G.J.B.A.H.S.,Vol.4(3):19-21 (July-September, 2015) ISSN: 2319 – 5584

GLOBAL JOURNAL OF BIOLOGY, AGRICULTURE & HEALTH SCIENCES
(**Published By**: Global Institute for Research & Education)

www.gifre.org

Nano-Particle Preparation from Ligno-Cellulose Based Banana Peel Biomass as a Tool of Nano-Biotechnology

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Abstract

Biomass is organic, plant or animal based source of material that can be converted into different forms of bioplastic materials, biofuel and bioenergy using different biotechnological procedures. Biomasses can be the source of biomaterial products such as bio-plastics, 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. This study was conducted to prepare nano-cellulose sized paricle for the multiple use in the industry. Nanopartical size was found 50nm 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 banana peel lingo-cellulosed based nanoparticle.

Keywords: *ligno-celluloses, nanoparticle, waste-banana peel*

Introduction

Agro waste biomass is one of the most promising area to produce biomaterials and bio-energy (Hossain and Mseddi, 2012, Hossain et al. 2008). Crop, fruit and municipal waste can be used for efficient conversion into biomaterials like bio-plastic, bio-polymer, bio-fibre, bio-fuels (Hossain and Mseddi, 2012, Hossain et al. 2010). 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 (Hossain and Mseddi, 2012). 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 ((Hossain and Mseddi, 2012). Starch is the main storage supply in agro bioresources. It is a widely available raw material on earth having different industrial applications such as paper, and textile. Starch granules can be isolated from agro biomaterial, plants and agro waste *(*Hossain et al. 2007).

About 50 percent of the bioplastics market, thermoplastic starch, such as plastarch material, presently the bio-plastic represents the most important and widely utilized (BI, 2008). In addition, Ccellulose 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 (BI, 2011, EC, 2011).

Banana plants and fruits have fibre in abundance. These fibres are obtained from the fruit, stem, leaf and peel. Banana 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, banana 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. Currently companies make limited application of banana fibres in making biocomposite materials. Nowadays nanofibre/nanocellolose is being made from banana peel and stem in brazil. Brazilian researchers are working on ways to use nanocellulose fibres from various plants to reinforce plastics in the automotive industry (Leao, 2011). Besides weight reduction, nano-cellulose reinforced plastics have mechanical advantages over conventional automotive plastics. Leao, (2011) 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 (HCBM, 2013). 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 preparatin

1 kg waste banana (*Musa acuminata)* was collected from the local market, Hail city, KSA. Banana peel was removed and washed to clean. Washed peel 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

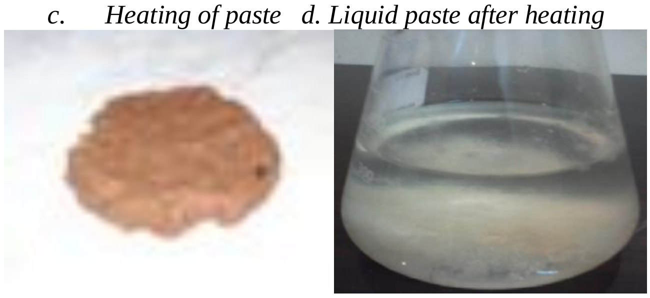
Paste sample was hydrolyzed (100ml/50g sample) by hydrochloric acid (HCl 99% pure) to make it micro to nano size particle for 8 hours. The water bath was used during the process of hydrolysis occurred. After 8 hours the samples were separated by separation funnel and washed by distilled water (Figure 1)..

Nanoparticle measurement

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

a. Waste banana peel *b. Blended peel paste*

c. Heating of paste *d. Liquid paste after heating*



e. Sample paste after cooling *f. nanoparticle sized sample after acid hydrolysis*

Figure 1. Photograph shows different steps of producing nano-particle from lignocellulose.

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 tartrate 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 50nm (Table 1). pH was determined from the nanoparticle and was found 7.3 which maintained the alkaline properties (Table 2). Cellulose was found to be higher content (45.3%) in the nanosized particle than the banana peel cellulose content (banana peel cellulose sample, it is 20-40%) as normal standard maintained by ASTM and USDA determination. Nair et al., (2014) 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.

Conclusion

It can be concluded that nanoparticle can be prepared from banana peel waste lignocellulose based biomass according to the identification of different properties by ASTM E2865standard method and results.

Acknowledgement

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

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Figure 2. Photograph shows the size of nanoparticle from banana peel lignocellulose

Table 1. Nanoparticle size and compare with the standard by ASTM

Materials	Particle size
Nanoparticle from banana sample	50nm
Standard by ASTM	10-100nm

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

Test	pH	Cellulose
Nanoparticle samples	7.3 ±0.01	45.3% ±0.1
Standard of banana peel sample	Alkaline ≥ 7	(Banana peel cellulose sample, it is 20-40%)

Mean ±SE (standard Error, n=3)