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RESEARCH ARTICLE

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# WORKING MODEL OF WATER TREATMENT PLANT USING *MORINGA OLIEFERA*

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**ABSTRACT**

The removal of organic and inorganic material from raw water is essential before it can be disinfected for human consumption. In a water treatment works, this clarification stage is normally achieved by the application of chemical coagulants which change the water from a liquid to a semi-solid state. This is usually followed by flocculation, the process of gentle and continuous stirring of coagulated water, which encourages the formation of 'flocs' through the aggregation of the minute particles present in the water. Flocs can be easily removed by settling or filtration. For many communities in developing countries, however, the use of coagulation, flocculation and sedimentation is inappropriate because of the high cost and low availability of chemical coagulants, such as aluminum sulphate and ferric salts.

This Technical Brief gives an overview of the application of an indigenous, naturally derived Coagulant, namely seed material from the multi-purpose tree Moringa oleifera Lam. (M.oleifera) which offers an alternative solution to the use of expensive chemical coagulants.

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## 1. INTRODUCTION

The world is becoming a global village, population explosion is the main threat to most of the countries all around the world which in turn resulting to lot of problems which among the water scarcity at the help. The water supply systems in many cities of the world are under severe stress, while backing up these problems the tall structures like the apartments, sky scrapers, shopping malls and multi-storied buildings are raising at each and every corner of the city.

Contamination of soil, water, and air by heavy metals, poses a detrimental threat to our environment, humans, animals, plants, and marine life. Lead uptake, transport, and accumulation by plants and animals as well as the potential for its propagation into the food chain exacerbate its toxic health effects. Presently there are no appropriate low-cost technologies available for removal of several commonly present groundwater contaminants. Fluoride is one such compound that is widely present in groundwater worldwide. Exposure to fluoride in drinking water has a number of adverse effects on human health including crippling skeletal fluorosis that is a significant cause of morbidity in a number of regions of the world. Chemical coagulants like Aluminium Sulphate (alum), $FeCl_2$ are used in Municipal drinking water treatment plant for purification process.

This excess use of amount of chemical coagulants can affect human health e.g. Aluminium has also been indicated to be a causative agent in neurological diseases such as pre-senile dementia. Ground water is polluted due to industrial effluents and municipal waste in water bodies. In rural and undeveloped countries people living in extreme poverty are presently drinking highly turbid and microbiologically contaminated water. Because they lack knowledge of proper drinking water treatment and they cannot afford costly chemical coagulants.

To overcome chemical coagulant problems it is necessary to increase the use of natural coagulants for drinking water treatment. Naturally occurring coagulants are usually presumed safe for human health. Some studies on natural coagulants have been carried out and various natural coagulants were produced or extracted from microorganisms, animals or plants. One of these alternatives is Moringa oleifera seeds. Earlier studies have found Moringa to be non-toxic, and recommended it for use as a coagulant in developing countries. The use of Moringa has an added advantage over the chemical treatment of water because it is biological and has been reported as edible. According to Muyibi and Evison, 1994, hardness removal efficiency of Moringa Oleifera was found to increase with increasing dosage.

In rural and undeveloped countries people living in extreme poverty are presently drinking highly turbid and microbiologically contaminated water as they lack of knowledge of proper drinking water treatment and also not afford to use high cost of chemical coagulants. Some drinking water treatment plant in developing countries face a myriad of problems which are: large seasonal variation in raw water quality e.g. turbidity, high cost of water treatment chemicals, under dosing of chemicals leading supply of poor drinking water. To overcome chemical coagulant problems it is necessary to increase the use of natural coagulants for drinking water treatment.

The need for simple, reliable and effective method of water treatment led to the application of plant materials, naturally occurring coagulants are usually presumed safe for human health. Some studies on natural coagulants have been carried out and various natural coagulants were produced or extracted from microorganisms, animals or plants.

Fig 1: Source of turbid water

One of these alternatives is Moringa oleifera seeds. It is a native tree of the sub-Himalayan parts of North West India, Pakistan and Afghanistan. Moringa oleifera is a perfect example of a so-called “multipurpose tree”. Earlier studies have found Moringa to be non-toxic, and recommended it to use as a coagulant in developing countries. The use of Moringa has an added advantage over the chemical treatment of water because it is biological and has been reported as edible. Among all the plant materials that have been tested over the years, powder processed from the seeds from Moringa oleifera has been shown to be one of the most effective as a primary coagulant for water treatment. Moringa Oleifera is a multipurpose tree that grows widely throughout the tropics. In addition to use as coagulant, Moringa Oleifera can also be used for removal of hardness of water.

**2. Objectives**

- To identify a sustainable, low cost, locally available, simple, reliable, acceptable, eco-friendly, household level point of use water treatment technology most suitable for rural population of developing countries.
- Evaluate the optimum dosage of MO for different levels of turbidity, and its removal efficiency at each level.
- Compare the treatment efficiency of MO to that of aluminium sulphate, regarding both treatment efficiency and influence and influence on water quality and characteristics.
- Find a suitable method of preparation for the MO coagulant, and establish a procedure manual for the preparation, use and dosage of MO in order to use it for drinking water treatment.

- Investigate the possibilities of using MO on an industrial scale, regarding availability and reliability of production and distribution.

## 3. MATERIALS AND METHODOLOGY

### Coagulant Materials

*Moringa oleifera* (good quality dried drumstick were selected and) wings and coat from seeds were removed. Fine powder was prepared by using mortar and pestle and this powder was directly used as coagulant. Water samples were collected for the study purpose. Treatment to water was given by directly using seed powder. The water quality parameters were checked before and after treatment. Doses of seed powder i.e. 50, 100 and 150 mg/l were selected for treatment by supporting table of Micheal Lea Clearing house, Low cost water treatment technologies for developing countries.

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Fig 2: *Moringa Oleifera* & Dried Moringa Oleifera

Fig 3: *Moringa oleifera* seeds with seed coating, without coating & seed powder

**Preparation of M*oringa oliefera* coagulant**


Fig4 : Flow chart of preparation of *Moringa oliefera* coagulant

**Coagulant dosage requirement**

| Raw water turbidity (NTU) | Dose range mg/l |
|---|---|
| < 50 | 10 – 50 |
| 50 – 150 | 30 – 100 |
| >150 | 50 – 200 |

**Preparation of synthetic turbid water**

In this study, synthetic turbid water was prepared by adding kaolin, in distilled water for all coagulation experiments. The kaolin suspension was prepared by dissolving 10 g of kaolin powder in 1L of distilled water. The suspension was stirred slowly at 20 rpm for 1 h to achieve uniform dispersion of the kaolin particles. The suspension was then permitted to stand for 24 h to allow for complete hydration of the kaolin. This suspension was used as astock solution for the preparation of water samples of varying turbidity for the coagulations tests. The initial pH was adjusted with 0.1M NaOH (or) 0.1M HCl to obtain desired values of turbidity and pH of the synthetic turbid water.

**Fig 5: Synthetic turbid water sample**

**Process of water treatment using natural coagulant**

The removal of organic and inorganic material from raw water is essential before it can be disinfected for human consumption. In a water treatment works, this clarification stage is normally achieved by the application of chemical coagulants which change the water from a liquid to a semi-solid state. This is usually followed by flocculation, the process of gentle and continuous stirring of coagulated water, which encourages the formation of 'flocs' through the aggregation of the minute particles present in the water. Flocs can be easily removed by settling or filtration. For many communities in developing countries, however, the use of coagulation, flocculation and sedimentation is inappropriate because of the high cost and low availability of chemical coagulants, such as aluminium sulphate and ferric salts.

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Coagulant, namely seed material from the multi-purpose tree Moringa oleifera Lam. (M.oleifera) which offers an alternative solution to the use of expensive chemical coagulants.

**Advantages of *Moringa oliefera* coagulant over Alum**

- It is natural, completely non toxic.
- The moringa oliefera seeds extract appears to have natural buffering capacity so no pH alkalinity adjustments are required.
- Beside level of turbidity it reduces the level of microorganisms in water.
- It is completely bio-degradable.
- The volume of sludge produced is considerably less in case of moringa oliefera than in case of alum.

**Methodology**

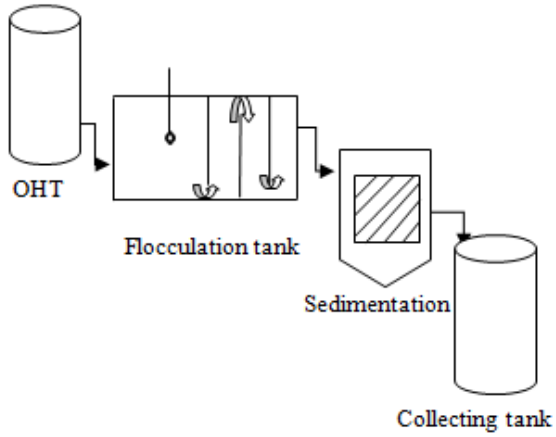


**Fig 6: Flow Chart of Water Treatment Plant**

**Fig 7: Treatment plant unit**

- Over Head Tank
- Floculation tank
- Sedimintation tank with
- laminar plates
- Collecting tank

**Design of Treatment Plant**

- **Design of storage tank**

Capacity of storage tank = 75 ltr

Depth = 1m

Diameter=d = 0.4m

Area = $\pi/4*0.4^2=0.125m^2$

$V=D*A=1*0.125= 0.125m^3$

Thus, D = 1.0m, d = 0.40m.

- **Design of sedimentation tank General provision**

*over flow rate=$15.30m^3/d/m^2$

*Detention period for coagulant water =2hr

*Minimised water depth= 0.5m
*Side slope for non-mechanical cleaning
=10% from sides towards the longitudinal central line
Longitudinal slope=1% (in case of rectangular tank)
Ratio of length and width= 3:1
Setting velocity= To ensure removal of size of particle of 0.02mm
Detention time to flocculation chamber= 10-30min

- **Hydraulic design of proposed sedimentation cum flocculation Tank**

Dimension of tank= 0.075 $m^3$/hr
Net loss in desludging=2%
Design avg. flow=0.075*100/100-2 =0.066$m^3$/hr
Assume the total detention period of 2hr.
Effective storage of sedimentation tank = 0.066*2=0.132$m^3$
Assume effective depth H =0.6m
Area of the tank required A = 0.132/0.6= 0.22$m^2$
Assume L/B =3:1
Thus 3B=B=0.22$m^2$
B=0.27m say 0.3m
L=0.81m say 0.9m
Provide tank size 0.9*0.3*0.6
[Provide free board of 0,1m]
Loading on the tank/ over flow rate= Q/Area
=0.066*24/0.9*0.3=4.8$m^3$/$m^2$/day
(This is within the described range of 15-30 m3/m2/day)

- **Design of Floc chamber**

In addition to 0.9m length of setting tank, assume the depth of the floc chamber is half of the depth of the sedimentation tank i.e. =0.7/2 =0.35m
Detention period 2 hours.

## 3. RESULTS AND DISCUSSIONS

I. pH test
II. Jar test
III. Turbidity

### 1) pH TEST:

| SL NO | SAMPLE | pH value |
|---|---|---|
| 1 | Alum<br>a) Initial turbid water<br>b) Final turbid water | a) 8.64<br>b) 7.80 |
| 2 | *Moringa oliefera* coagulant<br>a) Initial turbid water<br>b) Final turbid water | a) 8.64<br>b) 7.75 |

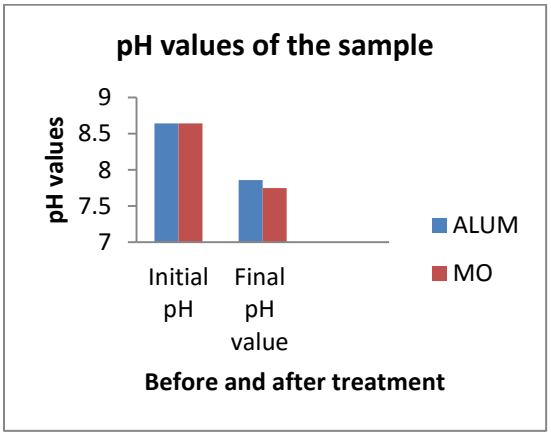


**Fig 8 : graph of pH values**

### 2) JAR TEST

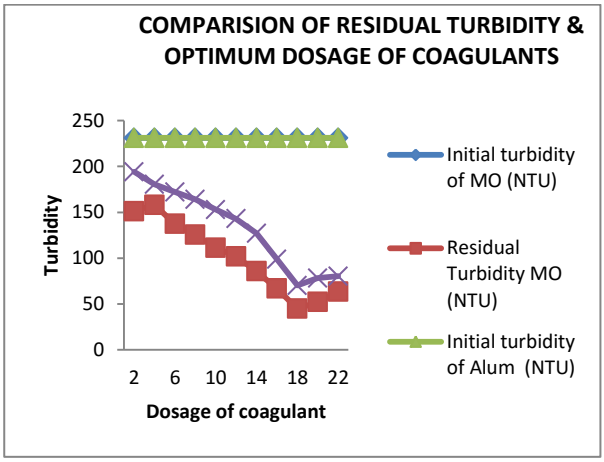


**Fig 9: Graph for comparison of residual turbidity & optimum dosage of coagulants**

### 3) TURBIDITY

| Sl No | Sample Details | Turbidity (NTU) |
|---|---|---|
| 1 | Alum coagulant<br>a)Before treatment<br>b) After treatment | a) 231<br>b) 10.05 |
| 2 | Moringa oliefera coagulant<br>a)Before treatment<br>b) After treatment | a) 231<br>b) 35.18 |

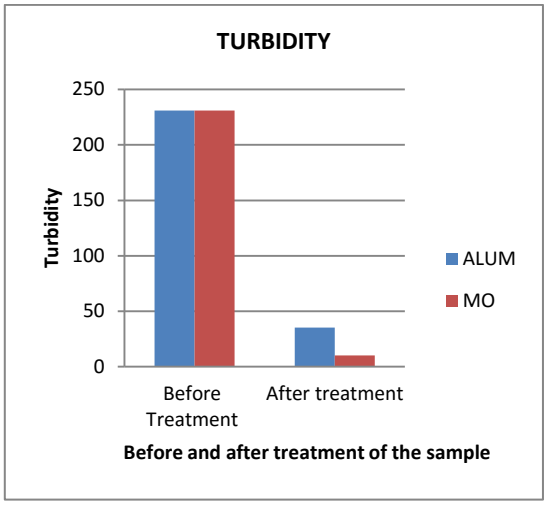


**Fig 10: Graph for turbidity**

## 4. APPLICATIONS, ADVANTAGES AND DISADVANTAGES

**Applications of moringa oliefera coagulant**

- All parts of the plant are used in a variety of traditional medicines
- Leaves are useful as animal fodder
- Presscake, obtained following oil extraction, is useful as a soil conditioner
- Grown as live fences and windbreaks
- Fuel wood source after coppicing (cutting back the main stem to encourage side shoots).
- As an intercrop with other crops
- Wood pulp may be used for paper-making.

**Advantages of moringa oliefera coagulant**

- Moringa oleifera is very nutritious.
- Moringa oleifera is rich in antioxidants.
- Moringa oleifera may lower blood sugar levels.
- Moringa oleifera may reduce inflammation.
- Moringa oleifera can lower cholesterol.
- Moringa oleifera may protect against arsenic toxicity.

**Disadvantages of moringa oliefera coagulant**

- At present availability of seeds is a problem, it require mass cultivation.
- The cost of the shelled seeds powder of moringa oliefera will probably higher than the cost of alum at present.
- The water treated by the moringa oliefera produces odour after 2days from treatment.
- Another disadvantage water extract increases dissolved organic carbon in treated water.

## 6. CONCLUSIONS

I. Moringa oliefera is a consumer friendly and environmental friendly, low alternative for rural areas or small scale water treatment plant. Moringa oliefera is a renewable resource can grow on large scale.

II. Research should therefore continue as so as to apply with to small and large scale water treatment in topical development countries.

III. Using MO as replacement coagulant for proprietary coagulants meets the needs for water technology in developing countries. This is simple to use and cheap to both install and maintain sustainable as household coagulant.

IV. Moringa oliefera seeds present a viable alternative to alum.

V. Moringa Oleifera is an environmentally-friendly natural coagulant most suitable for the treatment of water containing turbidity.

VI. It's easy to prepare the suspension and can be use as household water treatment.

VII. It is eco-friendly technology that is economically more advantageous than other treatment alternatives.

## 7. SCOPE OF FUTURE WORKS

- To check the turbidity of the sample by adding more dosage of Moringa Oliefera coagulant compare to alum. Also to check the pH value of the output sample.
- It may be implement to developing villages to find the turbidity and pH value by partial replacement of moringa oliefera with alum like 5,10.15%..Etc of moringa oliefera coagulant.
- This treatment may be implementing to the village lakes. For drinking purpose and also for potable use.

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