Feasibility of Natural Coagulant for the Treatment of Dairy Wastewater

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Abstract- The dairy industry is one of the most polluting of industries, not only in terms of the volume of effluent generated, but also in terms of its characteristics as well. Wastewater treatment methods include precipitation, coagulation/flotation, sedimentation, filtration, biological process, and chemical reactions. Each method has its own merits and limitations in applications because of their cost. Coagulant is one of the main components in the treatment process. The two most commonly used primary coagulants are aluminium and iron (III) salts. The recent studies have pointed out several drawbacks of using aluminium salts, such as Alzheimer's disease, Neurotoxicity, Cancer, etc. and large sludge volume. Recently uses some natural coagulant produced from plants, animals, & microorganisms. They are readily biodegradable & less volumetric sludge. Amount of sludge is 20 – 30 % that of alum treated. Some of the natural seeds used as natural coagulants are maize, grape seed, nirmali seed, pumpkin seed, Guar, common bean, etc. In this paper I studied with natural seeds such as common bean (*Pharsalus vulgaris*) and jack fruit (*Artocarpus heterophyllus*) are dried in oven and grained to 600µm powder. Coagulated in jar apparatus with dosage 0.2, 0.4, 0.6, 0.8, 1.0 gm/ 500ml of dairy wastewater sample agitated at 125 rpm for 30 minutes and after the samples were allowed to settle for 30 minutes. Characterize the treated effluent and compared and attained 99% removal efficiency.

Index Terms— Dairy wastewater, Common bean (*Phaseolus vulgaris*),Jack fruit (*Artocarpus heterophyllus)*, Seeds, Coagulation, Turbidity.

1. INTRODUCTION

Today, India is the largest milk producing country in the world. The dairy industry involves processing raw milk into products such as consume milk, butter, cheese, yogurt, condensed milk, dried milk (milk powder), and ice cream, using processes such as chilling, pasteurization, and homogenization[1]. Many coagulants are widely used in conventional water treatment processes, based on their chemical characteristics. These coagulants are classified into inorganic, synthetic organic polymers and natural coagulants. The two most commonly used primary coagulants are aluminum and iron salts [2]. Among these will leads to some adverse effect to the environment. Diseases like Alzheimer, nervous disorders, cancer, etc. So the study's lead to overcome these problems by using some natural treatment methods.

The need for simple, reliable and effective method of water treatment led to the application of plant materials, including seed of common bean *(Phaseolus vulgaris)* and jack fruit *(Artocarpus heterophyllus).*

Literature survey reveals that Bahman Ramavaneli studied with the coagulant extracted from Plantagoovatoto treat the turbid wastewater. For the study a biocoagulant extracted from P.ovatoseeds. The seeds soaked in water for a day then filtered seed is dried at 70°C in an oven.

Powdered seeds mixed with 80% ethanol using a magnetic stirrer for 60 minutes. Allow to settle and sludge dried at 60°C. The Coagulation test is carried out in jar test apparatus. Initial turbidity of effluent is 70 NTU and the removal achieved to the standard drinking water turbidity and maximum removal attained at pH < 8 [3].

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G. Muthuraman et al studied with three different seeds in a synthetic turbid wastewater. Synthetic turbid water prepared by adding kaolin in distilled water. Seeds used are *Moringaolifera, Stryhnouspotatorum, Phaseolusvulgaris.* The seedsare powdered and sieved through 63-500µm. Then the seeds are blended with different solvents such as NaCl, Distilled water, NaOH to extract the protein. The filtrate solution used in jar flock test. Varying seeds extracts are added and turbidity removal achieved maximum in 95% to 99% with *Moringaolifera* seed [4].

Garbride Wolf et al studied the experiments in two steps. In the first step determined the optimum pH and coagulant dosage. The optimum dosage and pH are10 – 60 mg/L and 3-9 respectively. Coagulated using tannin based product called Tan floc in jar test apparatus. The turbidity removed is greater than 80% at pH below 9 and below at dosage 20 mg/L. the treated effluent has the potential usage in toilet discharge [5].

T. PhaniMadaviet al studied the turbidity reduction with tamarind seed powder added 50 – 500mg/L and pH varies from 2 - 12 in six different beakers and coagulated in the standard jar test apparatus. The resultant turbidity values are 60, 29, 7, 26.3, and 29.2 at dosage 50,100,150,200,250 mg/L respectively. Then the optimum pH determined with coagulant dose at 150 mg/L are 20,43,47,78,70,65 at pH 2,4,6,8,10,12 respectively. The maximum turbidity removal achieved is 78% at pH 8 and optimum dosage 150 mg/L [6].

D. S Bhutada et al studied uses natural coagulant *Moringaolifera* as herbal coagulant to treat dairy wastewater. Seeds are dried and powered using laboratory crushers. The added ranges of dosage were 30 – 90 mg/L and fuller earths add as coagulant aid. Before coagulation done the preliminary treatment such as screening, oil and grease trap, holding cum equalization. Coagulated using jar test apparatus. The COD reductions attain 62 – 66 %[7].

Nawash B et al studied with *M. oleifera* seeds and otherlocal plants such as *V. unguiculata* and *C. procera*. The wastewater collected from dairy industry. Seeds of *Moringaolifera* and*V. unguiculata* and leaves of *C. procera.*Coagulants are completely dried and powdered. The mixed powder treated with wastewater in magnetic stirrer at 300rpm for 60 seconds. Analyzed the reduction of parameters such as BOD, COD, turbidity, hardness, pH. Reduction of pH from 8.26 to 7.42, hardness from 19-25%, turbidity from 3.5 – 1.75 NTU, COD removal from 685.4 – 450 mg/L and BOD from 127- 104.5 mg/L. They suggested the M. olifera seed is sustainable and economical way to treating dairy wastewater [8].

A. M. Abdelaal studied with natural coagulant bentonite clay. The experiment carried out in jar apparatus. The dosage of bentonite varies from 0 - 22 mg/L and 0 – 20 mg/L respectively. Using bentonite can remove colour from 20 to 92. 5%, COD from 27 to 6.5, SS from 197.5 to 5 mg/L, pH from 4.1 to 7.7. Bentonite is also a nontoxic material [9].

This study was an effort to investigate the dairy wastewater treatment potential of indigenous seeds common bean (*Phaseolus vulgaris*) and jack fruit (*Artocarpus heterophyllus*).

2. OBJECTIVES

The objectives of this study were

1. To identify the removal efficiency common bean (*Phaseolus vulgaris*) and jack fruit (*Artocarpus heterophyllus*).

2. To determine either common bean (*Phaseolus vulgaris*) or jack fruit (*Artocarpus heterophyllus*) is most effective.

3. MATERIALS AND METHODS

The dairy wastewater collected from the Thevally Milma Industry. This industry produce different products like ghee, butter, sweetened milk, cream, curd, etc. The treatments were done in the plant are screening, equalization, and activated sludge process finally the treated effluent discharged into the nearby lake. To conduct the study screened raw water collected and the initial parameters analyzed the procedure given in Standard Method [10].such as turbidity, pH, conductivity, TS, SS, DS are characterized. Shown in table 1

TABLE 1. INITIAL CHARACTERS OF WASTEWASTER

Parameters	Initial Characters
pH	6
Turbidity	475 NTU
Conductivity	500 µS/cm
TS	5000 mg/L

3.1 Seeds Preparation

Phaseolus vulgaris (Common Beans) and *Artocarpusheterophylius* (jack fruit) good quality seed collected by removing the husk. Dried in preheated oven at 100°C for a day and powdered. The finely powdered seeds sieved through the 300µm sieve and stored in an air tighten container.

Fig 1. Common Beans seed powder.

Fig 2. Jackfruit seed powder.

3.2 Jar Test Apparatus

Coagulation and flocculation are important unit processes in water and wastewater treatment plants. The purpose of coagulation/flocculation is to remove suspended matter, turbidity, colour, microorganisms, and odour producing substances. Coagulation involves the addition of chemicals to destabilize the suspended particles, colloidal materials, and macromolecules. Jar test apparatus was selected to be used for coagulation-sedimentation studies. Time constraints followed in coagulation sedimentation studies are: Rapid mixing- 5 min (100 rpm), Slow mixing- 25 min (130 rpm) and Sedimentation- 30 min.

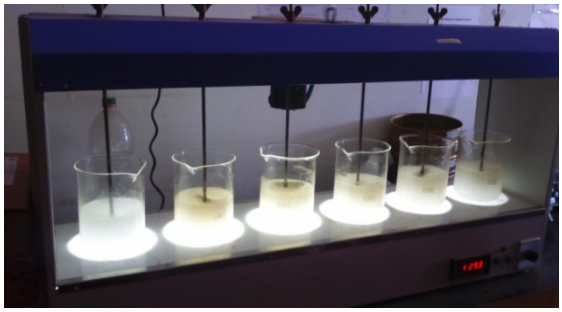

Fig. 4. Standard jar test apparatus.

Fig.4. After 30 minutes coagulation

Fig. 5. After settling & filtration

4. RESULTS AND DISCUSSION

4.1. Coagulation studies with *Artocarpus hertrophylius* (jack fruit)

The dosage of*Artocarpusheterophylius* (jack fruit) seed varies the different character of treated effluent are examined. The turbidity of effluent examined usingNephelometric Turbidity meter,pH using pH meter, conductivity with conductivity meter., also calculated the solid content. The treated effluent characters as shown in the table 2.

TABLE 2. TREATED EFFLUENT CHARACTERS USING *ARTOCAPHUS HETRROPHYLIUS (JACK FRUIT) SEED*

Dosage mg	Turbidity NTU	pH	Conductivity µS/cm	TS mg/L
Blank	10	6	483	5900
.2	27	7.7	1281	5200
.4	27	8.5	1087	4500
.6	26	8.3	1030	5600
.8	29	8.2	1010	1900
1.0	27	8.2	1313	1000

In treating with jack fruit seed the turbidity removal achieved to 94%. Variation turbidity, pH, conductivity with different dosage is shown in fig. 6, 7, 8. pH changes to nearly to neutral. But the conductivity increased too. It is due to the ionic characters of the seed.

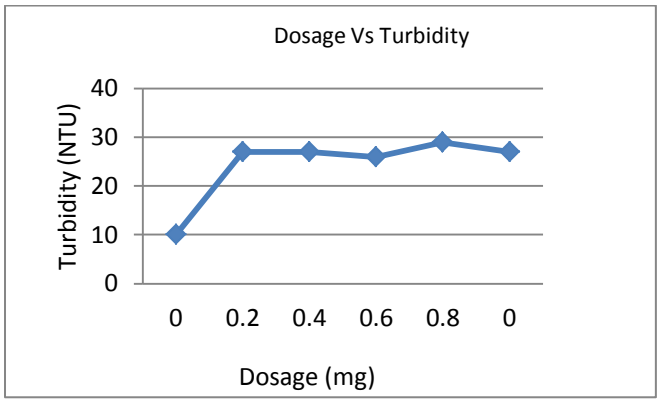

Fig. 6.Variation of turbidity for different dosage of *Artocarphus hetrophylius* (jack fruit) seed powder.

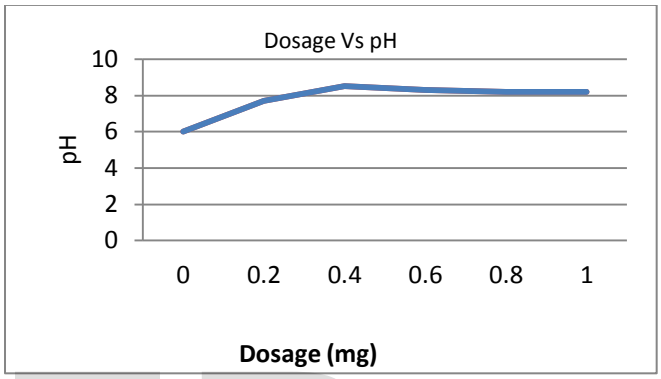

Fig. 7.Variation of pH for different dosage of *Artocarphus hetrophylius* (jack fruit) seed powder.

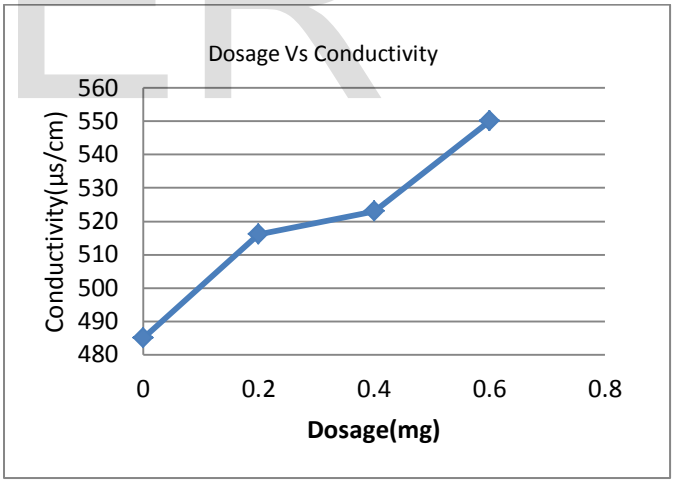

Fig 8.Variation ofconductivity for different dosage of *Artocarpus heterophylius* (jack fruit) seed powder.

4.2 Coagulation studies with *Phaseolus vulgaris* (common beans) Seed

The dosage of *Phaseolus vulgaris*(Common Beans)seed varies the different character of treated effluent are examined. Variation turbidity, pH, conductivity with different dosage is shown in fig. 9, 10, 11. The turbidity of effluent examined using pH using pH meter, conductivity with conductivity meter, also calculated the solid content. The treated effluent characters as shown in the table 3

TABLE 3. TREATED EFFLUENT CHARACTERS USING *PHASEOLUS VULGARIS(COMMON BEANS) SEED*

Dosage mg	Turbidity NTU	pH	Conductivity µS/cm	TS mg/L
Blank	10	6.0	485	7100
0.2	5	5.2	516	4300
0.4	5	5.3	523	2700
0.6	5	5.3	550	4200
0.8	5.0	5.4	576	4900
1.0	4.9	5.5	606	5200

While treating with common beans seed the turbidity removed upto 99%, pH value is also reduced. The conductivity slightly increased from the effluent waste. But the turbidity can be removed to maximum level.

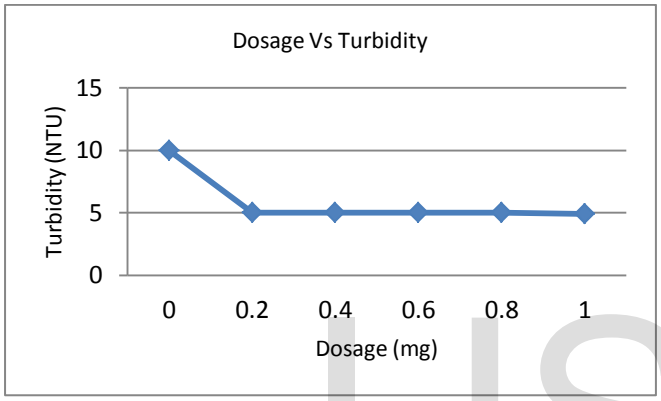

Fig 9: Variation of turbidity for different dosage of *Phaseolus vulgaris* (common Beans) seed powder.

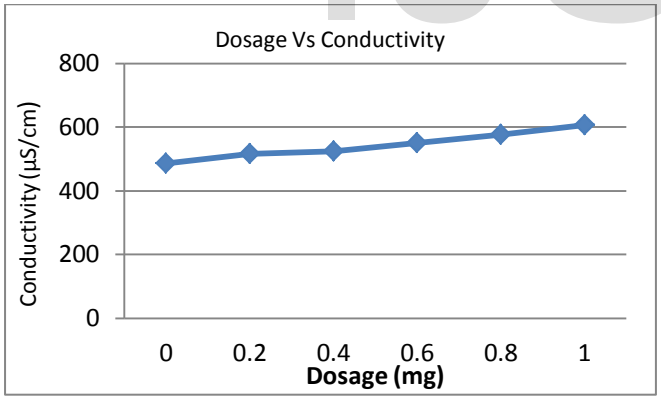

Fig 10: Variation of conductivity for different dosage of *Phaseolusvulgaris* (common Beans) seed powder.

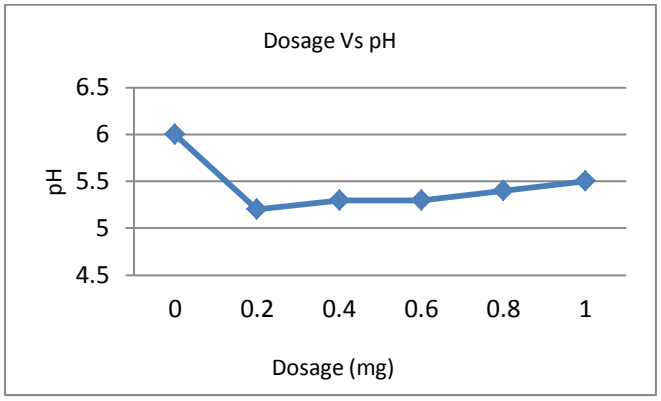

Fig 11: Variation of pH for different dosage of *Phaseolus vulgaris* (common Beans)seed powder.

5. CONCLUSIONS

The dairy industry is the one of the leading industry in the world. But the effluent content leads to the some problems such as turbidity, oil and grease, organic content etc. If treating this effluent with some chemicals leads some health problems. So these can be overcome by using some natural materials. In this study using the two seeds an effective removal of turbidity is obtained. Coagulating with *Artocarpusheterophylius* (jack fruit) seed attained 94% removal efficiency, while with the *Phaseolus vulgaris* (Common Beans) seed obtain a highly removal efficiency upto 99%.

Phaseolus vulgaris (Common Beans) seed can use as an effective coagulant in the dairy wastewater treatment mainly for the turbidity removal.

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REFERENCES

[1]. Pallavi N, Dr. S. Mahesh,"Feasibility Study of MoringaOleifera as a Natural Coagulant for the Treatment of Dairy Wastewater",*International Journal of Engineering Research*, Vol 2, pp: 200-202, July 2013.

[2] .KokilaParmar, YogeshDabhi, Rinku Patel,SarjuPrajapati,"Effectiveness ofMoringaoleifera as natural coagulant aid for waste watertreatment of dairy industry",*Asian Journal Of Environmental Science*, Vol. 7, pp167-171, December 2012.

[3] .BhamanRamavandi, "Treatment of water turbidity and bacteria by using a coagulant extracted from Plantago ovate", *Water Resources and Industry*, Vol 6, pp 36–50, 2014.

[4]. G. Muthuraman, S. Sasikala, N. Prakash, "Proteins from Natural Coagulant for Potential Application of Turbidity Removal in Water", *International Journal of Engineering and Innovative Technology (IJEIT)*, Vol 3, pp 278-283, July 2013.

[5]. Gabriele Wolf, Roselene Maria Schneider, MileneCarvalhoBongiovani, Eduardo Morgan Uliana, "Adriana Garcia do Amaral, Application of Coagulation/Flocculation Process of Dairy Wastewater from Conventional Treatment Using Natural Coagulant for Reuse", *The Italian Association of Chemical Engineering*, VOL. 43, pp 2041-2046, 2015.

[6]. T. PhaniMadhavi, R. RajKumar, "Utilisation of Natural Coagulant for Reduction of Turbidity from Waste water",

International Journal of Chem Tech Research, Vol.5, pp 1119-1123, April-June 2013.

[7]. D.S. Bhutada, M.T. Datar and S.N. Kaul, "Use of Herbal Coagulant for Primary Treatment of Dairy Wastewater", Journal of Industrial Pollution Control, vol 22, pp 139-148, 2006.

[8]. Nawash. B, Vasudevan. G, Yogesh. S, Ramesh Babu. N. G and Hemakalai Rani. R, "Comparative Study of Parameters for Treatment of Dairy Wastewater by Biomass of Various Plants", *International Journal of Engineering Research & Technology*, Vol. 3, pp 1072-1076, January – 2014.

[9]. A.M. Abdelaal,"Using A Natural Coagulant For Treating Wastewater", *Eighth International Water Technology Conference*, pp 781-792, 2004.

[10]. American Public Health Association, American Water Works Association and Water Pollutional Control Federation (WPCF) (1989). Standard Methods for the examination of Water and Wastewater, 17th Ed., APHA Pub.Office, Washington D.C.