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Evaluation of Adsorption Efficancy of *Caesalpinia decapetala*

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ABSTRACT

Activated charcoal obtained from the stem of *Caesalpinia decapetala* by routine method examined for its adsorption ability. Activated charcoal was also prepared by dipping stem of *Caesalpinia decapetala* in 5% $ZnSO_4$ and 5% H_3PO_4 and examined for a similar study. Commercial activated charcoal which is of animal origin available in the market was used for comparison. Charcoal obtained from the stem of *Caesalpinia decapetala*, 5% $ZnSO_4$ treated charcoal and 5% H_3PO_4treated charcoal were studied for adsorption of acetic acid and oxalic acid. Charcoal obtained from the plant showed better adsorption property for acetic acid and oxalic acid than other three charcoals. Adsorption property of 5% $ZnSO_4$ treated charcoal and 5% H_3PO_4treated charcoal decreases for acetic acid and oxalic acid as compared to the other two charcoals. The observations were well fitted in Langmuir adsorption isotherm. Observation showed that charcoal obtained from the stem of *Caesalpinia decapetala* was a very good adsorbent for acetic acid and oxalic acid than commercial activated charcoal of animal origin. Hence agriculture waste material can be used to prepare good activated charcoal with excellent adsorption property. Thus, a simple inexpensive and effective method can be used to remove the acetic acid as a pollutant from the effluent of petroleum fine chemicals, pharmaceutical, and textile industry.

INTRODUCTION

The environment gets polluted due to different factors. Pollutions are of different types e.g. water pollution, soil pollution, air pollution. Industrial wastewater, fertilizers, insecticides, etc. produces pollution. Industrial wastewater contains organic and inorganic components as pollutants[1-6]. Dilute acetic acid is an organic pollutant. Along with acetic acid, phenol, iodine, p-nitrophenol, caffeine, methylene blue, halophenols are also present in aqueous form as pollutants in industrial wastewater. These pollutants can be removed with the help of natural (Bio adsorbent) and synthetic adsorbents. Natural adsorbents include charcoal, clay, minerals, zeolites, and ores while synthetic adsorbents are resins, silica gel, and alumina[7-14]. Activated charcoal is a good adsorbent for above pollutant because it has more porosity hence large surface area. Agriculture byproducts produce activated charcoal which has good economic and environmental effect because it converts unwanted, low-value agricultural waste to use high-value adsorbent[15]. Activated carbons are widely used to remove organic chemicals and metals in wastewater because it is of low cost and environment-friendly method. Sand and charcoal were acting as filters for purification for water. It is reported in Hindu documents[16]. Activated charcoal was used for detoxification of drinking water, decolorization, deodourisation, purification of air, chemicals, food, etc[17]. Physical and chemical methods like ion exchange, electrochemical destruction, membrane filtration, irradiation, ozonation are used to remove the pollutants. But these methods are very expensive and not much effective. By producing the activated carbon from agriculture byproduct, reduces the importation of activated carbon, thus make economy healthy[18].

In the present work, phosphoric acid and zinc sulfate activated charcoal were prepared from the stem of *Caesalpinia decapetala*. It showed adsorbent property towards acetic acid and oxalic acid as a pollutant. Different parts of *Caesalpinia decapetala* also show antidiabetic, antioxidant, antitumor, antipyretic, anti-inflammatory, anti-malarial properties[19].

The stem of *Caesalpinia decapetala* was collected from Sawargaon, Tal- Junnar, Dist- Pune, Maharashtra. Stems were washed thoroughly with tap water and dried in the shade at room temperature. All the chemicals used were of analytical reagent grade purchased from Loba chemicals Pvt. Ltd. Solutions were prepared in double distilled water. Activated charcoal was prepared by following carbonization methods.

MATERIALS AND METHODS[20-21]:

PREPARATION OF ACTIVATED CHARCOAL:

1] NORMAL ACTIVATED CHARCOAL:

Small pieces of the stem of *Caesalpinia decapetala* were kept in the muffle furnace for one hour at 500^{o}C in absence of air. Charcoal was washed with distilled water till filtrate showed P^{H} around 6.5. The charcoal again dried, powdered and pass through sieves to get 50µ particle size.

2] 5% PHOSPHORIC ACID TREATED ACTIVATED CHARCOAL:

Small pieces of the stem of *Caesalpinia decapetala* were dipped in 5% Ortho Phosphoric acid (H_3PO_4) for 24 hours. Then they are dried in an oven at 100^{o}C. Dried pieces were kept in a muffle furnace at 500^{o}C for one hour in absence of air. Charcoal was washed with distilled water till filtrate showed P^{H} around 6.5.

3] 5% of ZINC SULPHATE TREATED ACTIVATED CHARCOAL:

Small pieces of the stem of *Caesalpinia decapetala* were dipped in 5% Zinc Sulphate solution for 24 hours. Then they are dried in an oven at 100^{o}C. Dried pieces were kept in a muffle furnace at 500^{o}C for one hour in absence of air. Charcoal was washed with distilled water till filtrate showed P^{H} around 6.5.

Four types of charcoal powder namely market, normal, phosphoric acid activated and zinc sulfate activated were used for adsorption study of acetic acid and oxalic acid.

METHODS

Five clean and dry stoppered bottles were taken 10, 20, 30, 40 and 50ml 0.5N acetic acid and 40, 30, 20, 10 and 0 ml distilled water was added respectively in this bottles. 1 gm of normal charcoal obtained from stems of *Caesalpinia decapetala* was added in each bottle. The bottles were kept in a water bath for 1 hour to attained constant temperature with constant stirring. An agitator digital thermostatic bath was used for constant stirring. After one hour each solution was filtered and titrated against 0.1N NaOH using phenolphthalein as indicator. Meanwhile, 10ml 0.5 N acetic acid was titrated against 0.1N NaOH.

The same procedure was repeated for market charcoal, 5% H_3PO_4 and 5% $ZnSO_4$ activated charcoal for the adsorption of acetic acid and oxalic acid.

RESULTS

Amount of acetic acid adsorbed per gram (x/m) by the normal, market, 5% H_3PO_4 and 5% $ZnSO_4$ activated charcoal of obtained from stems of *Caesalpinia decapetala*.

Table 1: Amount of acetic acid adsorbed

Sr. No.	Conc. of acetic acid (N)	x/m Market activated Charcoal	x/m Normal activated Charcoal	x/m 5% $ZnSO_4$ activated Charcoal	x/m 5% H_3PO_4 activated Charcoal
1	0.1	41.26	126.00	12.91	5.04
2	0.2	57.33	189.00	21.10	10.09
3	0.3	68.23	242.55	34.02	22.09
4	0.4	84.73	302.40	43.31	64.26
5	0.5	118.12	340.20	51.02	84.26

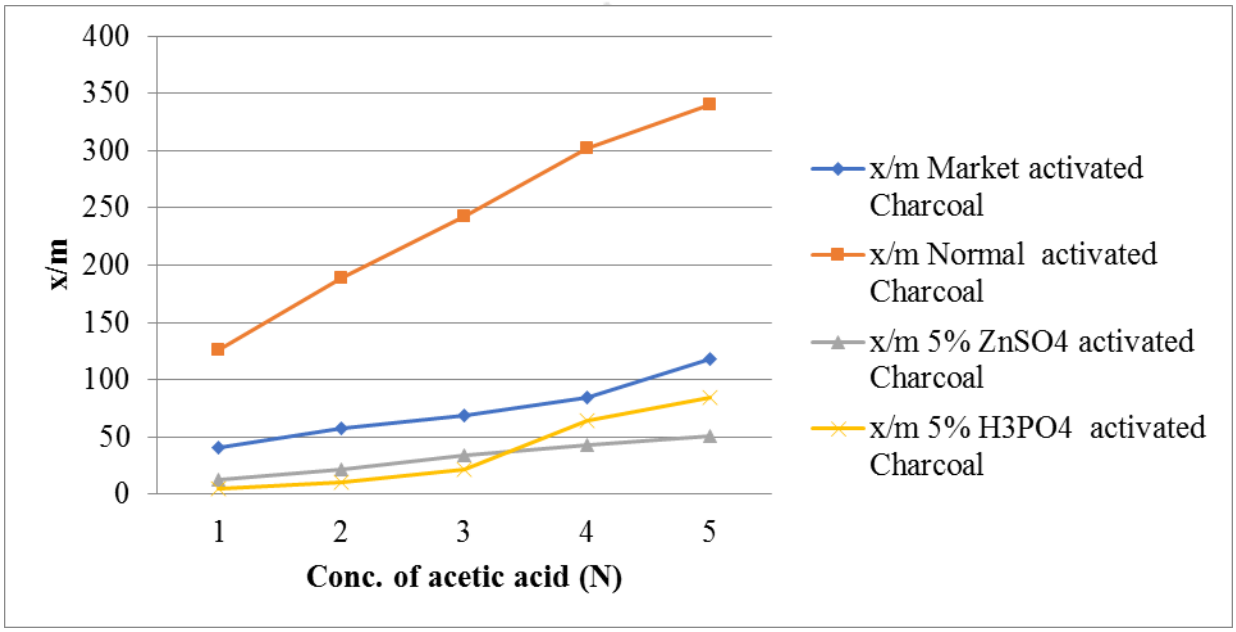

Figure 1: Amount of acetic acid adsorbed

Amount of oxalic acid adsorbed per gram (x/m) by the normal, market, 5% H_3PO_4 and 5% $ZnSO_4$ activated charcoal of obtained from stems of *Caesalpinia decapetala*.

Table 2: Amount of oxalic acid adsorbed

Sr. No.	Conc. of oxalic acid (N)	x/m Market activated Charcoal	x/m Normal activated Charcoal	x/m 5% $ZnSO_4$ activated Charcoal	x/m 5% H_3PO_4 activated Charcoal
1	0.1	42.52	43.84	39.69	30.24
2	0.2	83.47	96.70	46.30	44.73
3	0.3	107.10	115.14	71.82	45.04
4	0.4	121.27	130.63	85.16	62.68
5	0.5	132.30	150.57	98.46	94.50

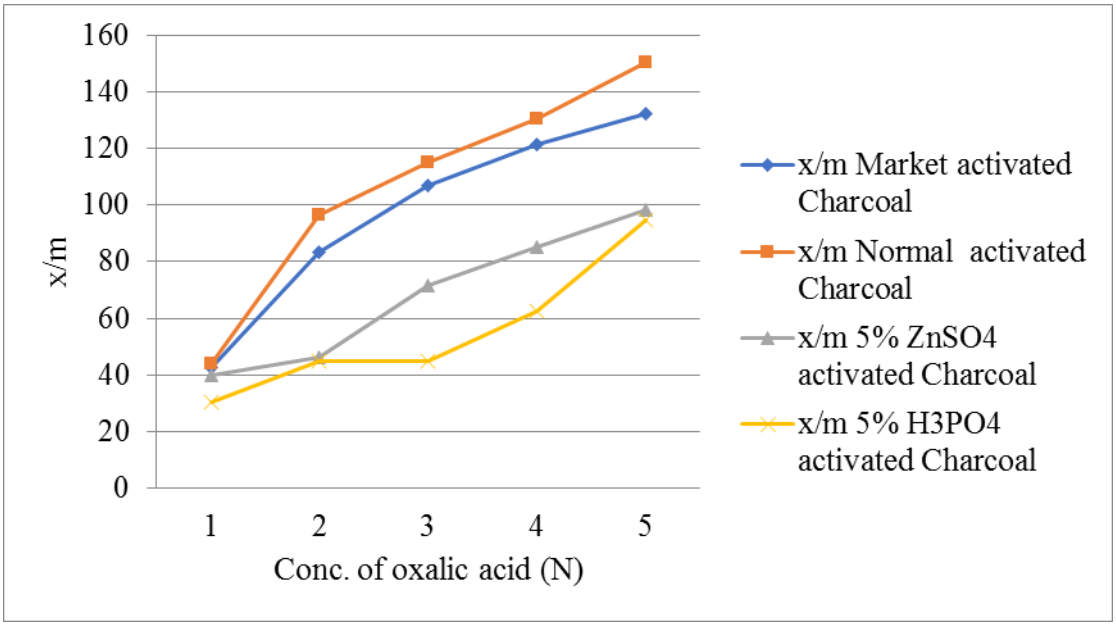

Figure 2: Amount of oxalic acid adsorbed

DISCUSSION

Charcoal obtained from the stem of *Caesalpinia decapetala* can be used as an adsorbent. Result obtained for the adsorption of acetic acid and oxalic acid by activated charcoal obtained from *Caesalpinia decapetala* obeyed the Langmuir adsorption isotherm. The plot is linear for the equation

$$\frac{C}{x/m} = \left(\frac{b}{a}\right)C + \frac{1}{a}$$

Thermal decomposition data obtained from TGA of *Caesalpinia decapetala* shows that the best temperature to obtained charcoal is 450^0C.

CONCLUSION

Normal charcoal obtained from *Caesalpinia decapetala* stem shows better adsorption efficancy than the market charcoal. It shows more adsorption for acetic acid as well as for oxalic acid. Charcoal obtained by the dipping stem of *Caesalpinia decapetala* into 5% $ZnSO_4$ and 5% H_3PO_4 shows reduced adsorption efficancy. It may be due to the deactivation of active sites on the surface of normal charcoal. This experimental adsorption study shows that activated charcoal obtained from the stem of *Caesalpinia decapetala* can be used as an effective and economical adsorbent.

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