Comparative Study of the Use of Sapodilla Seed and Ferrous Sulphate for the Treatment of Grey Water

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Abstract— Any domestic wastewater except for wastewater from toilets or urinals is termed as grey water. The main sources of grey water include kitchen sinks, baths, washing machines, showers etc. it is important to treat grey water and reuse it for crop irrigation and other domestic purposes like toilet flushing, washing and cleaning purposes. This study aims to a comparative study of the effectiveness of natural coagulant as sapodilla seed extract and artificial coagulant as ferrous sulphate and their combined use as primary coagulants for the treatment of grey water. The grey water sample used for this study is collected from the household. The initial parameters of the grey water were assessed using pH, turbidity, COD, BOD, TDS and TSS and measured as 8.7, 163 NTU, 3493 mg/l, 810 mg/l, 1284 mg/l, 98 mg/l respectively. When the coagulants such as sapodilla seed powder , ferrous sulphate and their combination were agitated with the grey water and the maximum percentage removal in turbidity, at a dosage value of 80 mg/l is 49.75% for sapodilla seed powder, 60 mg/l is 73.25% for ferrous sulphate, and combination of 60%/40% of sapodilla seed/ferrous sulphate ensure a removal efficiency of 78.77%, for COD, at a dosage value of 80 mg/l is 84.08% at a dosage of 80 mg/l for sapodilla seed powder, 60 mg/l is 87.91% for ferrous sulphate, and combination of 70%/30% of sapodilla seed/ferrous sulphate ensure a removal efficiency 90.19%, for BOD, TDS, TSS, at a dosage value of 80 mg/l is 66.17%, 57.32%, 74.89% for sapodilla seed powder, 60 mg/l is 71.11%, 53.11%, 68.37% for ferrous sulphate respectively and combination of 80%/20% of sapodilla/ferrous sulphate ensure a BOD removal efficiency of 73.04%, 70%/30% of sapodilla /ferrous sulphate ensure a TDS removal efficiency of 59.94% and 80%/20% of sapodilla/ferrous sulphate ensure a TSS removal efficiency of 77.96%.

Keywords— Coagulant, Ferrous sulphate, Grey water, Parameters, Removal efficiency, Sapodilla seed, Wastewater.

1 Introduction

Water is considered as the most essential compound on planet earth. Fresh water becomes necessary for human life and other forms of life. The fresh water demand increases due to uncontrolled use of water due to increasing population and industrialization, it becomes important to purify the water and reuse for several purposes.

The wastewater generated in households, public properties excluding toilets and urinals are generally termed as grey water. Showers, bath tub, sink, laundry effluent, kitchen sink, dishwasher are the sources of grey water. The commonly used chemical coagulant for the treatment of wastewater is alum. Which is cheaply available, but high level of alum in water treatment cause unhealthy effect on human health like Alzheimer disease. Inorder to reduce the cost of chemical coagulant and its health effects, natural coagulants are used for wastewater treatment [3]. Natural coagulants are biodegradable and present low toxicity and low level of sludge production [1]. Natural coagulant used is sapodilla seed powder. The present work intended to study the compoarative and combined use of sapodilla seed and ferrous sulphate for the treatment of grey water. Sapodilla is locally available and commonly used naturally derived coagulant [5]. Sapodilla seeds are used for the treatment of grey water.

The sapodilla seed have anti-microbial effect and its seed kernel oil is used skin ointment. Crushed seed act as diuretic and it protects kidney diseases. The ground seeds can be applied as a paste for alleviating stings and insect bites. Oil extracted from its seed helps moisturing and softening your hair, thus making it more manageable. It imparts sheen and is considered excellent for curly hair [4]. The seed kernels contain significant quantities of a series of low molecular weight, water-soluble proteins like phenolic compounds which, in solution, arry an overall positive charge [5].

2 Materials and Methodology

2.1 Preparation of Seed Powder

Sapodilla fruit is large burry about 4 to 8 cm in diameter. Sapodilla fruit were brought from local market. Seeds are collected from the fruit and they are sun dried for 10 hours. The dried seeds were grinded to fine powder using a domestic food blender [3]. Fig. 1 shows the sapodilaa seed powder.

Fig. 1 Sapodilla seed powder

The powdered seed were passed through 300 micron sieve

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and the fractions passed through the sieve are used for the experiment.

2.2 Ferrous Sulphate

Ferrous sulphate is also known as copperas. Ferrous sulphate is collected from the shop. It is a blue green coloured chemical. Fig. 2 shows the ferrous sulphate in crystal form.

Fig. 2 Ferrous sulphate

Ferrous sulphate is a widely used coagulant. It has been used for the treatment of wastewater of industry that is concerned with the production of potato chips and food processing industry [2]. Ferrous sulphate functions effectively in the pH ranges of 8.5 or above. It is not used for coloured water, as it does not give satisfactory results.

2.3 Collection of Grey Water Sample

The sample of grey water is collected from household and the sample is analysed for various parameters to obtain the characteristics of sample. Fig. 3 shows the grey water sample

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Fig. 3 Grey water sample

Grey water is the wastewater obtained from hand basins, kitchen sinks, showers, bath tubs and dish washer except wastewater from toilets.

2.4 Experimental Process

2.4.1 Jar Test

The coagulation and flocculation process was done by jar test experiment. 1 L of grey water samples taken in six beakers, each beakers having capacity of 1 L. Keep the beakers below the paddle and lower the paddle such that each one is about 1 cm above the bottom. Different concentrations of sapodilla seed, ferrous sulphate and the combination of sapodilla seed and ferrous sulphate were used varying from 20 mg/l to 120 mg/l. Rapid mixing was carried out first at 300 rpm speed for 1 minute and then slow mixing at 40 rpm speed for 30 minutes. The stirrer was then switched off and lift out the paddles and follow up by sedimentation for 30 minutes [3].

Fig. 4 Jar test apparatus

Fig. 4 shows the jar test apparatus. The supernatant is examined for various tests such as pH, turbidity, electric conductivity, COD, BOD, TDS, TSS, TS and chloride.

3 Result and Discussion

Collected grey water sample was analysed before and after treatment. Table 1 shows characteristics of grey water before treatment.

TABLE 1
INITIAL CHARACTERISTICS OF GREY WATER

Parameters	Initial concentration
pH	8.7
Turbidity (NTU)	163
Electric conductivity (mS/cm)	3.9
COD (mg/l)	3493
BOD (mg/l)	810
TDS (mg/l)	1284
TSS (mg/l)	98
TS (mg/l)	1320
Chloride (mg/l)	547.33

Contaminants found in grey water are food particles, salts, hairs, surfactance, microorganisms.

3.1 Coagulation Using Sapodilla Seed

Coagulation and flocculation was carried out using Jar test apparatus. Sapodilla seed is taken in different concentration to find out the optimum coagulant dosage. Concentration of sapodilla seed is varied from 20 mg/l to 120 mg/l. Table 2 shows the removal efficiency of grey water after treatment using sapodilla seed.

TABLE 2
REMOVAL EFFICIENCY OF TREATMENT USING SAPODILLA SEED

Parameters	Removal efficiency (%)					
	20 mg/l	40 mg/l	60 mg/l	80 mg/l	100 mg/l	120 mg/l
Turbidity	39.94	43.25	45.95	49.75	42.09	41.04
Electric conductivity	19.48	31.28	36.96	39.2	32.3	27.69
COD	60.83	71.28	71.85	84.08	68.76	65.76
BOD	24.69	32.34	59.75	66.17	50.16	44.07
TDS	40.88	53.5	50.62	57.32	40.73	38.86
TSS	42.81	54.08	61.42	74.89	67.85	63.47
TS	33.57	43.3	50.07	62.42	67.19	56.59
Chloride	37.9	42.46	43.83	47.03	42	35.16

From the table 2, the maximum removal efficiency for turbidity, electric conductivity, COD, BOD, TDS, TSS, TS and chlorides are 49.75%, 39.2%, 84.08%, 66.17%, 57.32%, 74.89%, 62.42% and 47.03% at an optimum dosage of 80 mg/l and over dose of coagulant results reduction in removal efficiency.

3.2 COAGULATION USING FERROUS SULPHATE

Coagulation and flocculations was carried out using Jar test apparatus. Ferrous sulphate is taken in different concentrations to find out the optimum coagulant dosage. Concentration of ferrous sulphate is varied from 20 mg/l to 120 mg/l. Table 3 shows the removal efficiency of grey water after treatment using ferrous sulphate.

TABLE 3
REMOVAL EFFICIENCY OF TREATMENT USING FERROUS SUPHATE

Parameters	Removal efficiency (%)					
	20 mg/l	40 mg/l	60 mg/l	80 mg/l	100 mg/l	120 mg/l
Turbidity	54.78	58.34	73.25	66.38	61.04	60.06
Electric conductivity	20.76	26.92	56.21	53.07	50	40.77
COD	42.37	60.32	87.91	85.71	83.51	77.12
BOD	36.79	51.11	71.1	64.4	62.22	53.2
TDS	24.92	34.66	53.11	46.88	43.61	33.25
TSS	15.3	19.38	68.37	62.24	57.14	44.89
TS	23.48	30.9	48.71	44.24	33.93	31.06
Chloride	27.13	43.84	68.58	60.2	59.81	56.2

From the table 3, the maximum removal efficiency for turbidity, electric conductivity, COD, BOD, TDS, TSS, TS and chlorides are 73.25%, 56.21%, 87.91%, 71.1%, 53.11%, 68.37%, 48.71% and 68.58% at an optimum coagulant dosage of 60 mg/l and the percentage removal is reduced while increasing dosages.

3.3 VARIATION OF PARAMETERS WITH DIFFERENT DOSAGES

After completion of treatment using sapodilla seed powder and ferrous sulphate, various parameters are tested and it is represented in graphical form.

Removal efficiency of turbidity for different dosages of sapodilla seed powder and ferrous sulphate is shown in fig. 5.

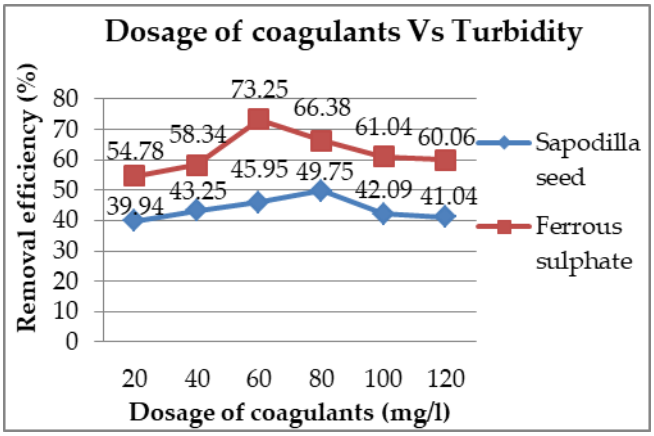

Fig. 5 Variation of turbidity for different dosages of sapodila seed powder and ferrous sulphate

The maximum percentage turbidity removal is 49.71% at a dosage of 80 mg/l for sapodilla seed powder and that for ferrous sulphate is 73.25% at a dosage of 60 mg/l. the percentage reduction of turbidity increases with increase in dosage and maximum percentage reduction of turbidity is obtained at the optimum dosage. Further increase in dosage, percentage reduction of turbidity gets reduced.

Removal efficiency of COD for different dosages of sapodilla seed powder and ferrous sulphate is shown in fig. 6.

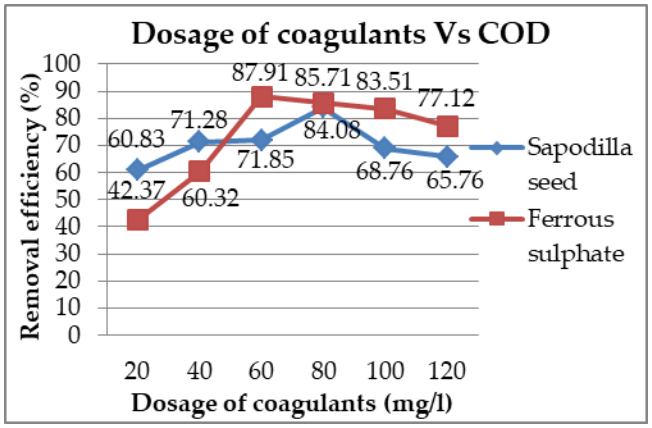

Fig. 6 Variation of COD for different dosages of sapodilla seed powder and ferrous sulphate

The percentage reduction of COD increases with increase in dosage and maximum percentage reduction of COD is obtained at a dosage of 80 mg/l is 84.08% for sapodilla seed powder and 60 mg/l is 87.91% for ferrous sulphate and the further increase in dosage, percentage removal for sapodilla seed powder and ferrous sulphate are decreases.

Removal efficiency of BOD for different dosages of sapodilla seed powder and ferrous sulphate is shown in fig. 7.

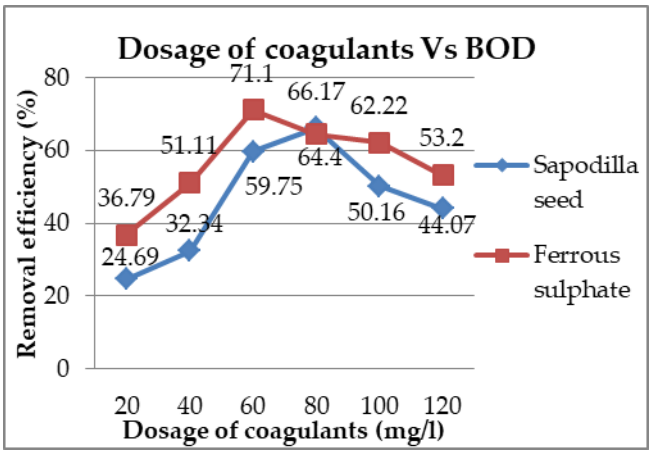

Fig. 7 Variation of BOD for different dosages of sapodilla seed and ferrous sulphate

The percentage reduction of BOD increases with increase in dosage and the maximum percentage reduction if BOD is obtained at a dosage of 80 mg/l is 66.17% for sapodilla seed powder and 60 mg/l is 71.1% for ferrous sulphate and further increase in dosage, percentage removal for sapodilla seed powder and ferrous sulphate are decreases.

The removal efficiency of TDS for different dosages of sapodilla seed powder and ferrous sulphate is shown in fig. 8.

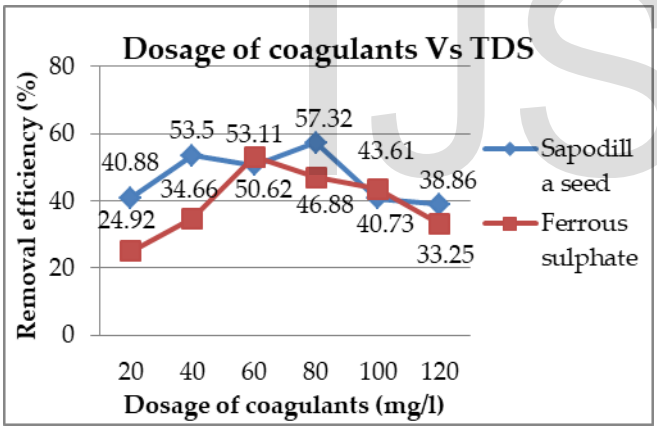

Fig. 8 Variation of TDS for different dosages of sapodilla seed powder and ferrous sulphate

The percentage reduction of total dissolved solids increases with increase in dosage and the maximum percentage reduction of total dissolved solids is obtained at a dosage of 80 mg/l is 57.32% for sapodilla seed powder and 60 mg/l is 53.11% for ferrous sulphate and the further increase in dosage, percentage removal for sapodilla seed powder and ferrous sulphate are decreased.

3.4 Coagulation Using Combined Use of Sapodilla Seed and Ferrous Sulphate

The optimum coagulant dosage obtained for sapodilla seed powder is 80 mg/l and for ferrous sulphate is 60 mg/l. Different percentages of these optimum dosages are selected for the combined use of sapodilla and ferrous sulphate. Table 4 shows the coagulant dosage in association.

TABLE 4
Coagulant Dosages in Association

% Coagulant (Sapodilla seed/Ferrous sulphate)	Coagulant dosage (mg/l)	
	Sapodilla seed	Ferrous sulphate
100%/0%	80	0
90%/10%	72	6
80%/20%	64	12
70%/30%	56	18
60%/40%	48	24
50%/50%	40	30

Optimal operational conditions are experimaentally determined. Table 5 shows the removal efficiency of treatment using combined use of sapodilla seed and ferrous sulphate.

TABLE 5
Removal Efficiency of Treatment Using Combined Use of Sapodilla Seed and Ferrous Sulphate

Parameters	Removal efficiency (%)					
	100%/0%	90%/10%	80%/20%	70%/30%	60%/40%	50%/50%
Turbidity	49.75	42.2	50	67.05	78.77	71.07
Electric conductivity	36.92	30.26	33.85	40	58.72	45.13
COD	71.86	75.75	83.68	90.19	87.98	86.3
BOD	59.75	72.28	73.04	63.63	62.1	61.73
TDS	50.62	50.93	58.96	59.94	59.41	58.88
TSS	67.86	75.77	77.96	60.97	58.67	56.38
TS	57.2	58.9	62.6	68.37	67.05	66.7
Chloride	43.84	45.76	53.73	56.21	66.27	69.05

From the table 5, the maximum removal efficiency for turbidity, and electric conductivity are 78.77% and 58.72% at a dosage of 60%/40% of sapodilla seed/ferrous sulphate, for COD, TDS and TS are 90.19%, 59.94% and 68.37% at a dosage of 70%/30% of sapodilla seed/ferrous sulphate, for BOD and TSS are 73.04% and 77.96% at a dosage of 80%/20% of sapodilla seed/ferrous sulphate, for chloride is 69.05% at a dosage of 50%/50%.

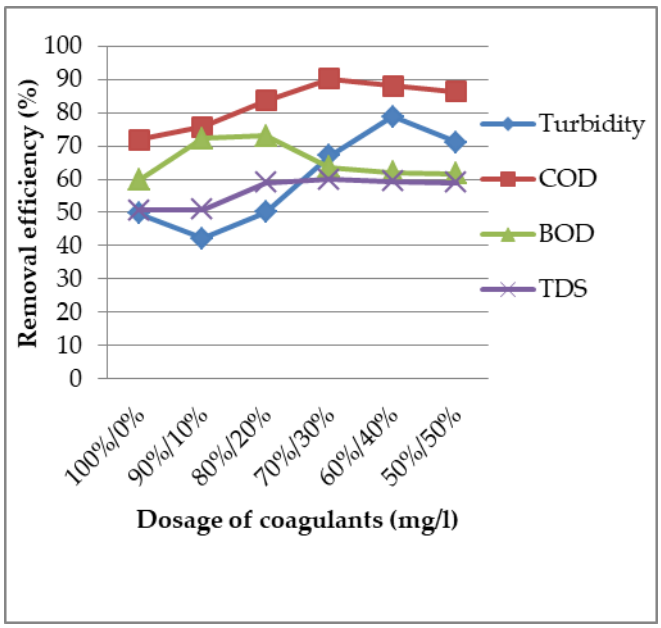

Fig. 9 Variation of turbidity, COD, BOD and TDS for different dosages of combined use of sapodilla seed and ferrous sulphate

The variations in removal efficiency of turbidity, COD, BOD and TDS for the combination of sapodilla seed powder and ferrous sulphate are shown in fig. 9. The combination of sapodilla seed powder and ferrous sulphate will have greater removal efficiency for all the tested parameters. By analyzing the removal efficiency for sapodilla seed powder, ferrous sulphate and their combination, the combined use of sapodilla seed powder and ferrous sulphate is more efficient than others.

4 Conclusion

Alum is the most commonly used chemical coagulant for turbidity removal. But the over use of alum cause Alzheimer disease. The chemical coagulant used in this study is ferrous sulphate, which is more effective in treatment of water heving pH above 8.5. Natural coagulant used in this study is sapodilla seed powder. The maximum percentage removal of turbidity was found to be 49.75% at 80 mg/l dosage for sapodilla seed powder and 73.25% at 60 mg/l dosage for ferrous sulphate. The maximum percentage removal of turbidity for the combination of sapodilla seed powder and ferrous sulphate is 78.77% at a dosage of 60%/40%. For maximum percentage removal for COD and BOD for sapodilla seed powder are 84.08% and 66.17% at a dosage of 80 mg/l and that for ferrous sulphate are 87.91% and 71.11% at a dosage of 60 mg/l and that for combination of sapodilla seed powder and ferrous sulphate are 90.19% at a dosage of 70%/30% and 73.04% at a dosage of 80%/20% respectively. The maximum removal efficiency for electric conductivity is 39.2% at a dosage of 80 mg/l for sapodilla seed powder and 56.21% at a dosage of 60 mg/l for ferrous sulphate and 58.72% for their combination at a dosage of 60%/40%. The maximum percentage removal for TDS, TSS and TS are 57.32%, 74.89% and 62.42% for sapodilla seed powder at a dosage of 80 mg/l and 53.11%, 68.37% and 48.71% for ferrous sulphate at a dosage of 60 mg/l and 59.94%, 77.96% and 68.37% for their combined use at a dosage of 70%/30%, 80%/20%, 70%/30% respectively. Maximum removal efficiency for chloride is 47.03% at a dosage of 80 mg/l for sapodilla seed powder, 68.58% at a dosage of 60 mg/l for ferrous sulphate and 69.05% at a dosage of 50%/50%. By conducting coagulation- flocculation process using jar test, the optimum coagulant dosage of sapodilla seed powder is 80 mg/l and of ferrous sulphate is 60 mg/l. Sapodilla seed powder and ferrous sulphate effective for grey water treatment and their combination is more effective for the treatment of grey water. The utilization of sapodilla seed powder can play a key role in reducing the amount of synthetic coagulant ferrous sulphate required to obtain treated water. This study demonstrated that the natural coagulants could be effectively used to complement synthetic coagulants in water treatment.

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