Advances in Bioresearch
Adv. Biores., Vol 7 (5) September 2016: 219-222
©2016 Society of Education, India
Print ISSN 0976-4585; Online ISSN 2277-1573
Journal's URL:http://www.soeagra.com/abr.html
CODEN: ABRDC3
ICV Value 8.21 [2014]

Advances in Bioresearch

ORIGINAL ARTICLE

Nano-cellulose Production from Date Palm Plant Biomass

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ABSTRACT
Biomass is the source of plant, animal forest and municipal waste that can be converted into different forms of biomaterials, biofiber, bio-film, bio-plastic based materials, bioethanol as anticeptic and use of cosmetic industries, bio-chemicals, bio-fuels, bioelectricity in the agro-industry, pharmaceuticals, biomedical and bioengineering aspect using different biotechnological procedures. This study was conducted to prepare nano-cellulose from date palm plant biomass for the multiple use in the industry. Nanopartical size was found 20nm and compared with the standard. Cellulose was found higher in nanosized particle than without nanosized particle. However, pH was found alkaline of nanosized particle which was under the standard value. Current results can conclude that it is possible to prepare date palm fiber (lingo-cellulosed) based nano-cellulose.
Keywords: *nano-cellulose, waste-fiber of date palm, ligno-celluloses*

Received 08/04/2016 Accepted 24/07/2016

How to cite this article:
A.B.M. Sharif Hossain and Musamma M. Uddin. Nano-cellulose Production from Date Palm Plant Biomass . Adv. Biores. Vol 7 [5] September 2016: 219-222. DOI: 10.15515/abr.0976-4585.7.5.219222

INTRODUCTION

Agro-waste biomass is an important biological source based materials to produce biomaterials and bio-plastic [1,2,3]. Plant, animal and municipal waste can be used for the effective conversion into biomaterials like bio-plastic, bio-polymer, bio-fibre, bio-fuels [1,4,5]. Advancements in the use of waste materials could also significantly improve the economics of the biopolymer, biomaterial products, paper and pulp industries by leading to new sources of raw materials and other innovations [1]. Cellulose is the first agro-polymer in the world. It is a cheap semi-crystalline material, which is widely used in paper production but also as reinforcing elements in polymer matrixes. Cellulose is modified to obtain a thermoplastic material, by acetylation (cellulose acetate). After acidic treatment, and elimination of the amorphous parts of cellulose microfibrils, the whiskers (mono-crystals) are obtained, which are used to develop nanocomposites materials [1]. Starch is the main storage supply in agro bioresources. Hossain *et al.* [6] reported that starch is a widely available raw material on earth having different industrial applications such as paper, and textile. Moreover, starch granules can be isolated from agro biomaterial, plants and agro waste.

50 percent of the bioplastics market, thermoplastic starch, such as plastarch material, presently the bio-plastic represents the most important and widely utilized [7]. In addition, cellulose bioplastics like cellulose esters, polyhydroxyalkanoates (PHAs) poly-3-hydroxy butyrate (PHB), polyhydroxy valerate (PHV) and polyhydroxy hexanoate PHH, Polylactic acid (PLA) plastics, Polyamide 11 (PA 11), bio-derived polyethylene are used for different biomaterials production [7, 8].

Date palm plants and fruits have fibre in abundance. These fibres as lignocelluloses are obtained from the fruit, stem, leaf and peel. Some plant fibre was primarily used for making items like ropes, mats, and some other composite materials. With the increasing environmental awareness and growing importance of unfriendly fabrics, plant fibre has also been recognized for all its good qualities and now its application is increasing in other fields too such as apparel garments and home furnishings. Hossain et al [3] reported that nano-particle sized preparation was made from waste banana peel. Leao [9] reported that various plants used to make nanocellulose fibres to reinforce plastics in the automotive industry. In addition to that weight reduction, nano-cellulose reinforced plastics have mechanical advantages over conventional automotive plastics. Leao [9] reported that the fibers used to reinforce the new plastics may come from delicate fruits like bananas and pineapples, but they are super strong. He reported that automobile manufacturers already tested nano-cellulose-reinforced plastics, with promising results, he predicted they would be used near future [10]. No literatures are found regarding the present research. This is why this research is innovative. The objective of the study was under taken to make sure to prepare nano-particle from banana peel waste biomass.

MATERIALS AND METHODS

Sample collection and preparation

2 kg waste date palm plant fiber was collected from the local garden, Hail city, KSA. Fiber was separated from each other and washed to clean. Washed fiber was sliced by scissors. Then it was blended by blender. After blending it was again ground for fine mixing by motor and pestle and put it to the beaker.

Samples pyrolysis

Blended and ground sample was heated at 150 0C in pressure cooker for 2 hours at 30psi until the sample was become liquid paste. After heating the liquid paste sample was cool down.

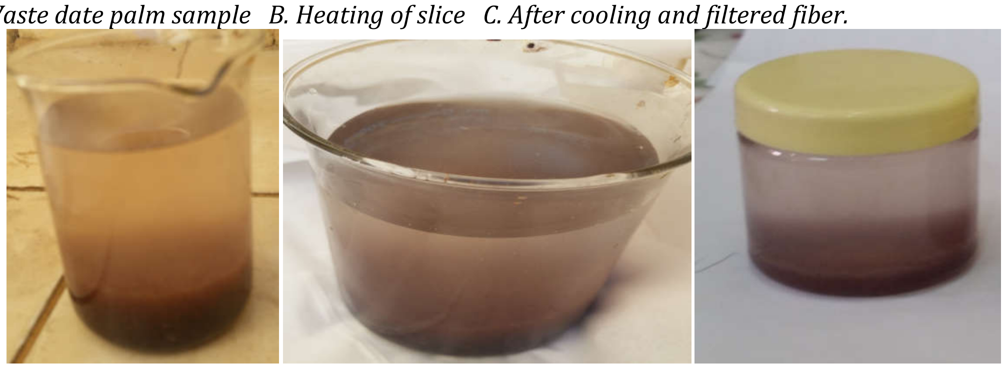
Acid Hydrolysis

Paste sample was hydrolyzed (100ml/50g sample) by sulfuric acid (H_2SO_4 99%) to make it micro to nano size particle for 12 hours. The water bath was used during the process of hydrolysis occurred. After 12 hours the samples were separated by separation funnel and washed by distilled water (Figure 1).

Nanoparticle measurement

Nano particle size was measured by Scanned electron microscopy (SEM).

A. Waste date palm sample B. Heating of slice C. After cooling and filtered fiber.



D. Acid hydrolysis and naocellulose E. Nanocellulose mixture F. Nanocellulose

Figure 1. Photograph shows different steps of producing bioplastic

SCANNING ELECTRON MICROSCOPY (SEM)

The scanning electron microscope (SEM) uses a focused beam of high-energy electrons to generate many of signals at the surface of solid sample. The signals that derive from electron-sample interactions revealed information about the sample including texture, chemical composition, and crystalline structure and orientation of materials making up the sample. In most applications, data were collected over a selected area of the surface of the sample, and a 2-dimensional image is generated that displays spatial variations in these properties. Areas ranging from approximately 1 cm to 5 microns in width could be imaged in a scanning mode using conventional SEM techniques (magnification ranging from 20 X to approximately 30,000 X, spatial resolution of 50 to 100 nm). The SEM was also capable of performing analyses of selected point locations on the sample; this approach is especially useful in qualitatively or semi-quantitatively determining chemical compositions.

pH determination
The pH was tested using Horiba Scientific pH meter.
Cellulose Determination
Dinitrosalicylic Acid (DNS) Method for cellulose Determination
Cellulose content was determined by 3, 5-dinitrosalicylic acid. A standard curve was drawn by measuring the absorbance of known concentration of cellulose solutions at 575nm. DNS reagent consisted of 1% dinitrosalicylic acid, 0.2% phenol, 0.05% sodium sulfite and 1% sodium hydroxide. To measure cellulose content, 3 ml of unknown cellulose solution was filled into a test tube, followed by addition of 3 ml of DNS reagent. The test tubes were then heated in boiling water bath for 15 minutes. 1 ml of 40% potassium sodium tarterate solution was then added prior to cooling. All test tubes were then cooled under running tap water and its absorbance at 575nm was measured.

RESULT AND DISCUSSION

From the figure 2 it has been shown that nanosized particle as nanocellulose was measured and found 20nm (Table 1). pH was determined from the nanoparticle and was found 7.5 which maintained the alkaline properties (Table 2). Cellulose was found to be higher content (48.2%) in the nanosized particle than the banana peel cellulose content (banana peel cellulose sample, it is 20-40%) as normal standard maintained by ASTM [11,12] and USDA determination. Nair *et al*. [13] reported that nanocellulose could be extracted from various plant resources through mechanical and chemical ways. Nanocellulose with its nanoscale dimensions, high crystalline nature and the ability to form hydrogen bonds resulting in strong network makes it very hard for the molecules to pass through, suggesting excellent barrier properties associated with films made from these material. The results can be an innovative and similar to the work done by the scientist from plant samples.

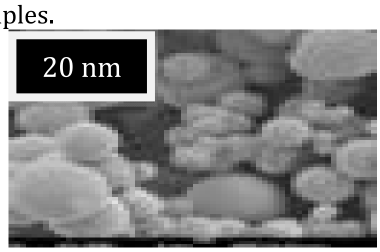


Figure 2. Photograph shows the size of nano-cellulose from date palm waste biomass

Table 1. Nanocellulose size and compare with the standard by ASTM E2865 [11]

Materials	Nano cellulose particle size
Nanoparticle from banana sample	20nm
Standard by ASTM	10-100nm

Table 2. Cellulose and pH determination from nanoparticle sized banana peel biomass

Test	pH	Cellulose percent
Nano-cellulose samples	7.5 ±0.01	48.2% ±0.11
Standard of date palm fiber sample	Alkaline ≥ 7	(Cellulose sample, it is 20-40%)

Mean ±SE (n=3)

CONCLUSION

It can be concluded that nano-cellulose can be prepared from date palm plant waste based biomass according to the identification of different properties by ASTM E2865standard method and results.

ACKNOWLEDGEMENT

Authors are thankful to the Department of Biology, Faculty of Science, University of Hail for financial support for this project.

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