TEXTILE EFFLUENT TREATMENT BY NATURAL WASTE ADSORBENTS TO REDUCE CHEMICAL COAGULANT DOSAGE

AT

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By

Jacob Tharakan , Dr. Lalita Choudhary
Department of Chemistry,
Shree Ramkrishna Institute of Computer Education and Applied Sciences, Surat , Gujarat

What is the need of this study?

- Textile industry is a major polluter of water bodies producing highly coloured wastewater which is high in suspended solids and COD. The volume of wastewater generated is also large.
- Colour is a visible pollutant in the water and the presence of even minute amounts of colouring substance makes it undesirable due to its appearance.
- The discharge of colours in the environment is a matter of concern for both toxicological and aesthetical reasons.
- A number of technologies have been developed over the years to remove Colour, COD, BOD, Solids etc, from industrial wastewater.
- The most important technologies include coagulation / flocculation process, membrane filtration, oxidation, biological process.

Objective of the study

The present work is an attempt to reduce the dosage of chemical coagulants in the treatment of textile waste water by adsorption and coagulation techniques both using:

- Low cost adsorbents: i.e.

  (a) corn cob and (b) spent tea leaves

- Coagulants-Alum and Bentonite clay

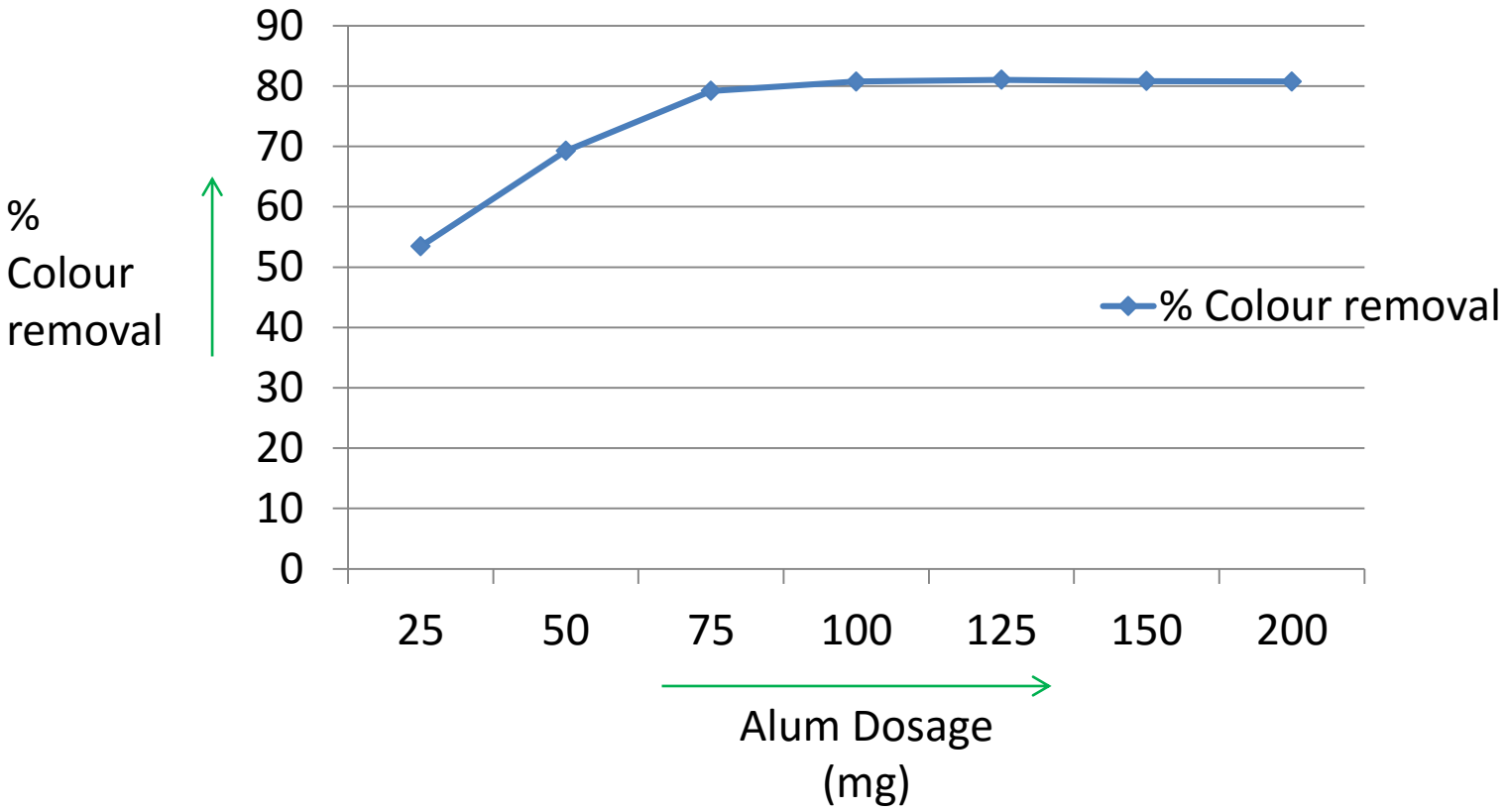
Methodology

- Textile waste water sample was collected from a dyeing industry in Sachin GIDC area of Surat
- Sample was analysed for pH, TDS, TSS, TS, COD, BOD and turbidity
- Wavelength of maximum absorbance was analysed to be 515 nm.
- Effectiveness of the two processes i.e. Adsorption (using treated corn cob and spent tea leaves) and Coagulation (Bentonite clay along with alum) individually as well their combined effect on the % removal of colour of textile industry effluent.
- SEM to study the changes in the surface of treated adsorbents.
- Proximate analysis of the adsorbent to understand its combustion properties for final disposal in the form of incineration.
- Effect of optimum conditions derived for colour removal on parameters (pH, TDS, TSS, TS, COD, BOD and turbidity)

Coagulation treatment with alum

No	Dosage (mg)/50 ml	% Colour removal	pH
1.	25	53.44	4.63
2.	50	69.26	4.11
3.	75	79.20	3.91
4.	100	80.73	3.83
5.	125	81.03	3.86
6.	150	80.83	3.89
7.	200	80.73	3.86

% Colour removal with Alum

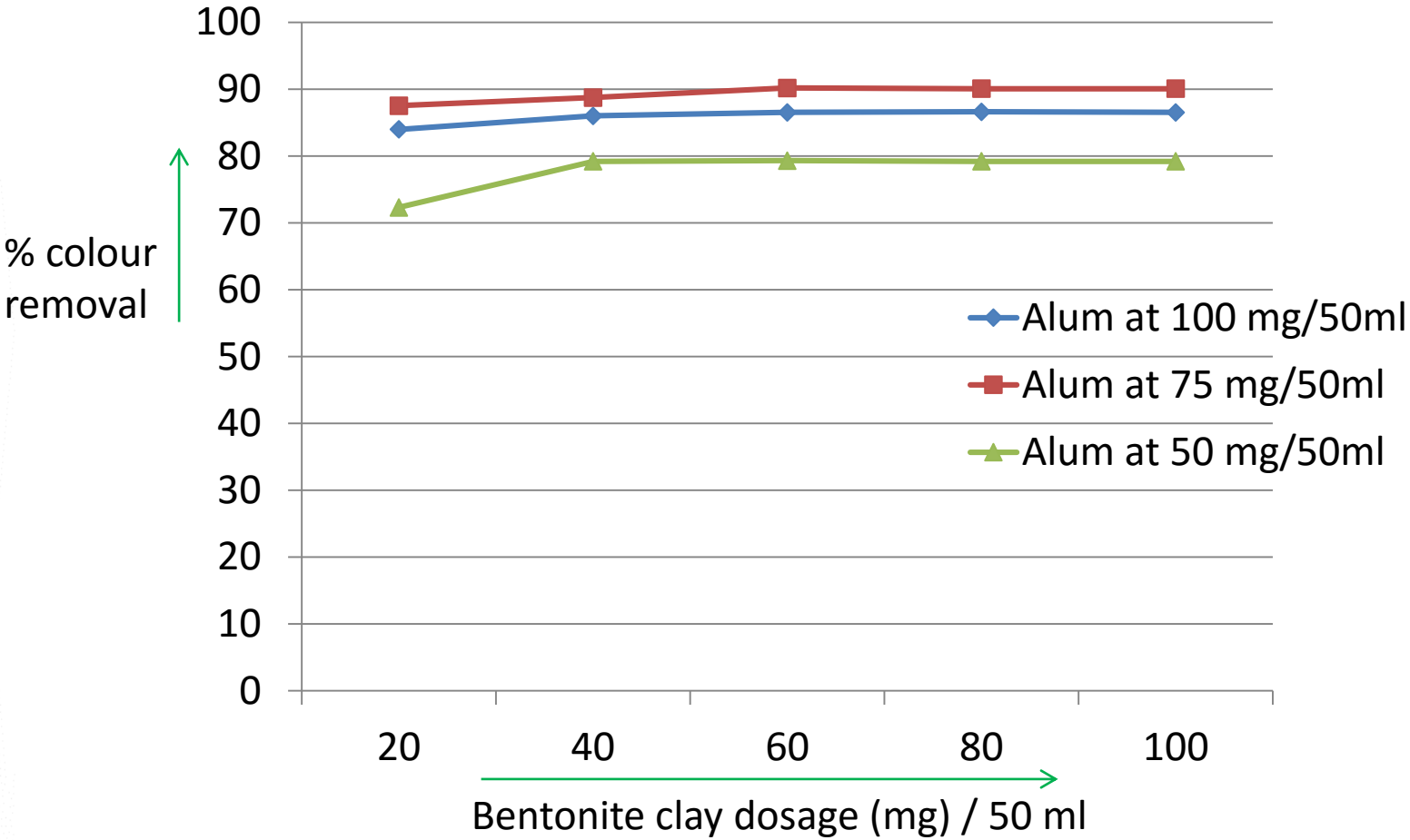


Conclusion : Optimum Dosage - 100 mg Alum / 50 ml
% colour removal - 80.73%

Treatment with Alum and Bentonite clay

No	Dosage of Bentonite clay (mg)	Alum at 100 mg/50ml		Alum at 75 mg/50 ml		Alum at 50 mg/50 ml	
		pH	% colour removal	pH	% colour removal	pH	% colour removal
1.	20 mg	3.97	83.97	3.86	87.52	3.83	72.31
2.	40 mg	3.96	86.00	3.89	88.74	3.83	79.20
3.	60 mg	3.96	86.51	3.89	90.16	3.91	79.31
4.	80 mg	3.95	86.61	3.90	90.06	3.97	79.20
5.	100 mg	3.96	86.51	4.94	90.06	4.04	79.20

% Colour removal with Alum & Bentonite clay



Conclusion : Alum Dosage - 75mg/50ml
Bentonite Clay - 60 mg/50 ml
% Colour removed - 90.16%

Preparation of Adsorbents

Corn cob

Corn cob collected from vendor.

↓

Grinded using grinder.

↓

Sieved to uniform particle size.

↓

Washed with distilled water.

↓

Dried using hot air oven at 100°C for 5hrs.

↓

Stored in air tight containers.

Spent tea leaves

STL recovered and repeatedly washed with distilled water

↓

Rinsed and oven dried at 60 °C for 24 h.

↓

Thermal activation by stepwise increase of the temperature (up to 400°C) and isothermal heating for a time of 0.5 to 2 h.

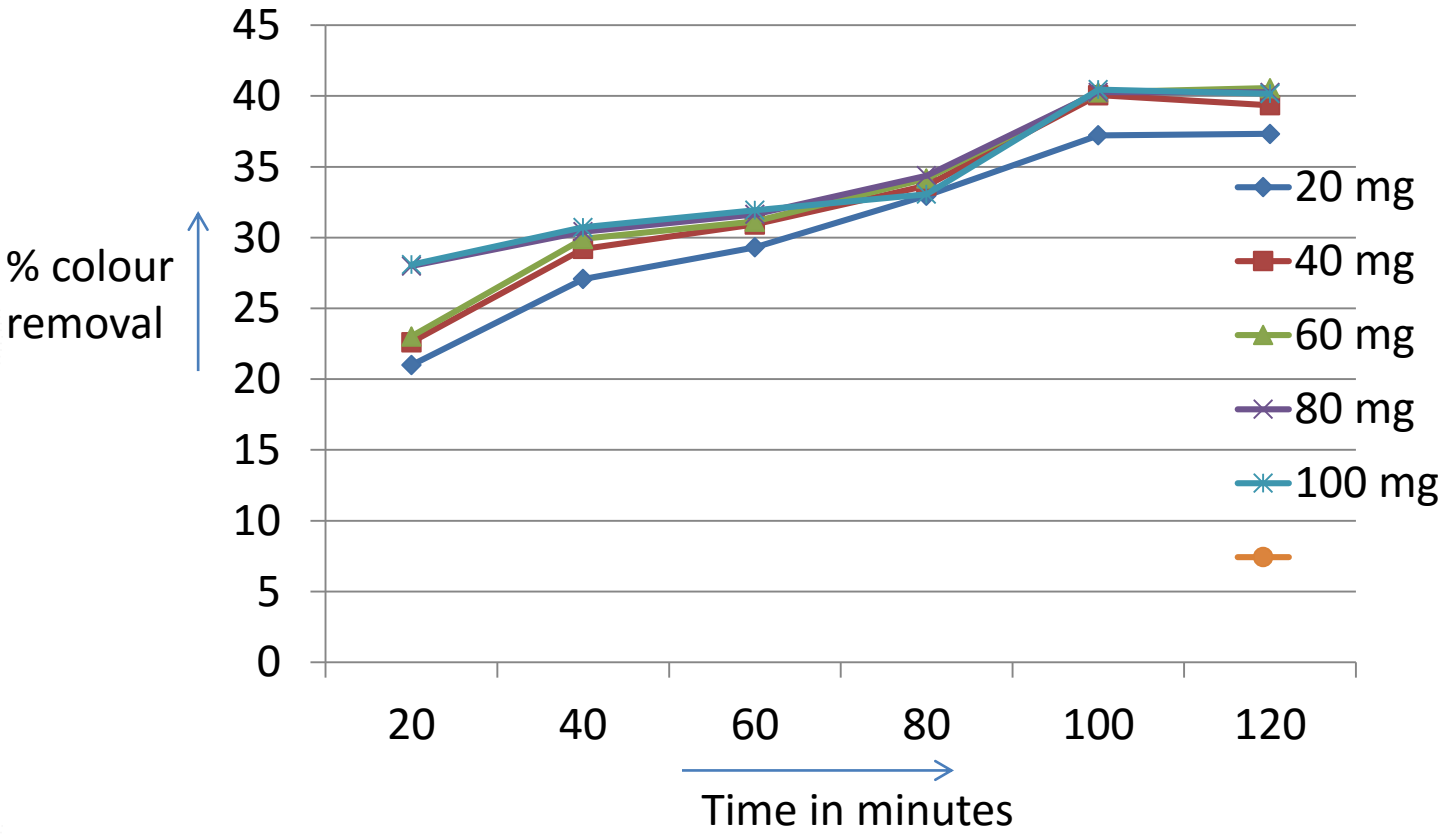
↓

Stored in air tight containers

Adsorption with Corncob

Time ↓ / Dosage / 50 ml →	% Colour removal				
	20 mg	40 mg	60 mg	80 mg	100 mg
20 min	20.99	22.61	23.02	27.99	28.09
40 min	27.07	29.20	29.91	30.42	30.73
60 min	29.31	30.93	31.13	31.64	31.94
80 min	32.96	33.67	34.17	34.38	33.06
100 min	37.22	40.06	40.26	40.26	40.46
120 min	37.32	39.35	40.56	40.26	40.16

% Colour removal with Corncob

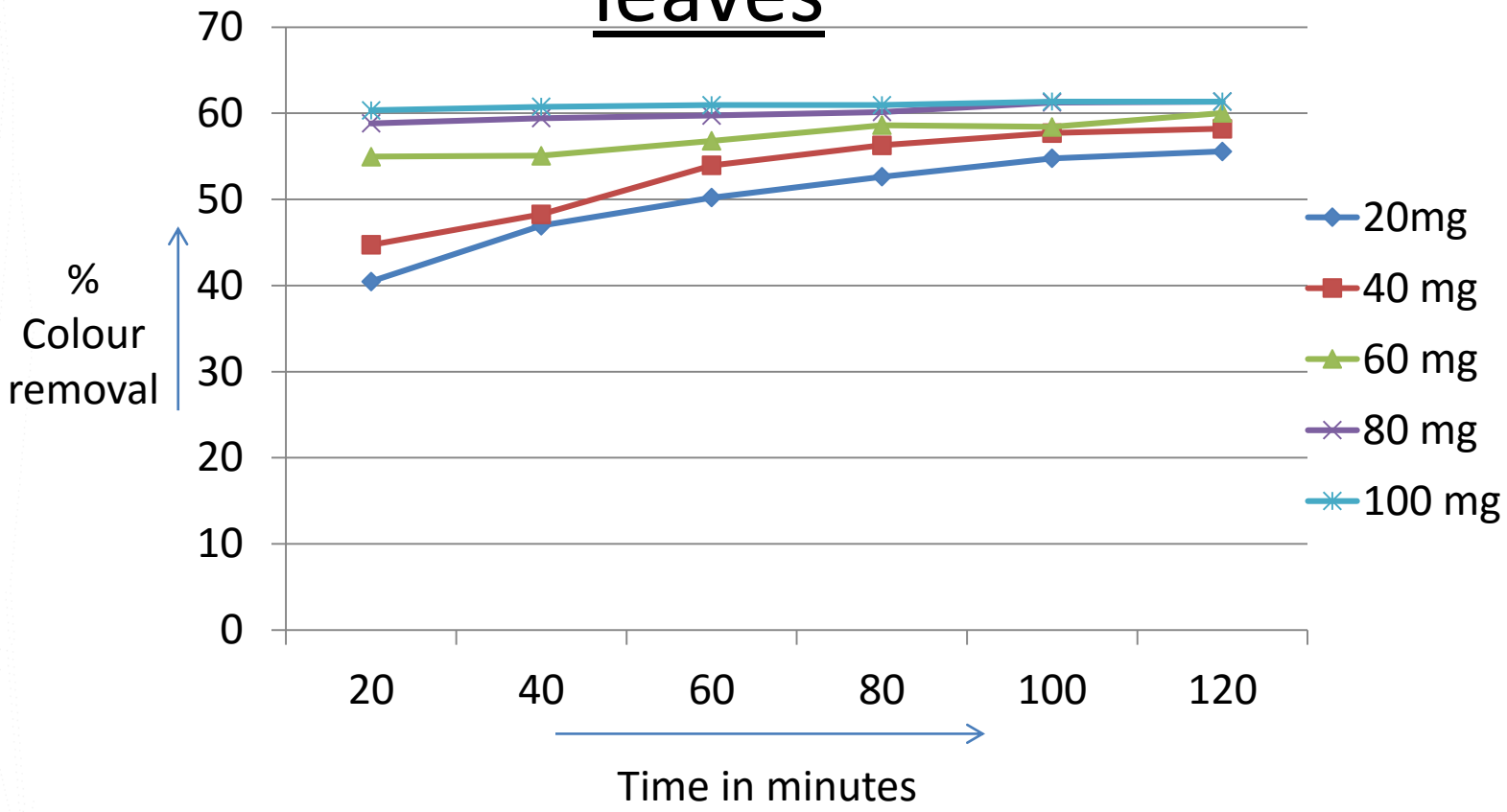


Conclusion : Optimum dosage : 60 mg/50 ml
Optimum time : 100 minutes
% Colour removal : 40.26

Adsorption with Spent tea leaves

Time ↓ / Dosage / 50 ml →	% Colour removal				
	20 mg	40 mg	60 mg	80 mg	100 mg
20 min	40.46	44.72	54.96	58.82	60.34
40 min	46.95	48.27	55.07	59.43	60.75
60 min	50.20	53.95	56.79	59.73	60.95
80 min	52.63	56.28	58.62	60.14	60.95
100 min	54.76	57.70	58.41	61.25	61.35
120 min	55.57	58.21	60.04	61.35	61.35

% Colour removal with Spent tea leaves



Conclusion : Optimum dosage : 60 mg/50 ml
Optimum time : 120 minutes
% Colour removal : 60.04

Adsorption followed by Coagulation

- **Adsorbents used :**

1. Corncob - 60 mg/50 ml
2. Spent tea leaves - 60 mg/50 ml

- **Coagulants used:**

Varied amounts of Alum and bentonite clay in the ratio of 5:4 based on optimum dosage (Alum - 75mg/50ml and Bentonite Clay - 60 mg/50 ml)

Methodology

Adsorbents
1.60 mg Corncob / 50 ml sample
2.60 mg Spent tea leaves / 50 ml sample

↓

Kept in incubator shaker
1.Corncob for 100 minutes
2. Spent tea leaves for 120 minutes

↓

Decantation

↓

Coagulation with alum and bentonite clay in varying dosages (5 sets with each adsorbent)

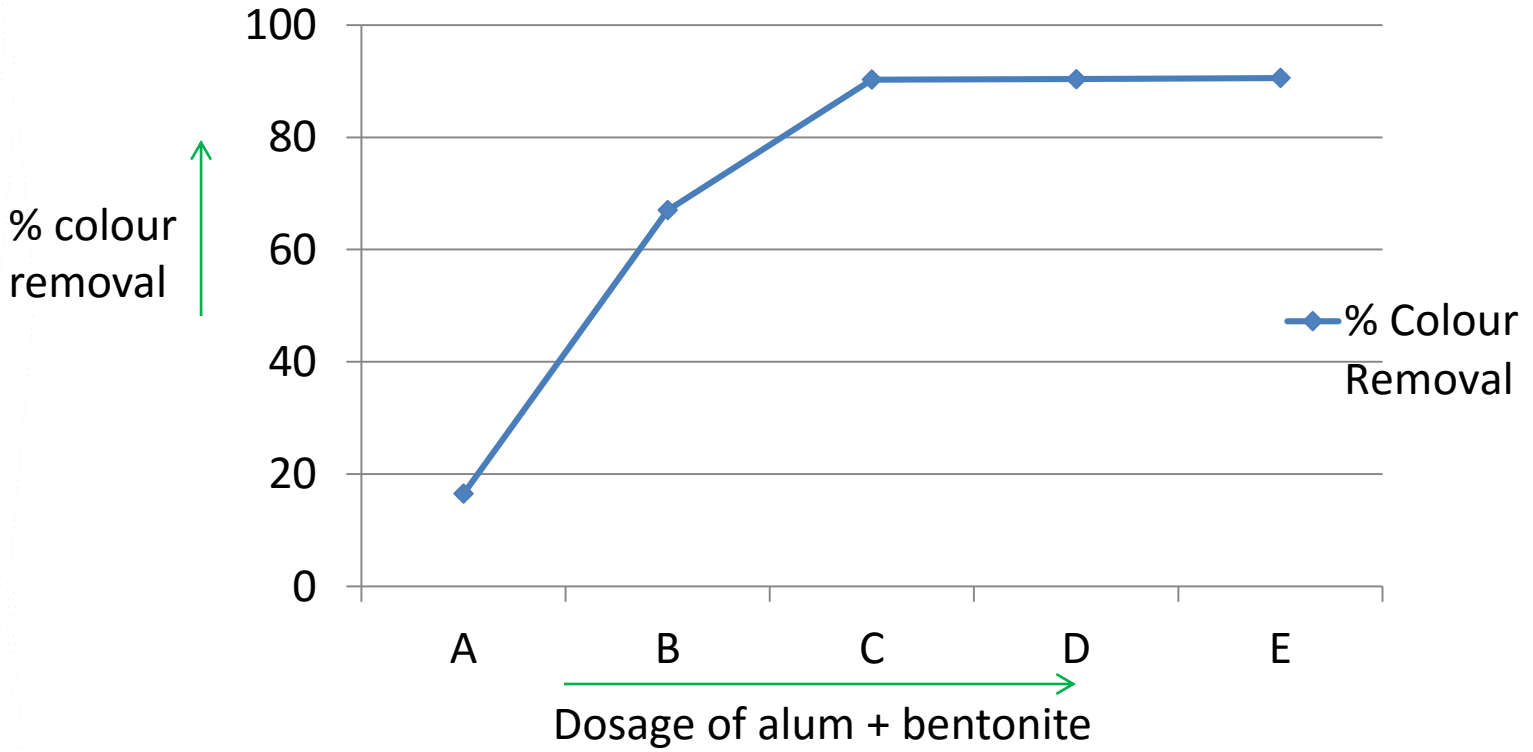
↓

Determination of absorbance at 515 nm

% Colour removal Adsorption with Corncob followed by Coagulation with Alum & Bentonite clay

After adsorption with 60 mg corncob / 50 ml for 100 mins	Alum mg	Bentonite Clay mg	% Colour Removal
1	20	16	16.53
2	40	32	67.03
3	60	48	90.26
4	80	64	90.36
5	100	80	90.56

% Colour removal; Corncob (adsorbent) + Alum & Bentonite clay (coagulants)



Conclusion :

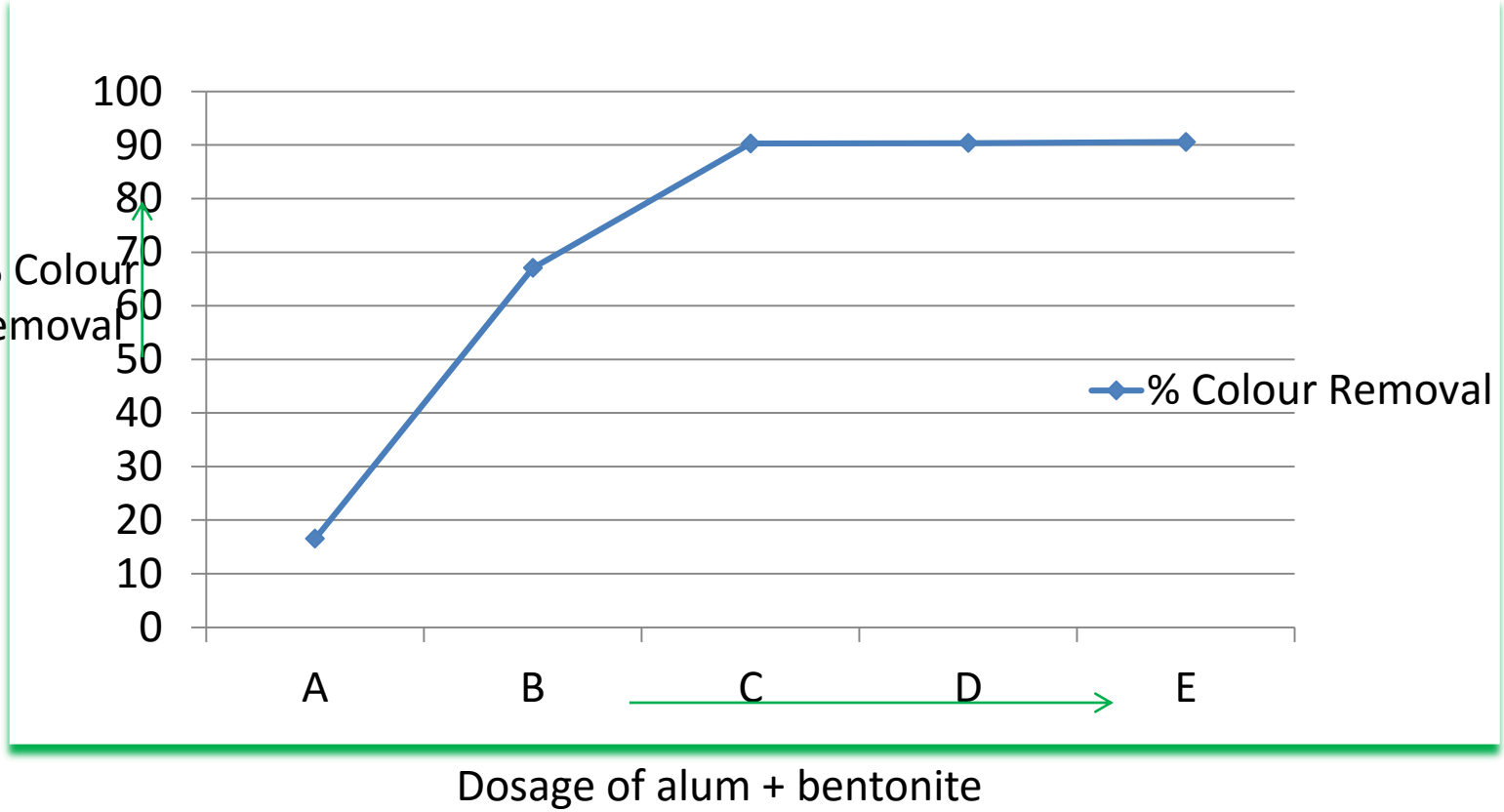
- **Optimum Dosage - 60 mg Alum + 48 mg Bentonite/50 ml**
- **% Colour removal - 90.26**

A = 20 mg alum + 16 mg Bentonite clay
B = 40 mg alum + 32 mg Bentonite clay
C = 60 mg alum + 48 mg Bentonite clay
D = 80 mg alum + 64 mg Bentonite clay
E = 100 mg alum + 80 mg Bentonite clay

% Colour removal by Adsorption with Spent tea leaves followed by Coagulation with Alum & Bentonite clay

After adsorption with 60 mg STL / 50 ml for 120 mins	Alum mg	Bentonite Clay mg	% Colour Removal
1	20	16	54.46
2	40	32	73.06
3	60	48	88.22
4	80	64	88.55
5	100	80	88.45

% Colour removal; Spent tea leaves (adsorbent), Alum & Bentonite clay (coagulants)



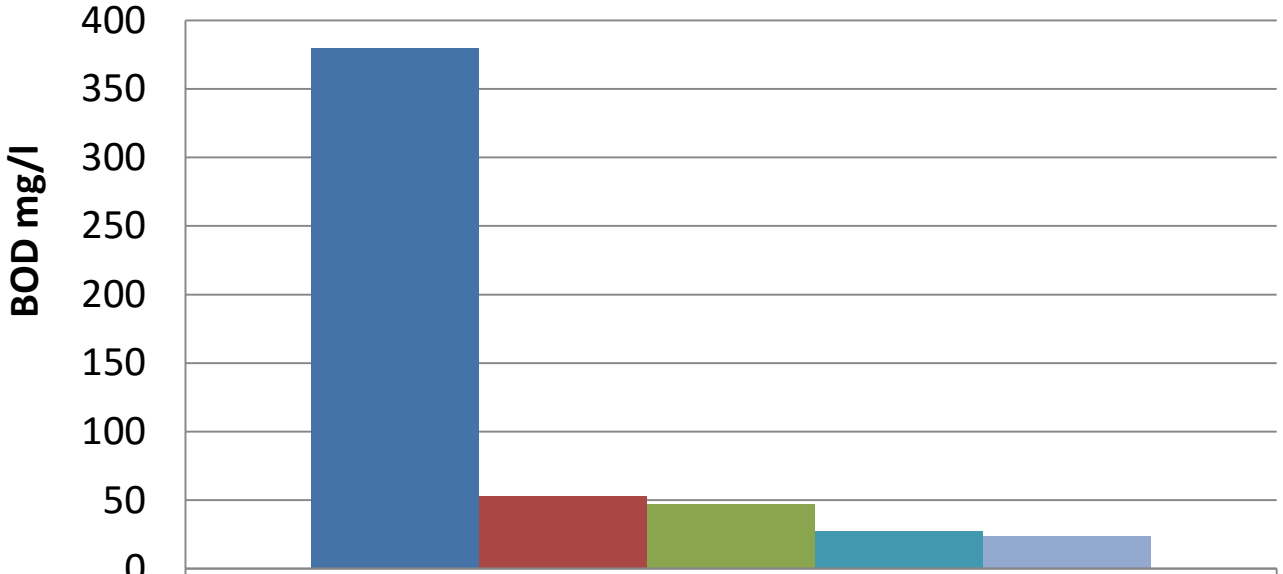
Conclusion :
Optimum Dosage - 60 mg alum + 48 mg Bentonite/50 ml
% Colour removal - 88.22

A = 20 mg alum + 16 mg Bentonite clay
B = 40 mg alum + 32 mg Bentonite clay
C = 60 mg alum + 48 mg Bentonite clay
D = 80 mg alum + 64 mg Bentonite clay
E = 100 mg alum + 80 mg Bentonite clay

Analysis of treated samples

Parameters and their inland surface water standards	Sample	Coagulation with Alum	Coagulation with Alum + BC	Adsorption with CC	Adsorption with CC + Coagulation With Alum +BC	Adsorption with STL	Adsorption with STL + Coagulation with Alum +BC
TS(ppm)	3394.4	945	910	2699	762	2459	771
TSS(ppm) 100	130	90	87	284	71	277	74
TDS(ppm)	3264.4	855	823	2415	691	2182	697
COD (mg/l) 250	1220.16	260	256	1480	243	621	230
BOD (mg/l) 30	380	53	47	124	27	98	24
Turbidity (NTU)	126	22	14	44	9.8	39	7.9

BIO CHEMICAL OXYGEN DEMAND



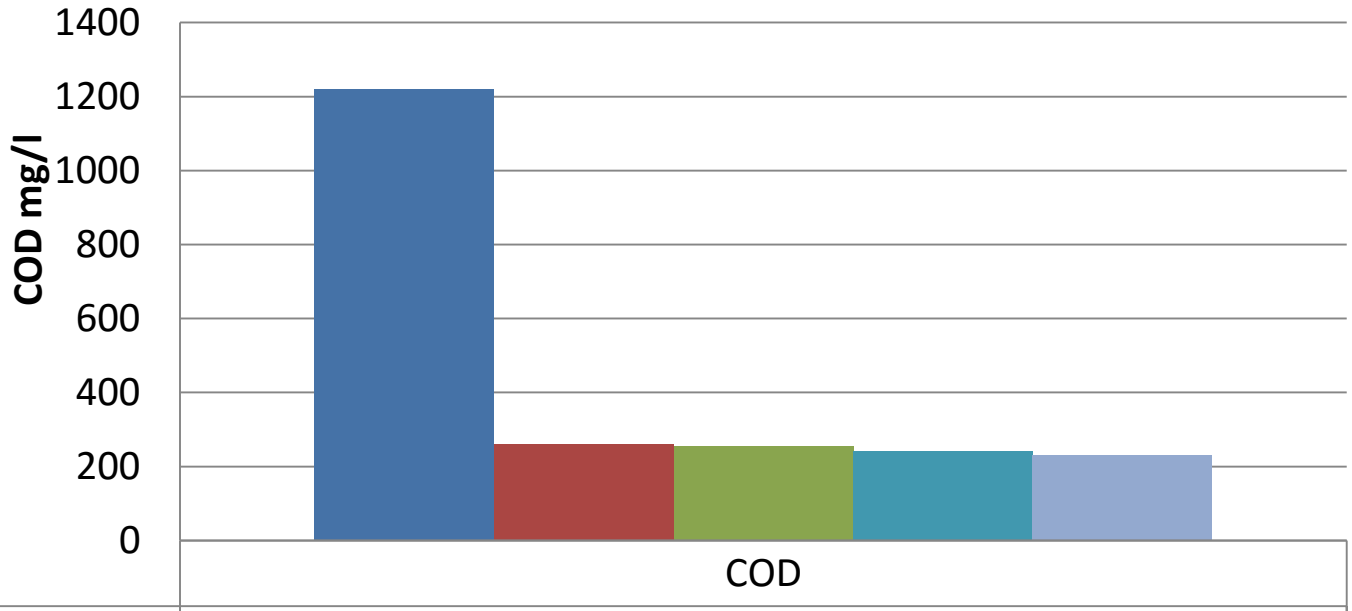
	BOD
Sample	380
Alum	53
Alum + BC	47
CC + Alum + BC	27
STL + Alum + BC	24

Conclusion:

- Maximum removal of BOD when treated with STL + Alum + BC
- CC + Alum + BC also showed Substantial similar BOD removal

➢ Both were able to bring BOD within permissible limits.

CHEMICAL OXYGEN DEMAND



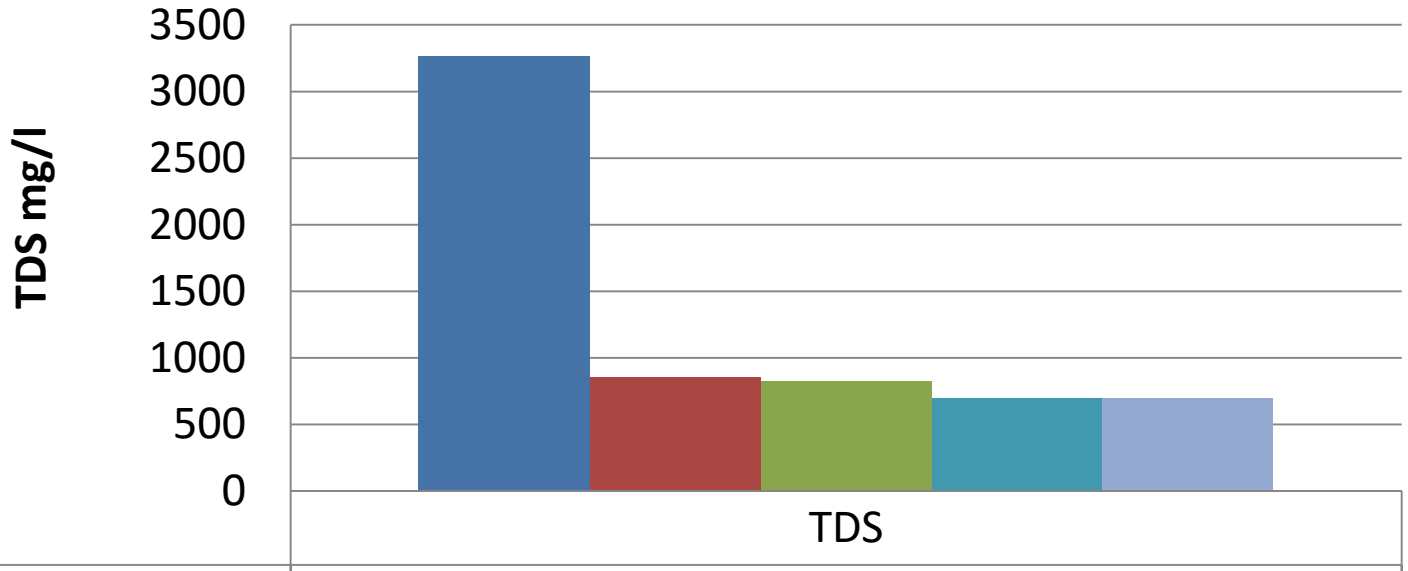
	COD
Sample	1220.16
Alum	260
Alum + BC	256
CC + Alum + BC	243
STL + Alum + BC	230

Conclusion:

- Maximum removal of COD when treated with STL + Alum +BC.
- CC + Alum + BC also showed Substantial similar COD removal .

➢ Both were able to bring COD within permissible limits for inland surface water.

TOTAL DISSOLVED SOLIDS

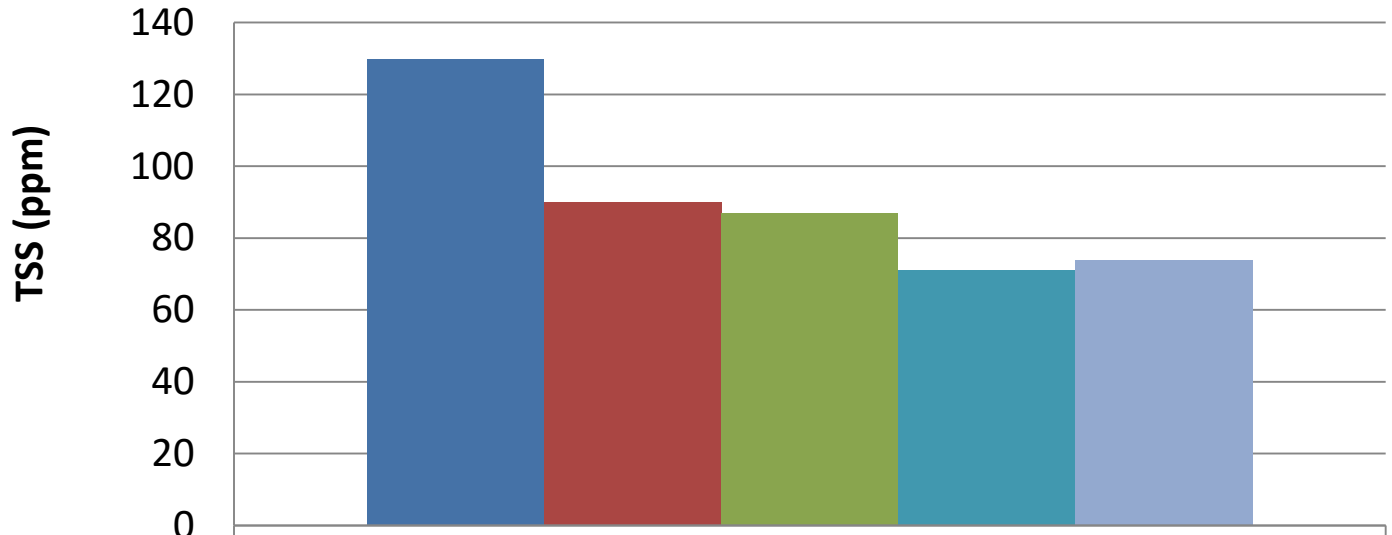


	TDS
Sample	3264.4
Alum	855
Alum + BC	823
CC + Alum + BC	691
STL + Alum + BC	697

<u>Conclusion:</u>

Maximum removal of TDS was shown when treated with CC+ Alum + BC followed by treatment with STL+ Alum +BC.

TOTAL SUSPENDED SOLIDS

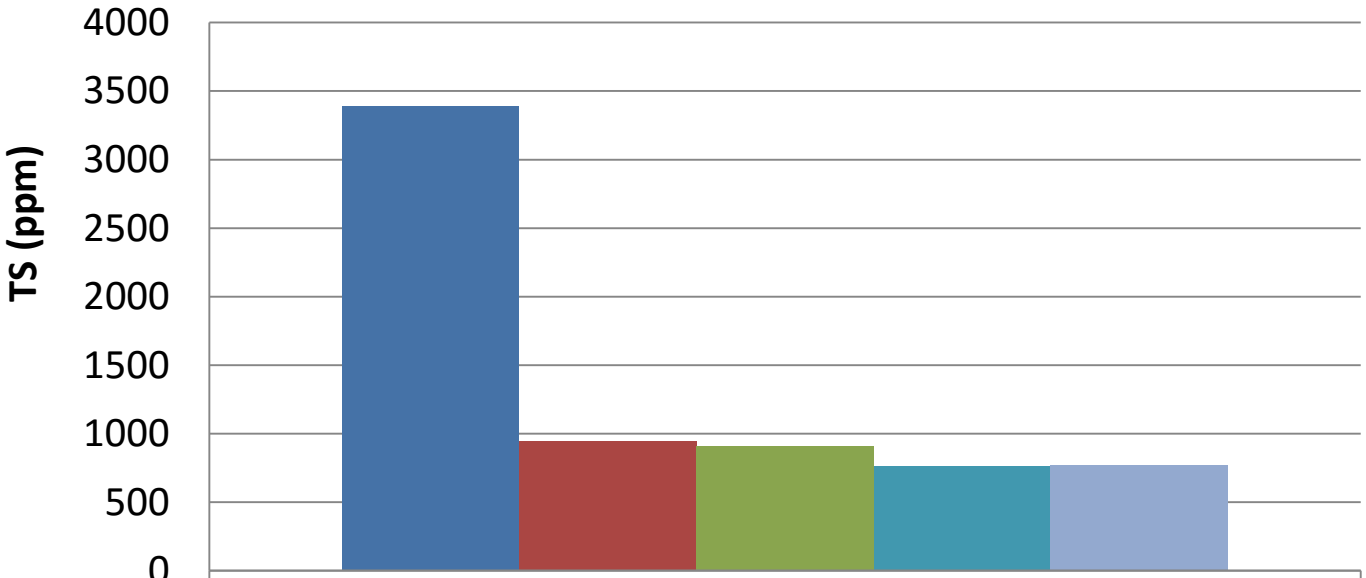


	TSS
Sample	130
Alum	90
Alum + BC	87
CC + Alum + BC	71
STL + Alum + BC	74

Conclusion:

- Maximum removal of TSS was shown when treated with CC+ Alum + BC closely followed by STL + Alum + BC.
- Both were able to bring TSS within permissible limits for inland surface waters.

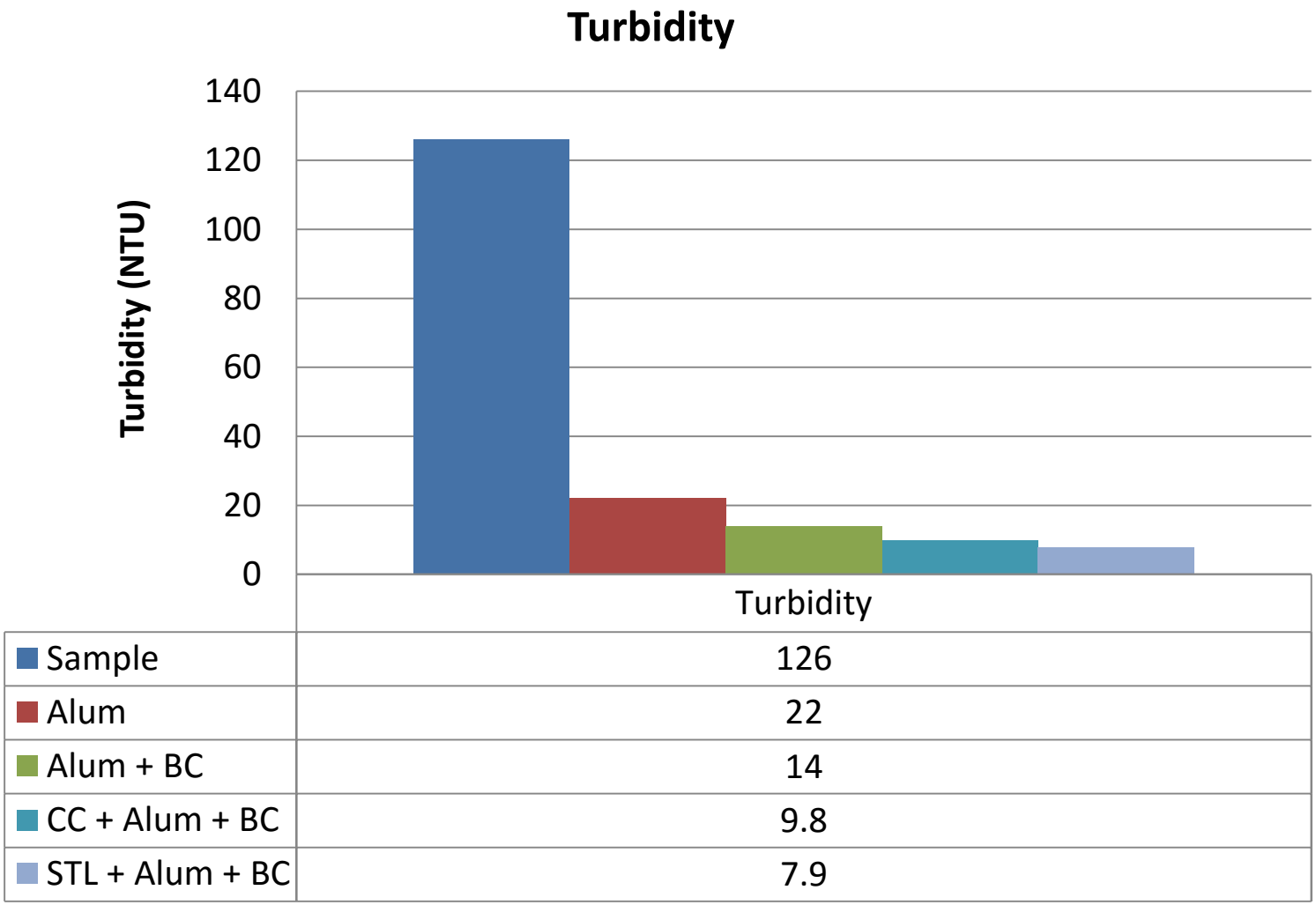
TOTAL SOLIDS



	TS
Sample	3394.4
Alum	945
Alum + BC	910
CC + Alum + BC	762
STL + Alum + BC	771

Conclusion:

Maximum removal of TS was shown when treated with CC+ Alum + BC closely followed by STL + Alum + BC

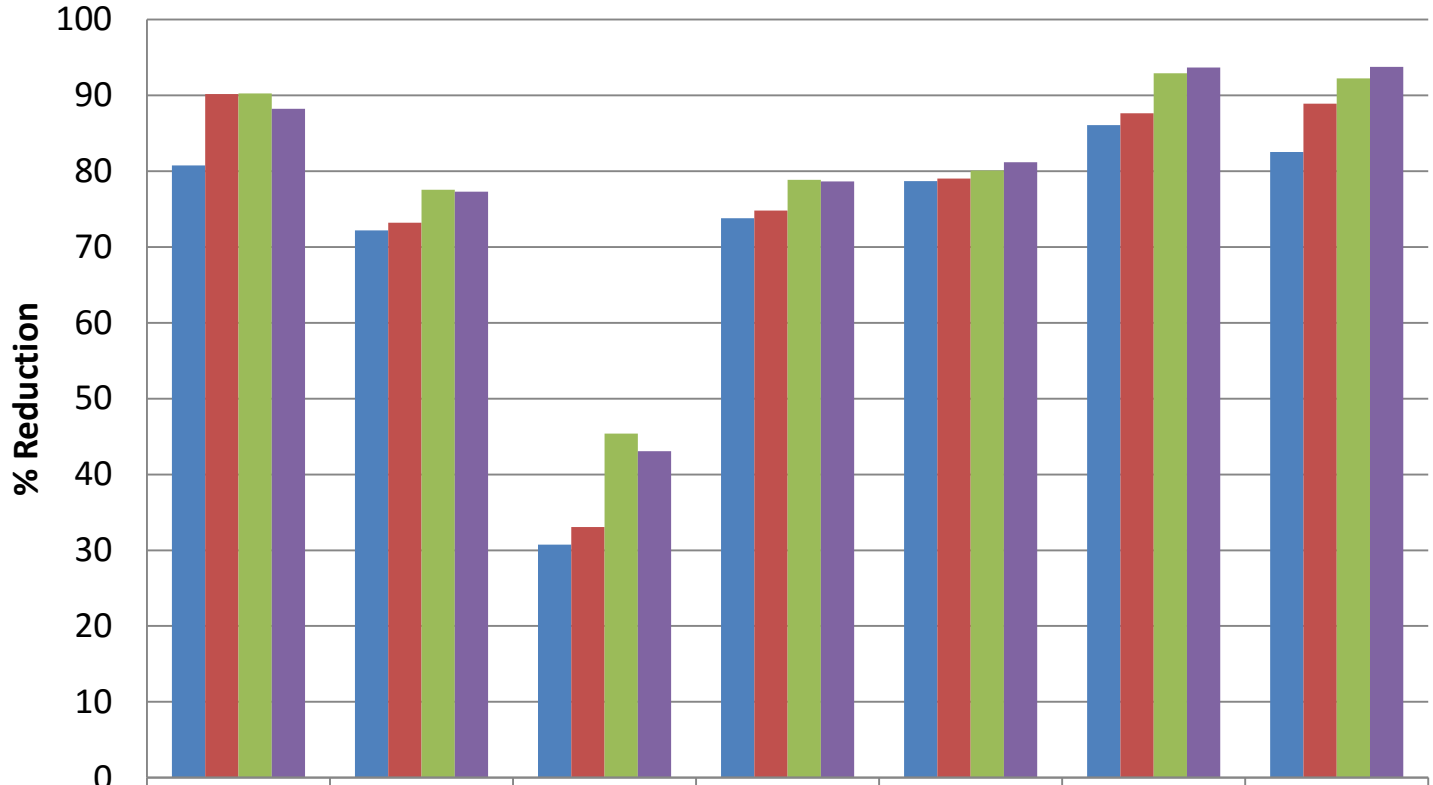


	Turbidity
Sample	126
Alum	22
Alum + BC	14
CC + Alum + BC	9.8
STL + Alum + BC	7.9

Conclusion:

- Maximum removal of Turbidity when treated with STL + Alum + BC closely followed by CC + Alum + BC.

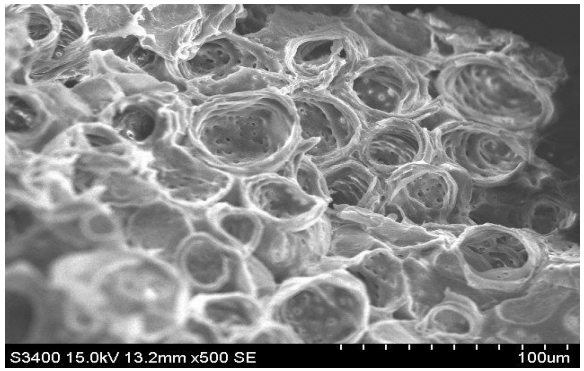
% Reduction in parameters



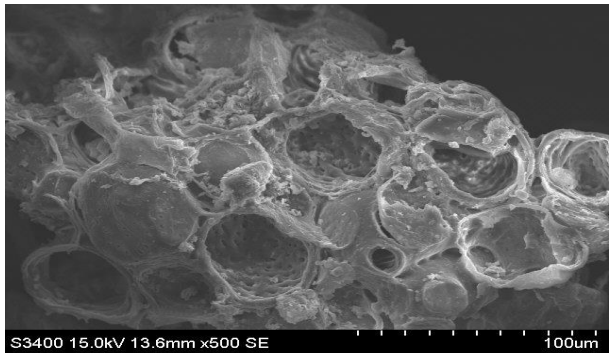
	% colour removal	%TS	%TSS	% TDS	% COD	%BOD	Turbidity
Alum	80.73	72.16	30.76	73.8	78.69	86.05	82.53
Alum + BC	90.16	73.19	33.07	74.78	79.01	87.63	88.88
Alum + BC+ CC	90.26	77.55	45.38	78.83	80.08	92.89	92.22
Alum + BC+ STL	88.22	77.28	43.07	78.64	81.15	93.68	93.73

SEM of the adsorbents

1. **Corn cob**

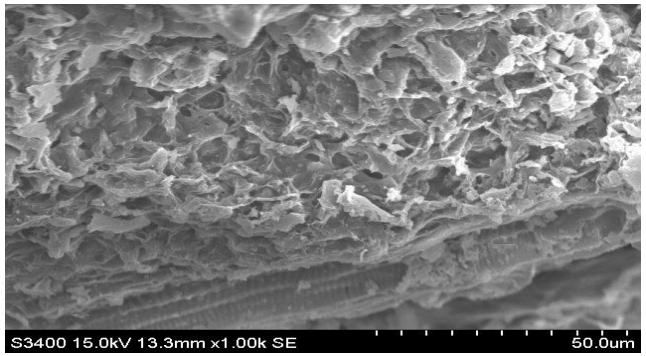


Corncob before adsorption

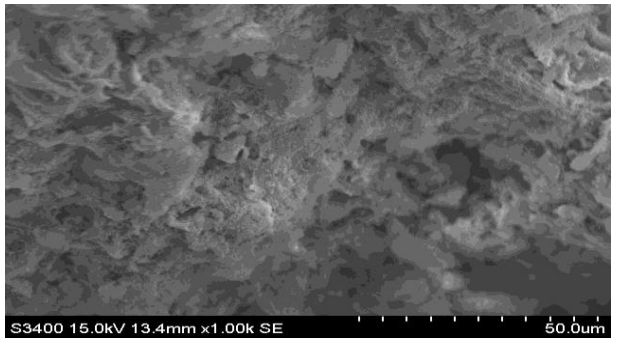


Corncob after adsorption

2. Spent Tea Leaves



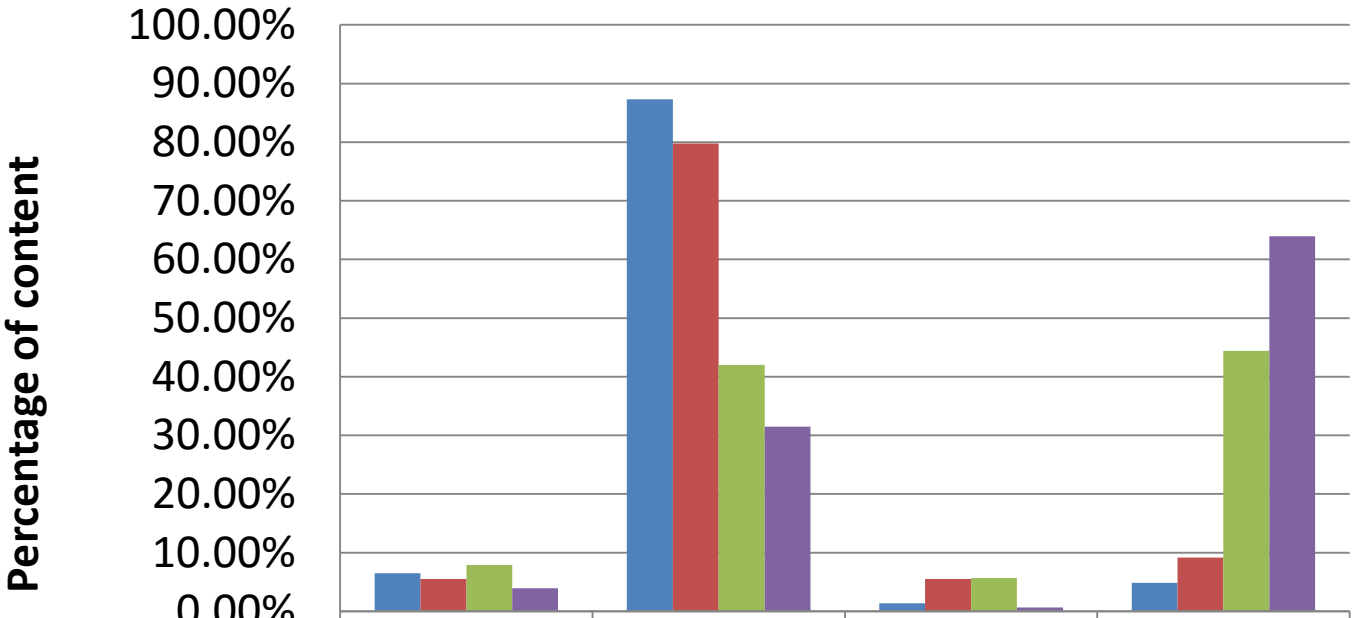
Spent tea leaves before adsorption



Spent tea leaves after adsorption

SEM of the adsorbent showed filling up of pores of adsorbent by adsorbate both in the case of spent tea leaves as well as corn cob.

Proximate Analysis of adsorbents and coagulants after treatment



	% Moisture	% Volatile Matter	% Ash	% Fixed Carbon
Corncob	6.50%	87.30%	1.36%	4.84%
Spent tea leaves	5.52%	79.80%	5.52%	9.16%
Alum	7.90%	42%	5.68%	44.42%
Alum + Bentonite clay	3.94%	31.50%	0.62%	63.94%

Proximate Analysis of adsorbents and coagulants after treatment

- **H**igh percentage of Fixed carbon for **Alum and Alum + Benotnite clay after coagulation** indicates the absorption of material from the effluent as there is no carbon content in the composition of alum and bentonite clay.
- High percentage of volatile matter for **Corncob and Spent tea leaves** suggested their high ignitibility.
- Relatively low amount of ash content observed advocates incineration as a mode of final disposal.

Conclusion

Treatment with:

- **Alum (**2g/l of sample): 80.73% colour removal
- **Alum and bentonite clay** : 90.16% of colour removal (1.5g and 1.2g /l of sample)
  - This was found to be more efficient in colour removal while reducing the dosage of alum by **25%.**
- **Corncob as adsorbent (1.2 g) and Alum (1.2 g) + Bentonite clay (0.96g) as coagulant/ litre** : 90.26% colour removal
- **Spent tea leaves as adsorbent (1.2 g) and Alum (1.2 g) + Bentonite clay (0.96g) as coagulant/ litre** : 88.06% colour removal .

Conclusion

- **Thus the result of this combination treatment in colour removal was better than alum alone as the dosage of alum is reduced by 40% .**
- Combination treatment was able to bring TSS, COD, BOD within **permissible limits** of standards for inland surface water.
- The amount of sludge is reduced which decreases the load on biological treatment.
- ***Thus sorption by these natural waste adsorbents followed by coagulation with Bentonite-alum combination is an efficient technique for the removal of color of dyes from waste water and an attempt to reduce the amount of coagulant simultaneously bringing other parameters in permissible limits***.

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12. Standard Methods for the Examination of Water and Wastewater - APHA.

THANK YOU

Scope of the study

- This study will emphasise on the usage of low cost natural adsorbents and coagulant rather than using expensive adsorbents, leading to an economic and environmental friendly method of treating textile waste water.
- Studies will be done on a single batch of effluent (from a dying industry) as arrangements for retention in the site are not made.
- As industries run in a cyclic manner, the effluents can be retained until the whole cycle is done. A similar to above study on such a stored effluent will possibly give a solution to that particular industry.
- There will be variations in the effluent treatment of every industry due to varying operation conditions and raw materials used in the industries.
- The use of bentonite clay will be beneficial in reducing sludge due to coagulation as compared to other clays. This sludge can be dried and incinerated or land filed as in the case of any other sludge.
- The adsorbent after adsorption can be incinerated or land filled. Incineration is found to be a better method. Proximate analysis of the adsorbent will be done to understand its combustion properties.

	Alum	Alum + BC	Alum + BC+ CC	Alum + BC+ STL
Dosage/ 50 m	100mg	75mg + 60mg	60mg+ 60mg+ 48mg	60mg+ 60mg+ 48mg
Dosage/ litre	2g	1.5g + 1.2g	1.2g+ 1.2g+ 0.96 g	1.2g+ 1.2g+ 0.96 g
% colour removal	80.73	90.16	90.26	88.22
%TS	72.16	73.19	77.55	77.28
%TSS	30.76	33.07	45.38	43.07
% TDS	73.80	74.78	78.83	78.64
% COD	78.69	79.01	80.08	81.15
%BOD	86.05	87.63	92.89	93.68
Turbidity	82.53	88.88	92.22	93.73

Analysis of the sample

Wavelength of maximum absorbance was analysed to be 515 nm.

PARAMETERS	BEFORE TREATMENT
Colour	Purple
Odour	Offensive
pH	4.8
COD	1220.16 mg/l
BOD	380 mg/l
TS	3394.4 ppm
TSS	130 ppm
TDS	3264.4 ppm
Turbidity (NTU)	126

Treatment with Alum

Addition

Alum to sample at dosage varying from 25-250 mg (7 sets)

Stirring

Slow stirring 15 min + fast stirring 5 min

Sedimentation

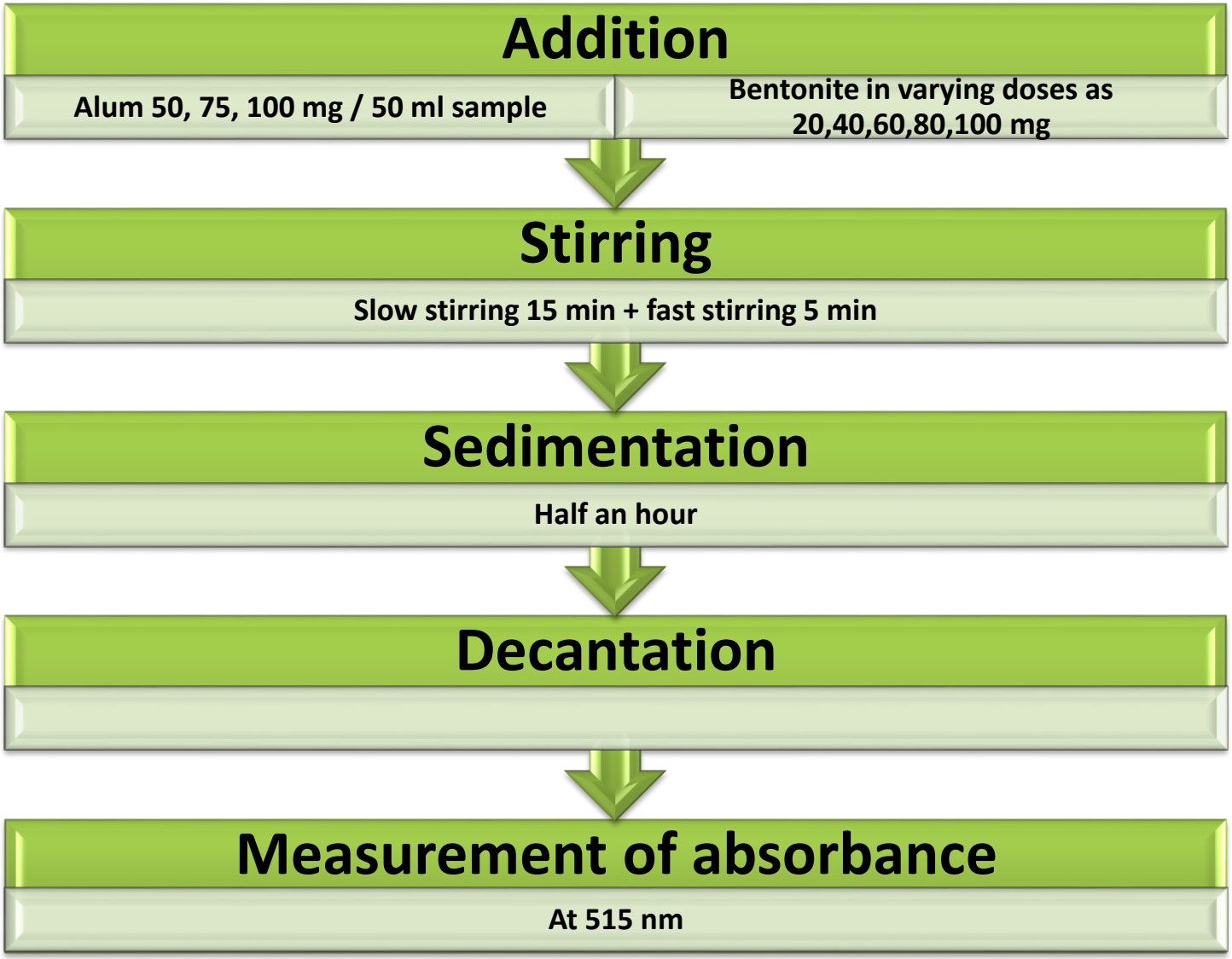
Two hours

Decantation

Measurement of absorbance

At 515 nm

Treatment with Alum and Bentonite clay



❖**Corncob** (1.2g /l of sample): 40.26% colour removal with contact period of 100 minutes.
Spent tea leaves (1.2g /l of sample): 60.04% colour removal with contact period of 120 minutes.

Proximate Analysis of adsorbents and coagulants after treatment

	Corncob	Spent tea leaves	Alum	Alum + Bentonite clay
% Moisture	6.50%	5.52%	7.9%	3.94%
% Volatile Matter	87.3%	79.80%	42%	31.5%
% Ash	1.36%	5.52%	5.68%	0.62%
% Fixed Carbon	4.84%	9.16%	44.42%	63.94%