Ms.T.Poornima Devi et al. International Journal of Recent Research Aspects ISSN: 2349-7688, Special Issue: Conscientious Computing Technologies, April 2018, pp. 863-870

Feasiblity Study of Punica Granatum as a Coagulant in the Treatment of Waste Water

Ms.T.Poornima Devi[1], K.Abirama Pandian[2], V.Bala Subramaniyan[3], K.Rajavignesh[4], G.Santhana BalaKumaran [5]

[1] Assistant professor, [2, 3, 4, 5] B.E students

[1,2,3,4,5] Department of civil engineering, Dr.sivanthi Aditanar College of engineering, tiruchendur-628215, thoothukudi (D.t), tamilnadu, India

Abstract: - The present study deals with the Potential of the Coagulation – Flocculation process using PUNICA GRANATUM (PG), peel powder as an Environment – friendly natural Coagulant and Antimicrobial agent for Clarification of Turbid water. Almost all the Industrial effluents are of High Turbidity, Hence it was aimed at analyzing PUNICA GRANATUM(PG) as a possible alternative for Alum and other synthetic Polyelectrolytes in Treating Waste water .Laboratory Scale Studies using Jar test Experiment were performed on Waste Water (WW) to determine the effect of Dosage , pH,Stirring time and Speed on Coagulation .Results obtained showed that at dosage of 1g/L,pH of10.0, Stirring time of 15mins , maximum Speed of 130 rpm AND thus Optimal Removal of Turbidity was obtained . For (KW) results obtained were dosage of 1g/L, pH of 5.0, stirring time 15mins, maximum Speed of 30 rpm, the optimal Removal of Turbidity was achieved. The percentage of Turbidity removal for (WW) and (KW) was found to be 30%,90%It can be thus concluded that this Technology is helpful for treating contaminated turbid water with low cost, lesser time and easiness and also Un-skilled Persons can be used to operate this system effectively.

Keywords: Coagulation, Turbidity, Optimum Dosage.

NOTATIONS:

PG - POMEGRENATE

WW -WASTE WATER from Workstation

KW- WASTE WATER from Kitchen

INTRODUCTION

Protection of environment is a task of utmost importance. Solid, gaseous contaminants and waste water from various sources finally reaches the aqueous system. Water contains a large variety of contaminants that changes the physiochemical and bacteriological characteristics above or below the threshold limit which make it undesirable for domestic, industrial and agricultural needs. Treatment of water with Chemical Coagulants (such as alum, ferric chloride) changes the contaminants from one form to another, which are harmful to human beings .Toxic sludge disposal is also a major problem in the case of chemical coagulants. Turbidity removal is one of the important steps in Water treatment process and generally is achieved using coagulation process Natural Coagulants are useful for the treatment of water and waste water because of its sustainability, cost effectiveness, non-toxicity and lesser quantity of Sludge formation. In Waste water treatment, coagulation has been practiced since the earliest times and the main objective is to remove colloidal impurities hence also removing turbidity from the water. Coagulant is a chemical used that is added to the water to withdraw the forces that stabilizes the colloidal particles and causing the particles to suspend in the water. Once the coagulant is introduced in the water, the individual colloids must aggregate and grow bigger so that the impurities can be settled down at the bottom of the beaker and separated from the water suspension. Aluminium and iron coagulants are commonly used in the most industries. However, when aluminium is used as a coagulant in waste water treatment ,it can caused several bad effects on human health such as intestinal constipation, loss of memory, abdominal colic's loss of energy and learning difficulties. Hence nowadays, there has been great attention in the improvement and implementation of natural coagulants in waste water treatment. These natural coagulants can be formed or extracted from animal. Microorganisms and also plant.

Natural Coagulant used in this Study are Punica Granatum which are locally available from market in Tuticorin. In this study an effort is made for a sustainable, simple, flexible, reliable, cost effective, and environment friendly water and waste water treatment for both high turbid and low turbid

water. This paper aim at investigating the potential of Punica granatum as a coagulant for the water treatment .This material was selected because the Punica Granatum contains as much as three times of Polyphenols including condensed tannins [44]

Catechins, gallocatechins and prodelphinidins [45]

Figure 1. - Punica Granatum

Objectives of the study:
The objectives of the study are

To use PUNICA GRANATUM (POMEGRANATE) Peel as a Natural Coagulant in order to remove the Turbidity of the waste water collected from Work Station. To determine the Potential of Punica Granatum as a natural coagulant and investigate the coagulation characteristics of waste water from Work Station.
To remove the suspended impurities from waste water
To remove the total solids(TS) from wastewater
To find the optimum coagulant dosage

Advantages of using natural based coagulant for treatment of wastewater:

- They are apparent
- They are cost effective
- They are unlikely to produce treated water with extreme pH and highly biodegradable.
- They are usually presumed safer human

II .METHODS AND MATERIALS:

2.1 Materials:
Materials used in this work included Punica granatum Peel (coagulant), Distilled Water, Digital pH meter, Electronic weighing balance, Nephlometric turbidity meter, Conductivity Meter, Heating Mantle, China dish , COD digester, Stop watch, Pipette , Beakers, Conical flask, Burette ,Measuring Jar, Jar test apparatus and Waste water collected from Workstation, kitchen in Tuticorin.

2.2 Methods
i. Punica Granatum Peel (coagulant) Preparation:

The Pomegranate fruits were collected and their peel has been removed and dried naturally by sun light for two weeks. After drying of two weeks, the peel was ground to fine powder by domestic blender .This powder was sieved through 600µm sieve. [4, 3, 6].

Figure 2- Punica granatum preparation as a Coagulant

ii. Sample Water Collection:
The raw water sample was collected from the workstation located in Tuticorin. Kitchen wastewater sample was also collected in Tuticorin.

Figure 3- Waste water collected from Workstation

Figure 4- Waste water collected from Kitchen waste

iii. Water Quality Tests:

a) Turbidity :
Turbidity of the waste water sample was measured before and after treatment using a Nephlometric Turbidity meter

b) Total Solids:
Sample of the wastewater taken from measuring jar (150mL) and poured in the beaker. A clean and dry crucible was weighed empty and the sample was then poured into it and re-weighed. Respective weights were recorded and the crucible together with the sample water were the placed on a heating mantle. When all water evaporated the crucible was allowed to cool down and re-weighed together with the residue. The total solids present was then calculated using the equation:

$$TS = W_1 - W_2 / v \times 10^6$$

Where, W_1 = Weight of the dry sample and china dish, gm.
W_2 = Weight of the empty china dish, gm.
V = Volume of sample taken, mL.

c) Total dissolved solids(TDS):
This TDS value of the water can be obtained by multiplying the conductivity value by 0.67.

TDS (in ppm or mg/l) = [conductivity ofµS/cm] 0.67

d) Total suspended solids (TSS) :
The difference between the total solids and the Suspended solids will then represent nothing but the Dissolved Solids.

TSS = TS – TDS

e) pH:
The pH of the samples was taken using an electronic pH meter.

f) Jar test:
The jar test apparatus was used to carry out coagulation and flocculation on the water samples. Six 500mL beakers were used to study the effect of the coagulant dosage on coagulation. The effect of pH on coagulation and effect of stirring time and speed on coagulation following parameter were measured on the filtrate after the coagulation was completed. Turbidity, Conductivity and Total Solids. Six different weights of the coagulant were placed in each beaker, first having 1g and the remaining five varying from 1gm to 6gm at 1gm interval in order to determine the optimum dosage. The raw water sample was added to make up the 500mL mark and the jars were placed in the jar test kit and the stirrers lowered into each. The stirring speed was set above 120rpm for rapid mixing for 2 minutes and 30rpm to 50rpm for 20minutes for slow mixing. After this was completed the samples were allowed to settle for minimum 15mins to 30mins and the flocs were formed and settle at bottom, the parameters listed above were measured on the filterate. From the results obtained the dosage with the best results in turbidity removal was taken as the optimum.

The procedure above was used again, however a dose of 3gm/l was maintained in all six beakers. The same speed and stirring time was used as above and the parameters listed above were measure after the coagulation-flocculation process. The pH at which the best turbidity removal were observed at was taken to be the optimum pH for coagulation.

Effect of coagulant dosage was also studied. The optimum dosage of 3g/l was used in all the beakers. The stirring speed was then varied ranging from 30rpm-130rpm at 20rpm interval. The same was done to determine the optimum stirring time, using the optimum speed to determine the best stirring time. The stirring time was varied at 2mins, 5mins, 8mins, 10mins and 15mins for each beaker. The obtained time was found to be 5mins.Then the samples varied in pH ranging from 5 to 10 at a interval of 1using Sodium Hydroxide (NaOH) and the optimum pH was recorded 6.0.The similar process which also mentioned for kitchen waste water sample. The optimum values for dosage, time, speed and pH were calculated. After the coagulation-flocculation process was completed, then the parameters (Total Solids, Turbidity, and Conductivity) for each samples were calculated.

III. RESULTS AND DISCUSSIONS

The physico chemical properties of the raw water sample used in study are presented in Table 1 from the turbidity value of raw water was with range 30 to 1400 NTU.

Table 1: Wastewater sample initial characteristics

CONTENTS	TYPE OF WASTE WATER	
	WORKSTATION	KITCHEN
pH	6.387(stable)	4.5(stable)

TOTAL SOLIDS(mg/l)	100000	150000
TURBIDITY(NTU)	430	330
COD(mg/l)	960	700
CONDUCTIVITY(µs/cm)	218	187

From Table 1 It can be seen that the turbidity exceeds the WHO standards hence the need for treatment.

a) Effect of dosage on coagulation : Table 2 &2.1shows the results of the effect of coagulant dosage on coagulation. The dosages were varied from 1g/l to 6g/l. The settling time 15 mins was used and the samples were observed for complete settling to take place.

Table 2: Effect of Coagulant Dosage Results for workstation waste

S.NO	OPTIMUM DOSAGE (g/l)	TOTAL SOLIDS (mg/l)	CONDUCTIVITY (µs/cm)	TURBIDITY(NTU)
1	1g	9000	107.3	304
2	2g	4000	109.8	503
3	3g	10000	121.4	1367
4	4g	2000	118.9	838
5	5g	3000	113.7	730
6	6g	6000	110.1	930

Table 2.1 Effect of Coagulant dosage Results for Waste Water From kitchen Waste:

S.NO	OPTIMUM DOSAGE (g/l)	TOTAL SOLIDS (mg/l)	CONDUCTIVITY (µs/cm)	TURBIDITY(NTU)
1	1g	13000	109.3	31
2	2g	17000	116.7	126
3	3g	6000	121.9	93
4	4g	20000	126.8	232
5	5g	10000	120.3	80
6	6g	1000	123.9	172

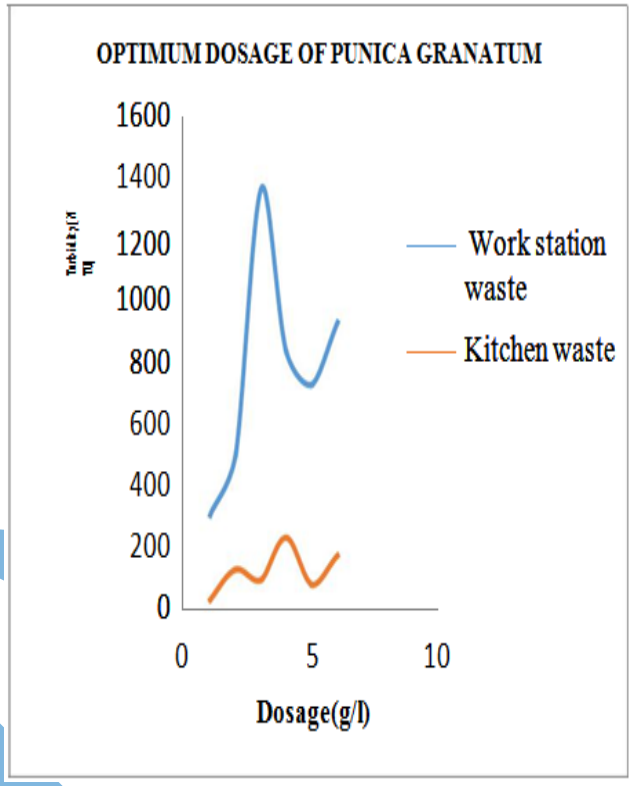

Fig 5: Plot of turbidity against dosage for both kitchen and workstation waste

At varying coagulant dosages, the effect of constituent parameters is shown on above in Table 2. At varying dosage no significant changes observed in pH temperature. However there was a notable decrease the turbidity of water sample. The optimum dosages were found to be 1g/l for workstation waste and 1g/l for Kitchen waste sample. The optimum dosage is defined the minimum amount of dosage found to produce a good flocs.

b) Effect of Stirring time on coagulation at constant dosage

Table 3&3.1 shows the results obtained when the effect of stirring time on coagulation was studied by varying the Stirring time at the constant of coagulant dosage.

Table 3: Effect of stirring time on coagulation at a constant dosage of 1g/l for Waste Water from Work Station:

S.NO	OPTIMUM TIME (mins)	TOTAL SOLIDS (mg/l)	CONDUCTIVITY (µs/cm)	TURBIDITY(NTU)
1	2	10000	109.8	612
2	5	50000	120.7	583
3	8	10000	112.4	506
4	10	40000	103.8	420
5	12	2000	118.2	399
6	15	5000	104.5	390

Table 3.1: Effect of stirring time on coagulation at a constant dosage of 1g/l for Waste Water from Kitchen waste:

S.NO	OPTIMUM Time(mins)	TOTAL SOLIDS (mg/l)	CONDUCTIVITY (µs/cm)	TURBIDITY (NTU)
1	2	15000	105.1	180
2	5	10000	106.8	150
3	8	30000	107.2	190
4	10	3000	106.5	148
5	12	5000	107.8	152
6	15	20000	103.4	61

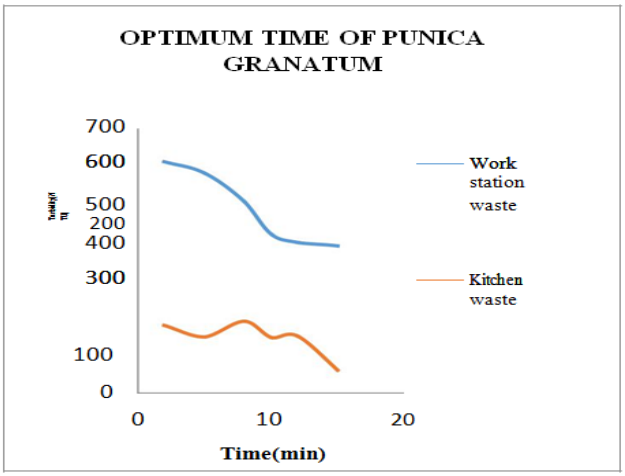

Fig6: Plot of Turbidity against Time for both Kitchen and Workstation waste

It can be seen From Table 3& Table 3.1 that, the effect of Stirring time on coagulation and as with the effect of dosage, the results obtained showed no Significant changes in pH or temperature. The Optimum time can be found for the Kitchen and Workstation waste samples are 15mins and 15 mins

c) Effect of mixing Speed on Coagulation at Dosage of 1g/l & 1g/l:

From Table 4&4.1, the effect of mixing speed on coagulation was observed to only have a moderate effect on the Coagulation process.

TABLE 4: Effect of mixing Speed on Coagulation at Dosage of1 g/l for Waste WATER from Work station:

S.NO	OPTIMUM SPEED	TOTAL SOLIDS (mg/l)	CONDUCTIVITY (µs/cm)	TURBIDITY(NTU)
1	30	10000	94.7	316
2	50	20000	102	390
3	60	2000	97	244
4	70	4000	98.1	232
5	80	7000	98.4	230
6	90	3000	97.8	222
7	110	9000	100.01	168
8	130	1000	95.1	160

Table 4.1: Effect of mixing Speed on Coagulation at Dosage of 1 g/l for Waste WATER from Kitchen waste water:

S.NO	OPTIMUM SPEED (rpm)	TOTALSOLIDS (mg/l)	CONDUCTIVITY (µs/cm)	TURBIDITY(NTU)
1	30	13000	116.6	120
2	50	32000	112.3	130
3	70	50000	119.3	265
4	90	22000	116.3	140
5	110	15000	113.3	158
6	130	40000	109	150

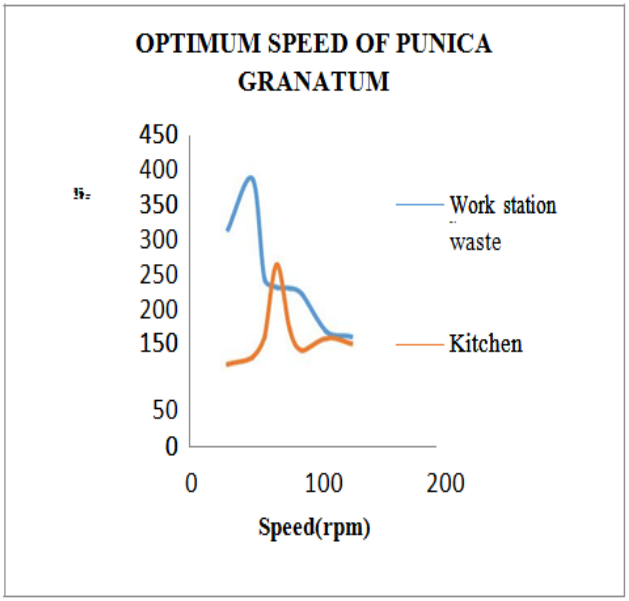

Fig 7: Effect of mixing speed on Turbidity removal Plot Turbidity vs. Speed

In determining the effect of Stirring speed on a Range of 30-130 rpm at an interval of 20 rpm was chosen. There was no much difference in temperature and pH. Also at 130 rpm the Turbidity was found to be Optimum for the Workstation waste water. Similarly for Kitchen waste water the Optimum value may be found to be 30 rpm, the turbidity removal found to be Optimum. It can be therefore mean that the lower mixing speed may improve the removal of Turbidity due to reduced shearing of the flocs during the initial formation which is in agreement with the findings of Fbeling etal(2004).

d) Effect of pH on coagulation

Table 5 &5.1 shows the results obtained when the pH of the raw water sample was varied to study the effect of pH on Coagulation.When adjustment may cause a change in the ionization of the molecule with corresponding effects on bond lengths and configurations and thus light absorption. From Figure 8 It can be found that by varying the pH of the both Workstation waste & Kitchen waste water samples the Optimum values for both Kitchen and Workstation waste were found out as 5.0 and 10.0

Table 5: Effect of pH on Coagulation results at dosage of 1g/L of Punica Granatum for Workstation Waste:

S.NO	OPTIMUM pH	TOTAL SOLIDS (mg/l)	CONDUCTIVITY (µs/cm)	TURBIDITY(NTU)
1	5	20000	102	692
2	6	30000	115.6	826
3	7	2000	114.9	610
4	8	7000	108.7	240
5	9	8000	109.6	793
6	10	20000	107.6	114

Table 5.1: Effect of pH on Coagulation results at dosage of 1g/L of Punica Granatum for Kitchen Waste:

S.NO	OPTIMUM pH	TOTAL SOLIDS (mg/l)	CONDUCTIVITY (µs/cm)	TURBIDITY(NTU)
1	5	5000	103.5	318
2	6	13000	105	368
3	7	25000	102.5	395
4	8	30000	106.9	420
5	9	15000	104.6	358
6	10	12000	105.8	339

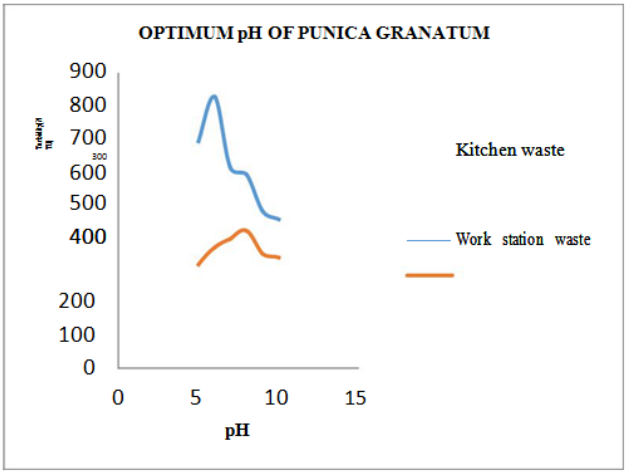

Figure 8: plot of Turbidity against pH showing the effect of pH on Turbidity.

IV. CONCLUSION

From this study, we found out the effects of pH, dosage, stirring speed, time and optimum pH of 10.0, dosage 1 g/l, optimum speed at 130 rpm and stirring time of 15 mins for Workstation Waste samples, we found out the effects of pH, dosage, stirring speed, time and optimum pH of 5.0, dosage 1 g/l, optimum speed at 30 rpm and stirring time of 15 mins for Kitchen Waste samples. The percentage of removal of Turbidity for Kitchen waste, Workstation waste were found to be 90%,30%. By Comparing the two Waste water Samples Punica Granatum has found to be Beneficial.

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