DEVELOPMENT OF ECO-FRIENDLY BIODEGRADABLE FOOD PACKAGING FILM FROM BY-PRODUCTS OF FRUIT WASTE AND PROCESSING WITH DIFFERENT PLASTICIZERS

Sapthagiri College of Engineering, Department of Biotechnology

Amulya S M , Harsshitha J K , Spandana Iyer , Vaishnavi R , Dr. Soumya C *, Dr.Shobha G
Email: sowmyac@sapthagiri.edu.in , 9538819506

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INTRODUCTION

Plastics have transformed everyday life usage is increasing and annual production is likely to exceed 300 million tonnes by 2010. However, concerns about usage and disposal are diverse and include accumulation of waste in landfills and in natural habitats, physical problems for wildlife resulting from ingestion or entanglement in plastic, the leaching of chemicals from plastic products and the potential for plastics to transfer chemicals to wildlife and humans.

One of the biggest environmental problems is the fast rising manufacture, usage, and disposal of plastic products. Our current situation, in which it has been shown that the food supply chain contains plastic particles and other pollutants derived from plastic, poses a serious threat to the health of people and animals as well as the environment. From this vantage point, biodegradable plastic material aspires to create eco-friendlier, sustainable world with less negative environmental impact. Since bio plastics are being looked into as an environmentally benign solution to this issue, the world's bioplastic output has significantly increased and expanded in recent years.

Fruit and vegetable waste has potential as a bioplastic material promoting environmental sustainability. Due to the accessibility of raw materials, affordability, abundance, environmental friendliness, suitable physical properties, distinctive sensory and nutritional properties, and increased physical properties and functionality, the use of underutilised compounds, such as by-products of fruit and vegetable processing in the production of biodegradable packaging films, is gaining more and more attention in this regard.

OBJECTIVES

1. ***Processing of Fruit waste (banana stem)***
   1.1 Collection of banana fibre and processing with NaOH is done in this objective

2. Extracting methods of value-added compounds from fruit by-products
   2.1 The banana stem fibres are soaked in sulphuric acid solution, to remove pectin and free sugars.

3. Production of biodegradable packaging films
   3.1 The cellulose, hemicellulose and lignin contents are measured according to detergent fibre method and Cellulose Films are prepared by extracted banana stem.

4. Thin films were characterized by FT-IR and XRD
   4.1 The sample shall be subjected to FT-IR and XRD for further characterization of films

5. Determine physical, mechanical, thermal properties and biodegradability of the film.
   5.1 Here Physical test represents Biodegradability test, Mechanical test represents solubility test- thermal test

METHODOLOGY

1. Processing of Fruit waste (banana stem)

The banana stem was added into the prepared NaOH solution and heated upto 60°C for 5- 10 mins

2. Extraction of by products:

The banana stem fibres are soaked in sulphuric acid solution at 50°C for 2 hours without agitation at a solid loading of 5% (w/v) to remove pectin and free sugars. The solid residue is separated by filtration and washed thoroughly with distilled water until the pH value of the filtrate is neutral. The washed solid residue is then soaked in sodium hydroxide solution (200 g/L) at 30°C for 30 min to remove lignin.

3. Production of Biodegradable packaging film:

The de-lignified residue is thoroughly washed with distilled water, squeezed to remove excess water. The cellulose, hemicellulose and lignin contents are measured according to detergent fiber method. Briefly, by boiling in deionized water and extracting with a neutral detergent solution the soluble fraction shall be removed and the neutral detergent fiber residue (NDF) will be obtained. Followed by the extraction with the Van Soest acid detergent, the acid detergent fiber residue (ADF) is obtained. By extracting the ADF by sulfuric acid, the acid detergent lignin residue (ADL) is obtained.

The cellulose, hemicelluloses and lignin contents are calculated as ADF–ADL, NDF–ADF, and ADL respectively. For polysaccharide-based films, with starch as the binding agent, the films were prepared. Considering the mechanical and surface properties, the plasticizing agents were selected. Within the group of glycerol, Ethylene glycerol, PEG and propylene glycol, less volatile the plasticizer, the better it is for use. Considering the plasticization efficiency and storage stability for chitosan films, GLY and PEG showed to be more suitable than EG and PG.

We chose glycerol as plasticizer. Two sets of petri plates were prepared using 3% starch with 5% and 10% glycerol, one set consist of standard cellulose and the second with extracted sample cellulose.

Cellulose Films are prepared by extracted banana stem cellulose (1 g) and [AMIm][Cl] (19 mL) are loaded into a 50 mL round-bottom flask, and then heated in a heating mantle at 80–90°C with agitation at 200 rpm for 3–4 h. Once a transparent appearance is obtained, the mixture of dissolved cellulose and ionic liquid shall be casted onto a glass plate and spread with a spreader to obtain a 0.5 mm-thick layer, which is then immediately immersed in a coagulation bath (aqueous ethanol solution, 20%) to form a cellulose hydrogel. The regenerated cellulose hydrogel is then washed at least for five times with distilled water to remove residual [AMIm][Cl]. The cellulose film is obtained by drying at room temperature.

4 Characterization techniques:

4a. FTIR- Fourier transform infrared spectroscopy:

The sample in chloroform is applied as a smear over the sodium chloride block and shall be analysed using the FTIR spectrophotometer. The FTIR spectrum of the sample is obtained at the wavelength in the range of 450- 4000 cm-1

4b. XRD- X-ray powder diffraction:

To get an insight into the structure of bioplastic formed by using banana stem, powder XRD patterns will be recorded by X-ray diffractometer using the Cu K-beta (30 kV, 100 mA) radiation. Data shall be recorded during the 2θ range of 10°-80° under continuous scan mode using the scan rate of 4°/min.

5. Application studies:

5a. Biodegradability (mechanical studied)

Two 400 ml beakers and 1.1 grams of a pre-weighed piece of bioplastics are taken, the pre - weighed bioplastic material prepared is placed under the beaker containing soil at a depth of 5cm from the surface. Some amount of water is sprinkled on the soil so that bacterial enzymatic activities could be enriched. These samples shall be kept in the beaker for about 15 days and each 3 days of interval we observed the decrease in the weight of the bioplastic material and results are recorded accordingly and each experiment is done in thrice in order to ensure results.

5b. Solubility studies (physical studies)

Two types of bioplastic are prepared and solubility studies are conducted to check persistence of these bioplastic materials. Samples of bioplastic from banana stem are soaked in sodium meta bisulfite solution and samples of bioplastic of banana stem which is obtained by a direct squeezing process will be considered. All the samples are cut into small pieces and are inserted into a test tube containing different solvents.

RESULTS AND CONCLUSIONS

Banana stem fibers and banana stem cellulose were extracted.

Fig 1 Banana stem fibers

Fig 2 Banana stem cellulose

SCOPE FOR FUTURE WORK

- To overcome the major problem related to plastic and its adverse affects on the environment , thickness of the plastic is reduced and its biodegradability is increased.
- Hence, production of bioplastic and biodegradable plastics helps in reduction of the waste

produced and is easy to recycle.