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An Experimental Study on Treatment of Waste Water by Natural Coagulants

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Abstract - *Tanning industry is one of the oldest industries which is highly complex and is characterized by high BOD, COD, and suspended solids, settle able solids, sulphide, chloride and chromium. Untreated tannery effluents when discharged directly into the water bodies or into the open lands cause irreversible damage to the environment. The sago factory is one of the important agro - industries in all over India. These industries release large amount of effluent containing solid and liquid wastes. The effluent has obnoxious odour, irritating colour, lower pH and higher BOD. Coagulation–flocculation is one of the most important physicochemical treatment steps employed in industrial wastewater treatment to reduce the suspended and colloidal materials responsible for turbidity of the wastewater. During the last decade, more interest has been given on the use of natural coagulants in treating industrial wastewater. Natural coagulants are, in general, used as point-of-use technology in less-developed communities, since they are relatively cost- effective compared to chemical coagulants. Also, they can be easily processed in usable form and biodegradable 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. So, the study's lead to overcome these problems by using some natural treatment methods. They are readily biodegradable & less volumetric sludge. Natural seeds used as natural coagulants are Cicer aretinum. Moringa Oleifera, Strychnos potatorum, Azadirachta indica.*

Key Words*: *Cicer aretinum, Moringa oleifera, Azadirachta indica, Turbidity, Chemical oxygen demand (COD).

1. INTRODUCTION

Ever increasing industrialization and rapid urbanization have considerably increased the rate of water pollution. The dwindling supplies of natural resources of water have made this a serious constraint for industrial growth and for a reasonable standard of urban living. Tanning Industry is one of industries, which is considered as highly polluting industry. Tanneries generate wastewater in the range of 30 - 35 L/kg skin or hide processed with variable pH and high concentrations of suspended solids, BOD, COD. Major problems are due to wastewater containing heavy metals, toxic chemicals, chloride, lime with high dissolved and suspended salts and other pollutants. Sago and starch production from tapioca is one of the major food industries in South-east Asia. There are nearly about 1000 sago and starch processing factories operation in Salem district of Tamil Nadu, India. The tapioca tubers are the raw material and it is converted into commercial sago through indigenous technology. During the process, on an average from 30,000 to 40,000 litre of effluent is generated per ton of sago processed and it takes about 10 days for the water to be let out of the factory as effluent. The release of high content of the organic Load along with the effluent when stored, results in obnoxious odour, irritating colour, lower pH and higher BOD and COD. When the effluent is released into the environment without proper treatment, it alters the characters of ecosystem. Coagulation is the most essential process in the treatment of both turbid surface and industrial wastewaters. Coagulation– flocculation is one of the most important physicochemical treatment steps in industrial wastewater treatment to reduce the suspended and colloidal materials responsible for turbidity of the wastewater and also for their reduction of organic matters which contributes to the BOD and COD content of the wastewater. There is also strong evidence linking aluminium- based coagulants to the development of Alzheimer's disease in human beings. It is therefore desirable to replace these chemical coagulants with plant-based coagulants to counteract the before mentioned drawbacks

2. STUDY AREA

2.1 Ambur, Tannery Industry

Vellore district exhibits many characteristic features of an industrial district. It specialises in manufacturing leather and leather products for international markets. Five main towns in Vellore district, Vaniyambadi. Ambur, Melvisharam and Ranipet are categorized as tannery clusters. Approximately, six hundred tanneries are clustered in and around these towns. Ranipet and the nearby industrial estates have the largest number of tanneries, over 200 followed by Vaniyambadi with 136. Ambur has 120 industries and also specialised in manufacturing footwear for export. Florence is one of the top tannery industries present in Ambur district which produces leather products for exports which is the study area we have chosen.Tanning Industry is one of industries, which is considered as highly polluting industry. Tanneries generate wastewater in the range of 30 - 35 L/kg skin or hide processed with variable pH and high concentrations of suspended solids, BOD, COD. Major problems are due to wastewater containing heavy metals, toxic chemicals, chloride, lime with high dissolved and suspended salts and other pollutants

2.2 Salem, Sago Industry

The area also houses a number of sago factories for the production starch. In Salem district, 34,000 hectares (130 sq. Miles) of land are devoted to cassava and 650 industrial units are engaged in tapioca processing. In 1981, the Salem Starch and Sago Manufacturers Service Industrial Co-operative Society (SAGOSERVE) was established to promote the sago industry and nearly 80 percent of the national demand for sago and starch is met by SAGOSERVE. In and around Salem cassava yields are 25–30 tons per hectare, one of the highest in the world; the national average is 19 tons per hectare, and the world average is 10 tons.Sri Annamalaiyar sago factory is one of the known sago industries present in Salem district which produces sago which is the study area we have chosen.

3. MATERIAL AND METHODOLOGY

In this study Cicer arietinum (Chickpea), Moringa oleifera (Drumstick seeds), Azadirachta indica(Neem leaves), Strychnos potatorum(Nirmali Seeds) were used as natural coagulants . Cicer arietinum (Chickpea), Moringa oleifera, Azadirachta indica, Strychnos potatorum were obtained from rural areas of vellore .Cicer arietnium and were collected by nearby shops.

3.1 Preparation of Natural Coagulants

Strychnos potatorum seeds were ground to fine powder and sieved to get particles of the size 600 µm. Moringa oleifera seeds were removed from the pods, kept for sun dry, and external shells were removed. Mature seeds showing no signs of discoloration, softening, or extreme desiccation were used. The seed kernels were ground to fine powder and sieved to get particles of the size 600 µm. Neem leaf were collected from nearby sources and dried for 2 or 3 days. Then the dried leaf was grained with the help of grinding tool to get fine particle and then sieved through 600 microns. Cicer arietnium was collected in shops and dried in sunlight and then grinded to fine particles, then sieved through 600 µm.

Fig – 1: Moringa Oleifera,Cicer Aretinium,Stychnos potatorum and Azadirachta Indica Powder

3.2 Initial Parameter of Tannery Effluent

Tanning Industry is one of industries, which is considered as highly polluting industry. Tanneries generate wastewater in the range of 30 - 35 L/kg skin or hide processed with variable pH and high concentrations of suspended solids, BOD, COD. Major problems are due to wastewater containing heavy metals, toxic chemicals, chloride, lime with high dissolved and suspended salts and other pollutants. In this chapter, we can discuss about the physio chemical analysis test values for the tannery waste water. The analysis of tannery waste water was done by IS standards methods for the examination of water and waste water, 19th edition

Table - 1: Tannery Effluent parameters

S.no	Parameter	Initial Values
1	APPEARANCE	Highly Turbid
2	pH	9.2
3	Total Suspended Solids	4800 Mg/L
4	ELECTRICAL CONDUCTIVITY	12100 µ s/Cm
5	ODOUR	Objectionable
6	COLOR	Dark Brown
7	BOD	490 mg/l
8	COD	1120 mg /l
9	TURBIDITY	53 NTU
10	TOTAL HARDNESS	1640mg/l
11	AMMONIACAL NITROGEN	27.6mg/l
12	TOTAL SOLIDS	21,120 mg/l

3.3 Initial Parameters of Sago effluent

Sago and starch production from tapioca is one of the major food industries in South-east Asia. There are nearly about 1,000 sago and starch processing factories operation in Salem district of Tamil Nadu, India. The tapioca tubers are the raw material and it is converted into commercial sago through indigenous technology. During the process, on an average from 30,000 to 40,000 liter of effluent is generated per ton of sago processed and it takes about 10 days for the water to be let out of the factory as effluent The release of high content of the organic load along with the effluent when stored, results in obnoxious odor, irritating color, lower pH and higher BOD and COD When the effluent is released into the environment without proper treatment, it alters the characters of ecosystem.

Table - 2: Sago Effluent parameters

S.no	Parameter	Initial Values
1	APPEARANCE	Slightly Turbid
2	pH	5.3
3	Total Suspended Solids	2550 Mg/L
4	ELECTRICAL CONDUCTIVITY	6320 µs/Cm
5	ODOUR	Objectionable
6	COLOR	Yellowish
7	BOD	670 mg/l

8	COD	1320 mg/l
9	TURBIDITY	40 NTU
10	TOTAL HARDNESS	1380mg/l
11	AMMONIACAL NITROGEN	21.6mg/l
12	TOTAL SOLIDS	12675 mg/l

3.4 Coagulation Studies

This study consists of batch experiments involving rapid mixing, slow mixing and sedimentation. For the study of coagulation, a jar apparatus was used. For treatment of tannery wastewater, the used dosages were 0.1gm, 0.2gm, 0.4gm, 0.6gm, 0.8gm, 1.0 gm of powdered seeds of Cicer aretinum, Moringa oleifera per 500 ml of wastewaters. To treat sago wastewater the used dosages were 0.1gm, 0.2gm, 0.4gm, 0.6gm, 0.8gm, 1.0gm of powdered seeds of Strychnos potatorum, Azadirachta Indica per 500 ml of wastewaters. The paddles were inserted in the jars, the apparatus was switched on and the whole procedures in the jar test were conducted in different rotating speed, which Consist of rapid mixing (100 rotation per minute, rpm) for 4 minute and slow mixing (40rpm) for 25 minutes. After the agitation being stopped, the suspensions were allowed to settle for 120 minutes. Before operating the jar test, the sample was mixed homogenously. Finally, a sample was withdrawn using a pipette from the middle of supernatant for physicochemical measurements, so that the effect of coagulant dose on coagulation could be studied. Then, the samples ought to be measured for turbidity, COD for representing an initial concentration.

4. RESULTS AND DISCUSSION

The optimum dosage of coagulants is determined by varying the dosage of coagulants are 0.15gm, 0.3gm, 0.45gm, 0.6gm, 0.75gmper 500ml at original pH of tannery wastewater (pH =9.2). And sago wastewater (pH=10.0).

4.1 Treatment of Tannery Industry Wastewater

The optimum dosage of natural coagulants was found by conducting several trails on turbidity and pH value of the sample. The most optimum value is further tested for several parameters for irrigation. The dosage of natural coagulants Moringa oleifera, cicer airtenium were varied between 0.3g, 0.6g, 0.9g, 1.2g, 1.5g grams per liter of the waste water sample taken (tannery effluent) and the most optimum dosage was found to be 1.2g/L for moringa oleifera which was able to reduce the turbidity up to 73.2% then the pH was measured using standard pH scale which shows at 1.2g/L the sample shows permissible value of 8.1 Cicer airtenium is found more efficient at 0.9g/l with slightly lesser turbidity reduction when compared to Moringa oleifera OF 53.4% and pH reduced to 7.9.

Table - 3: Final test of treated tannery effluent

S.no	Parameter	Moringa Oleifera	Cicer Airtenium
		Final Values	Final Values
1	pH	8.1	7.9
2	TSS	350 mg/l	400 mg/l
3	ELECTRICAL CONDUCTIVITY	5100 µS/cm	7330 µS/cm
4	BOD	225 mg/l	320 mg/l
5	COD	420 mg /l	375 mg /l
6	TURBIDITY	20 NTU	25 NTU
7	TOTAL HARDNESS	528 mg/l	665 mg/l
8	AMMONIACAL NITROGEN	2.6mg/l	5.3 mg/l
9	TOTAL SOLIDS	2,120 mg/l	3340 mg/l

The test results of the treated tannery water prove the reduced parameters with Moringa Oleifera being the most efficient than Cicer Airtenium which has almost treated the effluent. Hence, Moringa oleifera qualifies for further irrigation water suitability

test. Reduction in the test values proves the efficiency of natural coagulants. The results were obtained by continuous filtration and sedimentation 3 times using the same sample.

4.2 Sago Effluent

The dosage of natural coagulants Strychnos potatorum, Azadirachta Indica were varied between 0.3g, 0.6g, 0.9g, 1.2g, 1.5 grams per liter of the waste water sample taken (sago effluent) and the most optimum dosage was found to be 1.2g/L for Strychnos potatorum which was able to reduce the turbidity up to 75.3% then the pH was measured using standard pH scale which shows at 0.9g/L the sample shows permissible value of 6.8. Azadirachta Indica is found more efficient at 1.2 g/l with slightly lesser turbidity reduction when compared to Strychnos potatorum of 69.0% and pH at 6.9.

Table - 4: Final test of treated sago effluent

S.no	Parameter	Strychnos Potatorum	Azadirachta Indica
		Final Values	Final Values
1	pH	6.8	6.9
2	TSS	298 mg/l	325 mg/l
3	ELECTRICAL CONDUCTIVITY	3380µS/cm	2320 µS/cm
4	BOD	198 mg/l	220 mg/l
5	COD	420 mg /l	675 mg /l
6	TURBIDITY	20 NTU	25 NTU
7	TOTAL HARDNESS	338 mg/l	443mg/l
8	AMMONIACAL NITROGEN	1.4 mg/l	4.8 mg/l
9	TOTAL SOLIDS	1120 mg/l	2340 mg/l

The test results of the treated tannery water prove the reduced parameters with strychnos potatorum being the most efficient than azadirachta indica which has almost treated the effluent. Hence, it is safe to say strychnos potatorum qualifies for further irrigation water test. The results were obtained by continuous filtration and sedimentation 3 times using the sample.

4.3 Irrigation Water Qualities

According to IS 11624:1986 (R 2006), the chemical properties shall be considered for developing water quality criteria for irrigation are

1. Total salt concentration
2. Sodium Adsorption Ratio
3. Residual sodium carbonate
4. Boron content.

The boron content and total salt concentration are obtained by test results. Sodium Adsorption Ratio and Residual sodium carbonate are obtained by calculation of Ion concentrations.

Table - 5: Irrigation water quality

S.No	Chemical Properties	Tannery Effluent	Sago Effluent
		Moringa Oleifera	Strychnos Potatorum
1	Total Salt Concentration	5100 µS/cm	3380 µS/cm
2	Residual Sodium Carbonate(me/l)	2.35	4.44

3	Sodium Adsorption Ratio(mill mole/litre)$^{0.5}$	22.6	11.22
4	Boron Content	2.23 ppm	1.7 ppm

5. CONCLUSIONS

The following conclusions are drawn from the experimental study conducted on treatment of industry wastewater using natural coagulants:

(1) Tannery wastewater has the characteristics; pH-9.2, Color-Dark brown, COD- 1120 mg/l,BOD-490mg/l, Total solids-21,120mg/l, Suspended solids-4,800mg/l, Turbidity-53 and all the parameters are more than the permissible limit.
(2) Sago wastewater has the characteristics; pH-5.3, Color-Greenish brown, COD- 870 mg/l,BOD-1620mg/l, Total solids-12675mg/l, Suspended solids-2,550mg/l, Turbidity- 40 and all the parameters are more than the permissible limit.
(3) For tannery effluent, the optimum dosage of Moringa oleifera, Cicer aretinum powder as coagulant is found to be 0.6gm/500ml, 0.45gm/500ml.
(4) For sago effluent, the optimum dosage of Strychnos Potatorum, Azadirachta powder as coagulant is found to be 0.45gm/500ml, 0.6gm/500ml.
(5) The optimum pH in coagulation process for Moringa oleifera seed, Cicer aretinum Strychnos Potatorum, Azadirachta indica powder at optimum dosage is found to be 8.1, 7.9, 7.4, and 7.2 respectively.
(6) Increasing dosage of Moringa Oleifera, Cicer Airtenium, Strychnos Potatorum, Azadirachta indica lead to decrease in turbidity up to the optimum dosage after which the residual turbidity increases due to floc destabilization.
(7) Among the four natural coagulants used in the study, maximum turbidity reduction is found to be 73.30% with Moringa oleifera and 75.30% with Strychnos Potatorum and also lower pH value.
(8) As it is observed in tannery effluent that Moringa Oleifera is consistent in turbidity reduction of almost above 70.00%. Hence it is concluded that Moringa Oleifera has the potential to be utilized for tannery wastewater treatment.
(9) As it is observed in sago effluent that Strychnos Potatorum is consistent in turbidity reduction of almost above 75.00%. Hence it is concluded that Strychnos Potatorum has the potential to be utilized for Sago wastewater treatment.
(10) Among the four natural coagulants used in the study, Moringa oleifera and Strychnos Potatorum showed the potential to use as irrigation water.
(11) The sago effluent treated with Strychnos Potatorum and the tannery effluent treated with Moringa oleifera is suitable for irrigation water since it does qualify the IS codes (IS 11624:1986).
(12) According to the table 5 of IS 11624 :1986 (R 2006) code book, the Tannery effluent is suitable for
   a. 20-30 percent clay textural soil group of tolerant crops
   b. 10-20 percent clay textural soil group of tolerant crops
   c. Below 10 percent clay textural soil group of tolerant crops
   d. It is not suitable for semi-tolerant crops
(13) According to the table 5 of IS 11624 :1986 (R 2006) code book, the sago effluent is suitable for
   a. 20-30 percent clay textural soil group of tolerant and semi tolerant crops
   b. 10-20 percent clay textural soil group of tolerant and semi tolerant crops
   c. Below 10 percent clay soil group of tolerant crops only

REFERENCES

[1] Adichakkravarthy, Vijayaraghavan, G. & Sivakumar, T. &, Vimalkumar. (2011), "Application of Plant based coagulants for waste water treatment", International Journal Advanced Engineering Studies, 1(4). 88-92.
[2] Andrew D. Eaton, Rodger B Baird, Eugene W.Rice.(2011),"Standards methods for the examination of water and wastewater", General Publishers, United kingdom
[3] Arjun Virupakshi, Tsaneembano Kazi(2013), "Treatment of tannery waste water using natural coagulants", International Journal of Innovative Research in Science, Engineering and Technology, 2(8), 127-165
[4] Md. Asrafuzzaman, A.N. M. Fakhruddin, and Md. Alamgir Hossain (2011), "Reduction of Turbidity of Water Using Locally Available Natural Coagulants", ISRN Microbiology, 4(3), 176-214.
[5] Anu Sundaresan and Anu N. (2016), "Feasibility of Natural Coagulant for the Treatment of Dairy Wastewater", International Journal of Scientific & Engineering Research, (7)4, 245-249.
[6] D.S. Bhutada, M.T. Datar and S.N. Kaul, (2006), "Use of Herbal Coagulant for Primary Treatment of Dairy Wastewater", Journal of Industrial Pollution Control, 22(1), 139-148.
[7] Binayke Renuka A., Jadhav M.V (2013) "Application of natural coagulants in water purification", International Journal of Advanced Technology in Civil Engineering, 2(3), 20-29.
[8] A.H.Birima, H.A.Hammad, M N M Desa and Z C Muda. (2013), "Extraction of natural coagulant from peanut seeds for treatment of turbid water", IOP Conference Series: Earth and Environmental Science, 16(2), 492-499.

[9] Prof.Chidanand Patil and Ms. Manika Hugar (2017), "Treatment of dairy wastewater by natural coagulants, International Refereed Journal of Engineering and Science", 3(4), 81-85.

[10] G.Vijayaraghavan,T.Sivakumar,A. Vimal Kumar,(2011),"Application of plant based coagulants for Waste (water treatment", International Journal of Advanced Engineering Research and Studies, 1(1), 88-92.

[11] G.K.Follard,J.P.Sutherland(2013), "Natural coagulants for appropriate water treatment : a novel appro ach" , Journal Of Environmental Science And Management, 4(9), 278-290.

[12] P.Geetha Priya and J.Sharpudhin. (2016), "Comparative Study n Removal of Turbidity from Wastewater Using Chemical and Natural Coagulants", International Journal of Science, Engineering and Technology Research, 5(7), 1625-1629