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STUDIES ON CASSIA TORA AS STARTING MATERIAL FOR CARBON SYNTHESIS

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ABSTRACT

Activated carbon has various prominent applications in day to day life including biomedical sector. *Cassia tora* is a species that spreads overwhelmingly and affects the crop yields. Acid activation of *Cassia tora* results into channel formation and impart adsorption capacity to the biomass. Acetic and phosphoric acids are used for activation of the surface of biomass. Acid activation of the biomass is expressed in terms of % removal of colorants like phenolphthalein and methyl orange.

Keywords: *Cassia tora, Activated carbon, Acid activation, phenolphthalein, methyl orange*.

I. INTRODUCTION

Activated carbon is an extremely versatile material with high porosity and surface area [1]. Due to enhance surface properties [2], it has become one of the technically important materials for selective material. The structure of activated carbon is mainly microporous. Activated Carbon is used in broad range of application for both industrial and residential uses that include drinking water purification [3], ground [4], power plant and land gas emission [5] and precious metal recovery [6]. Mainly its application field is restricted due to high cost as the starting material is wood.

Figure – 1: Salient applications of activated carbon in day to day life

The main moto of this paper is to produce activated carbon from a bio mass material. *Cassia tora* (TAKALA) is a well known weed which is grown in rainy season [7] in barren lands, fields and even the farms under cultivation. Different parts of this weed are reputed for its medicinal use [8]. In few parts of rural Maharashtra even it is used as vegetable, part as a food. However, for farmers, *Cassia tora* is an un-desirous plant just like parthenium hysterophorous (Congress Grass). Eradication of these species is tedious as it spreads through anemophily pollination. The growth rate of *Cassia tora* is very high. Over population of the species dominate over the targeted crops and thus affecting the yield.

In addition to the existing uses of *Cassia tora*, to claim even a larger scale industrial application for *Cassia tora*, in this paper we propose a method for its acid activation to prepare activated carbon. The acid activation is proposed in reference to our earlier research work [9&10].

Figure – 2: Cassia tora, starting material for carbon preparation

II. MATERIALS AND METHODS

Selection of material:
Biomass such as *Cassia tora*'s leaves, stem and flower is used as raw material for preparation of activated carbon. Biomass is first washed properly with distilled water and then it was kept in hot air oven for 1 hr at 60°C to remove all the moisture present in the sample of the weed.

METHODS -EXPERIMENTAL:
The flowers were found to have considerably high moisture content, hence discarded from the starting materials. Leaves and stem sample was selected for the further studies.
Determination of lignin and cellulose content: In order to determine lignin and cellulose content of the *Cassia tora* the experimental process followed is as followed by Patil *et al* [11, 12].

Preparation of 17% NAOH:
Take 100 ml distilled water in conical flask then add 17gm of NAOH in it. Keep stirring the solution till it gets completely mixed. Then add pre weighed amount of fresh sample of stem and leaves in it. Keep the solution for 2 hours with constant stirring at room temperature.

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Preparation of 17% H2SO4:
Add 17ml of H2SO4 in 100ml of distilled water. Then add pre weighed fresh sample of leaves and stem in the solution. Keep the solution for 4 hours with constant stirring at room temperature.

Procedure to measure % Cellulose (as acid hydrolysable):
Sample was firstly weighed by using the high precision balance. Then it was treated with the solution. Then the sample was removed from the solution and it was filtered properly with the filter paper. The residue was removed and then kept in oven for 1 hour at 110 degree Celsius. The sample was again weighed. The weight loss in the sample indicates the %cellulose present in the sample.

Procedure to measure % Lignin (as alkali hydrolysable):
The sample before treating with the solution was weighed initially. Then after treating the sample with the solution, then the sample was filtered. The residue after filtration was kept in oven for 1 hour at 110degree Celsius . Then the sample was weighed. The weight loss in the sample indicates the % lignin present in the sample.
Preparation of Carbon:

H_3PO_4 and CH_3COOH acids are used for the preparation of carbon. As H3PO4 and CH3COOH are used as a activating agent. The known mass of activated agent was mixed with distilled water and biomass waste was impregnated in acidic solution. The mass ratio of activating agent to the dried material was 1:3. The impregnated sample was kept for 6 hours at room temperature with constant stirring.

III. RESULTS

Table1: % Lignin content as alkali soluble

SR NO.	SAMPLE	INITIAL WEIGHT	FINAL WEIGHT	WEIGHT LOSS	WEIGHT LOSS %
1	LEAVES	56. 887	4. 122	52. 165	92. 75%
2	STEM	48. 850	6. 401	42. 449	86. 89%

Table2: % Cellulose content as acid hydrolysable

SR NO.	**SAMPLE**	**INITIAL WEIGHT**	**FINAL WEIGHT**	**WEIGHT LOSS**	**WEIGHT LOSS %**
1	**LEAVES**	56. 887	**5. 589**	**38. 797**	**79. 42%**
2	**STEM**	48. 850	10. 053	**51. 293**	**90. 17%**

Results: Following are the 30X magnified microscopic images of stem and leaf of *Cassia tora* under different treatments

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Figure 3: Fresh leaf of Cassia tora

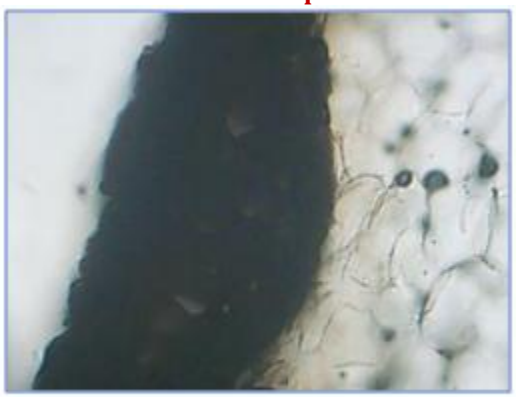

Figure 4: Acetic acid treated Cassia tora leaf post phenolphthalein dye adsorption

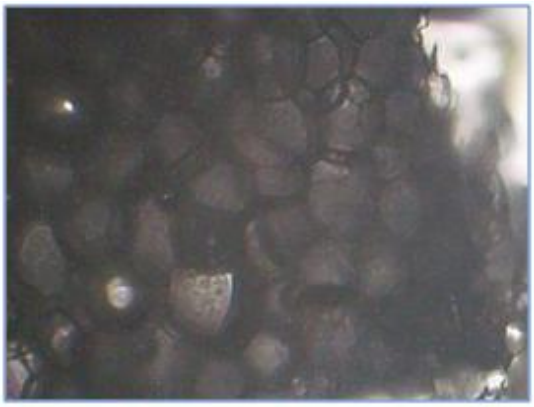

Figure 5: Fresh stem of *Cassia tora*

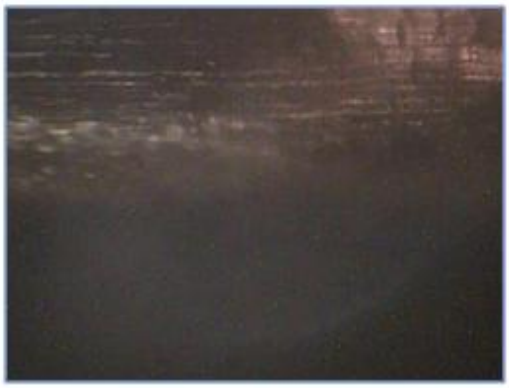

Figure 6: Acetic acid treated *Cassia tora* stem

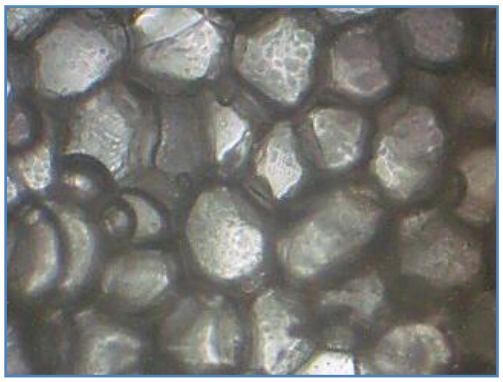

Figure 7: Phosphoric acid treated Cassia tora stem post phenolphthalein dye adsorption

Figure 3 clearly indicates the presence of fibrous structure of leaf. Figure 4 presents acetic acid treated leaf. In picture it can be seen very clearly the development of pores for the acid treatment. Figure 5 presents fresh stem of *Cassia tora.* Figure 6 reveals channel formation over the stem part of *Cassia tora.* Figure 7 depicts texture of H_3PO_4 treated stem of *Cassia tora* for the adsorption of phenolphthalein dye.

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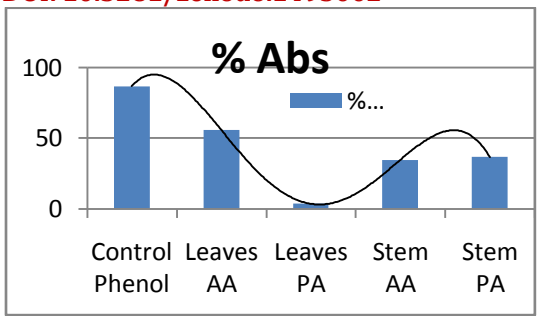

Figure 8: Trend in decreased % absorbance of acid activated carbon prepared from leaves and stem of *Cassia tora* post the phenolphthalein dye (0.01% v/v) removal from water. (λmax = 500 nm)

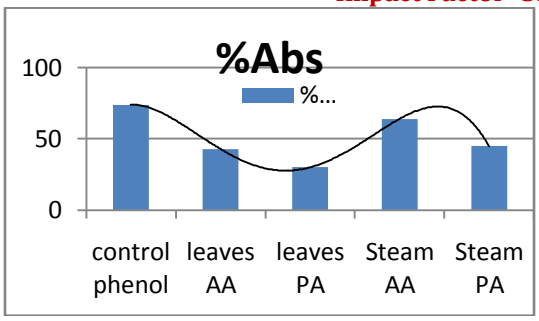

Figure 9: Trend in decreased % absorbance of acid activated carbon prepared from leaves and stem of *Cassia tora* post the phenolphthalein dye (0.1% v/v) removal from water. (λmax = 400 nm)

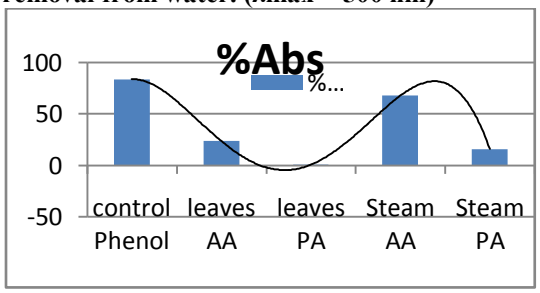

Figure 10: Trend in decreased % absorbance of acid acid activated carbon prepared from leaves and stem of *Cassia tora* post the phenolphthalein dye (1% v/v) removal from water. (λmax = 620 nm)

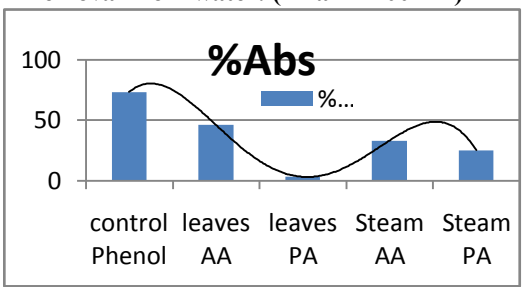

Figure 11: Trend in decreased % absorbance of activated carbon prepared from leaves and stem of *Cassia tora* post the phenolphthalein dye (10% v/v) removal from water. (λmax = 500 nm)

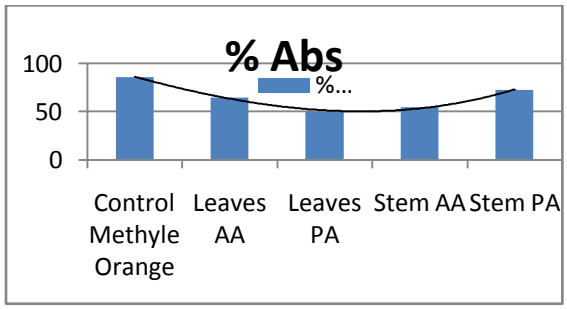

Figure 12: Trend in decreased % absorbance of acid acid activated carbon prepared from leaves and stem of *Cassia tora* post the methyl orange dye (0.01% v/v) removal from water. (λmax = 700 nm)

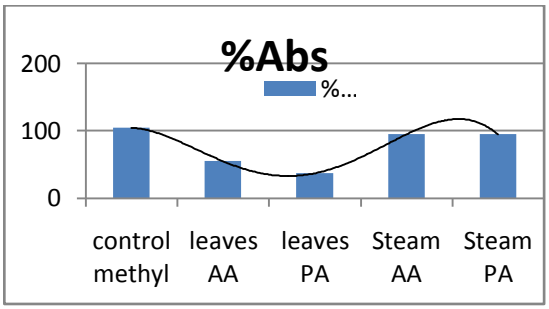

Figure 13: Trend in decreased % absorbance of activated carbon prepared from leaves and stem of *Cassia tora* post the methyl orange dye (0.1% v/v) removal from water. (λmax = 700 nm)

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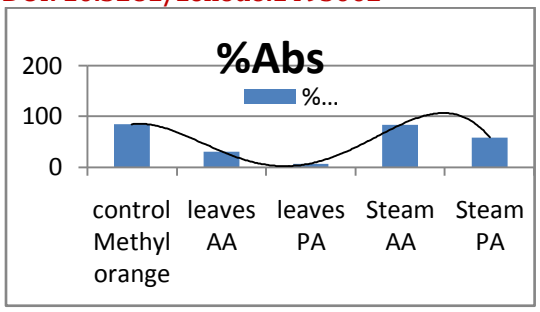

Figure 14: Trend in decreased % absorbance of acid activated carbon prepared from leaves and stem of *Cassia tora* post the methyl orange dye (1% v/v) removal from water. (λmax = 470 nm)

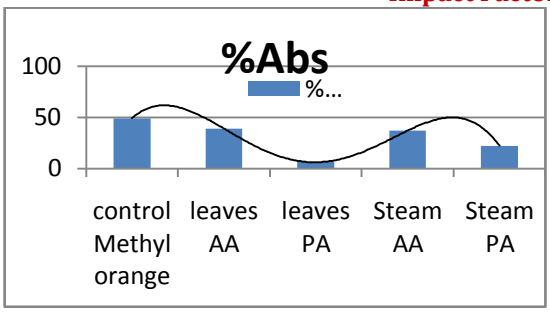

Figure 15: Trend in decreased % absorbance of acid activated carbon prepared from leaves and stem of *Cassia tora* post the methyl orange dye (10% v/v) removal from water. (λmax = 470 nm)

Table-3: Removal of 0.01% Phenolphthalein

Sample	% Abs	% concentration reduced
Control Phenol	87	0.01
Leaves AA	56	0.006436
Leaves PA	4	0.00046
Stem AA	35	0.004022
Stem PA	37	0.004252

Table-4: Removal of 0.1% Phenolphthalein

sample	%Abs	% concentration reduced
control phenol	74	0.1
leaves AA	43	0.067188
leaves PA	30	0.046875
Steam AA	64	0.115625
Steam PA	45	0.070331

Table-5: Removal of 1% Phenolphthalein

Sample	%Abs	% concentration reduced
control Phenol	84	1
leaves AA	24	0.028571
leaves PA	1	0.011905
Steam AA	68	0.809523
Steam PA	16	0.190476

Table-6 Removal of 10% Phenolphthalein

Sample	%Abs	% concentration reduced
control Phenol	73	10
leaves AA	46	6.30137
leaves PA	3	0.410958
Steam AA	33	4.520547
Steam PA	25	3.424658

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Table-7: Removal of 0.01% Methyl orange

Sample	% Abs	% concentration reduced
Control Methyle Orange	86	0.01
Leaves AA	65	0.007558
Leaves PA	50	0.005814
Stem AA	55	0.006395
Stem PA	73	0.00848

Table-8: Removal of 0.1% Methyl orange

Sample	%Abs	% concentration reduced
control methyl orange	105	0.1
leaves AA	55	0.057894
leaves PA	37	0.038947
Steam AA	95	0.110526
Steam PA	95	0.1

Table-9 Removal of 1% Methyl orange

Sample	%Abs	% concentration reduced
control Methyl orange	85	1
leaves AA	32	0.376471
leaves PA	8	0.094118
Steam AA	84	0.988235
Steam PA	59	0.694118

Table-10: Removal of 10% Methyl orange

Sample	%Abs	% concentration reduced
control Methyl orange	49	10
leaves AA	39	7.959183
leaves PA	6	1.22449
Steam AA	37	7.55102
Steam PA	22	4.487959

Tables (3-10) given above shows trends of % removal of phenolphthalein and methyl orange colorants from water by means of carbon prepared by acid activation. Acids used are Acetic acid and Phosphoric acid of strength 99.5% v/v and 85% v/v respectively. It is observed that the leaves, with either of the acids treated appear more effective than the stem to remove the colorants. Almost 50% removal v/v can be achieved in three of the different concentrations of the colorants. This might be due to fluffy texture of the leaves. The carbons are prepared simply by acid activation excluding firing in absence of oxygen. This study is followed to understand suitability of acid activation before firing of the lignocelluloses.

In earlier studies there was found a strong relation between lignin content and activation extent. Higher is the lignin content, more is the activation by acids. Same trend is observed in *Cassia tora*.

Between two of the acids phosphoric acid treated lignocelluloses was found with more and deep channel formation because the triprotic acid reacts with different kinetics of reaction till the three protons undergo reaction. First proton reacts the fastest rate possible, as its dissociation constant is greater than that of acetic acid (pKa CH3COOH = 4.756 and pKa H3PO4 = 2.16) as given in the Table-11.

Table-11: Comparison between Acetic acid and phosphoric acid

Name	Formula	Ka	pKa
Acetic acid	CH_3COOH	$1.75X10^{-5}$	4.756
Phosphoric acid	H_3PO_4	$6.9X10^{-3}$	2.16

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IV. CONCLUSION

Cassia tora can be used for activated carbon preparation Phosphoric acid appeared better than acetic acid as activation agent Leaves of Cassia tor found to be affected more than the stem for acid activation Between phenolphthalein and methyl orange removal % of phenolphthalein is slightly more than methyl orange

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