Research Article

Adsorption Study of Activated Charcoal obtained from *Caesalpinia bonducella* stem

Shirish S. Pingale[1*], Manohar G. Chaskar[2], Nirmala R. Kakade[3]
[1]P.G. Department of Chemistry, Gramonnati Mandal's Arts, Com. & Science College, Narayangaon, Pune, India.
[2]Department of Chemistry, Baburaoji Gholap College, Sangavi, Pune, India.
[3]Dadapatil Rajale Arts & Science College, Adinathnagar, Ahmednagar, India.
***Corresponding author's E-mail:** drsspingale@gmail.com

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ABSTRACT

Activated charcoals have been prepared from the stem material of *Caesalpinia bonducella* by using chemical activating agents like Zinc Sulphate and Ortho Phosphoric acid. Adsorption studies on carbon obtained from *Caesalpinia bonducella* activated with 5% $ZnSO_4$ and activated with 5% H_3PO_4 have shown that these materials have very good adsorption capacity for Acetic acid and Oxalic acid. The observations obtained in this experiment have been fitted into Langmuir adsorption isotherm. The plots obtained are found to be linear indicates that the Langmuir equation is applicable for this study. These observations obtained from adsorption study of activated charcoal obtained from *Caesalpinia bonducella* have given encouraging results.

Keywords: Activated Charcoal, Adsorption, *Caesalpinia bonducella*, Langmuir equation.

INTRODUCTION

There are various environmental issues threatening the survival of mankind on earth. Water pollution is also an environmental issue. The quality of ground water and surface water is changing due to the increasing population and industrialization day by day. There is large increase in the discharge of industrial water. So it is required to treat the industrial waste water before it is dispose into natural water by using cheap and effective method. By using physical or chemical processes including ion exchange, electrochemical destruction, membrane filtration, irradiation and ozonation, effluent is treated. But these processes are very expensive and not effective to treat the wide range of pollutants. The process of adsorption is a possible substitute for conventional treatment techniques for the removal of pollutants from the contaminated effluents. Adsorption is the most adjustable method and it is used widely because of its high removal capacity and it is easy to operate at large scale. In most natural, chemical, biological and physical systems, adsorption is effective[1-9].

Firstly charcoal was used for medicinal purpose in Egyptian papyri according to the ancient record. Charcoal was applied prominently to adsorb odorous vapors from putrefying wounds and from within the intestinal track [1500BC]. Drinking water was collected in charred wooden barrels according to the wrecks of Phoenician trading ships. This practice was followed until 18th century for extending the use of potable water on long sea voyages. There is reference of the use of sand and charcoal filter for the purification of drinking water in Hindu documents[10].

Activated carbon was used for purification, deodorization, decolorization and general detoxification of drinking water as well as to purify the air, chemicals, food etc[11]. The waste water produced by the industries has posed a serious problem of pollution. Organic and inorganic chemicals and waste cause water pollution. Acetic acid also plays very noticeable role of a pollutant. The waste water from petrochemicals and fine chemical industries contains acetic acid. To remove organic and inorganic components, many traditional methods are applied to treat waste water. But majority of these methods are very expensive. The process of adsorption is very effective, economical and environmentally friendly method to separate organic and inorganic components from waste water. Natural adsorbents and synthetic adsorbents are the classes of adsorbents. Charcoal, clays, minerals, zeolites, and ores are natural adsorbents[12].

The plant *Caesalpinia bonducella* is classified under the family of Caesalpiniaceae. Commonly it is called as Fever Nut, Bonduc Nut or Nicker Nut also. Leaves, stem, roots, seeds, bark and nuts of this plant are useful as herbal medicines. It is found in hotter parts of India mostly in west Bengal and the southern states of India. In conventional system of Indian medicine, Ayurveda, *Caesalpinia bonducella* (roxb.) is largely used for its antiperiodic, anti-inflammatory, antipyretic, anthelmintic, antimalarial properties. It is also described to have antibacterial, antioxidant, antitumor and antidiabetic activities[13].

MATERIALS AND METHODS[12, 14]

The stem of *Caesalpinia bonducella* were collected from Garbhagiri ranges, Pathardi, Ahmednagar, Maharashtra, India and identified from Department of Botanical Survey of India, Pune. Stems were thoroughly washed using tap water to remove foreign matter and rinsed in de-ionized water. They were dried in a shade at room temperature.

Two types of activated charcoal were prepared by using the process of carbonization from weighed dry stem material. The carbonization of *Caesalpinia bonducella* gave 45.73% of charcoal. In first case, the inactivated charcoal was dipped in 5% $ZnSO_4$solution and kept for 24 hours. Then it was filtered through Whatman filter paper no. 41 and washed with 2N HCl to remove Zinc and again washed with distilled water till washing (filtrate) shows neutral pH. This charcoal thus prepared was first powdered and then passed through sieves to get particles of uniform size (50µ).

In second case, small pieces of *Caesalpinia bonducella* were weighed and dipped in 5% of Ortho Phosphoric acid (H_3PO_4) for 24 hours. After that they were removed from acid solution, dried in oven at 100°C temperature and kept in muffle furnace for one hour at 700°C. The charcoal was washed with distilled water till washing (filtrate) showed around 6 to 6.5 pH. The charcoal again dried, powdered and passed through sieves to get particles of uniform size (50µ). These two types of charcoal powder were used to study adsorption of acetic acid and oxalic acid. 10, 20, 30, 40, 50 ml dilute acetic acid and 40,30,20,10,0 ml water was added respectively in Five clean 250 ml stoppered bottles. 10 ml of acetic acid solution from each bottle was titrated with 1N NaOH solution by using phenolphthalein as an indicator to determine the acetic acid concentration. Then 1 gm of normal activated charcoal of *Caesalpinia bonducella* was added in each flask. Then the bottles were kept in water bath for one hour to attain constant temperature with occasional stirring. An agitator digital thermostatic water bath was used to shake the flasks while controlling the temperature Mean while 10 ml of dilute acetic acid stalk solution was titrated with 1N NaOH using phenolphthalein as an indicator for determination of acetic acid concentration. After one hour the solution from each bottle was filtered and titrated against 1 N NaOH.

The same procedure was repeated for 5% $ZnSO_4$ and 5% H_3PO_4 treated charcoal and market charcoal for adsorption of acetic acid as well as oxalic acid.

RESULTS

Table 1: Adsorption Capability of Activated Charcoal prepared by 5% $ZnSO_4$and 5% H_3PO_4 for Acetic acid

S. No.	Conc. of Acetic Acid (N)	x/m	x/m	x/m	x/m
		Market Activated Charcoal	Normal Activated Charcoal of C. b.	5% $ZnSO_4$ treated Activated Charcoal	5% H_3PO_4 treated Activated Charcoal
1	0.1	89.17	94.28	66.96	50.44
2	0.2	114.00	118.90	100.88	96.38
3	0.3	131.24	136.30	124.30	113.79
4	0.4	143.11	147.70	138.72	128.21
5	0.5	150.90	156.13	153.13	148.23

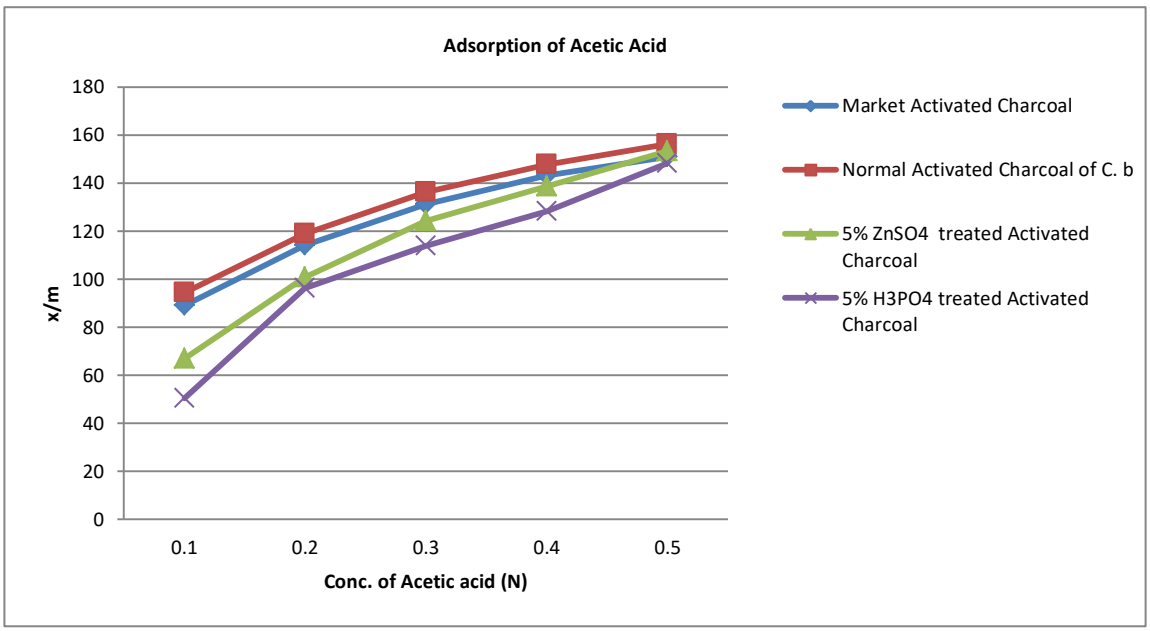
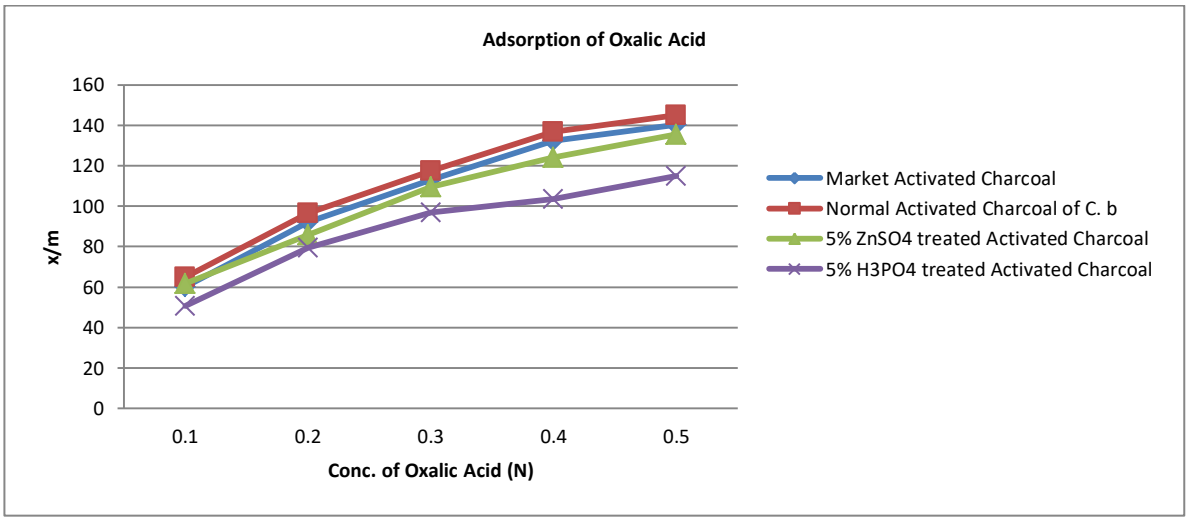


Table 2: Adsorption Capability of Activated Charcoal prepared by 5% $ZnSO_4$and 5% H_3PO_4 for Oxalic acid

Sr. No.	Conc. of Oxalic Acid (N)	x/m	x/m	x/m	x/m
		Market Activated Charcoal	Normal Activated Charcoal of C. b	5% $ZnSO_4$ treated Activated Charcoal	5% H_3PO_4 treated Activated Charcoal
1	0.1	60.32	64.89	61.74	50.70
2	0.2	92.25	96.71	85.68	79.38
3	0.3	113.02	117.50	109.62	97.02
4	0.4	132.23	136.70	124.11	103.64
5	0.5	140.39	144.90	135.45	114.98



DISCUSSION

This study showed that, the use of *Caesalpinia bonducella* stem as a raw material for preparation of activated charcoal is possible. Adsorption on *C. bonducella* adsorbent can be efficient and economical for the removal of acetic acid and oxalic acid. The adsorption capacity of charcoal decreases after treating with 5% $ZnSO_4$ and 5% H_3PO_4.

The results obtained from adsorption study of oxalic acid and acetic acid on activated charcoal of *Caesalpinia bonducella* has been fitted into Langmuir adsorption isotherm. As the Langmuir equation was applicable, the plots of the samples were linear

$C/(x/m) = 1/ab + (1/b)C$

The adsorption capacity of *Caesalpinia bonducella* activated charcoal is found to be comparable with that of animal charcoal.

CONCLUSION

From thermal decomposition curve with the help of TGA, it is observed that the best temperature to obtain charcoal is 450° C. Activated charcoal obtained from the plant like *Caesalpinia bonducella* by using chemical activating agents like Zinc sulphate and ortho phosphoric acid. Adsorption studies on carbon obtained from *Caesalpinia bonducella* activated with 5% $ZnSO_4$ and 5% H_3PO_4 have shown that these materials have good uptake capacity for acetic acid and oxalic acid. The activated charcoal obtained from *Caesalpinia bonducella* stem shows better adsorption activity than the normal activated charcoal available in the market.

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