

Adsorption of 2-chlorophenol onto the surface of underutilized seed of *Adenopus breviflorus*: A potential means of treating waste water



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ARTICLE INFO

Article history:

Received 20 October 2015

Received in revised form 8 December 2015

Accepted 9 December 2015

Available online 12 December 2015

Keywords:

Adenopus breviflorus

Adsorption

2-Chlorophenol

Isotherm

SEM

ABSTRACT

Seed of *Adenopus breviflorus* was prepared as an adsorbent and its adsorption capacities for 2-chlorophenol in aqueous solutions was studied. Fourier Infrared spectroscopy (FTIR), X-ray Diffraction analysis (XRD), particle size distribution, zeta potential, thermogravimetric (TG) analysis and Scanning Electron Microscopy (SEM) measurements were used to characterize the *A. breviflorus* seed adsorbent. The kinetics studies showed that the adsorption of 2-chlorophenol onto the adsorbent followed the pseudo-second order model while adsorption isotherm plots yielded good results for Temkin, Langmuir and Freundlich models. The adsorption capacity of 2-chlorophenol onto *A. breviflorus* seed increased with a decrease in pH of 2-chlorophenol solution. From the study, seed of *A. breviflorus* exhibited properties which suggested its potential application as adsorbent for the removal of 2-chlorophenol from polluted or waste water.

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1. Introduction

Rapid industrialization and modern agricultural practice in Nigeria is generating environmental contaminants which are found in water resources. Some of these contaminants belong to the group of phenol and its derivatives which have been consistently considered as priority pollutants since they are toxic to plants, animals and humans even at low concentrations [1]. Water pollution is primarily associated with domestic and industrial waste. Both types of waste water pose threats to water quality which may be classified into health hazards and sanitary nuisances [2]. In most parts of Africa, people have no access to potable water and consequently, raw water from polluted rivers and streams form the major source of water. Water treatment is a serious issue in Africa and other developing nations of the world as large volumes of waste water are generated from time to time with no adequate means of treatment. Although industrialization is crucial, it has also brought several devastating environmental and human hazard over a period of years with search light on industries as the major contributor to environmental degradation and pollution in developing nations.

Presently, there is increase in demand for food which has resulted in the use of large amounts of pesticides to control different agricultural pests [3]. 2-Chlorophenol is used in the manufacture of different compounds such as antiseptics, herbicides, dyes and other organic compounds [4]. Unfortunately, the presence of 2-chlorophenol and other chlorinated compounds has been detected in wastewaters; moreover, most chlorinated phenols have been found in municipal waste, agricultural run-off, leachates from polluted or contaminated site, soil, water, sediments, air, food products and body fluids [1,5–7].

Effective removal of phenol and its chlorinated derivatives from polluted and waste waters has been a problem. Chlorinated phenols are among the list of priority organic pollutants proposed by the US Environmental Protection Agency [8]. They are known to persist in many environments, because of inappropriate conditions for biodegradation [9]. Chlorophenols are carcinogenic and mutagenic; they are weak acids which are capable of penetrating human skin and are readily absorbed by gastro-intestinal tract with acute toxicity exhibiting symptoms like increased respiratory rate, vomiting and nausea [10]; thus it is important to get rid of them before they get into the environment in order to avoid the biomagnified toxicity to aquatic flora and fauna through various food chains [11].

Several methods have been used in waste water treatment some of these methods are based on ion exchange, chemical

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precipitation, oxidation, reduction and reverse osmosis [12]. However, many of these methods are less effective or difficult for practical use due to their toxicity, high price, sludge disposal problem, sustainability and selectivity. To minimize this problem, there is need to find an alternative approach to waste water treatment that will be low cost, effective, less toxic and efficient especially in developing countries like Nigeria. The quest for cheap and cost effective technology for removal of pollutants from wastewater containing organic pollutants has led to the use of materials of biological origin as adsorbent. Presently, the use of agricultural waste or biomass as adsorbent for waste or polluted water treatment is of much importance. Adsorption as a process is easy to control and design, cheap, reliable and may be easily start

up. Over the years, there has been a growing interest in the development of adsorption as a method for the treatment of contaminated or polluted wastewater using biomass [13–18] to remove pollutants from waste water. They have been recognized as potential adsorbents for the removal of pollutant ions from aqueous solution with the view to replacing existing technologies [19]. Some of these biomasses have low adsorption capacity for organic pollutants unlike in the case for inorganic pollutants. This has pointed attention in a search for better biomass with high adsorption capacity for organic pollutants.

The objective of the present study is to investigate the feasibility of using seed of *Adenopus breviflorus*—an underutilized plant as an adsorbent for the removal of 2-chlorophenol from

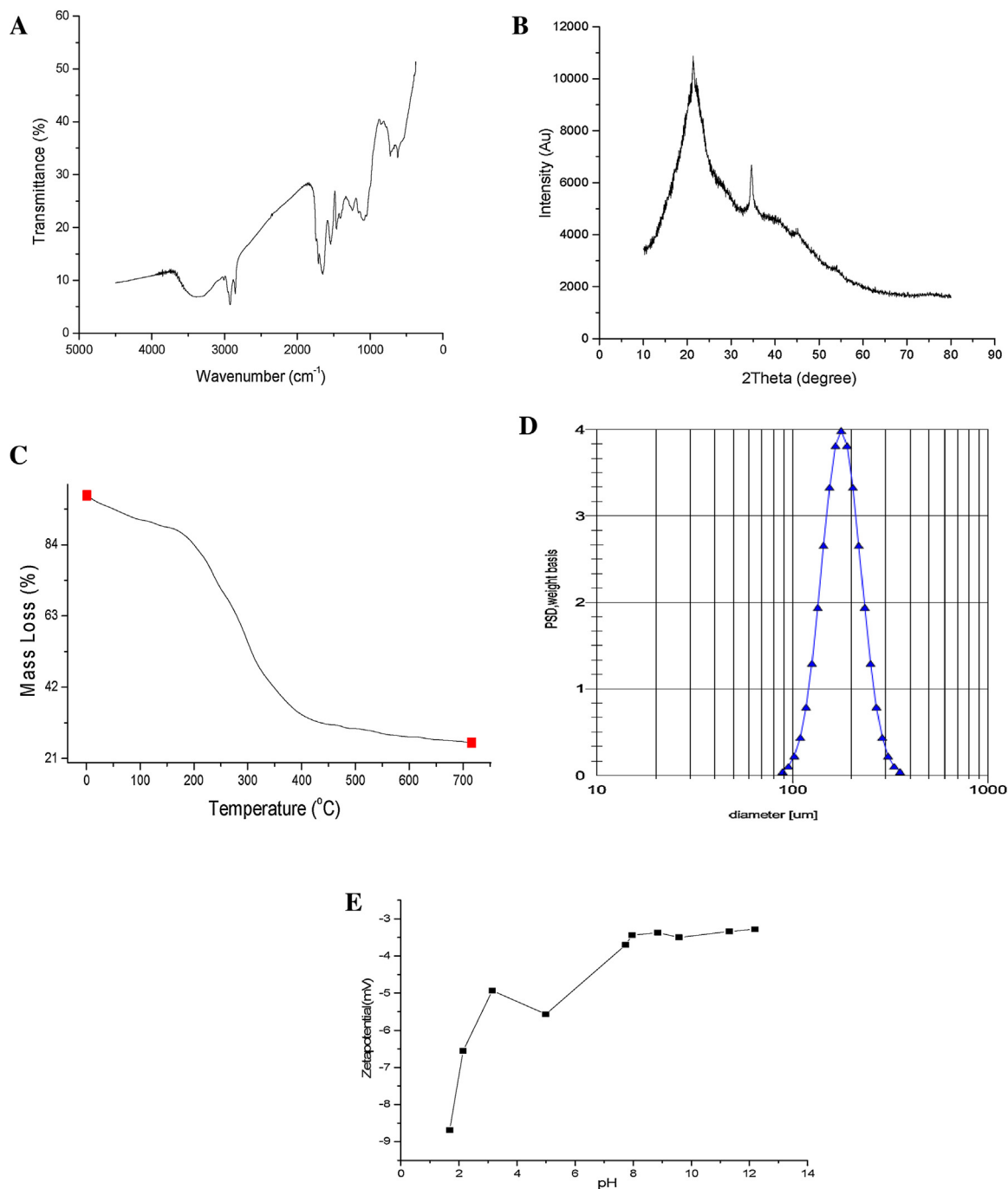


Fig. 1. (A) FTIR of *Adenopus breviflorus*, (B) XRD of *Adenopus breviflorus*, (C) TG of *Adenopus breviflorus*, (D) particle size distribution (PSD) and (E) zeta potential of *Adenopus breviflorus*.

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