0.25	0.5	1	2	3
			RT	80	36	20	10	6	6			
			Alum	10	10	10	10	10	10			
			Ext.	0	0.25	0.5	1	2	3			
			RT	39	28	15	6	6	8			
			250	20	10	Alum	3	3	3	3	3	3
						Ext.	0.75	1	1.5	0.75	1	1.5
						RT	22	11	10	16	10	9
			150	20	10	Alum	3	3	3	5	5	5
Ext.	0.75	1				1.5	0.75	1.0	1.5			
RT	18.0	17.5				15.0	17.0	16.0	12.5			

NOTE: * R.T. = Residual Turbidity, F.T. = Flocculation time, S.T. = Settling time.

7. EFFECT

Polyphosphate affect adversely waters by alum sent in low concentration. 1 mg/l of pyrophosphate was being the coagulation, Nirmali seed extract 1 mg/l not on alum required in overcoming of polyphosphate. It has shown that the quantity of coagulating waters of polyphosphate quantity required in absence of phosphorus.

8. EFFECT

When the coagulation is aided by magnesium chloride, and settleability in presence of high concentration of magnesium sulphate.

Further experiments and the extract showed that the turbidity of waters than in the absence of extract is probably due to the concentration of magnesium sulphate potential.

9. REM

The colour of water increased from 8 to 10 different quantities compared by heating leaves with water. At different turbidities, the colour were treated with different quantities of alum. It was found that colorimetric method is considerable effect by the extract. The extract was effective in removing color. Pressman¹⁴ showed that poly-electrolytes remove color effectively. According to him, color removal is due to adsorption or precipitation.

l water. Further time decreased ion. The opti s in the range of

as increased upto tity progressively removal of a bility took place rther experiments d settleability of the ionic con ers were ill-form sed water.

4	5	6
50	60	80
20	10	27
20	20	20
2	3	1
12	12	11
15	15	15
2	3	4
20	16	9
25	30	40
10	8	8
15	15	15
1	2	3
11	10	9
10	10	10
1	2	3
12	10	9
20	25	30
6	6	8
5	5	5
1	2	3
10	6	6
10	10	10
1	2	3
6	6	8
3	3	3
0.75	1	1.5
16	10	9
5	5	5
0.75	1.0	1.5
17.0	16.0	12.5

ling time.

7. EFFECT OF POLYPHOSPHATES:

Polyphosphates were reported^{17,18} to affect adversely the coagulation of turbid waters by alum even when they are present in low concentrations. For instance, 1 mg/l of pyrophosphate or Hexametaphosphate was observed adversely affecting the coagulation by alum. In comparison, Nirmali seed extract at a level of 1 mg/l not only reduced the dose of alum required to 1/3rd, but also helped in overcoming the objectionable effects of polyphosphates. Further experiments have shown that if alum alone is used, the quantity of alum required for coagulating waters containing 2 mg/l as 1 P of polyphosphates is about thrice the quantity required for coagulation in the absence of phosphates¹⁹.

8. EFFECT OF ELECTROLYTES:

When the coagulation of water was aided by magnesium sulphate and calcium chloride, it was found that the size and settleability of flocs improved in the presence of higher concentration of magnesium sulphate and calcium chloride. Further experiments showed that alum and the extract functioned better in hard waters than in soft waters. This is probably due to the influence of increased ion-concentration on lowering of the zeta potential.

9. REMOVAL OF COLOUR:

The colour of the raw water was increased from 8 to 40 units by adding different quantities of colour extract prepared by heating decaying straw, hay and leaves with water. Waters having different turbidities and varying intensities of colour were treated with required quantities of alum and the extract. It was found that colour can be removed to a considerable extent from turbid waters by the extract in conjunction with alum. The extract was found to be not effective in removing colour caused by tannic acid. Pressman¹⁴ showed that cationic poly-electrolytes removed colour from water effectively. According to him the colour removal is due to chemical interaction or precipitation.

10. COMPARISON WITH OTHER COAGULANT AIDS:

A number of jar tests were conducted to compare the efficacy of Nirmali seed extract as an aid to alum with other imported coagulant aids such as Nalco 600 (a product of Nalco Chemical Company, Chicago,) and Magnilloc 990 (a product of American Cyanamid Company, Wayne, N. J.)

It was observed that the extract compares very favourably with imported coagulant aids such as Nalco 600 and Magnilloc 990 in conjunction with alum.²⁰

11. CONCLUSIONS

The studies presented in this paper have brought out the following salient points:-

- (i) Nirmali seed extract serves as an effective aid to all the conventional metal coagulants. A dose of 1 to 2 mg/l reduces the quantity of metal coagulant required for optimum coagulation considerably.
- (ii) When nirmali seed extract is used as an aid, the floc formed is (a) strong and not easily broken up in turbulent flow and is (b) coarse. Besides, it settles quickly.
- (iii) The extract broadened the pH range of optimum coagulation by alum. The extract was not affected in the range of pH between 3 and 11.
- (iv) Prechlorination upto a residual of 10 mg/l had no adverse effect on the coagulation by alum in conjunction with the extract.
- (v) The optimum flocculation time for coagulation of turbid water was found to be 20-30 min, and settling time needed was 10 to 15 min for optimum clarity of treated water.
- (vi) Nirmali seed extract helped in overcoming the adverse effects of poly-phosphates on coagulation of turbid waters by alum.
- (vii) The presence of electrolytes like magnesium sulphate and

- calcium chloride in raw water favourably influenced the coagulation by alum and the extract.
- (viii) Colour can be removed to a considerable extent from turbid water by the extract in conjunction with alum.
- (xi) The poly-electrolyte present in Nirmali seed compared with the imported poly-electrolytes like Nalco 600 and Magnifloc 990 favourably.

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Basic Concep

1. GENERAL

A "System" ma objects which inter-dependent sis is related to respect to thos that are subject trol in order to The basic concep in Figure 1. The tem are: the inp the output or the transformatic by the complex the several system

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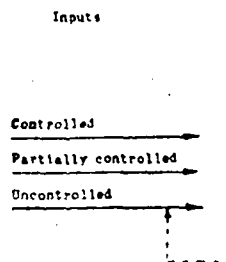


Fig. 1. The Concept (Dracup)

that does not vio "feasible policy". of all possible fea the "policy space"

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