Industrial Crops and Products 83 (2016) 387–390

Contents lists available at ScienceDirect

Industrial Crops and Products

journal homepage: www.elsevier.com/locate/indcrop

Short communication

Potential of *Calotropis gigantea* fiber as an absorbent for removal of oil from water

Yian Zheng[a,b,*], Yongfeng Zhu[b], Aiqin Wang[b], Huimin Hu[c]

[a] Gansu Key Laboratory for Environmental Pollution Prediction and Control, College of Earth and Environmental Sciences, Lanzhou University, Lanzhou 730000, China
[b] Center of Eco-materials and Green Chemistry, Lanzhou Institute of Chemical Physics, Chinese Academy of Sciences, Lanzhou 730000, China
[c] Shanghai Magic Tree Biotechnology Co., Ltd., Shanghai 201203, China

A R T I C L E I N F O

Article history:
Received 14 September 2015
Received in revised form 6 January 2016
Accepted 6 January 2016
Available online 25 January 2016

Keywords:
Calotropis gigantea fiber
Wettability
Absorbent
Removal
Oil–water separation

A B S T R A C T

In this study, *Calotropis gigantea* fiber was evaluated as an oil-absorbing material for removal of oil from water. Preliminary experiments show that water droplets can roll off the fiber surface, while oil droplets can spread over the surface completely, indicating its excellent hydrophobic–oleophilic properties. Further studies reveal that this fiber exhibits fast absorption kinetics and high absorption capacity between 22.6 and 47.6 g/g for various oils and organic liquids, and can efficiently recover the oil spills on the surface or below the water. Moreover, this fiber can be used as a recyclable absorbent for highly efficient oil–water separation.

1. Introduction

With increasing offshore oil production and transportation, the probability of oil spill accidents has aroused a great deal of attention as one of the most serious global concerns (Xue et al., 2011, 2014; Xu et al., 2015). Among current techniques, collecting oil spills from water using oil-absorbing materials has received increasing attention and a wide range of absorbents have been reported so far, including mainly inorganic mineral materials, organic natural materials and synthetic polymers. Inorganic mineral materials, such as silica (Syed et al., 2011), zeolites (Seal et al., 2013), perlite (Bastani et al., 2006), sepiolite (Zadaka-Amir et al., 2013) and vermiculite (Mysore et al., 2005) show low absorption capacity and inadequate buoyancy. Synthetic polymers such as polyurethane (Wu et al., 2015; Li et al., 2015), formaldehyde-melamine-sodium bisulfite copolymer (Ke et al., 2014) and polyvinyl-alcohol formaldehyde (Pan et al., 2014) have been demonstrated to present high absorption capacity and recyclability. However, the fabrication of such a high-performance oil absorbent requires expensive raw materials and complicated synthesis procedures. Given their environmentally friendly characteristics and low cost, some natural fibers have been investigated in recent years as the preeminent materials for developing environmentally sustainable absorbents for oil spill cleanup, especially kapok fiber (Wang et al., 2013a,b;Lim and Huang, 2007a,b).

Calotropis gigantea (*Calotropis gigantea* (L.) *Dryand.*) is a perennial, evergreen erect shrub belonging to the *asclepiadaceae* family. Initially, this plant was widely studied because of its medicinal properties (Babu and Karki, 2011; Deshmukha et al., 2009), and all parts of the plant exuded white latex that had immense potential to cure a variety of human and animals ailments. Further studies demonstrated that *C. gigantea* could also be used as a renewable source of hydrocarbons (Phoo et al., 2015). For the silky floss, i.e. fibers attached to the seed, valuable information had been provided on its potential application in fiber-reinforced composites (Ashori and Bahreini, 2009; Nourbakhsh, 2009) and in the textile industry (Chen et al., 2013; Sakthivel et al., 2005). In addition to its large lumen similar to kapok fiber, the main components with 66% cellulose, 21% hemicellulose, 8–9% lignin, 3% pectin and 1.8–3% wax have been identified (Chen et al., 2013), and accordingly, *C. gigantea* fiber is expected to show high affinity to oils but resistance to water. Therefore, the objective of this study was to evaluate the potential of *C. gigantea* fiber as an excellent oil-absorbing material for the removal of oil from water.

* Corresponding author.
E-mail addresses: zhengya@lzu.edu.cn, zhyian@gmail.com (Y. Zheng).

http://dx.doi.org/10.1016/j.indcrop.2016.01.009
0926-6690/

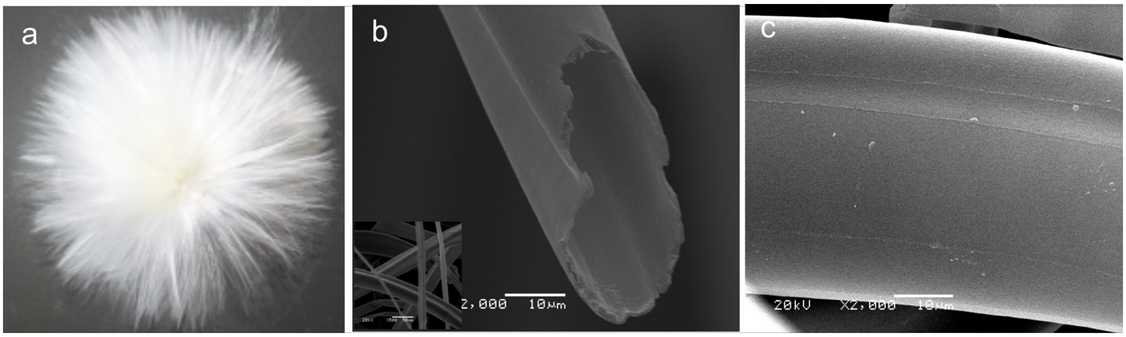

Fig. 1. Digital photo (a) and SEM images of the cross-section (b) and longitudinal (c) view of pristine *C. gigantea* fiber. Inset in (b) shows the SEM image at a magnification of 500×.

2. Materials and methods

2.1. Materials

C. gigantea fiber was provided by Shanghai Magic Tree Biotechnology Co., Ltd., Shanghai, China. Methylene blue and Sudan III were obtained from Sigma. Toluene, xylene, 1,2-dichloroethane, trichloromethane, carbon tetrachloride, *n*-hexane, cyclohexane and paraffin oil were all analytical grade and purchased from Sinopharm Chemical Reagent Co., Ltd., Shanghai, China. Rapeseed oil was received from a local supermarket, and was a product from Luhua Group Co., Ltd., Shandong, China.

2.2. Measurements of oil absorption capacity

An accurately weighed amount of *C. gigantea* fiber (50 mg) was dipped into 30 mL of oils or organic liquids for different intervals at 20 °C. Then, the wet fiber was drained for 10 s and quickly weighed. The oil absorption capacity per gram of fiber at any time can be calculated according to the weight ratio of the absorbed oil/liquid to the dry fiber.

2.3. Absorption selectivity

A small amount of toluene or trichloromethane was poured into a beaker to obtain an oil layer or a bigger oil droplet on the surface or below the water. Subsequently, the *C. gigantea* fiber was placed on the oil–water mixture to observe the oil absorption behavior.

2.4. Oil–water separation and reusability

The *C. gigantea* fiber was spread onto a funnel that is placed on an Erlenmeyer flask. The oil/water mixtures (50 v/v%) were then poured onto the funnel (Fig. S1, Supporting information).

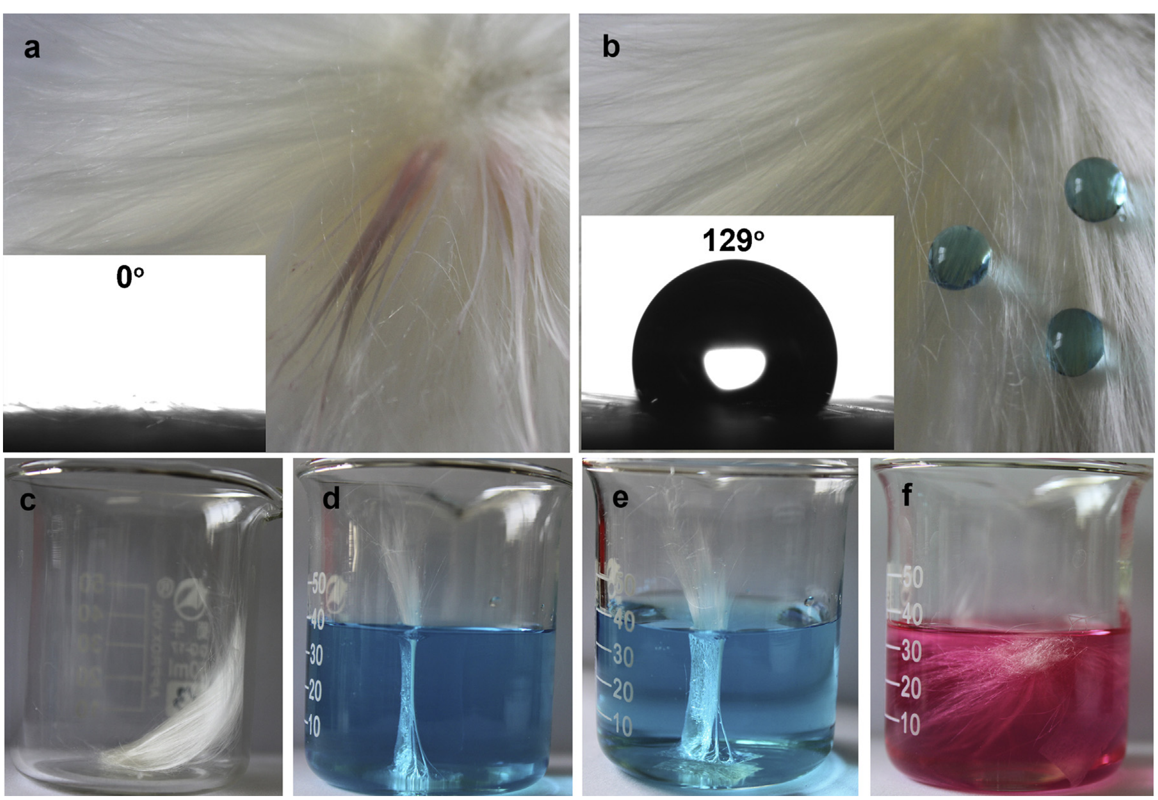

Fig. 2. Images of (a) red-colored trichloromethane droplets diffused into the surface of the *C. gigantea* fiber, (b) blue-colored water droplets sitting on the surface of the fiber, (c) raw fiber fixed on the bottom of a beaker, (d and e) raw fiber standing upright in water, and (f) raw fiber dispersed into trichloromethane. Trichloromethane and water were colored red (Sudan III dye) and blue (Methylene blue dye), respectively. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.).