3rd National Conference on Green Technology and Science for Sustainable Development
© 2020 IJSRST | Volume 5 | Issue 6 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
International Journal of Scientific Research in Science and Technology

# Preparation and Characterization of Activated Carbon from Bamboo Waste and its Application in adsorption of Herbicide

**Arvind Rathod*, Madhav Navhale, Mohd Saquib Farhan, Chintan Ingalkar**

Chemical Engineering Department/SGBAU Amravati/AEC Chikhli, Maharashtra, India

## ABSTRACT

The synthesis of activated carbon from low cost agricultural wastes or by-products has received great attention from academics and researchers due to its economic and environmental benefits. A huge quantity of agriculture waste is generated globally, amongst which bamboo waste is one of the furniture wastes. In the production of bamboo furniture or construction from bamboo, a significant amount of bamboo waste is inevitably generated. Therefore, this research aimed to prepare activated carbons from bamboo furniture waste by chemical activation. The influence of carbonization time on the properties and adsorption capacities of activated carbons is determined. The prepared activated carbon is characterized by FTIR, XRF analysis together with surface properties such as area, volume and pore diameter done. The adsorption capacity of prepared activated carbon is investigated using Langmuir isotherm.

**Keywords :** Bamboo, Activated Carbon, Adsorption.

## I. INTRODUCTION

Activated carbon prepared from various activation methods is an important adsorbent material for the removal of hazardous waste for the purification of water such as drinking water, surface water and ground water as well as waste water. The demand of activated carbon is continuously growing due to its wide range of usage as a result of environmental compliances. There are numbers of sources of carbon such as bone char, banana stalk, and date stone. Biomass is a one of the main sources of carbon for the production of activated carbon. By reusing or recycling these low cost materials to produce activated carbon, we are providing another environmentally alternative to dispose of the waste and waste by product. Researchers have studied the production of activated carbon from various types of biomass such as palm-tree corn cob, plum kernel, cassava peel, bagasse, jute fibre, rice husk, olive stone, date pit, fruit stones, coconut shell and nutshell. In the present work, a by product from the bamboo industry (i.e. Bamboo waste) was used as the precursor.

Bamboo is a natural resource and has been traditionally used to construct various living facilities and tools. Bamboo has been used as structural material construction because it is strong, tough and cheap. Bamboo can be converted into charcoal and activated carbon via carbonization by activation.

## II. METHODS AND MATERIAL

### A) Material

The precursor material was bamboo waste is collected from natural wastage. The operation on project was conducted in a high temperature. The reactor

produced 400 gm of activated carbon from 3 kg of bamboo wastage.

### B) Production Method

The production of activated carbon from agricultural residue was done using bamboo waste. The bamboo was obtained in natural wastage and cut into the particle size in the range of 2-3 cm and it is washed with distilled water and dried overnight in an oven at 80 °C. The raw material was ground and that they were thoroughly mixed with activating agent during the impregnation process.

In pyrolysis process, the raw material of bamboo was thrown into the reactor for combustion. It is heated at very high temperature (i.e. 600 °C to 900 °C) in the combustion chamber. It is converted into powder by grinding. Bamboo-based activated carbons that are produced from carbonization and activation processes can be used as a potentially commercially available activated carbon for the treatments of gaseous and liquid pollutants in industrial effluents and drinking water filtration applications.

The activation of the carbonized product (char) is either physical or chemical. The first activation i.e. physical activation is also known as thermal activation In this method, the char is obtained by carbonization of the precursor and then partially gasified by an oxidant atmosphere such as by using steam or carbon dioxide, The steam and carbon dioxide are clean, can be easily handles and also it assists the control of the activation process due to the slow reaction rate at temperatures around 800 $^0$C. In the chemical activation process the two steps are involve: chemical activating agents and oxidants. In chemical activation processes the chemical activating agent like phosphoric acid and zinc chloride. These act both as dehydrating agent and as oxidant, so that carbonization and activation take place simultaneously. Chemical activation involves the reaction of the precursor with the activating agent at temperature between (500-800 $^0$C). In the activation process, the bamboo chips were impregnated by 60 wt % KOH solution for 24 h and then dried at 105$^0$C for 24 h. The obtained bamboo-based activated carbon was washed with deionized water until the P$^H$ of neutral. Finally, the bamboo-based activated carbon was dried in an oven at 105 $^0$C for 12 h.

## III. RESULTS AND DISCUSSION

The internodes of bamboos at different portions were cut into small strips, ground into 2-3 cm size and used for chemical analysis. The resulting material was placed in sealed plastic container and labeled for chemical analysis. The chemical analysis was conducted using the test methods.

### A) BET Surface Analysis

The surfaces area of the charcoal or activated carbon were calculated from $N_2$ adsorption isotherms using Brunauer-Emmett Teller (BET) surface analyzer. The adsorption–desorption of nitrogen data were recorded at liquid nitrogen temperature 77 K. Prior to measurements, samples were out gassed at 573 K under nitrogen flow for at least two hours. About 0.5 g of sample was used in each adsorption experiment. Adsorption isotherm of nitrogen was measured over relative pressure range from approximately $10^{-2}$ to 1.

### BET surface area plot

BET Surface Area: 33.9946 ± 0.3684 m²/g
Slope: 0.127868 ± 0.001368 g/cm³ STP
Y-Intercept: 0.000187 ± 0.000234 g/cm³ STP
C: 684.206856
$Q_m$: 7.8091 cm³/g STP
Correlation Coefficient: 0.9997141
Molecular Cross-Sectional Area: 0.1620 nm²

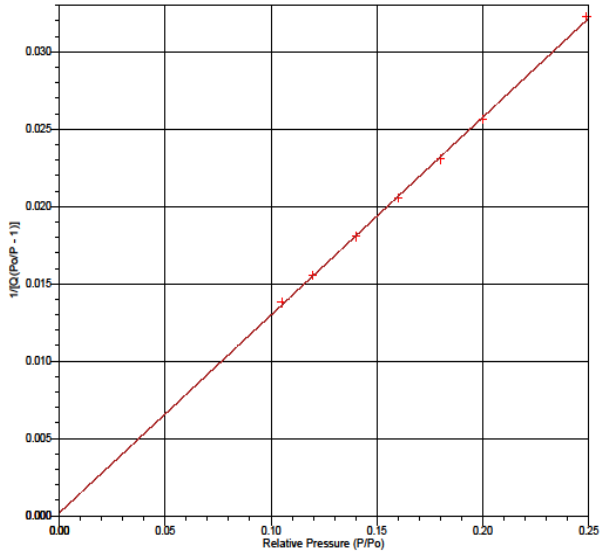


**Fig. 1** BET surface area plot

**Langmuir surface area plot**

Langmuir Surface Area: 52.7029 ± 0.9607 m²/g
Slope: 0.082599 ± 0.001506 g/cm³ STP
Y-Intercept: 2.943717 ± 0.195885 mmHg·g/cm³ STP
b: 0.028059 1/mmHg
$Q_m$: 12.1067 cm³/g STP
Correlation Coefficient: 0.999170
Molecular Cross-Sectional Area: 0.1620 nm²

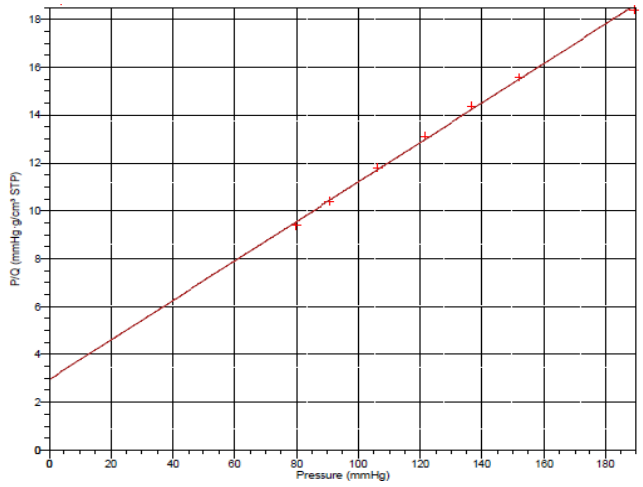


**Fig. 2** Langmuir Surface area plot

## B) Fourier Transform Infrared Spectroscopy (FTIR) Analysis

FTIR Spectroscopy is an analytical technique are used to identify the organic, polymeric and in some cases inorganic material. The FTIR analysis method used infrared light to scan test samples and observe chemical properties.

The FTIR spectra (Fig. 3) show a peak at 3650 $cm^{-1}$ indicating the presence of O–H bonding in the phenol free group. The O–H deformation coupled with C–H stretching is showed by a band at 2870 $cm^{-1}$. The O–H stretching bond is presented by a weak peak at 3650 $cm^{-1}$. In addition the peaks at 1038 and 1350 $cm^{-1}$ in the spectrum correspond to C–N bending vibrations of amines. The peaks at 1038 and 799 $cm^{-1}$ in the RHA spectrum represent the stretching vibrations of Si–O–Si and C–H bonds, respectively, while the peak at 469 $cm^{-1}$ is assigned for the Si–H bond.

## C) Adsorption Capacity

The Langmuir (Vijayarghavan *et al.* 2006) isotherm model was applied to the experimental data. The model provides a relationship between adsorbent capacity and adsorbate concentration. The non-linear regression presented in Figure 4 shows a Langmuir isotherm. The non linear equation of Langmuir isotherm is given as

$$q_l = \frac{Q_{max}\, K_L\, C_e}{1 + K_L\, C_e}$$

Where,

$Q_{max}$ = monolayer adsorption capacity (mg/g)

$K_L$ = constant of adsorption

$C_e$ = equilibrium aqueous phase concentration of absorbate (mg/L)

$q_l$ = equilibrium adsorbent phase concentration of adsorbate (mg/L)

Langmuir isotherms ($R^2$ = 0.994–0.988) gave a better fit to the experimental data. The dimensionless separation factor, $R_L = (1+ K_L C_0)^{-1}$, for the Langmuir isotherm is found to vary between 0.408 and 0.081. This implies favourability of Langmuir isotherm as $0 < R_L < 1$ (Hamdaoui and Naffrechoux 2007). The value of $K_L < 0.1$ is a sign of low surface energy, which indicates stronger bonding between adsorbate and adsorbent.

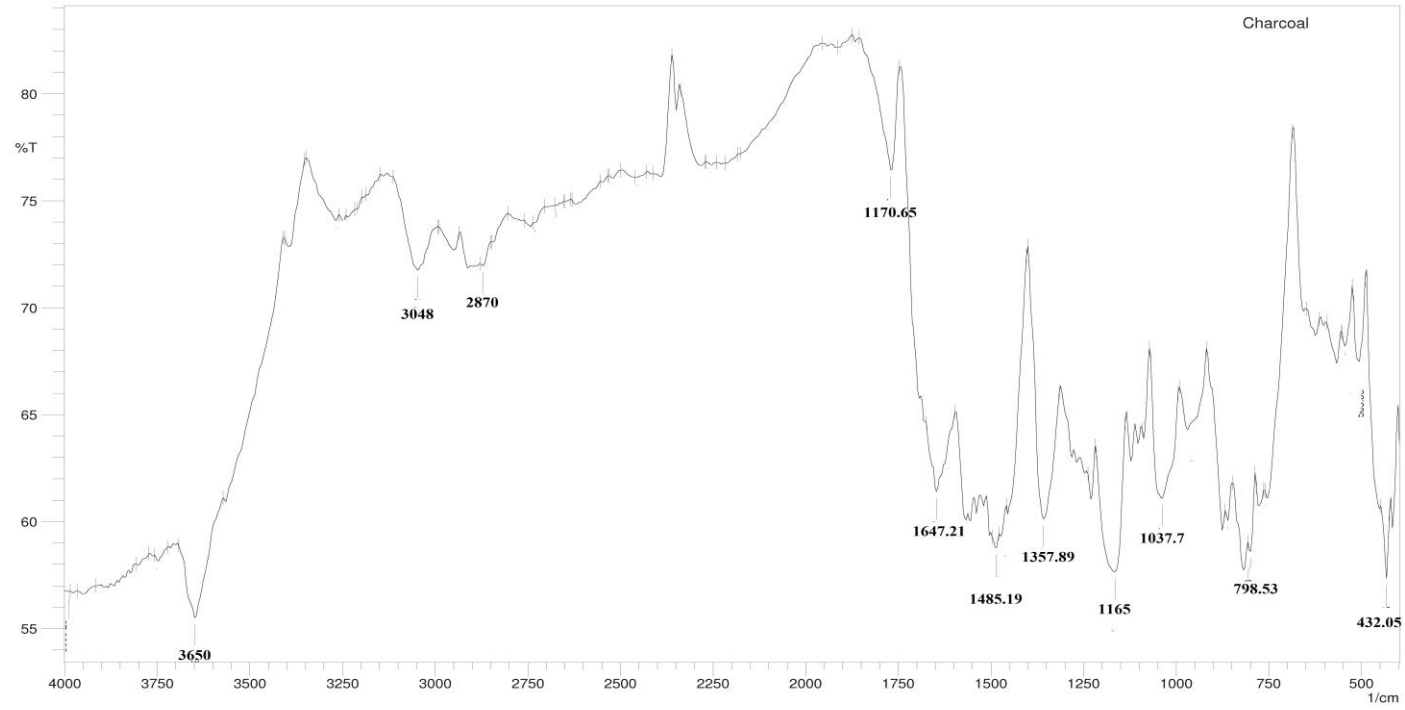


**Fig. 3** FTIR Analysis Plot

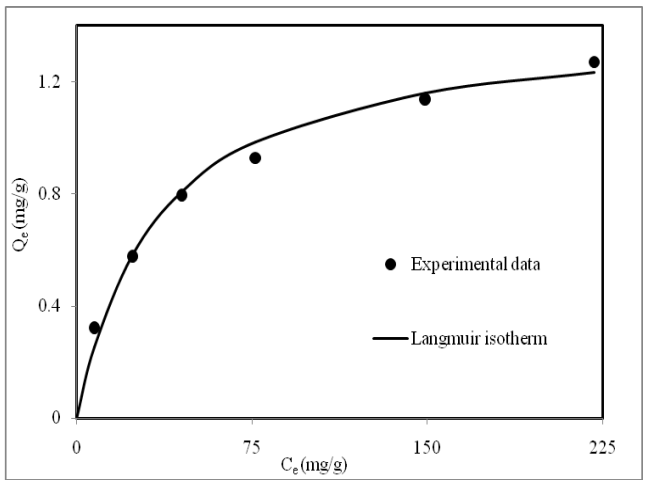


**Fig. 4** Langmuir Isotherm

The Langmuir adsorption capacity which is also called as maximum adsorption capacity is calculated as 1.425 (mg/g) and Langmuir constant as 0.029 (l/mg).

## IV. CONCLUSION

The activated carbon prepared from bamboo waste has 52.70 $m^2/g$ Langmuir surface area. The FTIR study has revealed the presence of functional groups such O-H, C-H, C-N, Si-H on the surface of activated carbon. The adsorption capacity of activated carbon was tested for MCPA herbicide. The adsorption capacity determined using Langmuir isotherm was found to be 1.425 (mg/g) and the value of Langmuir constant was 0.029 (l/mg). The value of coefficient of determination (0.994–0.988) indicated the fitting of Langmuir isotherm.

## V. REFERENCES

[1]. Vijayarghavan, K., Padmesh, T.V.N., Palanivelu, K. and Velan, M. (2006) J. Hazard. Mater. 133, 304.

[2]. Hamdaoui, O. and Naffrechoux, E. (2007) J. Hazard. Mater. 147, 381.

[3]. Deokar SK, Mandavgane SA (2015) Rice husk ash for fast removal of 2, 4 Dichlorophenoxy acetic acid from aqueous solution. Adsorption Sci Technol 33:429–440.

[4]. Yang T, Lua AC. Characteristics of activated carbons prepared from pistachio-nut shells by physical activation. J Colloid Interf Sci 2003; 267: 408–17.

[5]. Putun AE, Ozbay N, Onal EP, Putun E. Fixed-bed pyrolysis of cotton stalks for liquid and solid products. Fuel Process Technol 2005:86:1207–19.
[6]. Tsai WT, Chang CY, Lee SL. Preparation and characterization of activated carbons from corn cob. Carbon 1997:35:1198–200
[7]. Predel M, Kaminsky W. Pyrolysis of rape-seed in a fluidized-bed reactor. Bio resource Techno 1998:66: 113–7.
[8]. Yang T, Lua AC. Characteristics of activated carbons prepared from pistachio-nut shells by physical activation. J Colloid Interf Sci 2003:267:408–17.
[9]. Deokar SK, Mandavgane SA, Kulkarni BD (2016) Behaviour of biomass multicomponent ashes as adsorbents. Curr Sci 110:180–186.
[10]. Heijman SGJ, Hopman R. Activated carbon filtration in drinking water production: model prediction and new concepts. Colloid Surface A: Physicochem Eng Aspects 1999; 151: 303–10.
[11]. Byrne JF, Marsh H. Introductory overview. In: Patrick JW, editor. Porosity in carbons: characterisation and applications. New York: Halsted Press; 1995. p. 16–7.
[12]. Vijayaraghavan, K., Padmesh, T.V.N., Palanivelu, K. and Velan, M. (2006) J. Hazard. Mater. 133, 304.
[13]. Hameed, B.H., Salman, J.M. and Ahmad, A.L. (2009) J. Hazard. Mater. 163, 121.
[14]. Njoku, N.O. and Hameed, B.H. (2011) Chem. Eng. J. 173, 391.
[15]. Arivazhagan, M. and Meenakshi R. (2011) Spectrochim. Acta, Part A. 82, 316.