

ASSESSMENT AND OPTIMIZATION OF THE USE OF A PLANT BASED BIO-FLOCCULANTS FOR DAIRY EFFLUENT

Roopa S B¹, Dr. H B Aravinda²

¹ P.G Student, Department of Environmental Engineering, Bapuji Institute of Engineering and Technology, Davanagere, Karnataka, India

² Principal, Bapuji Institute of Engineering and Technology, Davanagere, Karnataka, India

Abstract- Generally, a huge amount of wastewater is generated from dairy industry. By treating dairy effluent at the end, sludge is produced which can be used as manure for agriculture purpose. Formation of sludge in effluent of dairy industry is mainly formed due to coagulation-flocculation process, they generally use chemical-coagulants in this process, which produces more sludge and are toxic in nature. When these toxic sludges are used in agriculture it may deplete the quality of crops. Hence to overcome these problems a plant-based bio-flocculants can be derived and used as an alternate for artificial-coagulants. Which are economical, non-toxic and biodegradable in nature. We have been selected tamarind seed and aloe vera as natural plant-based coagulants for treating of dairy effluent. Physio-chemical parameters of dairy effluent were carried out and later treated with these bio-flocculants. Mainly, optimum dosages of tamarind seed powder and aloe vera leaf powder were obtained by jar test. Optimum dosage of tamarind seed powder is 120 mg/l and aloe vera leaf powder are 100 mg/l. Tamarind seed powder showed more efficiency in treating BOD about 88.64% when compared to aloe vera leaf powder which is of 87.44%. Aloe vera leaf powder has showed great efficiency in treating COD and turbidity attained 88.44% and 87% respectively, compared to tamarind seed powder COD and turbidity is 86.89% and 63% of reduction respectively. For more effectiveness dosages aloe vera leaf powder can be increased in treating of dairy wastewater.

Key Words: Coagulation/flocculation process, Jar test, plant-based bio-flocculants, Tamarind seed, Aloe vera.

1. INTRODUCTION

India is a largest milk producing country in the world, which is about 22% of total world's production. Dairy industry is looking forward to increase its activities up to 9-11 percent in year 2021-2022. As per 2022, India's production is 203.5 MMT. Per capita consumption of milk is 406 g/day as per 2019-2020. Around 80 million people of India depends upon dairy farming for their income.

Pollution caused by industry is a significant concern throughout the world. Among all the industrial activities the food sector plays a major role in the highest consumption of water and it is one of the substantial producers of effluent per unit of mass production (Ashish Tikariha and

Omprakash Sahu 2014). Dairy industry is the main example of this sector. Dairy industry is one of the considerable food production industries in India, out of all countries India ranks first maximum milk producing country. The characteristics of dairy industry wastewater involves Temperature, P^H, Color, BOD, COD, DO, Dissolved solids, Suspended solids, Sulphate, Chlorides, Oil and Grease. It depends mainly on the quantity of milk clarified and type of the mass of product produced (Bharati S. Shete and N. P. Shinkar 2013).

The coagulation/flocculation procedure are part of the water and wastewater treatment process (L Muruganandam et al.,2017). Main purpose of this process is to clear the water or dividing the suspended particles by wastewater. Coagulation is explained as destabilization method of colloidal matter using amalgamate for treatment of water and wastewater. Flocculation is a technique of ease for collection, and is accomplished by larger molecular weight amalgamation (Setyo Budi Kurnaiwan et al.,2021).

Bio-flocculants/bio-coagulants are considered more environment friendly and useful as a substitute to reduce the risk that takes place in environment. Using chemical-based flocculant/coagulant are not good for environment and not good for human health for consumption purpose (Nandagopan S et al.,2021). To maintain safety for human health and environment using bio-flocculant/bio-coagulant is important, and at the same time cost effective and are easily available (Nandagopan S et al.,2021).

1.1 Scope of present study

Bio-coagulants/flocculants are developed from seeds and vegetables this are used for the wastewater treatment purpose. Examples for plant-based bio-flocculants are as follows aloe vera (leaf), fruit peels, fenugreek (mucilage), guar gum, hibiscus, tamarind (seed), dates, oil nut gum, okra, jackfruit seed and drum stick etc., In this study tamarind seed and aloe vera has been used as a plant-based bio-flocculants.

1.2 Objectives

1. To collect and characterize the dairy industry waste water.

2. To use tamarind seed and aloe vera as a plant-based bio-flocculants, as an alternative to chemical coagulants.
3. Extraction and preparation of plant-based bio-flocculants.
4. To treat the collected sample by tamarind seed and aloe vera.
5. To find out the optimum dosage of plant-based bio-flocculants.
6. To examine the coagulation/flocculation efficiency of tamarind seed and aloe vera in treating of dairy effluent.
7. To discuss on the cost-effective and suitability of plant-based bio-flocculants in the treatment of dairy wastewater.

2. MATERIALS AND METHODOLOGY

2.1 Preparation of plant-based bio-flocculants

2.1.1 Tamarind seed

Tamarind seed is used as a bio-flocculant in this study. Around 1 kg of tamarind seed was purchased in local market of davanagere city. Tamarind seeds were washed properly in tap water to remove dirt and sun dried for 2-3 days to remove moisture content present in it. And then sun-dried seeds were finely grinded to make powder and sieved against 4.75mm sieve and then tamarind power is stored in air tight container. Dilution of tamarind seed powder was made by using 0.1g of tamarind seed powder in 100ml of distilled water. Likewise, further different dilutions were made from tamarind seed powder to use as a bio-flocculant in the present work (Shivam B. Magar and M.V Jadhav 2018).



Fig 1: Tamarind seed powder preparation

2.1.2 Aloe vera

Aloe vera leaves are used as a plant-based bio-flocculants in this study. Aloe vera leaves was collected from some area in

Davanagere city. The aloe vera leaves were washed properly in tap water to remove dirt. And whole leaves were cut in to small pieces without removing any part of it. And then kept in hot air oven in 105°C for 24hrs. And then finely grinded to make aloe vera powder and sieved against 4.75mm sieve, then aloe vera powder was stored in air tight container. Dilution was done with 0.1g of aloe vera powder in 100ml of distilled water (Akhila Jinna et al.,2019). Further the different dilutions were made from aloe vera powder as per requirement of project work.



Fig 2: Aloe vera leaf powder preparation

2.2 Sample collection and analysis

In this the sample taken is dairy wastewater is collected. Grab sampling is involved for the collection of the sample. The sample is collected from equalizer tank where all process of dairy wastewater is stored in that tank. 20 litres of sample were taken, sample is taken at a particular space and time. Sampling tool depends upon the type of the sample. Here 20 litres are used for collection of samples. Safety measures depends upon the type of the sample. For hazardous waste safety measures must be taken for collection of wastewaters as per the guidelines. Here gloves and face mask were used to collect the sample (Amir Adul Azeez et al.,2020)

The initial parameters of the raw water sample have been carried out to determine the initial characteristics of wastewater and mentioned it as before treatment. The initial parameters like PH, turbidity, chlorides, calcium, TS, TDS, BOD and COD are studied.

Table 1: Initial parameters of raw sample

| Parameters | Initial value |
|------------|---------------|
| PH | 5.67 |
| Turbidity | 831 NTU |
| Chlorides | 254 mg/l |
| Calcium | 182.4 mg/l |
| TS | 4000 mg/l |

| | |
|-----|---------------|
| TDS | 3880 mg/l |
| BOD | 2890.02 mg/l |
| COD | 1,32,000 mg/l |

Table 2: Characteristics of Dairy effluent after treatment

| Sl.No. | Characteristics | Tamarind seed | Aloe vera |
|--------|-----------------|---------------|-------------|
| 1 | pH | 6.07 | 6.10 |
| 2 | Turbidity | 308 NTU | 109 NTU |
| 3 | Chlorides | 242 mg/l | 202 mg/l |
| 4 | Calcium | 60.8 mg/l | 102.4 mg/l |
| 5 | TS | 2800 mg/l | 2400 mg/l |
| 6 | TDS | 2400 mg/l | 2088 mg/l |
| 7 | BOD | 328.07 mg/l | 362.97 mg/l |
| 8 | COD | 17300 mg/l | 15250 mg/l |

3. Results and Discussion

Coagulation/flocculation process is carried out in laboratory by jar test for both tamarind seed and aloe vera as natural coagulants in treating of dairy effluent. Turbidity test is done for every dosage. The optimum dosage of tamarind seed is 120 mg/l and aloe vera is 100 mg/l in treatment of dairy wastewater in this particular study. Optimum dosage is considered corresponding to the lowest residual turbidity. Further experiments were conducted using optimum dosage as coagulant dosage.

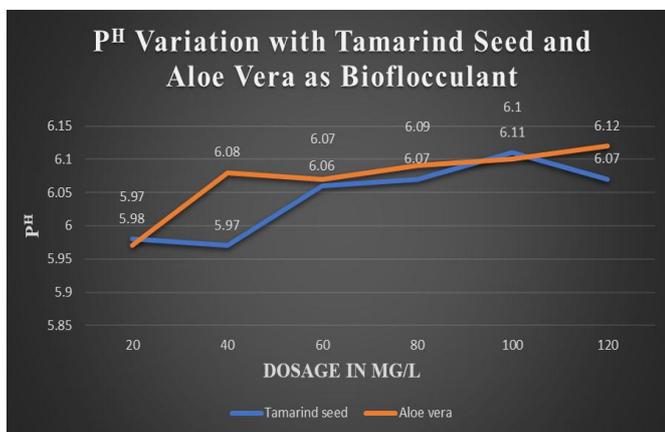


Chart-1: pH Variation

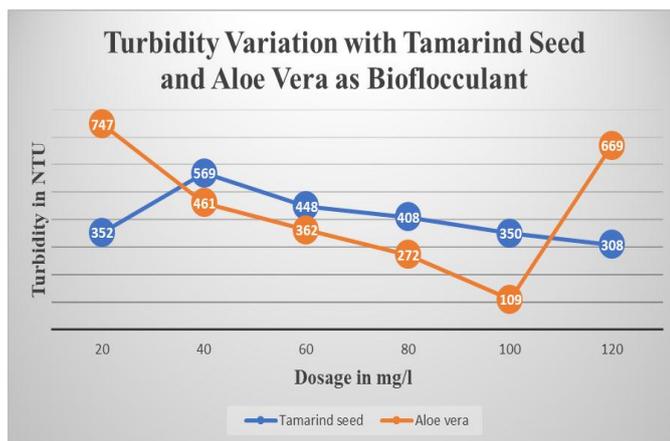


Chart-2: Turbidity Variation

In this present work, tamarind seed and aloe vera have been used as plant-derived bio-flocculants and their efficiency has been analyzed for treatment of dairy effluent. From above results we can conclude that optimum dosage of using tamarind seed powder was found to be 120 mg/l and aloe vera leaf powder is about 100 mg/l. From the examined results, the maximum percentage reduction efficiency, when compared between tamarind seed and aloe vera it was found that tamarind seed was more effective in treating dairy wastewater parameters like alkalinity, calcium and BOD and in aloe vera the most effective parameters were acidity, chlorides and COD.

4. CONCLUSION

In this study turbidity removal efficiency using tamarind seed powder is shown as 63% and while using aloe vera leaf powder is shown 87%. Hence, aloe vera is more efficient in removing turbidity compared to tamarind seed. In BOD removal efficiency the tamarind seed powder achieved 88.64% while aloe vera leaf powder achieved 87.44%. Hence tamarind seed is highly effective in removing BOD compared to aloe vera. In cod removal efficiency the tamarind seed powder obtained 86.89% and while aloe vera has obtained 88.44%. Hence aloe vera has great efficiency in removing BOD. Aloe vera can be used as an effective coagulant in dairy wastewater treatment mainly for COD and for turbidity removal.

REFERENCES

[1] Akhila Jinna, Anu M R, Nijesh Krishnan, Vyshnavy Sanal, Litty Das (2019) "Comparative study of efficiency of local plants in water treatment". International research journal of engineering and technology, vol 06, issue 04, pp 4046-4052.

- [2] Aliyu Isa, Maina Mohammed Idris, Haruna Karamba, Rabia Ayoubi (2018) "Tamarindus indica – A review paper on efficacy of tamarind plant in water treatment and purification". International journal of scientific and engineering research, vol 9, issue 10, pp 2024-2034.
- [3] Amare Tiruneh Adugna and Nahom Mankir Gebresilasie (2018) "Aloe steudneri gel as natural flocculant for textile wastewater treatment". Water practice and technology, vol 13, no 3, pp 495-504.
- [4] Amir Abdul Azeez, Asna K.A, Aneesha, Christy George, Ranjitha N (2020) "Use of plant-based coagulants for water treatment". Vol 6, issue 3, pp 231-242.
- [5] Anuj S and K.Mophin-Kani (2016) "Exploring the use of organic peel and neem leaf powder as alternative coagulant in treatment of dairy wastewater". International journal of science and engineering research, vol 7, issue 4, pp 238-244.
- [6] Anu Sundaresan and Anu N (2016) "Feasibility of natural coagulant for the treatment of dairy wastewater". International journal of science and engineering research, vol 7, issue 4, pp 245-249.
- [7] Asish Tikariha and Omprakash Sahu (2014) "Study of characteristics and treatment of dairy industry waste water". Journal of applied and environmental microbiology, vol 2, no. 1, pp 16-22.
- [8] Azmi Ahmad, Siti Rozaimah Sheikh Abdullah, Hassimi Abu Hasan, Ahmad Razi Othman, Nur Izzati Ismail (2021) "Potential of local plant leaves as natural coagulant for turbidity removal". Environmental science and pollution research.
- [9] Aziz H.A., Yii Y.C., Syed Zainal S.F.F. and Akinbile C.O. (2018) "Effect of using tamarindus indica seeds as a natural coagulant aid in landfill leachate treatment". Global NEST journal, vol 20, no 2, pp 373-380.
- [10] Bharati S. Shete and N. P. Shinkar (2013) "Dairy industry wastewater sources, Characteristics and its effect on environment". International journal of current engineering and technology, Vol 3, no 5, pp 1611-1615
- [11] Dhanush Patel H G, Mrs Veena D V (2019) "Treatment of dairy industry wastewater using tamarindus indica seed as an adsorbent". International research journal of engineering and technology, vol 06, issue 07, pp 1600-1603.
- [12] Gulmire Amruta and G.R. Munavalli (2017) "Use of aloe vera as coagulant aid in turbidity removal". International journal of engineering research and technology, vol 10, no 1, pp 314-317.
- [13] Hitesh S. Patil, Sanket A. Shinde, Ganesh A. Raut, Nilesh p. Nawale, Pro. Ashish Hakke, Prof. Manoj Deosarkar (2020) "Use of aloe-vera gel as natural coagulant in treatment of drinking water". International journal of advance scientific research and engineering trends, vol 5, issue 9, pp 81-89.
- [14] Jibrin Ndejiko Mohammed and Wan Rosmiza Zana Wan Dagang (2020) "Implications for industrial application of bioflocculant demand alternatives to conventional media: waste as a substitute". Water science and technology.
- [15] Juduth Emilian Christy SS, Anantharaj R, Ambedkar B and Dhanalakshmi J. (2017) "Treatment of synthetic turbid water using natural tamarind seeds at atmospheric conditions". Research journal of pharmaceutical, biological and chemical sciences, pp 352-359.
- [16] L Muruganandam, M P Saravana kumar, Amarjit jena, Sudiv Gulla and Bhagesh Godhwani (2017) "Treatment of waste water by coagulation and flocculation using biomaterials". IOP Conf. Series: Materials science and engineering 263 032006.
- [17] Mayowa O. Agunbiade, Carolina H. Pohll, Anofi O.T. Ashafa (2016) "A review of the application of bioflocculants in wastewater treatment". Pol. J. Environ. Stud, vol 25, no 4, pp 1381-1389.
- [18] Megharaj A, Dr. D P Nagarajappa, Dr. P. Shiva Keshava Kumar, Sreekanth N (2020) "Treatment of dairy waste water using natural adsorbents". International research journal of engineering and technology, vol 07, issue 08, pp 3521-3525.
- [19] Nandagopan S, Nongki Perme, Sruthy A R, Yugma V, Prof. Jency Nadayil (2021) "Waste water treatment using natural coagulants". International research journal of engineering and technology, vol 08, issue 07, pp 590-592.
- [20] N A Zainol and Nur Nasuha Mohd Fadli (2020) "Surface water treatment using tamarind seed as coagulants via coagulation process". IOP conference series: Materials science and engineering 864 0123172.
- [21] Nilanjana Das, Nupur Ojha and Sanjeeb Kumar Mandal (2021) "Wastewater treatment using plant-derived bioflocculants: green chemistry approach for safe environment". Water science and technology, pp 1797-1812.
- [22] Nor Suhaili Binti Mohamad Zin, Wan Nurhazirah Binti Kamaruzaman, Chia Soi Lee (2016) "Study the effectiveness of biocoagulant between aloe vera (L.). Burm. F and okra mucilage in coagulation and flocculation treatment". pp 34-38.
- [23] Premkumar R, S.Rajesh, Prasanna Venkadesh M (2021) "Feasibility study on application of natural coagulants". Journal of physics: Conference series 2070 012186.
- [24] Prof. T D Raju, Asst Prof. Ahana K Reji, Naji Raheem, Sruthi Sasikumar, Veena Vikraman, Shimil C P, Sneha K M (2018) "Role of moringa oleifera and tamarind seed in water

treatment". International journal of engineering research and technology, vol 7, issue 04, pp 454-462.

[25] Reena Abraham, Harsha P (2019) "Efficiency of tamarind and papaya seed powder as natural coagulants". International research journal of engineering and technology, vol 06, issue 04, pp 4849-4853.

[26] Rohit Gupta (2020) "Performance evaluation of effluent treatment plant of dairy plant". Journal of emerging technologies and innovative research, vol 7, issue 11, pp 613-619.

[27] Ronke Ruth Ayangunna, Saidat Olanipekun Giwa, Abdulwahab Giwa (2016) "Coagulation-flocculation treatment of industrial wastewater using tamarind seed powder". International journal of chem tech research, vol 9, no 5, pp 771-780.

[28] Saidat Olanipekun Giwa, Danladi Yakubu SAID, Mustapha Danladi IBRAHIM and Abdulwahab GIWA (2017) "Textile wastewater treatment using Sodom apple (*Calotropis procera*) - aided tamarind seed as a coagulant". International journal of engineering research in africa, vol 32, pp 76-85.

[29] Setyo Budi Kurniawan, Muhammad Fauzul Imron, Che Engku Noramalina Che Engku Chik, Amina Adedoja Owodunni (2021) "What compound inside biocoagulants/bioflocculants is contributing the most to the coagulation and flocculation processes?". Article in science of the total environment.

[30] Shivam B. Magar, Dr. M.V Jadhav (2018) "Use of herbal coagulants for treatment of dairy waste water". International journal for research trends and innovation, vol 3, issue 12, pp 24-33.

[31] Upendra Kumar, Kanchan Nahar, Ajay Singh Thakur (2022) "Sustainable treatment of water and wastewater using natural plant-based coagulants: A Review". International journal of engineering research and technology, vol 11, issue 05, pp 650-656.

[32] Wan Nurhazirah Binti Kamaruzaman, Nor Suhaili Binti Mohamad zin (2016) "Study effectiveness of biocoagulant between aloevera (*L.*). *Burn.F* and *tetragonus pad* in coagulation and flocculation treatment".