RJC

RASĀYAN *J. Chem.*
Vol. 9 | No. 3 |325 - 330 | July - September | 2016
ISSN: 0974-1496 | e-ISSN: 0976-0083 | CODEN: RJCABP
http://www.rasayanjournal.com
http://www.rasayanjournal.co.in

LOW COST NATURAL ADSORBENT TECHNOLOGY FOR WATER TREATMENT

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ABSTRACT

Four herbs namely Moringa Oleifera, Okra, Calotropis Procera, Cassia Auriculata were chosen for this study in the place of chemical coagulants like Alum, polyelectrolyte, etc. The efficiency of the extracts of Moringa Oleifera, Okra, Calotropis Procera, and Cassia Auriculata made them used as natural coagulants for the clarification of water Turbidity (NTU). In the present study experiments were conducted in the lab to investigate the efficiency of stock solutions obtained from the herbs of Moringa Oleifera (Drum sticks), Okra gum, and the mucilage isolated from the dry flowers of Calotropis Procera and Cassia Auriculata as coagulant for the treatment of turbid water sample containing various turbidity. Jar test experiments were carried out for high, low levels of turbidity with the coagulant for various herbs and the results were compared with the results of chemical coagulant. Further studies are also conducted using natural herbal seeds to remove the turbidity and the effect of the natural herbal product was investigated to utilize the same for the large scale water treatment. The medicinal value of the herbals to be used in the water treatment was studied cost comparison and the pollutant removal efficiency studies was also carried out to bring them into practical application for the benefit of mankind.

Key words: Stock solutions, Coagulant, Natural herbal seed, Turbidity, Water Treatment.

INTRODUCTION

The production of drinking water from most raw water sources involves coagulant usage at a coagulation stage to remove turbidity in the form of suspended and colloidal particles. In the conventional water treatment process the chemicals which are used can be classified into inorganic coagulants and synthetic organic polymers. Aluminium sulphate is widely used coagulant but reveals low efficiency in coagulation of cold water and usually imported one and this adds extra cost to the water treatment industry[1-3]. In recent years, the usage of natural coagulants, which are biodegradable with human health safety and less voluminous sludge amounting to 20 – 30% to that of alum treated counterpart has been used traditionally to clarify turbid raw waters[3]. Using of Alum as well as other metallic salt coagulants produces large volumes of non-biodegradable sludge[4].The lime for pH adjustment is added to the water treatment process which is considered as an additional cost for water treatment companies But it has been indicated to be a causative agent in neurological diseases and also there is a fear that ingestion of aluminum ions may induce Alzheimer's disease. Regarding the application of synthetic polymers, the presence of residual monomers is undesirable because of their neurotoxicity and strong carcinogenic properties[5-8].

Even though new developments in Environmental Engineering are providing promising solutions to many water pollution problems, natural coagulants of plant and soil origin have been practiced traditionally in many developing countries[9-15]. Therefore, this paper focused to develop an efficient and cost effective processing technique using M*oringa Oleifera* seed and other natural coagulants for drinking water treatment. Main Objective of the study is to achieve maximum of 86% turbidity removal efficiency.

EXPERIMENTAL

Material and Methods

Water samples collected from Potheri Lake (low turbidity) and Vallencherry Lake (high turbidity) near Chennai.

Natural coagulants

Seeds of Moringa Oleifera, dried in an oven for 24 hr at 50 ^{0} C and powdered. Okra pods gum was collected and flowers of Cassia Auriculata, Calotropis Procera, from Maraimalai Nagar, Chennai. Flowers were dried naturally and grinded in domestic grind blender, is stored in an air tight container and kept in refrigerator.

Preparation of Distilled water extract

Stock solution is prepared by –

i. Mixing 5gm of grinded powder of size 600µm (approximately).
ii. Stirring for 20 minutes using a magnetic field,
iii. Filtering through a Whatman filter no.40.
iv. Cooled by storing at 20ºC.

Preparation of Okra mucilage

The sticky mucilage obtained from mixing 5g of fresh inner okra gum with 100ml of water is centrifuged at 600 turns per minute during 20 mins.

Preparation of Alum Stock solution

Hydrazine Sulphate solution is prepared by mixing 1g of Hydrazine Sulphate in 100ml of distilled water, whereas Hexamethylene Tetramine solution is prepared by mixing 10g of Hexamethylene Tetramine in 100 ml of distilled water.The above solutions are prepared and mixed with the water sample and they ware analyzed for alkalinity, chloride, hardness, turbidity and coagulant dosage using jar test apparatus as per the guidelines of central pollution control board and the experiments were conducted using Standard methods for the examination of water and waste water, American Public Health Association (APHA, 2005) which is in vogue.[16]

RESULTS AND DISCUSSION

Properties of Moringa oleifera seed powder

The maximum turbidity removal was obtained with 5mg/l as coagulant aid for low turbid water as 55% and for high turbid water as 86%.

Table-1: Properties of Moringa oleifera

Parameters	Potheri Lake	Vallencery Lake
pH	9.54	9.26
Turbidity (NTU)	73	101
Hardness (mg/l)	232	176
Chlorides(mg/l)	265.70	92.86
OH(mg/l)	12	32
HCO_3(mg/l)	96	25
CO_3(mg/l)	25	60

Properties of cassia auriculata powder

The maximum turbidity removal was obtained with 5mg/l as coagulant aid for low turbid water as 52% and for high turbid water as 68%.

Table-2: Properties of cassia auriculata powder

Parameters	Potheri Lake	Vallencery Lake
pH	9.54	9.26
Turbidity (NTU)	73	101

Hardness (mg/l)	245	182
Chlorides(mg/l)	239.9	112.24
OH(mg/l)	15	27
HCO_3(mg/l)	82	26
CO_3(mg/l)	15	80

Properties of calotropis procera powder extract

The maximum turbidity removal was obtained with 5mg/l of Calotropis procera as coagulant aid for low turbid water as 62% and for high turbid water as 73%.

Table-3: Properties of calotropis procera powder extract

Parameters	Potheri Lake	Vallencery Lake
pH	9.54	9.26
Turbidity (NTU)	73	101
Hardness (mg/l)	280	165
Chlorides(mg/l)	325	98.89
OH(mg/l)	5	25
HCO_3(mg/l)	95	25
CO_3(mg/l)	15	55

Properties of okra mucilage extract

The maximum turbidity removal was obtained with 5mg/l of Okra as coagulant aid for low turbid water as 58% and for high turbid water as 83%.

Table-4: Properties of okra mucilage extract

Parameters	Potheri Lake	Vallencery Lake
pH	9.54	9.26
Turbidity (NTU)	73	101
Hardness (mg/l)	265	140
Chlorides(mg/l)	285	76.8
OH(mg/l)	8	24
HCO_3(mg/l)	76	18
CO_3(mg/l)	12	48

Table-5: Parameters furnished after Alum treatment

Parameters	Potheri Lake	Vallencery Lake
pH	9.54	9.26
Turbidity (NTU)	73	101
Hardness (mg/l)	265	192.5
Chlorides(mg/l)	309.90	109.96
OH(mg/l)	10	35
HCO_3(mg/l)	105	30
CO_3(mg/l)	20	70

Batch Coagulation test and comparison of turbidity removal of residual turbidity by alum with Moringa Oleifera, Okra, Cassia Auriculata and Calotropis Procera on varying doses to low and high turbid water. The jar test operations using different coagulants were carried out in different turbidity ranges namely lower and higher turbid water.

Results of jar test for 5 beakers of residual turbidity on turbid water after applying each dosage of coagulant separately are computed in combined format and their comparison is represented in above tables 1 to 5 and the graphs in the following figures 1 to 4 as furnished below.

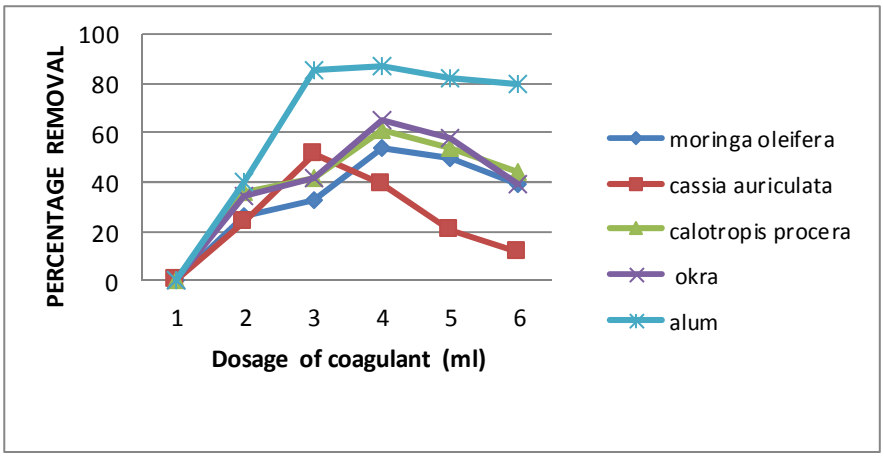

Fig.-1: Comparison of Removal Efficiency of Various Natural and Chemical Coagulants for Low Turbid Water (Potheri Lake)

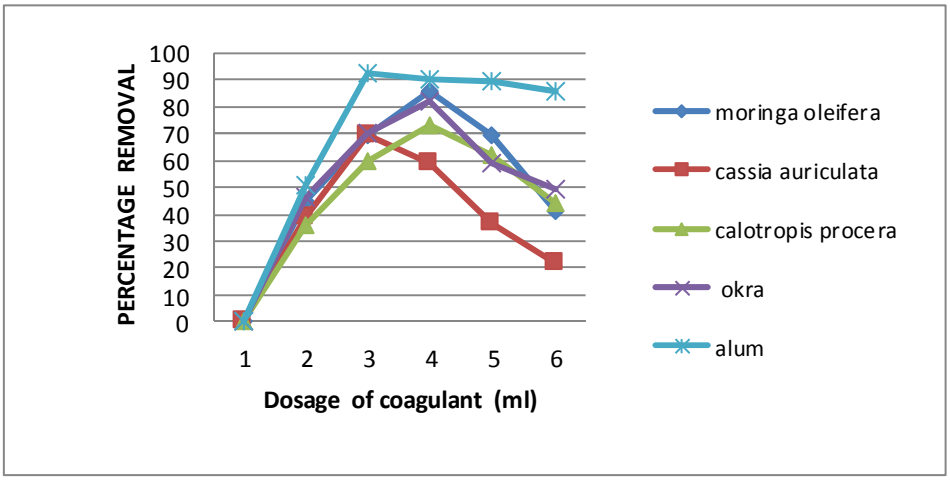

Fig.-2: Comparison of Removal Efficiency of Various Natural and Chemical Coagulants for High Turbid Water (Vallencherry Lake)

Comparative study of turbidity removal by alum and natural coagulants

Here the comparative of the natural coagulants was done with the present conventional used coagulant Alum. In this the comparative study was done for low and high turbid samples. The above figures shows the comparison of removal efficiency with different dosage for all the four coagulants. It was clear that the removal achieved by Moringa Oleifera and Alum was almost same and the removal was also high for both water samples. But the dosage required was different. The dosage required by the Moringa Oleifera was 100mg/l and for the same removal the dosage consumed in the case of alum was high and of 240mg/l. The other coagulant extracts were showing poor efficiency when compared to Moringa Oleifera. The pH variation in the case of natural coagulants was in the limit and almost same. But in the case of Alum, the pH is getting decreased with increased dosage, this was due to the contribution of H^+ ions by the Alum to the sample. To avoid this we have to provide additional alkalinity to the sample. The coagulation activity represents the actual work done by the coagulant as some particle matter will get settled by applying the controlled condition itself. Here the coagulation activity was almost same as that of removal efficiency, the coagulation activity for Alum and Moringa Oleifera was high, when compared to other coagulants.

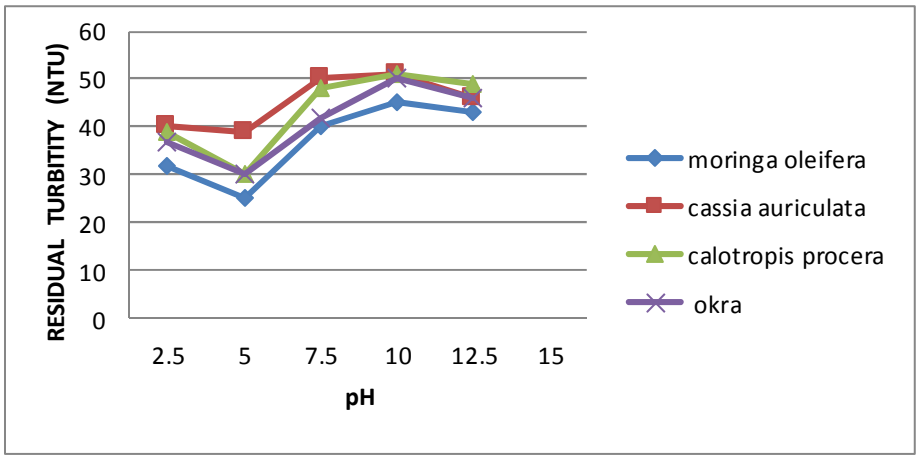

Fig.-3: Comparison of Residual Turbidity (NTU) by Varying pH Low turbid Water (Poyheri Lake)

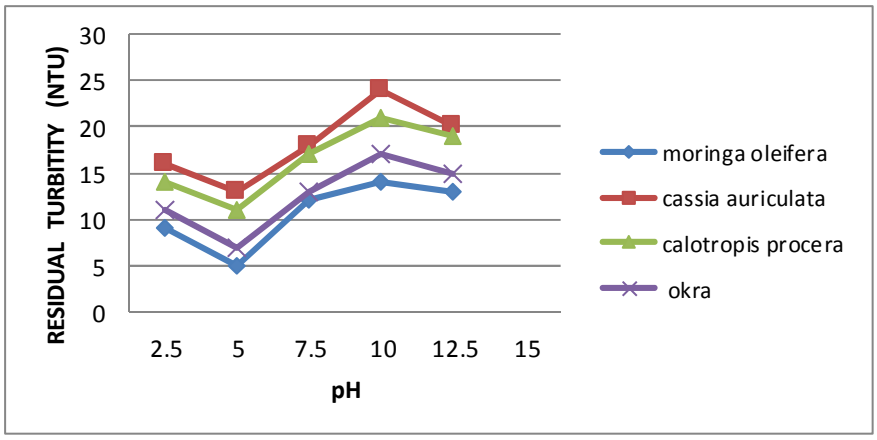

Fig.-4: Comparison of Residual Turbidity (NTU) by varying pH High Turbid Water (Vallencherry Lake)

CONCLUSION

From the Batch coagulation test, the optimum doses of Moringa Oleifera, Okra, Cassia Auriculata and C. procera were 3, 3, 2 and 3mg/l with the maximum turbidity removal efficiencies of 55%, 58%, 52% and 62% for low turbid waters and 86%, 83%, 68% and 73% for high turbid water along with an optimum pH of 5, 5.4, 6 and 5.5 respectively. Natural coagulants have bright future, because of their abundant source, low price, environment friendly, multifunctionality and their biodegradable nature in water purification.

ACKNOWLEDGEMENTS

The author thanks, Head of the Department Civil Engineering and the Management of SRM University for continuous support and encouragement in successful completion of the study.

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[RJC-1427/2016]