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Preparation and Characterization of Activated Carbon from the *Prosopis juliflora* Plant

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In this study, attempts have been made to develop a low cost high-grade activated carbon from a woody material like *Prosopis juliflora* with inherent mechanical strength, high carbon and low ash content. Their physico-chemical characterization studies such as bulk density, moisture content, ash content, carbon content, matter soluble in water, matter soluble in acid, pH, iron content, surface area, pore specific volume and surface morphology have been carried out to assess the suitability of the plant (*Prosopis juliflora*) as precursor for manufacturing of activated carbon. The result obtained shows that this activated carbon can serve as a good adsorbent for the removal of both organics and inorganic.

Key Words: Low cost adsorbent, *Prosopis juliflora*, Activated carbon, Adsorption.

INTRODUCTION

Activated carbon is a black solid substance resembling granular or powdered charcoal. It is a highly porous material which has various applications in adsorbing both inorganic and organic pollutants from wastewater[1-3].

Recently, several attempts have been made to prepare activated carbon from organic precursors such as bamboo, coconut shell, sawdust, seeds and wood[4-6]. Activated carbon is a versatile product with good market demand. The non-availability of high quality produce in the Indian market, to cater the needs of the effluent treatment plant. The pharmaceutical and fine chemical sectors have necessitated imports to India.

In the present study, attempts have been made to produce a high-grade activated carbon from the wood portion of the plant material *Prosopis juliflora* and to find the optimum conditions in making activated carbon with well-developed porosity. Their characteristics such as bulk density, moisture content matter soluble in acid, matter soluble in water, pH and iron content were determined[7,8] to assess the suitability of this carbon for water and wastewater treatment. Thus in South India, with extensive reserves of *Prosopis juliflora* plant, there exists excellent scope for producing this wood based high-grade activated carbon.

EXPERIMENTAL

The wood of *Prosopis juliflora* as a precursor material was collected, cut into small pieces and dried at 110 °C for 3 to 4 h. The dried material, were soaked in concentrated sulphuric acid for 24 h. At the end of 24 h, the product was washed with excess of water to remove free acids, dried at 110 °C and followed by thermal activation at 800 °C for a period of 0.5 h in a muffle furnace[9]. Then the material is cooled to room temperature, powdered, sieved and stored in an airtight container for further characterization. The surface area was determined by BET method using nitrogen as the adsorbent at liquid nitrogen temperature. To study the chemical surface of the activated carbon the FT-IR spectrum was recorded as shown in Fig. 1. The surface morphology of activated carbon has also been analyzed with scanning electron microscope is also shown in Fig. 2.

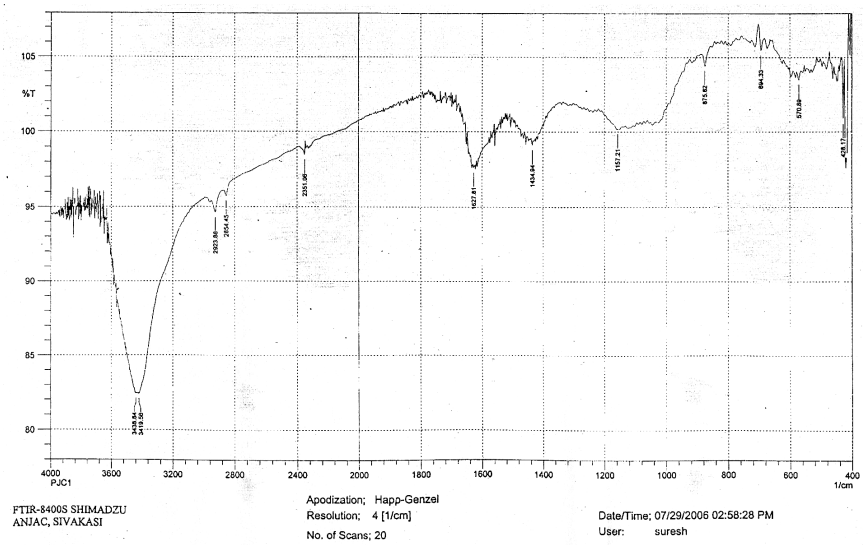

Fig. 1. FT-IR Spectrum of activated *Prosopis juliflora*

RESULTS AND DISCUSSION

A comparative study of characteristics of different activated carbons with the experimental carbon has been made and presented in Table-1. The characterization of the adsorbent prepared are carried out by the methods suggested by the Bureau of Indian Standards[8].

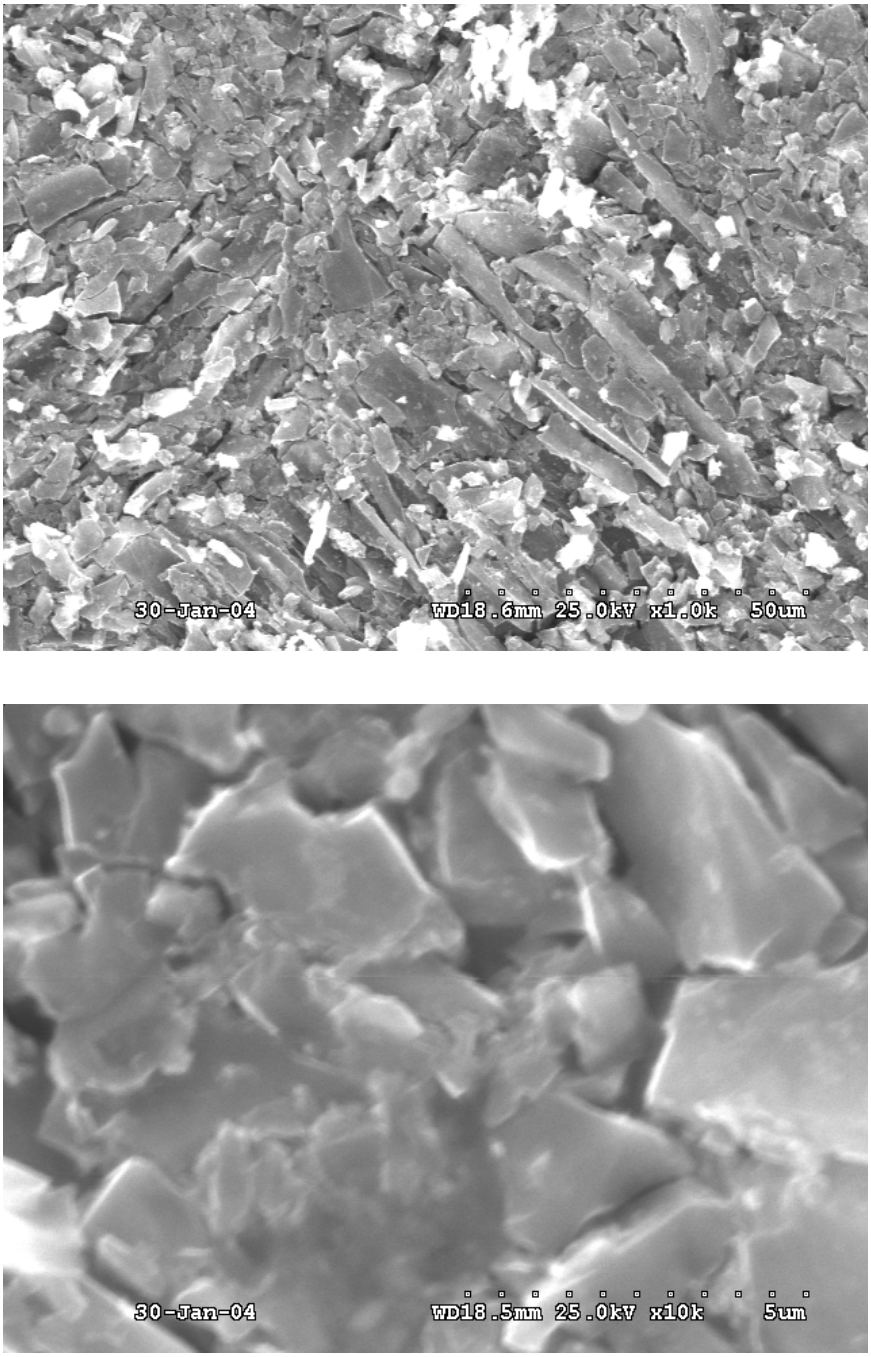

Fig. 2. SEM micrograph of the prepared *Prosopis juliflora* in two different magnification

TABLE-1

Control tests	CAC	RSCC	PSCC	MWC	CSC	PJC
Bulk density (g/cc)	0.680	0.690	0.520	0.650	0.460	0.603
Moisture (%)	12.570	13.620	14.910	13.960	12.130	4.440
Ash (%)	2.910	4.350	3.160	3.370	6.000	6.990
Fixed carbon content (%)	97.090	95.650	96.840	96.630	94.000	93.010
Matter soluble in water (%)	1.550	2.070	1.770	1.680	1.710	7.700
Matter soluble in acid (%)	4.580	3.220	2.960	2.530	2.480	7.200
pH	9.200	4.460	3.360	3.900	4.100	6.800
Surface area (m^2/g)	296.000	313.000	427.000	351.000	269.000	616.000
Iron content (%)	–	0.095	0.024	0.027	0.107	0.070

CAC = Commercial activated carbon, RSCC = Rubber seed coated carbon, PSCC = Poly seed coated carbon, MWC = Myrobalon waste carbon, CSC = Cashew nut sheath carbon, PJC = *Prosopis juliflora* carbon.

The bulk density is found to be 0.603 g/cc and is comparable with those of the other activated carbons. The moisture content is found to be only 4.4 % and is comparatively very less than those for the other carbons and hence the experimental carbon is found to have more surface area for adsorption. The ash content and the fixed carbon in percentage reveal that the experimental carbon is comparable.

The matter soluble in water and acid in percentage are also comparable with those of other activated carbons prepared from various waste materials. The pH value suggests that the substance is close to neutral in nature.

Most of all, the surface area is found to be 616 m^2/g which is very large when compared with any other materials of comparison and hence it may be assumed that as the surface area increases, the available area of adsorption also increases. This has been further confirmed by the surface morphology studies using SEM (Fig. 2), that, it contains more pores which lead to develop more adsorption sites. The FT-IR spectrum shown in Fig. 1, indicates that the activated carbon used contains a number of functional groups such as -SH, -COOH, O-H (bend) *etc.* Therefore, the adsorptive characteristics of the PJC is expected to be highly effective than the other carbons.

Conclusion

The feasibility of the activated carbon obtained from the plant *Prosopis juliflora* has been proved to be a success. Thus, the present study concludes that the *Prosopis juliflora* may be employed as low-cost adsorbent alternative to commercial activated carbon in water and wastewater treatment.

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