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Research Article

Synthesis of Cotton from Tossa Jute Fiber and Comparison with Original Cotton

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Cotton fibers were synthesized from tossa jute and characteristics were compared with original cotton by using FTIR and TGA. The FTIR results indicated that the peak intensity of OH group from jute cotton fibers occurred at 3336 cm^{-1} whereas the peak intensity of original cotton fibers occurred at 3338 cm^{-1}. This indicated that the synthesized cotton fiber properties were very similar to the original cotton fibers. The TGA result showed that maximum rate of mass loss, the onset of decomposition, end of decomposition, and activation energy of synthesized cotton were higher than original cotton. The activation energy of jute cotton fibers was higher than the original cotton fibers.

1. Introduction

In recent years, lignocellulosic materials have grown to be more attractive to the material engineering sectors. These materials, comprising lignin, hemicellulose, and cellulose, have become alternatives to conventional materials. This is due to their environmentally friendly nature and lignocellulosic materials are derived from plants. If the cellulose resources can be fully utilized, much energy can be saved and the environmental pollution can be decreased [1].

Jute is a natural biodegradable fiber, largely produced in India, China, and Bangladesh. In recent years, the development of biodegradable materials from renewable sources has increased [2]. Jute fibers are durable with many advantages, which include low cost, low density, and light weight. Jute fibers are conventionally used as packaging material and carpet backing. Nowadays, jute fiber of improved qualities has attracted its use in different areas, namely, technical textiles, jute gunny sack, jute gunny bag, jute yearn, household textiles, and so forth [3]. Therefore, it is important to develop new products from jute to regain its economic importance. Original cotton fiber is a natural soft fiber obtained from the boll of the cotton plant.

The largest producing areas of cotton are China, India, Pakistan, Bangladesh, Republic of Uzbekistan, Brazil, Australia, Greece, and Syria. Original cotton is stable with many advantages such as low cost, light weight, and easy possessing. The original cotton fibers are conventionally used in medical sector and household textiles. Presently, original cotton fibers are increasingly used in different items, like paper, fiber pulp, food casing, textile mills, spinning mills, knitting mills, and so forth. The original cotton production, however, is less than the actual demand. Therefore, synthesized cotton fibers can be used to fulfill the high demand for original cotton.

Acetic acid and alkali processing is an effective alternative method to fabricate jute cotton fibers [4]. This method also includes dewaxing and delignification. The fabricated cotton fibers derived from jute fibers possess improved properties [5]. The synthesized jute cotton fibers can be used for diverse purposes. In this present work, a new technique and chemical

process were developed to prepare cotton from jute fibers, and the result was compared with the characteristics of original cotton fiber.

2. Materials and Methods

2.1. Materials. Chemicals used in this study were ethanol approximately 96% (C_2H_6O), hydrogen peroxide 35% (H_2O_2), supplied by Brightchem Sdn Bhd. Malaysia, toluene ($C_6H_5CH_3$), acetic acid (glacial) 100% (CH_3COOH), titanium (IV) oxide (TiO_2), and potassium hydroxide (solid KOH), supplied by Mallinckrodt Baker, Inc., Sweden. The jute fibers were collected from Bangladesh Jute Research Institute (BJRI), Dhaka, Bangladesh.

2.1.1. Fiber Extraction. The raw jute fibers were cleaned and then washed with tap water to remove dust and other undesirable elements. After that, the jute fibers were air-dried for two days under direct sunlight. The middle parts of the jute fibers were taken and chopped into lengths of approximately 3 mm. Then, the chop fibers were placed in a forced air convection oven for drying to remove the moisture content, with a temperature of 105°C for 24 hours to ensure that all the moisture has evaporated.

2.1.2. Dewaxing. The dewaxing was done by applying the Leavitt-Danzer method. In this process, two types of chemicals were used, namely, toluene ($C_6H_5CH_3$) and ethanol (C_2H_6O), with ratios of 2 : 1. The extraction process was done using the extraction column (Soxhlet extractor, Round Bottom Flask, Liebig Condenser, Heater, Membrane, and Thermometer). Then, the chopped jute fibers were immersed in the extraction column. This process was continued for 3 hours at 150°C. The collected fibers were later placed in the forced air convention oven for 24 hours at 75°C.

2.1.3. Delignification. The delignification was implied using acetic acid (CH_3COOH) and hydrogen peroxide (H_2O_2) in present titanium oxide (TiO_2) in a round bottom vector vessel. Then, the dewaxed jute fibers were placed in the round bottom vessel. This process was continued for 3 hours at 130°C. After this, the collected fibers were carefully washed and placed in the forced air convention oven for 24 hours at 70°C.

2.1.4. Alkali Treatment. Potassium hydroxide (6%) (KOH) was placed in 1000 mL of conical flax and the delignified jute fibers were immersed in the solution for eight hours at 30°C and 60°C, respectively. After that, the collected samples were carefully washed and placed in the forced air convention oven for 24 hours at 70°C. Dried fibers used as synthesis cotton fibers characterization are shown in Figure 1.

2.2. Microstructural Analysis

2.2.1. Fourier Transform Infrared (FTIR) Spectroscopy. The infrared spectra of the synthesized cotton fibers from jute and original cotton fibers were recorded on a Shimadzu FTIR Spectrophotometer with dynamic alignment system sealed

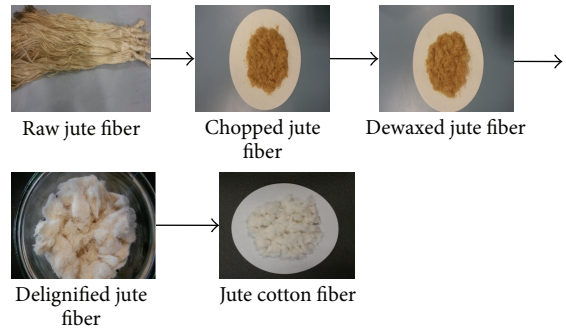

Figure 1: Flow chart of the synthesized jute cotton fibers.

interferometer with autodryer and wavenumber range was 350 to 7,800 cm^{-1}. The obtained spectra are presented and discussed in Section 3.

2.2.2. Thermogravimetric Analysis (TGA). Thermogravimetric analysis (TGA) was used to study the thermal stability of synthesized cotton fibers from jute fibers and original cotton fibers. The thermal stability analysis was performed using Perkin-Elmer thermal analyzer (TGA). The specimen (10 mg) was heated from room temperature to 800°C at a dynamic heating rate of 5°C/min under N_2 using a flow rate of 100 mL/min.

3. Result and Discussion

3.1. Fourier Transform Infrared (FTIR) Spectroscopy. The FTIR spectroscopic analyses of the cotton fibers from jute and original cotton fibers are shown in Figure 2. The wavenumber from 3600 to 3000 cm^{-1} corresponded to the stretching of H bonds in the OH groups [6, 7]. The IR spectrum showed the peak intensity of jute cotton fibers at 3336 cm^{-1} of OH groups whereas the original cotton fibers peak intensity was recorded at 3338 cm^{-1}.

Stretching of the C-H group of synthesized jute cotton fibers occurred at 2897 cm^{-1} while the original cotton fibers showed stretching at 2890 to 2362 cm^{-1} [8]. The C=O absorption band for jute cotton occurred at 1654 cm^{-1} and the original cotton fibers absorption band occurred at 1648 cm^{-1} [9]. The absorption band of synthesized jute cotton and original cotton fibers at 1313 and 1321 cm^{-1} can be attributed to the symmetrical deformation of NO_2 in the cellulose azo compound [10]. Therefore, the FTIR results proved that both synthesized jute cotton fibers and original cotton fibers possess similar properties.

3.2. Thermogravimetric Analysis (TGA). Thermogravimetric analysis (TGA) was carried out on the synthesized cotton fibers and original cotton fibers to determine the thermal stability. The thermal stability of synthesized cotton fibers and original cotton fibers is shown in Figure 3. The weight losses of synthesized cotton fibers and original cotton fibers can be illustrated in three stages: (1) dehydration of absorbed moisture and water (<200°C), (2) the breaking of the cellulose