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Treatment of Municipal Waste Water Using Naturally Available Coagulant

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ABSTRACT

This paper reviews an attempt to evaluate the comparative effectiveness of natural coagulants such as tamarindus indica seed powder and carica papaya seed powder for the treatment of Municipal waste water. This study mainly focused on turbidity removal, Total dissolved solids, Chemical oxygen demand, total suspended solids from Municipal waste water. The main aim of the environmental agencies and government are to seek ways to minimize the considerable increase in the rate of water pollution due to urbanization and industrialization. Coagulation and flocculation using chemicals are also adopted for treatment process. But due to high cost of chemical coagulants, this can be replaced by natural coagulants. This experiment was conducted at room temperature without adjusting the PH. Various conditions such as coagulant dose, stirring time and settling time is varied and its optimum values are obtained. Results show the reduction in turbidity, TDS, TSS, Ph, TS and COD by using natural coagulants.

Keywords: *Municipal waste water, Tamarind seed powder, Papaya seed powder.*

1. Introduction

Water is the second most important need for life to exist after air. As a result, water quality has been extensively described in the scientific literature. It is also used for variety of purpose like drinking, washing, bathing, recreation as well as numerous other varied industrial applications. World Health Organization (WHO), report that wholesome of water means absence of suspended solids, inorganic solids and pathogens. Water covers 71% of earth surface, 96.5% of planet water is found in ocean, 1.7% in ground water, 1.7% in glaciers and icecap in Antarctica and Greenland, a small fraction in various other water bodies, and precipitation only 2.5% of earth water is fresh water and 98.8% of that water is in ice and ground water, less than 0.3% of all fresh water is in river, lakes and the atmosphere, and an even small amount of earth's fresh water contained within biological bodies and manufactured products. Safe water is essential for human and other forms of life even though it provides no calories or organic nutrients. Access to safe water is improved over last decades in almost every part of the world, but approximately one billion people still lack to safe water and over 2.5 billion lack accesses to safe sanitation. Increasing amount of discharged sewage progressing urbanization, the use of chemicals in agriculture and industry as well as anthropogenic activities all effects quality of waters.

The final effect of water degradation is the limits to the use of drinking water. The most popular definition of water quality is "it is the physical, chemical and biological characteristics of water". Water quality is of concern to everyone. Quality is the acceptability of the water for uses like drinking, cooking, bathing, and laundering. Most municipality treated water is safe and generally of good quality. Water from private or community wells can be contaminated. Contaminated water may have off-tastes, odours, or visible particles.

The conventional method of water purification using aluminium sulphate (alum) and calcium hypochlorite puts a pressure on the nation's over-burdened financial resource since they are imported making treated water very expensive in most developing countries and beyond the reach of most rural folks. Hence, they resort to the sources like dams, dug outs, streams, rivers and lakes. Water from these sources is usually turbid and contaminated with

microorganisms that cause many diseases. Natural coagulants have been used in rural areas as effective coagulants. The naturally occurring coagulants are presumed safe for human health. The study also focused on the determination of optimum dosage and contact time for using papaya and tamarind as a natural coagulant in municipal waste water treatment as well as community water treatment plants [1]-[4]. The comparative efficiency studies of tamarind and papaya seed for water treatment is also studied. The material selected for this study has high protein content and some authors have considered that the active coagulating agents in plant extract are proteins. Researchers developed naturally available treatment methods for the waste water treatment plants for specific needs [5]-[7]. Natural resources are depleting worldwide while at the same time the generated waste from industries, municipalities increasing substantially. The sustainable development for treatment waste treatment involves the use of naturally available materials instead of chemical substances to compensate the lack of natural resources and to find an alternative way in conserving environment [8],[9],[10].

1.1. The objective of this paper is as follows

(1) To determine the performance between tamaridus indica seed powder and carica papaya seed powder.

(2) To demonstrate that natural coagulants are effective in the reduction of turbidity, COD, BOD, Total dissolved solids and Total suspended solids.

1.2. Scope of the Study

(1) Nowadays, strategies must be developed for the global impact on the environment.

(2) If the strategies are not maintained, there will be no reduction in the environmental loads and their effects.

2. Material and Methods

2.1. Carica Papaya

Papaya fruit contain large number of small black colour seeds. The fruit as well as seeds contain large protein content and have medicinal values.

Fig.1. Papaya seed

Papaya seed have anti-inflammatory properties, wound healing properties, suitable for digestion, prevention of cancer and kidney disorders, provide heart health and its use increase immunity because it contains vitamin A & C. Papaya seed is a rich source of proteins. Seed work as a coagulant due to the presence of positively charged proteins

which bind with negatively charged particles (silt, clay, bacteria and toxins etc), allowing the resulting flocs to settle and obtain clear water (adsorption & charge neutralization). Also papaya seed powder has ability to join with solids in water and settle to the bottom. Papain (Papaya proteinase) is the important protein present which contains 345 amino acid residues and consists of a single sequence of propeptide and mature peptide.

2.2. Tamarindus Indica

Tamarind seed juice is known to be a natural remedy to cure indigestion and increase bile production. Moreover, it is rich in dietary fibre, which further results in reduction of cholesterol. Fibre also helps in improving your digestive system. Tamarind seed kernel powder, is an effective agent to make turbid municipal and industrial waste water clear. The present study found that alum increases toxic metal and ion in treated water and could cause diseases like the Alzheimer's. Tamarindus seed powder compared to alum is not toxic and biodegradable.

Fig.2. Tamarind seed

2.3. Municipal Waste Water

The municipal waste water is collected from the Kasimvayal, which is a village consists of around 300 families and a playground. This village is located at Gudalur, The Nilgiris, Tamilnadu. It was a flowing river and due to rapid increase in the urbanization and industrialisation the river bed got polluted and then results in the main source for dumping household waste, waste from hotels, waste from vegetable and fruit shop, waste from fish and chicken market. In congested areas the water supplies get polluted by domestic and industrial waste. Hence it is important to treat waste water for agricultural purpose and car washing.

Fig.3. Municipal waste water

2.4. Preparation of Carica Papaya Seed Powder

Carica papaya seeds were collected from the market and nearby locations. The fruits were sliced open using a clean knife, seeds were taken and washed severally with water. Then the seeds were dried under sunlight for a period of 7

days before crushing. The seed were made into fine powder using home grinder and sieved through a sieve of 600 micron and powder was collected in sterile bottle with air tight cap then used as coagulant.

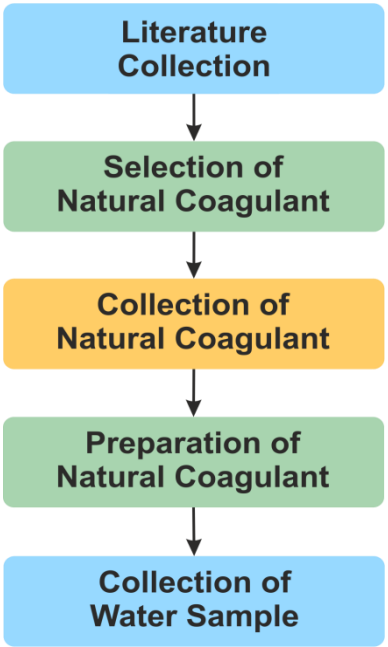
Fig.4. Papaya seed powder

2.5. Preparation of Tamarindus Indica Seed Powder

The Tamarindus Indica seeds were collected washed with water to remove dust and pulp and the clean seeds were dried in the sunlight for a period of 7 days before crushing. The seed were made into fine powder and sieved through a sieve of 600 micron and powder was collected in sterile bottle with air tight cap then used as coagulant.

Fig.5. Tamarind seed powder

3. Methodology



4. Experimental Methodology

4.1. Jar Test

The purpose of the Jar test is to determine the most effective doses of coagulant for specific water in the control of Coagulation – Flocculation especially when water flocculates rapidly. In this project, two different experimental setup takes place: First, Tamarind seed powder as coagulant, then, Papaya seed powder as coagulant. The coagulation and flocculation of water is influenced by a few factors such as turbidity, pH, TS, TDS, TSS and COD and degree of agitation and characteristics of coagulants.

In this experiment the apparatus consist of six jars of 1000ml quantity and six steel paddles. Before testing, the sample water was mixed homogenously for the measurement of initial turbidity, TS, TDS, TSS, pH, and COD. The jars were taken out and the sample water of 1000ml is filled in each jar and first coagulant (tamarind seed powder) of six different weights were added to the jar, first jar having 0.1g and the remaining five varying from 0.1g-1.1g at 0.2g interval in order to determine the optimum dosage.

Then the paddles were lowered into each jar. The stirring speed was set at 100rpm for rapid mixing for duration of 1 minute and 40 rpm for slow mixing for duration of 15 minutes. After the process was complete, the samples were allowed to settle for 30 minutes. Using a large pipette, a portion of supernatant was taken out from each portion without disturbing the floc and finally it was taken for analysis. From the results obtained the dosage with the best results was taken as the optimum.

The above procedure was repeated for the second coagulant (papaya seed powder) at different doses was maintained in all six beakers, the optimum was determined for those. After the coagulation process was completed, the samples were then analyzed for various tests. From the results obtained the efficiency of both the seeds for the treatment of waste water was compared.

4.2. Determinations of Turbidity

Turbidity is the cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in air. The turbidity is measured by using Nephelometric turbidity meter. To determine the turbidity, first switch on the instrument and let the instrument warm for 15-20 minutes. The distilled water was taken in the glass cell and insert it into the cell holder and close the lid. For adjusting the panel meter to zero use a zero adjusting knob. Then select the range to 200NTU in cell holder. Then take the solution from cell holder and place the sample water in the cell and close the lid. The readings were taken for the six sample solution from the turbidity meter and noted in the table given below.

4.3. Determinations of pH

The pH of the solution is determined by using digital pH meter. Take two standard buffer solution of 100 ml of pH 4 and 7 and insert the electrode into the solutions. It is a solution offering resistances. The temperature was determined and is entered into the meter to allow for a temperature correction. Then raise the electrode and carefully wipe it with a tissue paper. Then dip the electrode into the sample solution wait upto 1 min for steady pH meter reading. The reading was taken and the indicator value remains constant for about 9 minutes.

4.4. Determinations of TS, TDS, SS

4.4.1. Total Solids

Take 20ml of sample water in an evaporating dish and subject to a preliminary drying in an oven at the same temperature intended for the residue cool in desiccators and place it on a water bath and measure it into the 100ml. Evaporate it to dryness and further dry at 103 -105^{0}c for one to two hours in an oven. Then cool it in a desiccator and weigh.

4.4.2. Total Dissolved Solids

Filter the suitable volume of water through Whatman no: 42 or equivalent filter paper. Evaporate the filtered sample on porcelain dish for sewage and industrial effluents. Dry the residue at 103-105^{0}c.The increase in weight of dish equals the total dissolved solids.

4.4.3. Total Suspended Solids

Suspended solids = the difference between the total solids and dissolved solids.

4.4.4. Determination of COD

COD is the measure of oxygen consumed during the oxidation of organic matter by a strong oxidizing agent. In this method the COD is determined by taking 20ml of sample water in a conical flask and adding 10ml of $K_2Cr_2O_7$ solution. Then add 30ml of H_2SO_4 and mix thoroughly. Reflex atleast for 2hours. Remove the flask to cool and add 90ml of distilled water. Add 2-3 drops of ferrous indicator and titrate against 0.1N ferrous ammonium sulphate. The end point is the sharp colour changes from bluish green to reddish brown.

4.5. Sieve Analysis

Sieve analysis is the method to separate the materials in different fractions based on the particle size. In this experiment a quantity of 300 grams of sample is sieved through 600µ, 300µ, 212µ, 150µ, 75µ and mass of the material retained in the sieves are taken. Then percentage of the sample retained is determined and the percentage of the sample passed through sieve is also determined.

5. Result and Discussion

5.1. Initial Value of the Municipal Waste Water before Testing

S. No.	Parameters	Initial Value
1	Turbidity	200 NTU
2	pH	7.4
3	Total dissolved solids	750 mg/l
4	Total suspended solids	1230 mg/l
5	Total solids	1980 mg/l
6	COD	1082 mg/l

5.2. Final Value of the Municipal Waste Water after Testing

Parameters	Coagulant	Dosage					
		0.1 g	**0.3 g**	**0.5 g**	**0.7 g**	**0.9 g**	**1.1 g**
Turbidity (NTU)	Papaya seed powder	83	85	80	74	79	76
Ph		6.5	6.8	6.5	7.2	7	7.1
Total suspended solids (mg/l)		190	120	88	76	86	93
Total dissolved solids (mg/l)		140	138	148	120	115	150
Total solids (mg/l)		330	258	236	196	201	243
Chemical oxygen demand (mg/l)		538	436	350	447	458	406
Turbidity (NTU)	Tamarind seed powder	75	70	69	74	79	74
pH		6.7	6.5	7.1	6.9	6.45	6.8
Total suspended solids (mg/l)		210	236	313	158	167	168
Total dissolved solids (mg/l)		240	190	150	133	128	136
Total solids (mg/l)		450	426	463	291	295	304
Chemical oxygen demand (mg/l)		434	338	196	188	173	136

5.3. Efficiency Removal

Parameters	Coagulant	% Efficiency
Turbidity	Papaya seed powder	60%
pH		-
Total dissolved solids		81%
Total suspended solids		91%

Total solids		87%
Chemical oxygen demand		60%
Turbidity	Tamarind seed powder	63%
pH		-
Total dissolved solids		78%
Total suspended solids		83%
Total solids		81%
Chemical oxygen demand		77%

5.4. Sieve Analysis of Papaya Seed Powder

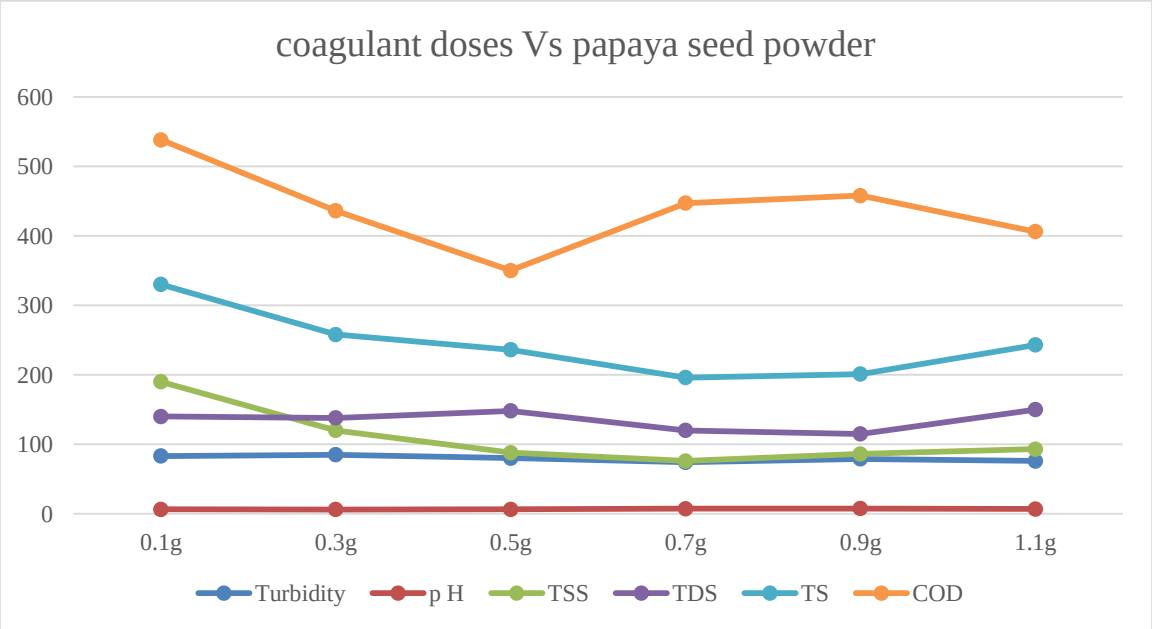
Sieve Size	Weight Retained	Percentage Weight Retained	Cumulative Percentage Retained	% Finer
600µ	70.61	24.61	24.61	75.39
300µ	82.63	28.8	53.41	46.59
212µ	90.84	31.66	85.07	14.93
150µ	29.14	10.16	95.23	4.77
75µ	11.55	0.04	95.27	4.73
pan	2.13	0.0072	95.28	4.72

5.5. Sieve Analysis of Tamarind Seed Powder

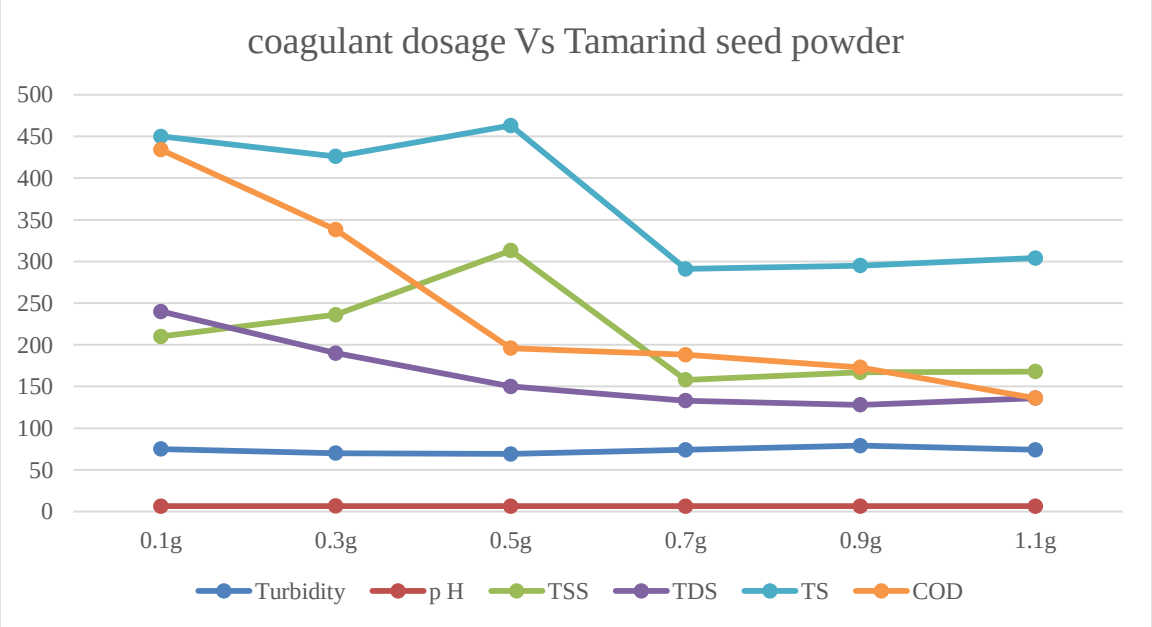
Sieve Size	Weight Retained	Percentage Retained	Cumulative Weight Retained	% Finer
600µ	72.63	25.40	25.40	74.6
300µ	80.56	28.17	53.57	46.43
212µ	89.68	31.36	84.93	15.07
150µ	32.15	11.24	96.17	3.83
75µ	9.62	0.03	96.2	3.8
pan	1.32	0.0046	96.20	3.8

5.6. Graphical representation

5.6.1. Effect of Coagulant Dosage by Using Papaya Seed



5.6.2. Effect of Coagulant Dosage by Using Tamarind Seed



6. Conclusion

The above project shows that the use of papaya seed powder is more effective in removing TSS, TDS and TS, this will also neutralize the charge without an effect on pH and withdraws the forces that stabilize the colloidal particles causing the particles to suspend in the water.

Whereas the tamarind seed powder is more effective in removing turbidity and COD. The locally available natural coagulants can also be used in the treatment of kitchen waste water, textile industry water, tannery waste water etc, because the coagulants are cost effective and safe method for the water treatment. Hence there is a

need in search for the native materials for the treatment of waste water, which is the used for irrigation purpose, car washing etc. These can bring the technologies into hands.

Declarations

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This research did not receive any grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing Interests Statement

The authors declare no competing financial, professional and personal interests.

Ethical Approval

Not Applicable.

Consent for publication

Authors declare that they consented for the publication of this research work.

Availability of data and material

Authors are willing to share data and material according to the relevant needs.

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