TREATMENT OF DRINKING WATER FOR TURBIDITY REDUCTION USING *STRYCHNOS POTATORUM* LINN SEED IN PILOT PLANT

[1]Gayathri Parivallal, [2]Ranadive Ananth Govindaraju, [3]Arun Nagalingam,[4]Sumitha Devarajan

[1]COO, [2]CEO, [3]Research Associate, [4]Assisant Professor

[1 2 3]Technology Transfer Department,

[4]PG & Research Department of Microbiology,

[1 2 3]Green Enviro Polestar, Ariyankuppam, Puducherry-605007, India.

[4]St. Joseph's College of Arts and Science (Autonomous),

Cuddalore, Tamil Nadu, - 607001, India.

ABSTRACT: Turbidity is one of the major culprits which help microbes present in water and waste water to survive. Also drastically impact the water treatment efficiency mainly the process of disinfection. Coagulants such as Alum, PAC (Poly Aluminium Chloride), $FeCl_3$ etc, are majorly used for the turbidity removal in water. Among this Alum is the most widely used coagulant in water treatment, because of its proven performance and cost effectiveness. Although alum has a proven track record, usage of same in drinking water system increases the concentration of Aluminium ion which does not falls under the WHO (World Health Organization) norms of drinking water standards. Hence this study would be an alternate approach for turbidity reduction in water by using natural coagulants. Different studies in ancient Tamil Literature show *Strychnos potatorum* Linn or Nirmali seed act as a best coagulating agent, which in turn helps in removal of turbidity in water. This study was done to evaluate the effectiveness of *Strychnos potatorum* Linn seed extract in removal of turbidity from the selected water samples. An existing water softener system of capacity 2 m^3/hr from a Residential Apartment named M/s.Ozone Pavillion was selected with an existing scheme of Alum dosing system, Pressure sand filter, Activated Carbon filter and Softener. In this scheme the Alum dosing was replaced with *Strychnos potatorum* Linn seed extract dosing and the softener filter was bypassed. Two different water samples were selected (Bore Well Water and Surface Water) and jar test was performed with the *Strychnos potatorum* Linn extract to arrive the best suited dose for the turbidity reduction. Here the jar test performed with different concentration of *Strychnos potatorum* Linn extract starting from 20 mg/l to 60 mg/l and selected the concentration of 60 mg/l as the best suited dose for turbidity reduction. The selected concentration was used for a pilot plant study in the existing water treatment plant designed by M/s. Green Enviro Polestar. The study showed the turbidity removal efficiency of 40% to 60% and highly emphasizes the usage of *Strychnos potatorum* Linn seed extract as a natural coagulant in water treatment systems.

Index Terms – Strychnos potatorum Linn*,* Water turbidity removal, Natural Coagulants, Drinking Water Treatment, Jar Test, Pilot Plant.

1. INTRODUCTION

Knowing the importance of clean supply of water, this study was carried out in finding an alternate and eco-friendly solution for water treatment process. A different factor like physical, chemical and biological parameters speaks about the water quality. Turbidity one of the vital parameter makes water cloudy or opaque *(*Swanson, H.A.et al., 1965). Turbidity is the measure of relative clarity and optical characteristic of water. It tends to scatter the light passes through it which can be measured by scattering intensity. Higher the intensity of scattered light, higher the turbidity in water. Excessive turbidity in drinking water leads to various health implications and also affects the water treatment method. The process of disinfection in water can be drastically affected by the higher turbidity content of water by reducing the disinfectant chemicals exposure in water (Gayathri Parivallal, et al., 2021). Water turbidity can be removed by the process of coagulation and flocculation which can be achieved by coagulating agents. Coagulation and Flocculation of suspended and particulate matters in water will be the upstream procedure required to improve the Settling and Filtration process. Hence depends upon various applications the measured quantity of chemical agents will be dosed into the water stream to remove turbidity. There are a number of chemical coagulants that are available for turbidity removal which includes Aluminum Sulfate (Alum)*,* Ferric Chloride ($FeCl_3$), PAC (Poly Aluminum Chloride) etc. Alum is the most widely used coagulant in water and waste treatment, because of its viable performance and cost effectiveness. But this increases the aluminum concentration in finished water (Barnett et al., 1969; Miller et al., 1984; Pitchai et al., 1992; Selvapathy and Vijayaraghavan 1994). Hence we need an alternate and eco friendly coagulating agent to remove turbidity from water. Conventional water treatment processes have the ability to effectively remove turbidity and even dissolved solids (Source: U.S. Environmental Protection Agency). Hence for this study we have selected natural coagulants (*Strychnos*

potatorum Linn seed extract). Although turbidity is not a direct indicator of health risk, numerous studies show the importance of turbidity removal. Conventional water treatment typically involves coagulation, sedimentation, filtration, and disinfection (Lee et al., 2014). Turbidity is measured in Nephelometric Turbidity Units (NTU).

Many researches and studies were recently aimed at the development of safe and cost-effective coagulants. Some natural coagulants such as *Strychnos potatorum* Linn, *Moringa olifera* Lam, etc., observed to be an alternative coagulation agent. Similarly, the present study focuses on the cost-effective production of eco-friendly coagulants from natural raw materials. *Strychnos potatorum* Linn seeds observed to be the one of the best natural coagulants as per ancient Tamil literature were used in this study.

Figure 1: *Strychnos potatorum* Linn

Strychnos potatorum Linn seed extracts were prepared and performed jar test to obtain the best required dosage for turbidity removal in the selected water samples. The obtained dosage (mg/l) of *Strychnos potatorum* Linn was dosed through the dosing system present in an existing water treatment system of capacity 2 m3/hr. The existing Water treatment system used in this study was erected by M/S. Green Enviro Polestar at Ozone Pavilion Apartment, Ozone Urbana, Bangalore. Schemes available with the system are Filter Feed Pumps, Alum Dosing System, Pressure Sand Filter, Activated Carbon Filter and Softener. Here we used the Alum Dosing System for dosing our *Strychnos potatorum* Linn extract with the obtained dosage of 60 mg/l at strength of 2% concentration. Also the softener filter was bypassed during the whole study. The selected water samples were checked for turbidity after treating through the system. There was a considerable reduction of turbidity in all the selected water samples observed. The removal efficiency was observed to be between 30-50% after passing through the treatment system with *Strychnos potatorum* Linn dosage. Hence this study emphasizes exclusively about the usage natural coagulants for turbidity removal in water treatment.

2.0 MATERIALS AND METHODS

2.1 *Strychnos potatorum* Linn Seeds Extract Preparation:

Strychnos potatorum Linn seeds were collected from Devanahalli, Bangalore Dist, Karnataka, India. Since the green seeds do not possess any coagulation activity (Ndabigengesere et al., 1995), the collected seeds completely shade dried for 4 days. The shade dried seeds were collected and homogenized in a commercial blender machine to a fine powder. The seed powder was then mixed with distilled water to prepare 2% (w/v) of stock solution (5 grams of seed powder in 250 ml of distilled water). For each and every downstream steps freshly prepared seed suspension were used.

2.2 Collection of Water Samples:

Bore well water samples were collected from M/s.Ozone Pavilion Apartment, Bangalore through the centrifugal pumps and surface water (Sample B) collected at Devanahalli Area Near Bangalore Airport through a water tanker having capacity 5000 L. Both the water samples were stored separately in the storage tank of capacity 10 m³ Volume (existing) during the operation. Each sample volume of 4000 Litres was used in this study.

2.3 Jar Test for Turbidity removal:

For performing jar test procedure both the selected water samples were taken in 250 ml beakers and triplicates were prepared and analyzed using magnetic stirrer. The Freshly prepared *Strychnos potatorum* Linn extract was added to the sample containing beakers with a dosage ranging from 20 mg/l to 60 mg/l and kept for proper stirring. The stirring procedure was done for 2 minutes and allowed for coagulation, precipitation and settling for 10 minutes at 100 rpm (Jar testing Apparatus: Phipps and Bird Inc., USA) and tested for relative turbidity.

2.4 Water Treatment Plant Existing:

Project Name	: Ozone Pavilion Apartment, Ozone Urbana, Bangalore
Project Type	: Water Softener
Flow Capacity	: 2 cum/hr.
Operation Hours	: 10 hrs.
Water Sources	: Surface Water and Bore Well Water from Bangalore City.
System Erected by	: M/S. Green Enviro Polestar, Pondicherry.

Table 1: The scheme and technical specifications of Existing Water Treatment Plant

S.No	Existing Scheme of Water Treatment Plant	Technical Specification

1.	Water Storage Tank	Capacity: 20 KL
2.	Filter Feed Pumps	Flow Rate: 2 m³/hr, Head: 35 m, Make: Kirloskar, Type: Vertical Submersible, MOC: Cast Iron.
3.	Alum Dosing System	Pump Flow rate: 6 Lph, Make: Edose, Dosing Tank Capacity: 250 Litre, Make: HDPE (High Density Poly Propylene)
4.	Pressure Sand Filter	Design Velocity: 12 – 15 m/hr, Operating Pressure: 3.5 Kg/cm², Filter Diameter: 600 mm, HOS (Height on Straight): 1250 mm, MOC (Material of Construction): MS (Mild Steel), Filter Make: GEPS
5.	Activated Carbon Filter	Design Velocity: 14 – 18 m/hr, Operating Pressure: 3.5 Kg/cm², Filter Diameter: 600 mm, HOS (Height on Straight): 1250 mm, MOC (Material of Construction): MS (Mild Steel), Filter Make: GEPS.
7.	Chlorine Dosing System	Pump Flow rate: 6 Lph, Make: Edose, Dosing Tank Capacity: 250 Litre, Make: HDPE (High Density Poly Propylene)
8.	Treated Water Storage Tank	Capacity: 10 KL, RCC tank water proofed.

Both the collected water samples were filled one by one in the untreated water tank. The Sample volume 4000 Litres of each was utilized and the system was operated for 1 hr each. For each batch 2000 L of the sample water was treated and the treated samples were taken for Turbidity analysis *Standard Methods* (APHA, 1992).

2.5 Pilot Plant working with *Strychnos potatorum* Linn seed extracts:

The available water treatment scheme does not require a softening process; hence the softener filter was bypassed during operation. Also the alum dosing system was replaced with *Strychnos potatorum* Linn extract. *Strychnos potatorum* Linn extract with 2% strength (2 Kg of *Strychnos potatorum* Linn extract in 100 Litres normal water) was prepared freshly and stirred with a mechanical mixer for 2 minutes at 100 rpm. After proper mixing the extract was dosed on line to the plant flow with a dosage concentration of 60 mg/l which was obtained from the jar test. The dosage was performed using the existing dosing pump of capacity 6 Lph with a 100% stroke rate.

Table 2: Procedure of Turbidity removal by Dosing System

Plant Flow Rate	2 m³/hr
Operating hours	10 hrs
Flow per day	Flow rate * Operating hrs 2 m³/hr * 10 hrs : **20 m³/day**
Dosage obtained from jar test	60 mg/l
Dosage for 20 m³/d capacity in (Kg)	(20 m³/d * 60 mg/l)/1000 : **1.2 Kg/days**
Converting to Lpd (Litres/day)	Dosage in Kg/Solution strength 1.2 Kg/0.02 : **60 Lpd (Litres/day)**
Dosing Pump Flow rate (per hr)	Dosage per day/operating hrs 60 Lpd/10 hrs : **6 Lph (Litre/hr)**
Dosing Pump Stroke Rate (%)	100 %

Both the collected water samples were allowed to pass through the water treatment system separately at a designed flow rate of 2 cum/hr and the treated water was tested for Turbidity.

3.0 RESULTS AND DISCUSSION

Compared to all the selected dosages, 60 mg/l dosage of seed extract of *Strychnos potatorum* Linn were effective for turbidity reduction in the water sample treatment. The removal efficiency observed to be more than 40% for both the Bore well water (Table 3) and Surface Water (Table 4). Hence 60 mg/l dosage was used in an existing water treatment plant of capacity 2 m3/hr, which can treat up to 20 cum of water per day. Even though chemical coagulants were widely used in water treatment, it may be toxic to environment and human being (Barnett et al., 1969). Based on the results of this study natural coagulant like *Strychnos potatorum* Linn seed extract can be used in water treatment. Table 5 represents the treatment of Bore well and Surface water with *Strychnos potatorum* Linn seed extract. The results of the turbidity removal efficiency were found to be similar in the treatment of both water samples. An untreated control was used for both the samples to check their efficiency percentage. In further studies different seed extracts like *Strychnos potatorum* Linn can be studied separately or in a combination to get a best efficacy.

Table 3: Bore Well Water Sample: Initial Turbidity (3.36 NTU)

Water Source	Strychnos potatorum Linn	Turbidity Values (NTU)			
	Dosage (mg/l)	Replicate 1	Replicate 3	Replicate 3	Mean Value ($\mu = \sum x / n$)
Bore Well Sample	0	3.41	3.30	3.38	**3.36**
	20	3.12	3.08	3.34	3.18
	30	2.86	2.84	2.83	2.84
	40	2.38	2.47	2.45	2.43
	50	2.12	2.15	2.12	2.13
	60	1.82	1.83	1.80	**1.81**

Table 4: Surface Water Sample: Initial Turbidity (3.59 NTU)

Water Source	Strychnos potatorum Linn	Turbidity Values (NTU)			
	Dosage (mg/l)	Replicate 1	Replicate 3	Replicate 3	Mean Value ($\mu = \sum x / n$)
Surface Water Sample	0	3.62	3.58	3.58	**3.59**
	20	3.31	3.55	3.54	3.46
	30	2.93	3.01	2.98	2.97
	40	2.45	2.51	2.54	2.50
	50	2.42	2.14	2.18	2.24
	60	1.85	1.84	1.84	**1.84**

Table 5: Evaluation of Turbidity removal Efficiency:

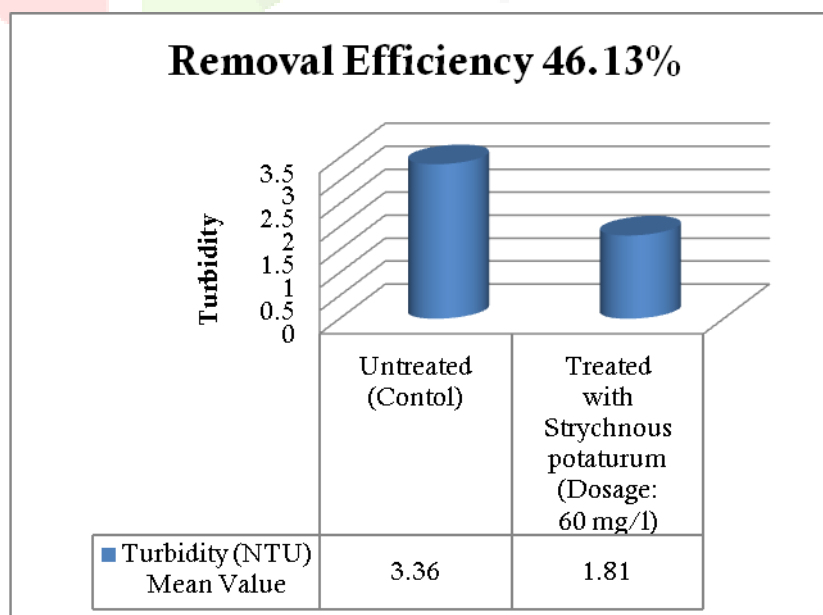| Water Source	Sample Type	Turbidity (NTU) Mean Value	Turbidity Removal Efficiency %
Bore Well	Untreated (Contol)	3.36	-
	Treated with Strychnos potatorum Linn	1.81	**46.13%**
Surface Water	Untreated (Control)	3.59	-
	Treated with Strychnos potatorum Linn	1.84	**48.74%**

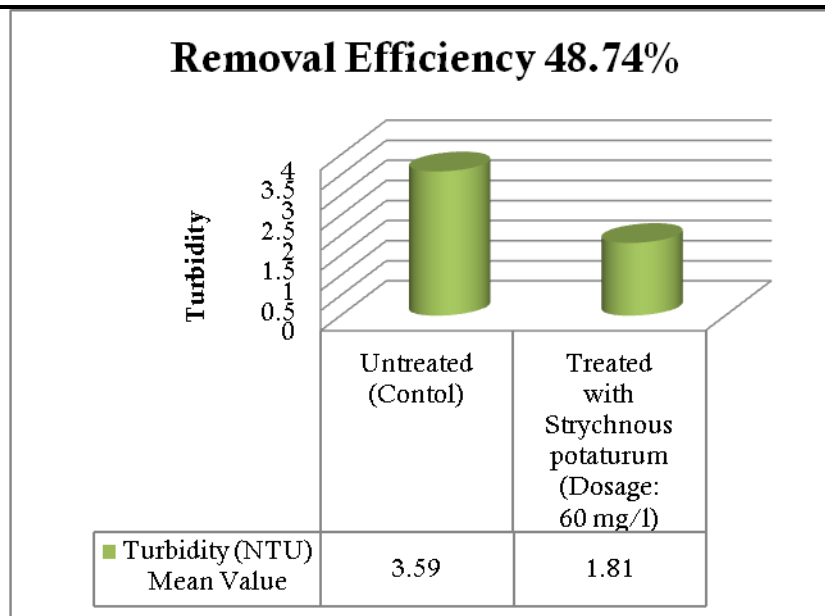Figure 2: Turbidity Removal Efficiency Of Bore Well Water

Figure 3: Turbidity Removal Efficiency Of Surface Water

4.0 CONCLUSION

The study carried out in the pilot plant exhibited a higher efficiency of turbidity reduction using *Strychnos potatorum* Linn seed extract. Hence natural coagulants can be used in commercial of treatment of different water samples like drinking water, process water and even waste water. Further studies can be carried out with different natural coagulants to attain a cost effective eco-friendly water treatment process.

5.0 ACKNOWLEDGEMENT

6.0 REFERENCES:

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