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Use of Natural Coagulant for Dairy Wastewater Treatment

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Abstract: The dairy industry uses massive amounts of water to process raw milk for dairy products and generates roughly 3 L of wastewater per 1 L of processed milk. The wastewater discharge from this dairy industry contains a high concentration of organic material such as fats, carbohydrates, grease, proteins, etc. Due to these organic materials, dairy wastewater having high COD and BOD values. Turbidity is the generally cloudy appearance of water; Due to pollutants available in dairy wastewater, if it is not properly treated then it may cause serious environmental issues. As per the current Water Pollution Control Regulations, all industry has to comply with the norms for effluent discharge. Therefore characterization, appropriate treatment, and disposal of Dairy effluents are of important concern. The most important challenge is to find cost-efficient and environmentally sustainable approaches to enable water reuse and waste management. The present study focuses on comprising the coagulant activity of alternatives to treat Dairy wastewater with environment-friendly natural coagulants. The main purpose of this study is to investigate the assessment of three different plant-based natural coagulants namely cactus, orange peels, and neem tree leaves.

1. Introduction

Dairy wastewater contains organic material which has high concentration such as fats, carbohydrates, grease, proteins, etc. Due to these organic materials, dairy wastewater having high COD and BOD values. Dairy wastewater is treated by physical, chemical, and biological processes. In the chemical process various chemical coagulants like Aluminium Sulphate (Alum), Poly Aluminium Chloride, Aluminium Chloride, Ferric Chloride, etc, are very costly for wastewater treatment and are not economical. Because use of chemical coagulants to remove colloidal particles leads to the generation of sludge. Again, treatment and disposal of sludge is a problem. So in place of chemical coagulants, we use natural coagulants such as cactus, neem leaves, orange peels. The main aim of this review is the use of natural coagulants in wastewater treatment, to reduce COD, Turbidity, TDS, and to obtain suitable pH. The use of natural coagulants in wastewater treatment may help in reducing cost as in place of costly chemical coagulants and are also environment - friendly.

2. Materials and Method

Sample collection

Wastewater sample was collected from the "Dairy Wastewater Treatment Plant", which processes a huge amount of milk and produces its by-products like cottage cheese, flavor milk, Ghee, Spiced butter-milk, curd, etc. The Wastewater of dairy contains high Turbidity, PH, COD & TDS, by treating & making reusable such a huge quantity of wastewater will truly serve the society & due to this reason, the dairy is selected for the study purpose. Wastewater Effluent was collected after Screening, 4 times in a week.

Coagulant Preparation

Orange peel:

Orange peels were collected from the local market & washed many times with tap water to remove adhesive dirt from it and a further sample was dried under Sunlight for 4 to 6 days.

Later on, crushed it with mixture & obtained powder form sieved with mesh size 3 to 5 mm. Again washed with distilled water to remove any acidity or alkalinity & oven-dried at 80°c for 24 hours, then used it as a coagulant.

Neem Leaves:

Neem leaves were collected and washed many times with tap water to remove impurities and dirt from it. The leaves were then dried under sunlight for 2 to 3 days & then ground to make fine neem leaves powder.

Cactus:

Cactus was collected from the farm & its thrones were removed. Then washed it with tap water to remove adhesive dirt and impurities present in it. Further cactus was dried under sunlight for 7 to 8 days. Later on, ground it with mixture & sieved it. Again, washed with distilled water & oven-dried at 100°c for 24 hours & then used it as a coagulant.

Jar test:

The dose of the coagulant to be used can be determined via the jar test. The jar test involves exposing the same volume samples of the water to be treated to different doses of the coagulant and then simultaneously mixing the samples at a constant rapid mixing time. The micro floc formed after coagulation further undergoes flocculation and is allowed to settle. Then the turbidity of the samples is measured and the dose with the lowest turbidity can be said to be optimum.

Jar test experiments

For an effective coagulant dose, we have performed some experiments on dairy wastewater at the environment laboratory. Using moringa oleifera, brinjal seeds, Chana powder, Hibiscus (flower) powder, etc.

Experimental setup:

Jar test experiment carried out using the jar test apparatus which consists of six beakers with mixing paddle

and a gauge for revolution per minute (rpm). The experiments were performed using dairy wastewater samples. For each water sample, six beakers were filled with 1000ml, placed in the jar tester and then coagulant with different dosages was added. After that stirred at approximately 100 rpm for 1 minute. The rapid mix stage allows dispersing the coagulant throughout each container, then speed was Reduced up to 30 to 40 rpm and maintained at slow mixing for 20 minutes. The slower mixing speed helps promote floc formation by enhancing particle collision which leads to larger floc formation. Turn off the mixer and allow the containers to settle for 30 minutes. Then measure the final turbidity in each container. After that, a graph of residual Turbidity vs. Coagulant dosage is plotted and the optimum dosage is determined.

For the test results following parameters were checked:

a. Initial turbidity
b. Initial pH
c. Turbidity of a sample at different dosages
d. the pH of a sample after coagulation

Results:

Effect on total solids & COD at the optimum dose

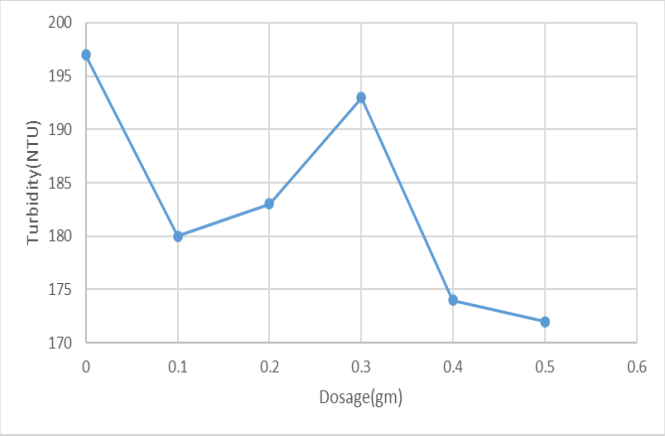
1) Coagulant: Cactus

Sample: Wastewater of Dairy Industry

Initial Turbidity: 487NTU

Initial pH: 7.6

Dosage(gm)	Turbidity (NTU)	pH
0	197	7.3
0.1	180	7.5
0.2	183	7.5
0.3	193	7.5
0.4	174	7.4
0.5	**172**	**7.5**



COD test table

	Initial	Final
Blank sample (distilled water)	**0**	**22.8**
Initial (w. w)	**0**	**12.4**
Cactus	**0**	**19.7**

Initial COD = 3328 mg/l.

Outlet COD = 992 mg/l.

TDS test table

Filter paper weight		Container weight	
Initial (gm)	**Final (gm)**	**Initial (gm)**	**Final (gm)**
4.623	**4.781**	**120.737**	**120.798**

Suspended solids = 0.158 gm

Dissolved solids = 0.061 gm

Total solids = 0.219 gm

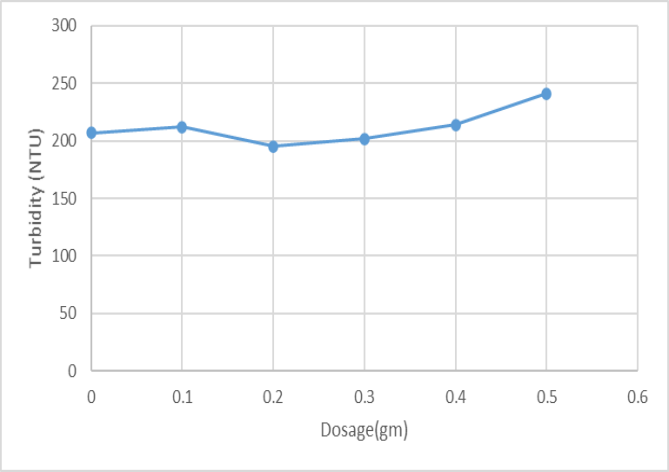
2) Coagulant: Orange peel powder

Sample: Wastewater of Dairy Industry

Initial Turbidity: 487NTU

Initial pH: 7.6

Dosage(gm)	Turbidity (NTU)	pH
0	207	7.2
0.1	212	7.3
0.2	**195**	**7.3**
0.3	202	6.8
0.4	214	6.3
0.5	241	6.1



COD test table

	Initial	Final
Blank sample (distilled water)	**0**	**22.8**
Initial (w. w)	**0**	**12.4**
Orange peel powder	**0**	**18.5**

Initial COD = 3328 mg/l.

Outlet COD = 1376 mg/l.

TDS test table

Filter paper weight		Container weight	
Initial (gm)	Final (gm)	Initial (gm)	Final (gm)
4.623	**4.781**	**120.737**	**120.798**

Suspended solids = 0.158 gm

Dissolved solids = 0.061 gm

Total solids = 0.219 gm

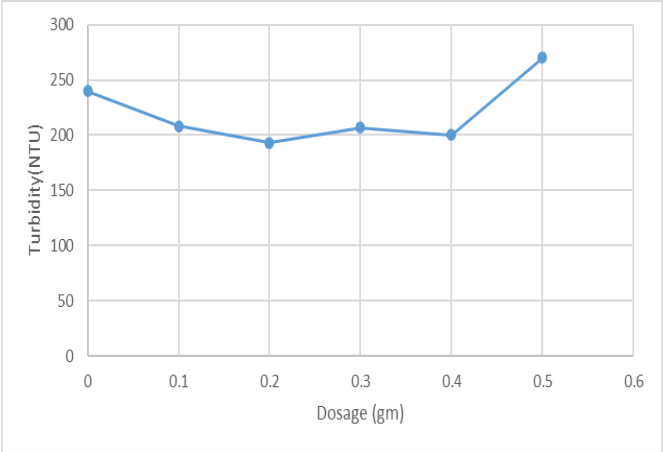
3) Coagulant: Neem tree leaves

Sample: Wastewater of Dairy Industry

Initial Turbidity: 422NTU

Initial pH: 9.5

Dosage(gm)	Turbidity (NTU)	pH
0	240	9.3
0.1	208	9.3
0.2	**193**	**9.3**
0.3	207	9.3
0.4	200	9.5
0.5	270	9.6



COD test table

	Initial	Final
Blank sample (distilled water)	**0**	**23.6**
Initial (w. w)	**0**	**11.9**
Neem tree leaves	**0**	**18.2**

Initial COD = 3744 mg/l.

Outlet COD = 1728 mg/l.

TDS test table

Filter paper weight		Container weight	
Initial (gm)	Final (gm)	Initial (gm)	Final (gm)
4.579	4.748	114.021	114.087

Suspended solids = 0.169 gm

Dissolved solids = 0.066 gm

Total solids = 0.235 gm

Conclusion

Dairy wastewater is treated by physical, chemical, and biological processes. In the chemical process, various chemical coagulants like alum, ferric chloride, etc are used. The use of chemical coagulants to remove colloidal particles leads to the generation of more sludge. Again treatment and disposal of sludge is a problem. So in place of chemical coagulants, we use natural coagulants such as cactus, neem leaves, orange peels. The results obtained using natural coagulants are very satisfactory. Among these three natural coagulants Cactus was found most effective. Coagulating with Cactus attained 64.65% Turbidity removal efficiency and 72.60% COD removal efficiency. So by using a natural coagulants environment will be benefited and also economical.

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