# Synthesis, Characterization and Application of Nanoparticles Prepared from Tamarind Seeds

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*Abstract*— Activated carbons (AC) are generally fabricated from biomass resources like oil palm shell, almond shell, tamarind seeds, coconut shell, dates seeds, coffee beans, apricot seeds, grape seeds etc., and have been studied for various applications. These activated carbons with micropores, are considered for gas adsorption as well as hydrogen storage applications due to their high specific surface areas and high adsorption properties. In the present work involves the synthesis of activated carbon from tamarind seeds by thermal technique method using KOH for activation and also characterization of the activating agents increase the porosity and the surface area. The pore size of the activated carbon is mostly in the range of mesa pore and macro pores. The activated carbon derived from tamarind seeds were characterized by using X-ray powder diffraction (XRD), Scanning electron microscopy (SEM). The tamarind seed based activated carbon produced at 500oC for 1hour and the KOH/Carbon ratio was varied from 1:1, 1:2, and 1:3. The synthesized activated carbon was used for dye degradation studies.

***Key words:*** Activated carbons, Tamarind seeds, Surface area, Dye degradation

## I. Introduction

Over the last few decades, adsorption has gained importance as a purification, separation and recovery process on an industrial scale. Activated carbon (AC) is perhaps one of the most widely used adsorbents in industry for environmental applications. Activated carbons are highly micro porous structure with both high internal surface area and porosity, and commercially the most common adsorbents used for the removal of organic and inorganic pollutants from air and water streams Activated carbon demand will benefit from a continuing intensification of the global environmental movement as well as rapid industrialization. In most developing and developed countries, use of AC in pharmaceutical sector offers the strongest growth prospect. Additionally, environmental concerns in developing regions will spur new growth in water treatment applications, which is already the largest single market in developed countries. Besides the necessity of clean drinking water, government environmental regulations that vary by region also impact the demand for AC in this sector significantly. The high adsorption capacities of activated carbons are related to the properties such as surface area, pore volume and pore size distribution (PSD). These unique characteristics depend on the type of raw materials employed for preparation of AC and the method of activation [1].

Activated carbon has been proved to be an excellent adsorbent for removing organic or inorganic pollutants [2]. It could be produced from agricultural by products with low cost and in abundance [3]. Tamarind seed has also been used as a raw material for activated carbon prepared by induced chemical activation with KOH for the adsorption treatment of dye degradation method. Activation increases the porosity and there by the surface area. These activated carbons with micro pores, are considered for gas adsorption as well as for hydrogen storage applications due to their high specific surface areas and high adsorption properties [4, 5]. In this paper, tamarind seed was used as precursor for the production of activated carbon using KOH activation. Basically there are two different processes for the preparation of AC. physical activation and chemical activation. Physical activation involves carbonization of carbonaceous material followed by the activation of the resulting char at high temperatures (800 – 1100ºC) in presence of oxidizing agents such as $CO_2$ and steam. In chemical activation the precursor is mixed with a chemical agent and then pyrolyzed at low temperatures (400 – 600ºC) in absence of air. Chemical activation offers several advantages over physical activation as it is carried out in a single step combining carbonization and activation, performed at lower temperatures and therefore resulting in the development of a better porous structure [6].

Textile industry serves major fraction of income and strongly depend on economic development of any country. However, the untreated liquid effluents containing dyes from the outlet of these industries cause very severe environmental pollution problems. Therefore, it is inevitable to treat the dye effluent streams before they release into water bodies. Dye degradation treatment techniques have been classified as physical, chemical, and biological. Physical techniques such as adsorption, causes secondary pollution to the environment as they require further treatment of solid-wastes, finally this adds additional cost to the process. Chemical processes involve adsorption on organic or inorganic matrices, ozonation, chemical oxidation processes release toxic unstable metabolites thus impart adverse effects on human health [7-12]. Biological techniques involving aerobic and anaerobic conditions are known to be ineffective for degradation of dyes due to higher molecular weight of coloured substances [13].

## II. Materials and methods

### A. *Materials*

Tamarind seeds, KOH (MOLYCHEM 97%), Crystal violet dye (SIGMA-ALORICH), Sodium sulphate (SRLCHEM 99.5%), Nafion per fluorinated resin solution (SIGMA-ALORICH). The tamarind seeds were used as a precursor for the preparation of activated carbon. The tamarind fruits were purchased from local market in Anantapur.

### B. *Preparation of Activated carbon*

Generally activated carbon can be prepared from various raw materials including agricultural and forestry residues. Most of the precursors (Tamarindus indica) used for the

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preparation of activated carbon are rich in carbon [14]. Seeds were removed from the fruit, washed and dried. Dried seeds were processed to obtain activated carbon as described below. The analytical grade potassium hydroxide (KOH) pellets were purchased. Production of AC was achieved typically through chemical activation by thermal method. Chemical activation offers several advantages over physical activation which mainly include (i) lower activation temperature (< 500ºC) compared to the physical activation temperature (500 – 800ºC) [15], (ii) single activation step, (iii) higher yields, (iv) better characteristics, and (v) shorter activation times [16]. The most commonly used chemical activating agents are $H_3PO_4$, $ZnCl_2$, and KOH.

### *C. Synthesis of Activated carbon*

Accurately weighed samples of dried tamarind seed (weighed with analytical balance, Sartorius Basic) were carbonized in a closed crucible at 300°C in muffle furnace for 1 h. The charcoal product was ground and sieved to 2 mm size. The activation was performed at 500º C for 1 h and the KOH/carbon ratio was varied from 1:1, 1:2 and 1:3. All the samples were powdered well, washed with deionised water and dried.

## III. RESULTS AND DISCUSSION

### *A. Characterization of Activated Carbon*

Activated carbons are strongly heterogeneous due to the existence of different sizes of Pores including micro pores, mesopores and macropores. In addition, the surface heterogeneity of activated carbons is often significant because of various oxygen and other groups present on the surface. Surface and structural properties of the activated carbons can be studied directly by employing X-ray technique , SEM analysis.

### *B. XRD*

XRD diffractograms revealed that the activated carbon prepared from tamarind seed is semi crystalline in nature. It shows the two main diffraction peaks for the (002) and (101) planes of graphite structure at 2θ = 23.36º and 43.03º.

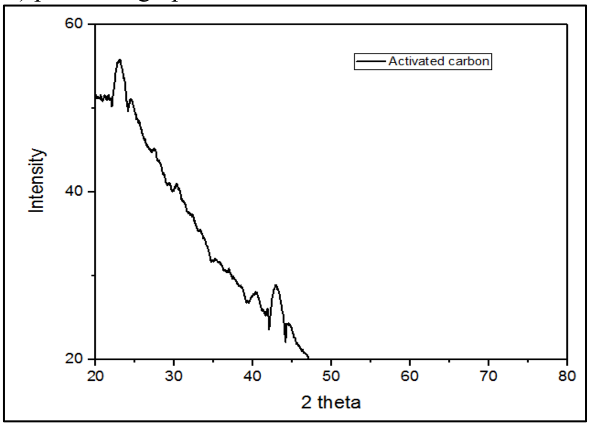


Fig. 1: X-ray diffraction pattern of activated carbon.

### *C. SEM*

SEM image of tamarind seed based activated carbon with 1:3 impregnation ratio at an activation temperature of 500oC. It can be seen from activated carbon particles are macropores.

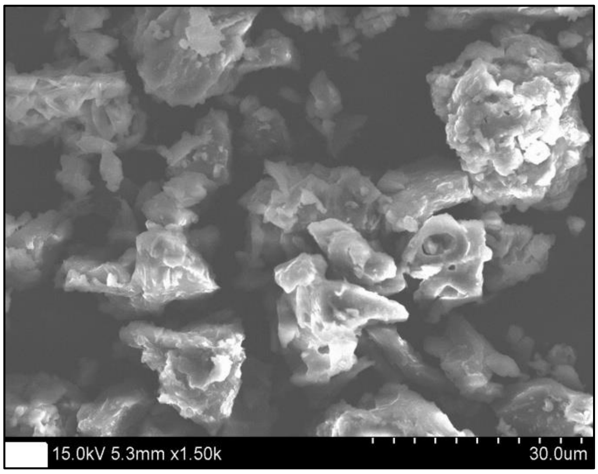


Fig. 2: SEM image of activated carbon

### *D. UV-Visible Analysis for dye degradation*

Electrochemical degradation before and during treatment (at various treatment times) was studied using UV-Visible analysis. Intense blue colour of crystal violet is showed at absorption band ($\lambda_{max}$ = 576 nm) and methyl group is responsible for the colour of the crystal violet dye [17]. Complete decolourization was achieved in 14 hours for Activated carbon.

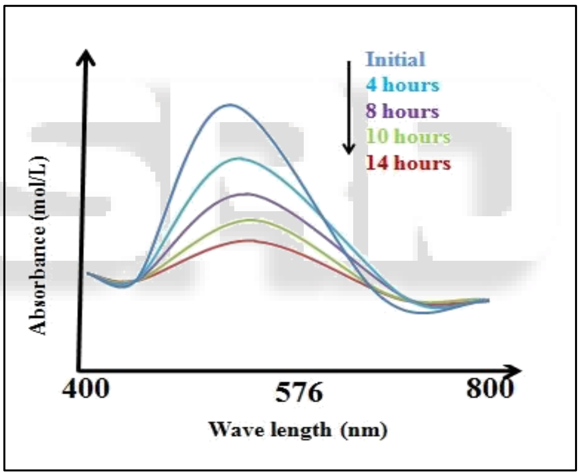


Fig. 3: UV-Visible spectrum of activated carbon.

## IV. CONCLUSIONS

Tamarind seed could be used for charcoal and activated carbon preparation. Tamarind seed charcoal product was prepared by carbonization at 500°C. In the present work the adsorption and desorption capacity of activated carbon prepared from tamarind seeds carbonized by thermal method and activated by KOH agent. The XRD characterization shows that it has two diffraction peaks, graphite structure and crystallite size of sample was 145.79 nm. The Electro chemical process shows that prepared particles may effectively utilized for dye degradation and UV-Visible analysis as time increases the dye degradation also increases.

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