

Treatment of dairy wastewater by natural coagulants

Prof. Chidanand Patil¹, Ms. Manika Hugar²

¹ Assistant professor, Environmental Engineering, KLEMSSCET Belgaum, Karnataka, India

²PG Scholar, Environmental Engineering, KLEMSSCET Belgaum, Karnataka, India

Abstract - The dairy industry is generally considered to be largest source of food processing. These industries wastewater is characterized by high COD, BOD, nutrients etc. Such wastewater is to be treated natural coagulants and then tests are to be carried to check the water characteristics like BOD, COD, pH and turbidity, etc. The initial pH, Turbidity, COD are 7.41, 289.5 NTU, 10000 mg/l respectively. Natural coagulants to be used are Moringa Oleifera seeds, Trigonella foenum-graecum, Dolichos lablab and Cicer arietinum. The efficiency of reduction of turbidity by M.oleifera, Dolichos lablab, T.foenum-graecum and Cicer arietinum are 61.60%, 71.74%, 58.20% and 78.33% respectively. The efficiency of reduction of COD from M.oleifera, Dolichos lablab, T.foenum-graecum and Cicer arietinum are 65.0%, 75%, 62.5% and 83% respectively. For variation of doses of these natural coagulants the reduction of solids takes place. There is not much change in pH and conductivity due to natural coagulants. The efficiency of Cicer arietinum is more compared to other three; this depends on the protein content which is present in the natural coagulant. The increase of dosage causes the increase of turbidity.

Key Words: natural coagulant, Solids, turbidity, COD, water treatment, M.oleifera, C.arietinum, D.lablab, T.foenum-graecum

1. Introduction

The dairy industry is generally considered to be the largest source of food processing wastewater in many countries. With increase in demand for milk and milk products, many dairies of different sizes have come up in different places. These dairies collect the milk from the produces, and then either simply bottle it for marketing, or produce different milk foods according to their capacities. Large quantity of wastewater originates due to their different operations. The organic substances in the wastes comes either in the form in which they were present in milk, or in a degraded form due to their processing. As such, the dairy wastes, through biodegradable, are very strong in nature. [1]

1.1. Characteristics of wastewater

In dairy, wastewater is often discharged intermittently. The nature and composition of wastes depends on type of products produced and processing capacity of the plants. Dairy cleaning waters may also contain a variety of sterilizing agents and various acid and alkaline detergents. Thus, the pH of the wastewaters can vary significantly depending on the cleaning strategy employed. Dairy wastewaters are characterized by high biochemical oxygen demand (BOD) and chemical oxygen demand (COD) concentrations. Chemical oxygen demand (COD), which is normally about 1.5 times the BOD level, It also contains total solids, total dissolved solids, nitrogen and phosphorous. Important indicators for the quantification of organic load of dairy plant effluents are biological oxygen demand (BOD), chemical oxygen demand (COD), the ratio of COD to BOD indicates the biodegradability of organic materials under aerobic or anaerobic condition. [2]

Table-1: Characteristics of dairy wastewater

Parameter	Units	Value (untreated)
pH	-	7.41
Color	Hazen	White
BOD	mg/L	2250
COD	mg/L	10000
Total solids	mg/L	2033
Total Dissolved solids	mg/L	1200
Total suspended solids	mg/L	833
Oil and grease	mg/L	1425
chloride	mg/L	417

1.2. Material and Methodology

The coagulants which are used in this study are *Moringa oleifera*, *Trigonella foenum-graecum*, *Dolichos lablab* and *Cicer arietinum* for treatment of dairy wastewater. The natural coagulants are collected from the local market of belagavi, Karnataka, India.



Fig-1: *M.oleifera*



Fig-2: *C.arietinum*



Fig-3: *D.lablab*



Fig-4: *T.foenum-graecum*

1.3. Preparation of natural coagulants

The seed pods of *Cicer arietinum*, *Dolichos lablab*, *Moringa oleifera* and *T.foenum-graecum* are collected, and dried naturally by sunlight. And remove the seeds from the pod manually. The dried seeds were ground to fine powder by domestic blender. This powder was sieved through 600µm sieve. [4, 3, 6]

1.4. Coagulation study

For the study of coagulation jar apparatus has been used. The doses considered for the natural coagulants are 0.025gm, 0.05gm, 0.1gm, 0.2gm, 0.3gm, 0.4gm, 0.5gm. The jar apparatus has the six beakers and six steel paddles which helps in the agitation process. The initial speed of agitation is 100rpm for 2 min, followed by 40rpm for 30min. The settling time applied for this coagulation process is 60 min.

2. Results and discussion

2.1. Optimum dosage

The optimum dosage of coagulants are determined by varying the dosage of coagulants are 0.025gm, 0.05gm, 0.1gm, 0.2gm, 0.3gm, 0.4gm, 0.5gm/500ml at original pH of dairy wastewater (pH =7.41).

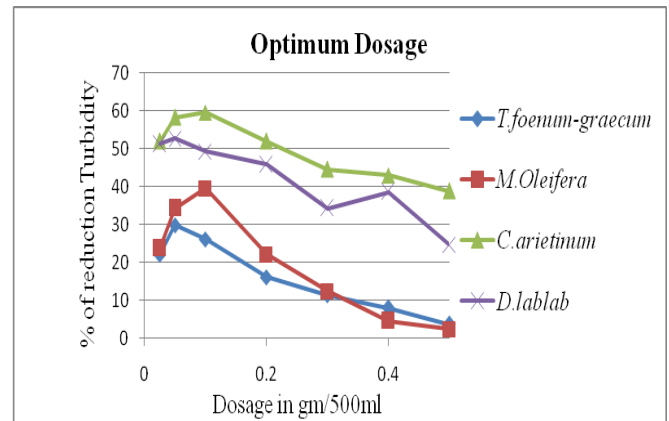


Chart -1: Optimum Dosage of natural coagulants

The optimum dosage of *T.foenum-graecum*, *M.oleifera*, *C.arietinum* and *D.lablab* are 0.05gm, 0.1gm, 0.1gm and 0.05gm respectively.

2.2 Optimum pH

Optimum pH is pH at which the maximum reduction of turbidity takes place. Optimum pH can be determined by varying the pH value as 6, 7.41, 8, 9, 10, 11. The below chart-2 shows optimum pH. [5]

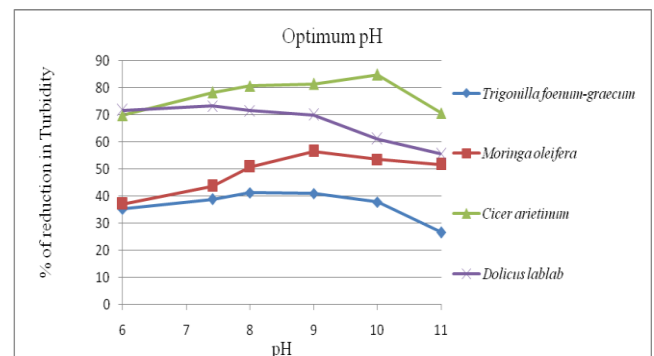


Chart-2: optimum pH of natural coagulants

The optimum pH for the *T.foenum-graecum*, *M.oleifera*, *C.arietinum* and *D.lablab* are 8, 9, 10 and 7.41 respectively.

2.3. Efficiency of natural coagulants

The performance evaluation can be determined by varying the COD value by dilution method and note down the initial value of Turbidity. Efficiency can be determined by maximum reduction of turbidity and COD after treatment of Dairy wastewater by natural coagulants with optimum dosage at optimum pH.

Table -2: Loading rate of COD

SL NO	COD mg/l
1	2000
2	4000
3	6000
4	8000
5	10000

2.3.1. Efficiency of *T. foenum-Graecum*

For each loading rate of COD, note down the initial turbidity. Then treat the dairy wastewater by *T. foenum-graecum* coagulant with optimum dosage (0.05/500ml) at optimum pH (8) of wastewater and determined the reduction of turbidity as shown in chart 3.

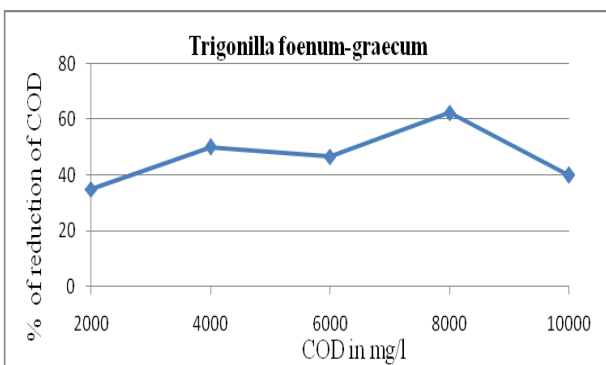


Chart-3: Effect of *Trigonilla foenum-graecum* in reduction of turbidity

The maximum reduction in turbidity is 58.20% at 8000mg/l, hence the reduction efficiency of *Trigonella foenum-graecum* is 58.20%. Chitti Ramamurthy et al. studied the reduction of turbidity of pond water was due to phytochemical compounds (Plant sterol and steroid) which are present in the *Trigonella foenum-graecum*. [7]

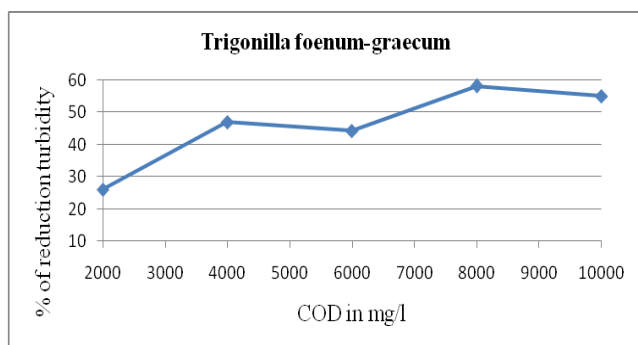


Chart-4: Effect of *Trigonella foenum-graecum* on reduction of COD

The maximum reduction of COD by *Trigonella foenum-graecum* with optimum dosage (0.05gm/500ml) at optimum pH (8) is 62.5%. Hence the efficiency of *Trigonella foenum-graecum* is 62.5% in reduction of COD.

2.3.2. Efficiency of *Moringa oleifera*

The COD varies as shown in the table 2. By the effect of *Moringa Oleifera* coagulant the reduction of turbidity is 61.60 %. The earlier study of Parmar Gaurang and Parikh Punita recommended the reduction of turbidity was takes place due to active component of *M.oleifera* seeds, which was found to be soluble cationic proteins having molecular weight of 13 kDa. This will binds with solid particles. Hence the reduction of turbidity and COD takes place. [8]

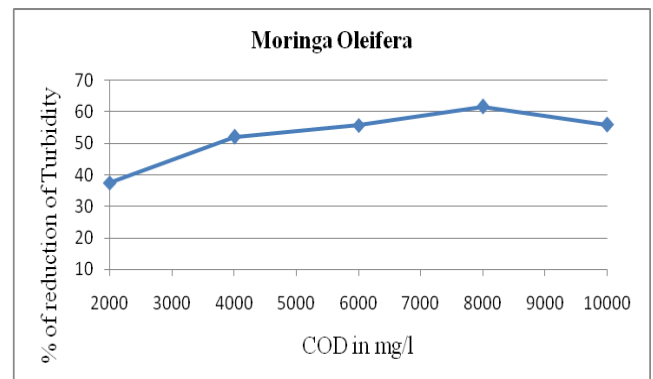


Chart-5: Effect of *Moringa Oleifera* in reduction of turbidity

Efficiency of *Moringa oleifera* is determined by optimum dosage of coagulant with optimum pH of dairy wastewater. By the effect of *Moringa Oleifera* coagulant the reduction of turbidity is 61.60 % at COD value of 8000 mg/l.

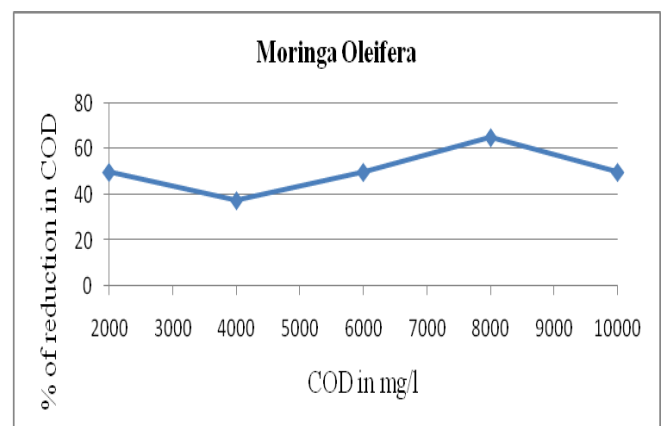


Chart-6: Effect of *Moringa Oleifera* in reduction of COD

The reduction of COD is 65% at 8000 mg/l by optimum dosage of 0.1 gm/ml and optimum pH of 9 for *Moringa Oleifera* coagulant.

2.3.3. Efficiency of *Cicer arietinum*

To determination of efficiency of *C. arietinum*, the optimum dosage and optimum pH can be maintained. Optimum dosage is 0.1gm/500ml and optimum pH is 10.

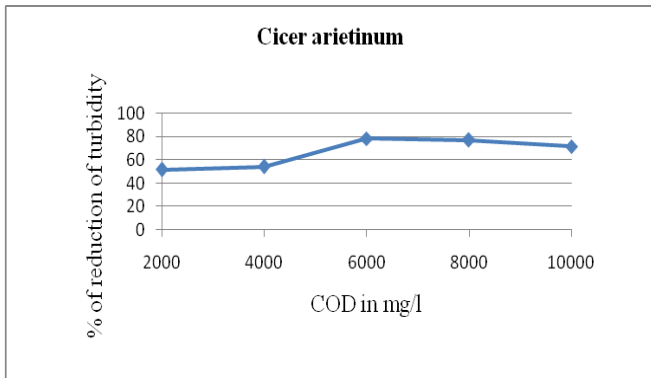


Chart-7: Effect of *Cicer arietinum* in reduction of turbidity

The reduction in turbidity for the dairy wastewater is 78.33 % at 6000 mg/l by the influence of *Cicer arietinum* coagulant. The *Cicer arietinum* is more effective than other natural coagulants such as *T.foenum-graecum*, *M.oleifera* and *D.lablab*. Sonal Choubey et al. [9], studied the efficiency of *M.oleifera*, *D.lablab* and *Cicer arietinum* in reduction of turbidity of synthetic turbid water and in the study also *Cicer Arietinum* is more effective than the other two.

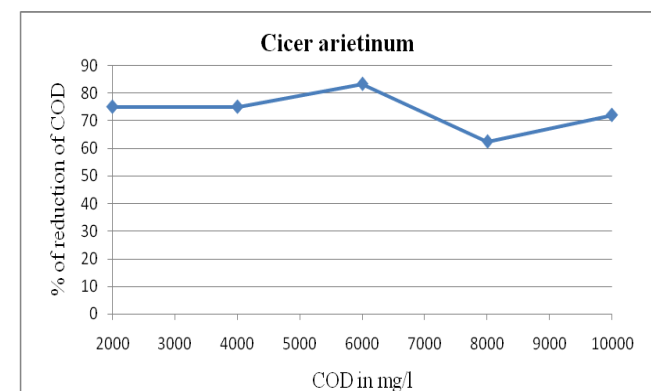


Chart-8: Effect of *Cicer arietinum* in reduction in COD

The reduction of COD is 83.3 % at 6000 mg/l of COD by optimum dosage and optimum pH of *Cicer arietinum*.

2.3.4. Efficiency of *Dolichos lablab*

The efficiency of *Dolichos lablab* can be determined with the optimum dosage and optimum pH. The optimum dosage is 0.05gm/500ml and optimum pH is 7.41.

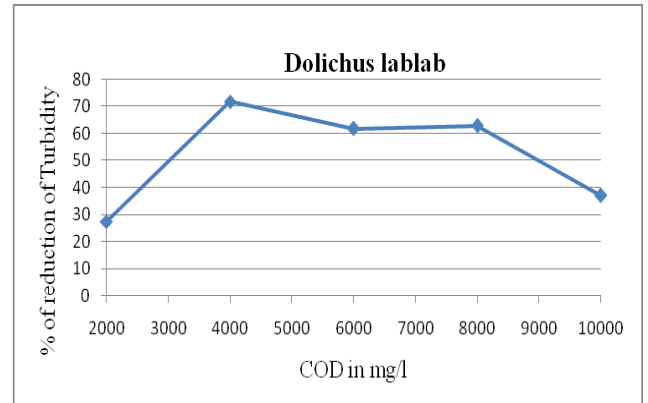


Chart-9: Effect of *dolichos lablab* in reduction of turbidity

The reduction of turbidity is 71.74 % at 4000 mg/l of COD at dosage of 0.05gm and pH of 7.41.

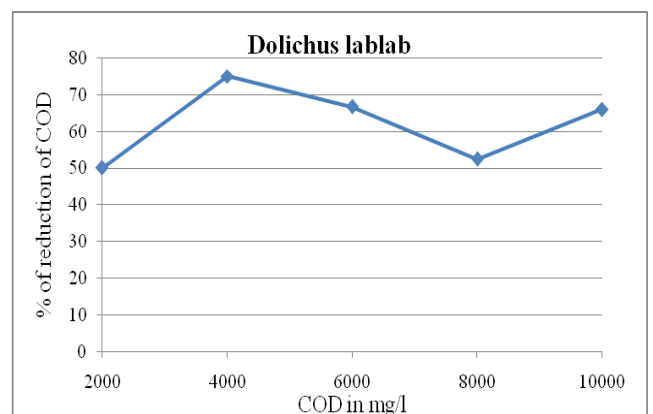


Chart-10: Effect of *Dolichus lablab* in reduction of COD

The reduction of COD is from 4000 mg/l to 1000 mg/l which means the percentage of reduction is 75%.

2.4. Comparison of efficiency of natural coagulants in terms of reduction of both turbidity and COD

Table-3: Comparison of efficiency of natural coagulants

SL NO	Natural Coagulants	% of Reduction of Turbidity	% of Reduction of COD
1	<i>Trigonella foenum-graecum</i>	58.20	62.5
2	<i>Moringa Oleifera</i>	61.60	65.0

3	<i>Dolicus lablab</i>	71.74	75
4	<i>Cicer arietinum</i>	78.33	83

The efficiency of *T. foenum-graecum*, *M.oleifera*, *C.arietinum* and *D.lablab* in the reduction of turbidity and COD with their optimum dosage at optimum pH value are given in the above table. Among the four natural coagulants, the maximum reduction of turbidity and COD is 78.33% and 83% for *Cicer arietinum*; hence the *Cicer arietinum* is more effective for treatment of dairy wastewater.

2.5. Effect of natural coagulant on pH

After treatment of dairy wastewater by natural coagulants with the initial pH, Change in pH can be analyzed and it is shown in the below figure.

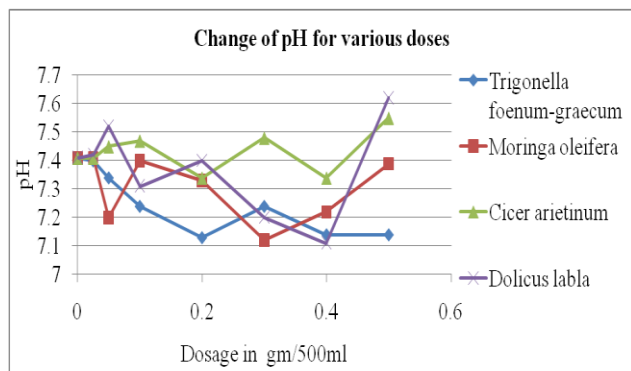


Chart-19: The change of pH due to natural coagulants

There is no significant change in pH due to natural coagulants. It is changing in decimal values so it is considered as almost negligible.

2.6. Effect of natural coagulant on Conductivity

There is no significant change in conductivity due to natural coagulants.

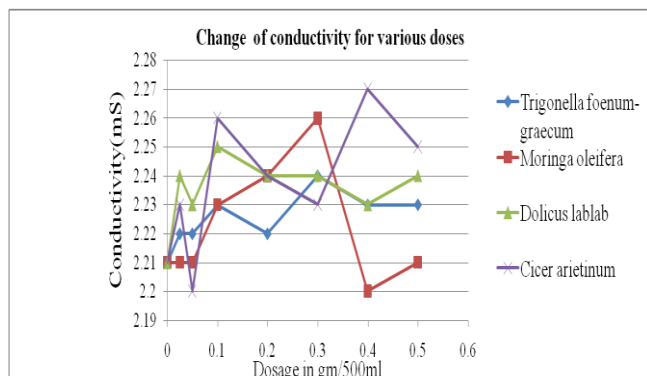


Chart-20: The change of conductivity due to natural

Coagulants

3. CONCLUSIONS

The characteristics of untreated dairy wastewater are pH - 7.41, conductivity-2.21mS/cm, COD-10000 mg/l, BOD-2250 mg/l, total solids-2033 mg/l, suspended solids- 1200 mg/l, dissolved solids-833 mg/l, Turbidity-289.5 NTU. The optimum dosage of *T.foenum-graecum*, *Moringa Oleifera*, *Cicer arietinum* and *Dolichos lablab* seed powder as a coagulant is found to be 0.05/500ml, 0.1gm/500ml, 0.1gm/500ml and 0.05gm/500ml respectively. The optimum pH of *T.foenum-graecum*, *M.oleifera*, *C. arietinum* and *D.lablab* are found to be 8, 9, 10, 7.41 respectively. Among the three natural coagulants, the maximum reduction of turbidity and COD is found to be 78.33% and 83% with *Cicer arietinum*; hence the *Cicer arietinum* is more effective for treatment of dairy wastewater.

ACKNOWLEDGEMENT

The authors can acknowledge any person/authorities in this section. This is not mandatory.

REFERENCES

- [1] M.N.Rao, A.K.Datta, "wastewater treatment, Rational Methods of design an industrial practices", Oxford & IBH Publishing Co.Pvt.Ltd, 3rd Edition, 1999.
- [2] Onet Crisian, "Characteristics of the untreated wastewater produced by food industry" Journal of Environmental Sciences, Vol. XV, 2010.
- [3] C.Ramamurthy, Malige Uma maheswari, Natarajan Selvaganabathy, "Evaluation of eco-friendly coagulant from *Trigonella foenum-graecum* seed", Journal Of Advances in Biological Chemistry, vol.2,pp.58-63,2012.
- [4] Syeda Azeem Unnisa, Punam deepthi and Khagga mukanti, "Efficiency studies with *dolichos lablab* and solar disinfection for treating turbid waste waters", Journal Of Environmental Protection Science, vol.4,pp.8-12, 2010.
- [5] Md. Asrafuzzaman, A.N.M. Fakhruddin, and Md. Alamgir Hossain, "Reduction of Turbidity of Water Using Locally Available Natural Coagulants" ISRN Microbiology Volume, Article ID 632189, 2011.
- [6] Tasneem banu Kazi, Arjun Virupakshi, "Treatment of Tannery Wastewater Using Natural Coagulants" International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue 8, 2013, pp: 43-47.
- [7] Chitteti Ramamurthy, Malige Uma Maheswari, Natarajan Selvaganabathy, Muthuvel Suresh Kumar, Venugopal Sujatha, Chinnasamy Thirunavukkarasu, "Evaluation of eco-friendly coagulant from *Trigonella*

- foenum-graecumseed”, *Advances in Biological Chemistry*, vol. 2, pp.58-63, 2012.
- [8] Parmar Gaurang and Parikh Punita, “An evolution of turbidity removal from industrial waste by natural coagulants obtained from some plants”, *Journal of Environmental Research and Development*, Vol. 7 No. 2A, pp.1043-1046, 2012.
- [9] Sonal Choubey, S.K.Rajput, K.N.Bapat, “Comparison of Efficiency of some Natural Coagulants-Bioremediation”, *International Journal of Emerging Technology and Advanced Engineering*, ISSN 2250-2459, Volume 2, Issue 10, pp.429-434, 2012.