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Utilisation of Waste Banana Peels for the Preparation of Environment Friendly Bio-plastic Film: A Preliminary Study

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Abstract

Plastics, which are dumped in landfills and disintegrate very slowly, are one of the main drivers of land pollution. Because of this, biodegradable and biocompatible polymers are currently increasing importance in both fundamental and practical research domains across the globe. Plastics made from renewable biomass sources, such as food scraps and agricultural byproducts, are known as bioplastics. Transparent, adaptable, strong, excellent as a barrier, and heat resistant, bioplastic is also. We carried out a study in the Biotechnology department of the Govt College in Hisar, Haryana, keeping all these issues in mind. In this study, we used leftover banana peels and turned them into a bioplastic film by treating them with acid and alkali. Successful production of bioplastic sheets from a mixture of banana peel and industrial maize starch was done. At 4% maize starch content, the films were able to offer tensile strength with a maximum value of 3.50 n. The hydrophilic properties of starch molecules increased the water intake for all of the bioplastic films by more than 50%, according to the water absorption test. It was discovered during a biodegradability test that all of the bioplastic films disintegrate within a week. It is advised to carry out additional experiments in the future to improve the performance of the film, particularly in terms of mechanical characteristics and FTIR studies, as this is only a preliminary study. For better and more environmentally friendly outcomes, more and more waste peels, such as fruit and vegetable peels can be examined.

Keywords: *Banana, Bioplastic, Environment, Films, Waste.*

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Introduction: The major sources of land pollution are petroleum-based plastics [1]. The excess production of chemical-based plastics creates a lot of environmental problems like deposition and slow degradation [2]. Due to its durability and low cost, chemical based plastic is used frequently in many areas [3]. Almost all the living organisms including humans get affected due to extensive use of plastics. So, in some places, there have been initiatives to minimize plastic use and pollution while promoting plastic recycling. Plastics are potentially hazardous and may be carcinogenic due to the excessive use of chemical additives during production. Some of the main additives are utilized as brominated flame retardants and phthalate plasticizers. As a result, scientists are currently investigating viable substitutes for the conventional plastics made from petrochemical sources. One of the best alternatives of chemical-based plastic is biodegradable bioplastic. Nowadays, both fundamental and applied research domains, such as pharmacology, biomedicine, and environmental applications, are placing more and more emphasis on biodegradable and biocompatible polymers [4-9]. The preparation of bioplastics from waste banana peels is an interesting and innovative approach to address the issue of plastic pollution [10]. Bioplastics are biodegradable and have the potential to replace traditional plastics made from non-renewable resources. Banana peels are an abundant and readily available source of raw material, making them an attractive option for bioplastic production [11]. The process of preparing bioplastics from banana peels is cost effective. One of the benefits of using banana peels as a source of bioplastics is that they contain high amounts of starch, which can be converted into a biodegradable plastic. The starch content of banana peels is about 18.5% [12]. In addition, banana peels also contain cellulose and lignin, which can be used as reinforcing agents to improve the mechanical properties of the bioplastic. However, there are also some challenges associated with the preparation of bioplastics from banana peels. For example, the process can be energy-intensive and may require specialized equipment. In addition, the mechanical properties of the bioplastic may not be as good as those of traditional plastics, which

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could limit their use in certain applications. Overall, the preparation of bioplastics from waste banana peels is a promising approach to address the issue of plastic pollution. Further research is needed to optimize the process and improve the mechanical properties of the bioplastics.

At present, we could see the use of conventional plastic in every corner of the world, but their use raises serious environmental issues and public irritation because of their non-degradable nature. Hence, nowadays it is indispensable to have a potential bioplastic material in alternate over the conventional plastics. The bioplastic obtained will be environmentally friendly, trendy, user friendly and degradation tractable properties. By keeping all these aspect in mind, we have conducted experiment for preparation of bioplastic from banana in Govt College, Hisar.

Materials and method

Present investigation on "**Utilization of waste banana peels for the preparation of environment friendly bioplastic film**" was conducted in Department of Biotechnology, Govt. College, Hisar (Haryana). In this study we made efforts towards preparation of bioplastic film from waste such as banana peels as banana peels are very good source of starch. Therefore, banana peels can be suggested as a suitable source for the manufacturing of bioplastics. The chemicals used here are of HI-MEDIA and glassware used was of high quality Borosil. Different instruments used in this study were Hot plate, Hot air oven, Blender and pH meter. Waste banana peels were obtained from a banana shake seller who stands in the local market of Hisar (Haryana) and commercial corn starch was purchased from local grocery shop. Analytical grade hydrochloric acid (HCl; 36 % v/v), Analytical grade sodium hydroxide and glycerol (99.5 % v/v) were purchased from Bharat instruments and chemicals.

Methodology applied for preparation of Bioplastic film

In the first step, approximately 300 g of banana peels were taken and washed by dipping in acetic acid solution. Then, washed peels were placed into a beaker containing 800 mL water and boiled for 30 minutes. The water was decanted off and the peels were

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left to dry for 30 minutes at room temperature. The banana peels were then placed in a clean 500 mL beaker. Using a hand blender, the banana peels were pureed and 25 ml of the paste was placed in a 50 ml starch was then added as co-biopolymer and the mixtures with different concentration of corn starch was stirred again. Then, a 3 mL of 0.5 M NaOH was added to the mixture and stirred. The mixture was poured into a mould and spread into a thin layer with a wooden rod. The mould was then placed in a 130ºC oven and baked for 30 minutes. The tile is allowed to cool and the film is scraped off the surface.

Testing Procedure

To test the tensile strength of prepared bioplastic sample, some procedures are adopted. One of them is:

- ✓ **Visual analysis** which is done to locate any defects in the sample. The common forms of defects can be perforations, tears and very low thickness. If there is no effect in the sample, it is approved for further testing. For further testing, a 2cm by 4cm rectangular slice is cut out of the sample and clamped between 2 clips.

beaker containing 3mL of 0.5M HCL. The whole mixture was stirred using a spatula. Then 2 mL of 15% glycerol solution was added and the mixture was again stirred. A 3 mL of 1%, 2%, 3%, 4% and, 5% corn

One end of the clip is attached to a support and the other end has a suspended pan for placing weights in them. Applying the thumb rule for tensile strength testing, the samples are clamped such that 60% of the sample is between the clamps and is our testing region. Once the sample has been clamped, weights are added in steps of 10 grams each. A gap of 20 seconds is provided between the addition of weights to allow the sample to stretch and tear. The final weight at which the sample tears is noted using an electronic balance. For tensile strength calculations, we use the following formula:

Tensile strength (MPa) = Weight (N)/ Cross sectional Area (mm^2)

- ✓ **Water Absorption Test:** A small piece of the sample was cut into 1 cm

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× 2 cm size. The initial weight of the sample was recorded. The sample was then placed into a beaker containing 60 mL of water at room temperature for 24 hours. The sample was then taken out from the water and wiped off. The final weight was recorded. The amount of water uptake was calculated by using the following formula:

WA (%) = Final weight (g) – Initial (g)/Initial weight (g) x 100

- ✓ **Biodegradability Analysis of prepared bioplastic film:** Biodegradation process of agro bioplastic was also studied under lab conditions. For this purpose, prepared bioplastic was added to tubes containing sterile distilled water, soil water, sewage water and water containing bacterial culture. The process of degradation was studied till 7 days.

Results and Discussion

Research was done to characterize and prepare bioplastic film made from waste peels. We have made an effort to solve the two main issues of waste management and pollution brought on by petroleum-based plastics. During this study, first step was hydrolysis of starch present in the waste banana peels. Starch consists of two different types of polymer chains, called amylose and amylopectin, made up of adjoined glucose molecules. The hydrochloric acid is used in the hydrolysis of amylopectin, which is needed in order to aid the process of film formation due to the H-bonding amongst the chains of glucose in starch, since amylopectin restricts the film formation. The sodium hydroxide in the experiment is simply used to neutralize the pH of the medium.

Figures 1 below show the complete procedure of preparation of BP films with different percentage of corn starch. It is probable that the development of brownish color was due to the caramelization of the sugar in the ingredients.

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Banana Peels were taken

Chopping of Peels

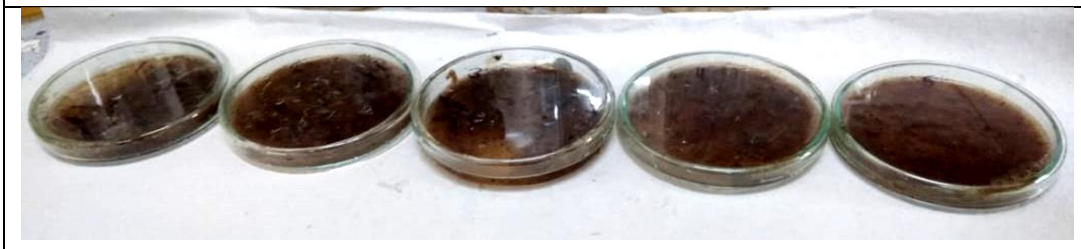
Washing of peels

Boiling of peels

Drying of peels

Pureed banana peels

Banana puree after adding of different concentration of corn starch



Casting of banana puree with different concentration of corn starch

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Final bioplastic film after drying and scrapping

Figure 1: Complete procedure of preparation of biofilm from waste banana peels

Acid hydrolysis changes the physiochemical properties of starch without changing its granule structure. Kerr et al [13] said that at the temperature below the gelatinization temperature, the amylopectin region of starch gets hydrolyzed preferentially than the amylopectin. However, if the hydrolysis time was increased up to 6 hours, the amylose content decreased slightly. After complete hydrolysis, plasticizer was added. Plasticizers are generally small molecules such as polyols like sorbitol, glycerol and polyethylene glycol (PEG) that intersperse and intercalate among and between polymer chains, disrupting hydrogen bonding and spreading the chains apart, which not only increases flexibility, but also water vapor and gas permeabilities. During the present study, glycerol was used as a plasticizer. It is generally accepted that plasticizers lower the number of physical cross- links between starch chains, and consequently retard the rate of retrogradation. Further many testings procedure were adopted. Visual analysis showed that some biofilms have perforations amylose region. Abdorezza et al [14], obtained native starch from the stem of palm trees using 0.14N HCl. During the initial stages of hydrolysis, the amylose content increased due to the hydrolysis of branched chains of while some are very fine with no perforations. As far as we are concerned with thickness, films were thin. In the load test, it was found that the biofuel with 4% corn starch have highest tensile strength as compared to 1% corn starch. After that 5% is the second one to have highest tensile strength. Our result is also supported by the study of Sultan and Johri (2017) who conducted almost same type of experiments for the preparation of banana leaf. According to Azhari et. al (2011), as the filler-filler interaction became more prominent due to the increase in the amount of starch, the tensile strength tended to decrease. This shows that 4% of corn starch is the maximum amount to be added for the film. The tensile strength of the films is far smaller compared to previous studies on starch-based films. Another test

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performed was water absorption test. The test of the plasticized starch BP film was carried out at room temperature for 24 hours to obtain the maximum water uptake data. Based on Table 1, the highest water uptake is by BP film with 1% corn starch which is 100.88%.

Table 1: Water absorption test of prepared bioplastic film

Sample	Tensile property (n)	Water absorption (%)
1% corn starch	1.29	99.6
2% corn starch	0.99	67.1
3% corn starch	2.47	52.1
4% corn starch	3.50	53.1
5% corn starch	2.98	56.1

Biodegradability test was done to check the degradability of Bioplastic film. It was found that all the bioplastic films get degraded during the one week. These films were test in soil, tap water and waste water. So, this experiment suggested the ecofriendly nature of biofilm.

Conclusion

In this study, we used leftover banana peels and turned them into a bioplastic film by treating them with acid and alkali. The mixture of banana peel and industrial maize starch was effectively used to create bioplastic films. At 4% maize starch content, the films were able to offer tensile strength with a maximum value of 3.50 n. It is claimed that a modest increase in the concentration of plasticizer will be able to produce a superior tensile strength because the films were made of starches from two separate sources. The hydrophilic nature of starch molecules boosts the water intake for all of the bioplastic BP films by more than 50%, according to the water absorption test. It is advised to carry out additional experiments in the future to improve the performance of the film, particularly in terms of mechanical characteristics and FTIR

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studies, as this is only a preliminary study. As a result, new formulations can be created in the future to satisfy the standards for standard bioplastics. For better and more environmentally friendly outcomes, more and more waste peels, such as fruit and vegetable peels can be examined.

References

1.Modebelu M. N., Edward I., Environmental health hazards and rural community development in Abia State of Nigeria. *Int. Lett. Nat. Sci.* 2014; 20: 129-138.http://pubs.sciepub.com/education/3/5/5/index.html

2.Qin Y, Yang J, Xue J. Characterization of antimicrobial poly (lactic acid)/poly (trimethylene carbonate) films with cinnamaldehyde. *J Mater Sci.* 2015; 50:1150-1158.https://link.springer.com/article/10.1007/s10853-014-8671-8

3.Agustin MB, Ahmmad B, Alonzo SMM, Patriana FM. Bioplastic based on starch and cellulose nanocrystals from rice straw. *J ReinfPlast Compos*. 2014; 33:2205-2213. https://journals.sagepub.com/doi/abs/10.1177/0731684414558325.

4. Khan JH, Schue F, George GA. Heterogeneous ring-opening polymerization of lactones for biomedical applications. *Polym. Int.* 2009; 58: 296–301. https://doi.org/10.1002/pi.2531.

5. Meulen I, Geus M, Antheunis H, Deumens R, Joosten EAJ, Koning CE, et al. Polymers from functional macrolactones as potential biomaterials: enzymatic ring opening polymerization, biodegradation, and biocompatibility. *Biomacromolecules.* 2008; 9:3404–10. https://pubmed.ncbi.nlm.nih.gov/18975906/.

6. Jérôme C, Lecomte P. Recent advances in the synthesis of aliphatic polyesters by ring-opening polymerization. *Adv. Drug Delivery Rev*. 2008; 60:1056–76. https://pubmed.ncbi.nlm.nih.gov/18403043/.

7. Albertsson AC, Varma IK. Recent developments in ring opening polymerization of lactones for biomedical applications. *Biomacromolecules.* 2003; 4:1466–86. https://pubmed.ncbi.nlm.nih.gov/14606869/.

@2023 International Council for Education Research and Training 2023, Vol. 02, Issue 03, 324-333
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8. Mckee MG, Unal S, Wilkes GL, Long TE. Branched polyesters: recent advances in synthesis and performance. *Prog. Polym. Sci.* 2005; 30 :507–39. https://asu.elsevierpure.com/en/publications/branched-polyesters-recent-advances-in-synthesis-and-performanc.
9. Kamber NE, Jeong W, Waymouth RM, Pratt RC, Lohmeijer BGG, Hedrick JL. Organocatalytic ringopening polymerization. *Chem. Rev.* 2007; 107 :5813–40. https://pubmed.ncbi.nlm.nih.gov/17988157/.
10. Sultan NF, and Johari WL. The Development of Banana Peel/Corn Starch Bioplastic Film: A Preliminary Study. *Bioremediat. Sci. Technol. Res.*2017; 5:12-17. https://journal.hibiscuspublisher.com/index.php/BSTR/article/view/352.
11. Nasution Z, Lim RY, WZS, WH. Banana Peel Flour: An Alternative Ingredient for Wholemeal bread. Unpublished PhD Thesis, 2012 University Malaysia Terengganu. https://www.researchgate.net/publication/279921919_Banana_peel_flour_an_alternative_ingredient_for_wholemeal_bread.
12. Astuiti P, Erprihana AA. Antimicrobial Edible Film from Banana Peels as Food Packaging. *Am J Oil Chem Technol*, 2014; 2(2):65-70. https://www.semanticscholar.org/paper/Antimicrobial-Edible-Film-from-Banana-Peels-as-Food-Astuti-Erprihana/372b037146432d4cd6a58d27a12fabc8a709ef40.
13. Kerr R W. Degradation of corn starch in the granule state by acid. *Starch/staerke,* 1952: 4-39. https://pubmed.ncbi.nlm.nih.gov/35917855/.
14. Abdorreza MN, Robal M. ChengLH, Tajul AY and Karim, AA (2012). Physicochemical, thermal and rheological properties of acid-hydrolyzed sago (Metroxylonsagu) starch. *Food Sci. Technol.*, 2012; 46:135-141. https://www.cabdirect.org/cabdirect/abstract/20123119739.

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