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APPLICATION OF NATURAL COAGULANTS IN WATER PURIFICATION

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Abstract— In the present study experiments were conducted inthe 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 C.Procera as flocculent for the treatment of turbid water samples containing synthetic turbidity caused by clay materials. Jar test experiments were carried out for high(250NTU and 500NTU), low levels (15NTU,30NTU and 50 NTU) and medium level(100NTU) of turbidity with the flocculent dosages of 0mg/l 2.5mg/l ,5.0mg/l ,7.5mg/l ,10.0mg/l ,12.5mg/l ,15.0mg/l for Moringa Oleifera , Okra and C.Procera. The results have been compared with the results of alum. The supernatant turbidities obtained from this phase of the study were > 5 NTU. In the next phase again jar tests results were obtained from adding nearly 50% optimum dose of the natural coagulant was kept as constant and dosage of alum was varied. The supernatant turbidities obtained from this study were nearly equal to 5 NTU. (Guide line value recommended by WHO).

Keywords- *Turbidity, Moringa Oliefera, Okra, C.procera coagulant, flocculation,WHO.*

I. INTRODUCTION

Drinking water is a vital resource for all human beings and the access to safe and clean drinking water is a major concern throughout the world. Producing potable water from surface water or ground water usually involves one or several treatment steps for removing unwanted substances. Need of water treatment process Treatment of water is so important that we can avoid many possible water borne diseases like cholera, typhoid jaundice and so on. It's true that water borne infections are responsible for more than 80% of the diseases in all over the world. Whenever there is contamination of drinking water sources and water logging after rain there is in an outbreak o infection.
Water quality is of concern to everyone. Quality is the acceptability of the water for uses like drinking, cooking bathing, and laundering. Most municipally treated water is safe and generally of good quality. You may have concerns regarding taste, odors, clarity even hardness. Water from private or community wells can be contaminated. Contaminated water may have off-tastes, odors, or visible particles. However, some dangerous contaminants in wate are not easy to detect. Accurate water testing is needed to determine safety and quality. Water testing may be done by private testing labs, county and state health laboratories, departments of health, and some local environmental consulting companies.
1.2. Various problems due to impure water in developing countries

1. Large seasonal variation in raw water quality e.g. turbidity.
2. Water treatment chemicals are imported with scarce foreign currency.
3. High cost of water treatment chemicals which constitute in between 35% to 70% of recurrent expenditure.
4. Inadequate supply of chemicals for water treatment.
5. Inadequate laboratory facilities to monitor process performances required to operate the plants, Inadequate funding, Low revenue base.
6. Water supply considered as a social commodity rather than an economic resource inadequate skilled manpower, Poor operational and maintenance schedules, Adoption of inappropriate technology.
7. Inadequate supply to meet growing demand Under dosing of chemicals leading supply of poor quality water.

1.2.1. Problems are due to use of chemicals in water treatment

1. Aluminum has also been indicated to be a causative agent in neurological diseases such Foreign exchange problem as pre-senile dementia.
2. There is a fear that ingestion of aluminum ions may induce Alzheimer's disease.
3. Sludge produced is voluminous and non-biodegradable after treatment and therefore poses disposal problems leading to increase cost of treatment.
4. The costs of these chemicals have been increasing at an alarming rate in developing countries.
5. Most of the water treatment companies cannot

II. MATERIALS AND METHODS

2.1 Materials- s

Few materials were used in this study such as water, natural coagulants (M.Oleifera, Okra and C.Procera), alum and clay materials. The detail descriptions of those coagulants are as given below. There are three natural coagulants used in this present study. They are namely seeds of Moringa Olifera, Okra gum and dry flowers of Calotropis procera. The descriptions of these coagulants are given below :

2.1.1. M.Oleifera-

Plant species - Genus Moringa Family- Moringaceae. Common Name- Drum stick (Golden shower) Moringa oleifera, known as Moringa, is native to north India but is now found throughout the tropics. It grows fast and reaches up to 12m. The bark is grey and thick and looks like cork, peeling in patches. Moringa is full of nutrients and vitamins and is good in your food as well as in the food of your animals. Moringa helps to clean dirty water and is a useful source of medecines.

2.1.2.Okra:

Plant species – A.esculentus Family- Mavacae Common Name- lady's finger or Gumbo Okra Abelmoschus esculentus L. (Moench), is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. This crop is suitable for cultivation as a garden crop as well as on large commercial farms. Okra gum is soluble in cold water. It is used in the food industry as a good emulsifying and foam stabilizing agent. In the range of studied, it is observed that whatever the volume of gumbo mucilage, the turbidity decreases when the pH increases. The reduction in turbidity is significant when the volume of mucilage used, confirming the preceding results. The mucilage, from its sticky nature, contains polymer molecules (Nacoulima et al, 2000). The flocculating activity can be either due to a chemical reaction, or a complex formation.

2.1.3. Calotropis Procera- Plant species – C.Procera Family- Aclepiadaceae Common Name- calotrope Calotropis procera are abundantly available in he tropics, mostly planted as ornamental shrubs. Calotropis procera have been reported Ogundiwin nd Oke, (1983) and Aworh et al. (1994) to contain calotropin, a very active non- toxic proteolytic enzyme used in curdling milk protein in traditional cheese - making in Nigeria. Also, Kareem et al. (2002), reported the use of C. procera latex for enzyme purification, a simple method based on recipitation for the cope with the high costs due to declining revenues and funding.

6. The inability of local supplies to satisfy the demand due to competing uses for imported chemicals. The use of alum as a coagulant in the treatment of water increases the aluminium concentration. A high concentrationof aluminium is also of concern because of its adverse effects on health. Aluminium intake into the body has been linked with several neuropathological diseases including percentile dementia and Alzheimer's disease.There is also the problem of reaction of alum with natural alkalinity present in water leading to reduction of pH and a low efficiency in coagulation of cold waters.Under-dosing of chemicals so as to meet the increasing water demand leading to production of poor quality drinking water. Using alum as well as other metallic salt coagulants produces large sludge volumes which are also non- biodegradable. Ferric salts and synthetic polymers have also been used as coagulants but with limited success because of the same disadvantages manifested in the use of aluminum salts.

1.3. Use of natural herbs in purification of water Developing countries are facing potable water supply problems because of inadequate financial resources. The cost of water treatment is increasing, and the quality of river water is not stable due to a suspended and colloidal particle load caused by land development and high storm runoff during the rainy season such is experienced in a country like Malaysia and other countries. Due to many problems created by using the synthetic coagulants such as aluminium sulphate which is used worldwide, there is a high demand to find an alternative coagulant which is preferable to be a natural coagulant. Naturally occurring coagulants are usually presumed safe for human health. Many researchers have reported on Moringa oleifera various uses and as a coagulant specifically for the last 25 years have found that the Moringa oleifera seed is non-toxic and good coagulant in water treatment. It is recommended to be used as a coagulant in developing countries. Usually, the aluminum sulphate is the most used coagulant in water treatment for coagulation- flocculation process. Aluminium sulphate is usually imported and this adds extra cost to the water treatment industry. The lime for pH adjustment is added to the water treatment process, which is considered as an additional cost for water treatment companies. Therefore, this paper is focused on presenting the developed, efficient and cost effective processing technique for Moringa oleifera seed and other natural coagulants to be used for drinking water treatment. purification of amylase from solid culture of Aspergillus oryzae using C. procera latex, which have received little attention but have confirmed C. procera latex as a good clarifying agent and unveils its potential as plant material for enzyme concentration.

2.2. PREPARATION OF HERBS:

2.2.1. M.Oleifera-

Good quality of M.Oleifera were allowed to completely dry on the tree and then its collected from Adgaon region ,Nasik . The seeds to be removed from the pods, keep for sun dry and external shells will remove. Seeds powder is used as a coagulant dose. Dried and shelled MO seeds were obtained from field. The shells were ground to a fine powder using a blender. The powder was then weighed and dissolved in distilled water to make a 50 g/l solution. The solution was stirred for 20 minutes using a magnetic stirrer, and finally filtrated through a Whatman filter no. 40. The filtered solution is called a "crude extract" or "stock olution" and could be used for treating water without further preparation. 2.2.2. Okra (lady's finger) - Good quality of Okra pods purchased from Nasik market and the okra gum was obtained by aqueous extraction of the seedpod of okra plant. For mucilage obtaining, approximately 5g of fresh inner okra gum were mixed in 100 mL water. The sticky liquid (mucilage) obtained was centrifuged at 600 turns per minute during 20 min. in order to eliminate the suspended particles. 2.2.3. Calotropis procera- Good quality of C.Procera flowers are collected from Chandwad. The flowers are sun dried naturally and grinded it in to blender and stock solution is prepared by adding 5gm of powder mixed in 100 ml distilled water. The solution was stirred for 20 minutes using a magnetic stirrer, and finally filtrated through a Whatman filter no. 40. The filtered solution is called a "crude extract" or "stock solution". Stock solution bottles were stored at 200 c for cooling and used it as per required.

2.3. Preparation of synthetic turbid water- Synthetic turbid water for the jar tests was prepared by adding clay materials to tap water. Clay materials collected from Chandwad area. About 30 g of the clay materials was added to 1 liter of distilled 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 supernatant suspension of synthetic turbid water was added to the sample water to achieve the desired turbidity just before coagulation. The alum used in this study was reagent grade aluminium sulphate $Al2(SO4) 3. 16 H2O$. It was supplied by Space Laboratories Ltd, Ambad, and Nasik.

2.5. Methods

The various methods used for the experimentation for different phases of the study are described below:

2.5.1. Batch coagulation test Flocculation/coagulation experiments were conducted using a range of coagulant dosing from the stock solutions and a control without coagulant addition. For repeatability, each experimental set-up was repeated 3 times. Laboratories jar test apparatus i.e. Jar Flocculator with timer and RPM indicator is to be used with 1000 ml beakers as the flocculation/coagulation reactor volume. The jars are injected with coagulant dosages and mixed to match flash mix & flocculation field conditions as closely as possible, after mixing and settling the jars are observed to determine which dosage produce the largest, strongest flock or which dosage produces the flock that settles the fastest. Depending on the particular experimental set-up, dosing is to be set for the Moringa, C.Procera, okra mucilage stock solution and alum stock solution. Turbidity test is to be carried out on synthetic turbid water of low (15, 30 and 50 NTU), medium (100) and high (250 and 500 NTU) turbidity. For different doses of coagulants, seven beakers were in used (6 at the applied dose and 1 control). Jar Tests were carried out for 500ml synthetic turbid water, turbidity to be measured for the initial condition (raw water sample) prior to the coagulation. Immediately following coagulant dosing, the beaker contents of 500 ml were mixed rapidly for 60 sec at 352 RPM; this was followed by 20 min of gentle mixing at 40 RPM to aid in flock formation. The flocculated suspensions were allowed to stand without disturbance for 30 min to simulate settling. The supernatants thus formed were sampled and measured for turbidity. Jar tests were carried out on prepared synthetic turbid water with the flocculent stock solution doses of 0mg/lit, 2.5mg/lit ,5.0 mg/lit, 7.5 mg/lit, 10 mg/lit, 12.5mg/lit and 15 mg/lit for M.oleifera, okra and c.procera Turbidities were recorded after 30 minutes of the Jar test. The optimal dosage for each coagulant was obtained.

III. RESULTS AND DISCUSSIONS

Experimental work of this study has been divided in following phases-

A. .Batch coagulation tests by Alum, M.Oleifera, Okra and C.Procera on various turbid water..

B. Optimization of natural coagulants as coagulant aid in conjunction with alum on synthetic turbid water.

1) A discussion of the results follows each phase of the experimental work and results are presented in tabular and graphical form.

Table 3.2: Performance of Alum, M.Oleifera, Okra and C.Procera in Batch Coagulation-Test performance of Alum, M.Oleifera ,Okra and C.Procera in batch coagulation test at optimum dose (based on supernatant turbidity) are analyzed in table 3.2

3.2 Optimization of natural coagulants as coagulant aid in conjunction with alum. In the present study was aimed to investigate the effects of natural coagulants like M.O.,Okra and C.Procera as a coagulant aid in conjunction with alum on the removal of turbidity. To reduce the disadvantages associated with the usage of chemical-based coagulants such as ineffectiveness in low temperature, relatively high procurement costs, detrimental effect on human health, production of large sludge volume due to aluminium based coagulants it is more advisable to mix the chemical coagulant with alum. In this research the conventional coagulant alum has been mixed with nearly 50% of optimal dosages of each coagulant. Table 3.3 to Table 3.5 shows the observations of above study

3.2.1 Alum with Moringa Oleifera as a coagulant aid
In this experiment nearly 50% of the optimal dosage of Moringa Oleifera was applied with various dosages of alum. In this study among various ranges of turbid waters 50 NTU for was selected as lower range, 100NTU as medium and 500NTU as higher range of synthetic turbid water .The residual turbidities after the jar test have been tabulated as below. From the table 3.3 we can clearly see that turbidity removal has been obtained by 7.5 mg/lit of alum with 5 mg/lit of M.O. dosages and fig. 3.1 shows the effect of coagulant dosage on turbidity removal on lower turbid water of 50 NTU.
This Fig 3.1 shows the effect of coagulant dosage on turbidity removal and so we can conclude that the maximum turbidity removal was obtained when 7.5 mg/l of alum dosage with 5mg/l of M.Oleifera as a coagulant aid for lower turbid water (50NTU), as well as medium (100NTU) and high turbid water (250NTU).

From Fig. 3.2 we can conclude that the maximum turbidity removal efficiency of 88%, 95% and 98% were obtained for 7.5mg/l of alum dosage with 5mg/l of M.O. as a coagulant aid for low, medium and high synthetic turbid water samples respectively. In the next experiment 50% of optimum dosage obtained in batch coagulation test that is of 5mg/lit of okra was mixed with various dosages of alum. Jar tests were conducted and residual turbidities were noted after 30 minutes. Fig. 3.3 illustrates the effect of dosages on turbidity removal. From this table we can conclude that the maximum turbidity removal for 10 mg/l of alum dosage with 5mg/l of okra gum as a coagulant aid. From Fig. 3.4 we can conclude that the maximum turbidity removal efficiency of 96%, 97% and 98% were obtained for 10 mg/l of alum dosage with 5mg/l of Okra as a coagulant aid for low, medium and high synthetic turbid water samples respectively.
Table 3.5 shows the observations taken when C.Procera was used as a coagulant aid during experimentation. In this experiment 50% of optimum dosage obtained in batch coagulation test that is of 7.5mg/lit of C.Procera was mixed with various dosages of alum. Jar tests were conducted and residual turbidities were noted after 30 minutes. It also illustrates the effect of dosages on turbidity removal. From this table we can conclude that the maximum turbidity removal for 10 mg/l of alum dosage with 5mg/l of okra gum as a coagulant aid. From table 3.4 and Fig. 3.6 we can conclude that the maximum turbidity removal efficiency of 98%, 97% and 97.2% were obtained for 10 mg/l of alum dosage with 5mg/l of C.Procera as a coagulant aid for low, medium and high synthetic turbid water samples respectively. The results obtained from this study revealed that coagulant aid should be added one minute after the addition of alum. The use of Moringa, okra and C.Procera as coagulant aids decreased the alum dose 7.5mg/l to 10 mg/l and dropped the residual turbidity which is nearer to the value recommended by WHO.
Table 3.3, 3.4 and 3.5 shows the performance of Moringa, okra and C.Procera as coagulant aids in conjunction with alum for turbid water treatment. So the use of coagulant aid reduces the dosage of alum, the residual turbidity obtained from this phase of study was nearer and lesser to 5 NTU (recommended value by WHO).

CONCLUSION

- From the first phase (Batch Coagulation Test) of the study , it was found that the optimum dosages of Alum, Moringa Oliefera, Okra and C.procera were 10 mg/l , 7.5 mg/l , 10 mg/l and 15 mg/l with the maximum turbidity removal efficiencies of 96% , 76% , 54 % and 64 % for low turbid waters and 92% , 87% , 68% and 73% for medium turbid waters and 98% , 92% , 74% and 86.8% for high turbid water respectively. The supernatant turbidities obtained at the end of this phase for medium turbid water were 8NTU, 13 NTU, 32 NTU and 27 NTU when Alum, S.Potatorum, Cactus and C.Indica were applied as a coagulant respectively. These values are greater than 5 NTU (value recommended by WHO). From the second phase of the study, it was found that when nearly and equal to 50% optimum dose of each coagulants (5 mg/l in the case of Moringa Oliefera, 5 mg/l in the case of Okra and 7.5 mg/l in the case of C.Procera) were applied with varying dosages of alum (2.5 mg/l , 5 mg/l , 7.5 mg/l , 10 mg/l , 12.5 mg/l , 15 mg/l 17.5 mg/l and 20mg/l) it was found that alum of 5 mg/l gave the maximum turbidity removal efficiencies. The supernatant turbidities obtained at the end of this test were 5 NTU, 2 NTU and 3 NTU for Moringa Oliefera, Okra and C.Procera respectively which are equal to and less than 5NTU. From the observations taken it was also concluded that when natural coagulants were used as a coagulant aid, the dosage of alum can be reduced to almost 50% which can help to reduce the detrimental effects caused by chemical based coagulants. Natural coagulant is sustainable and economical way of water treatment process.

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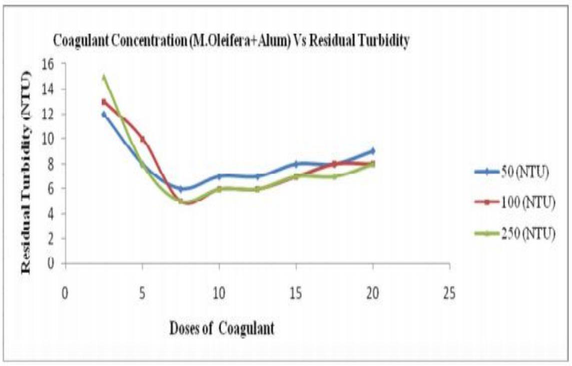

Fig 3.1 Graph of Coagulant Doses Vs Residual turbidity

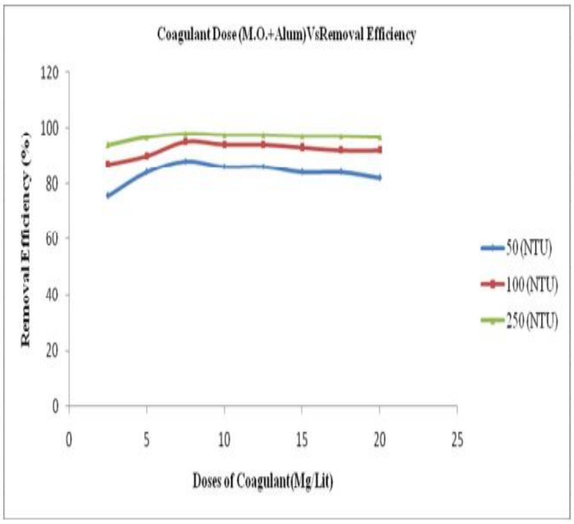

Fig 3.2 Dosage Vs Removal Efficiency

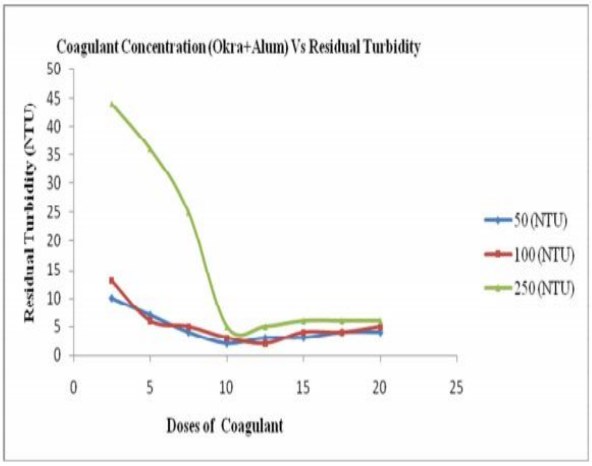

Fig 3.3 Graph of Coagulant Doses Vs Residual turbidity

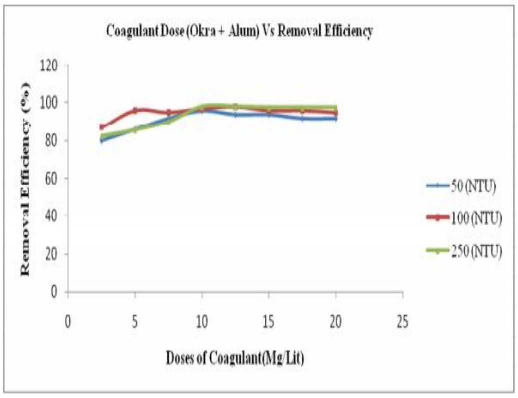

Fig 3.4 Doses of coagulant Vs Removal Efficiency

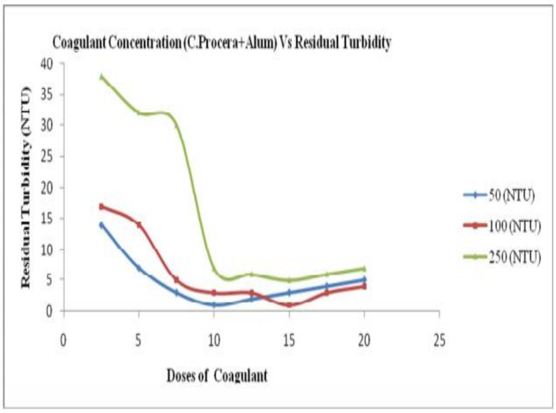

Fig.3.5. Graph of Coagulant Doses Vs Residual turbidity

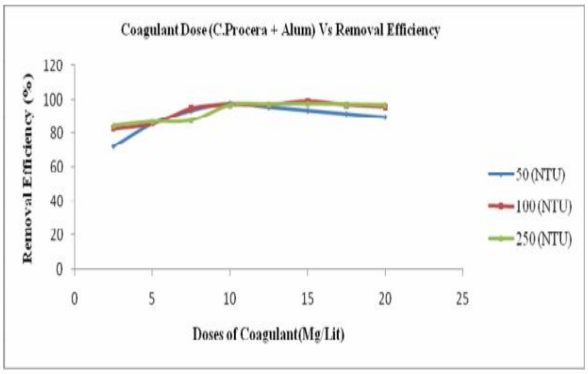

Fig.3.6 Doses of coagulant Vs Removal Efficiency

Table 3.2: Performance of Alum, M.Oleifera, Okra and C.Procera in Batch Coagulation-Test

Raw Water Turbidity	Parameter	Alum	*M. Oleifera*	*Okra*	*C.Procera*
Low Turbidity (50 NTU)	Optimum Dose(mg/l)	10	7.5	10	15
	Min. Residual Turbidity (NTU)	2	12	23	18
	Maximum Turbidity Removal Efficiency (%)	96	76	54	64
Medium Turbidity (100 NTU)	Optimum Dose (mg/l)	10	7.5	10	15
	Min. Residual Turbidity (NTU)	8	13	32	27
	Maximum Turbidity Removal Efficiency (%)	92	87	68	73
High Turbidity (250 NTU)	Optimum Dose (mg/l)	10	7.5	10	15
	Min. Residual Turbidity (NTU)	5	20	65	33
	Maximum Turbidity Removal Efficiency (%)	98	92	74	86.8

Table3.3: Performance of M.O., Okra and C.Procera as coagulant aids in conjunction with alum (low Turbidity- 50NTU)

Name of the coagulant	Dosage of alum mg/l	Dosage of coagulant	Residual Turbidity (NTU)	Turbidity Removal Efficiency (%)
M.O.	7.5	5	6	88
Okra	10	5	2	96
C.Procera	10	7.5	1	98

Table 3.4: Performance of M.O., Okra and C.Procera as coagulant aids in conjunction with alum (Medium Turbidity- 100NTU)

Name of the coagulant	Dosage of alum mg/l	Dosage of coagulant	Residual Turbidity (NTU)	Turbidity Removal Efficiency (%)
M.O	7.5	5	5	95
Okra	12.5	5	2	97
C.Procera	10	7.5	3	97

Table 3.5: Performance of M.O., Okra and C.Procera as coagulant aids in conjunction with alum (Higher Turbidity-250NTU)

Name of the coagulant	Dosage of alum mg/l	Dosage of coagulant	Residual Turbidity (NTU)	Turbidity Removal Efficiency (%)
M.O	7.5	5	5	98
Okra	10	5	5	98
C.Procera	12.5	7.5	6	97.2

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