WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Bioplastic Synthesis and Characterization from Banana Peel

[1*]Vimal Priya, S., [2]Sathiya Sheela, D., [3]Shanthi priya, E., [4]Amitha, T.V. and [4]Aleena B. Eluvathingal

[1]PG and Research Department of Botany, Kongunadu Arts and Science College, Coimbatore-641 019, Tamil Nadu, INDIA.

[2]Assistant Professor, PG and Research Department of Botany, Sri Vijay Vidyalaya College of Arts and Science, Nallampalli, Dharmapuri-636 807, Tamil Nadu, INDIA.

[3]Assistant Professor, Department of Botany, Bharathiar Arts and Science College for Women, Salem- 636 112, Tamil Nadu, INDIA.

[4]PG and Research Department of Botany, Nirmala College for Women, Coimbatore-641 018, Tamil Nadu, INDIA

DOI: https://doi.org/10.55248/gengpi.5.0424.10120

A B S T R A C T

In the recent years, bioplastic have attracted increasing interest due to their wide application in food packaging and in the biomedical science. These eco-friendly bioplastics reduce rapidly and replace the usage of the petroleum based plastic due to their safety and biodegradability. This research focuses on starch based bio plastic making from Musa paradisiaca . It aims to characterize the resulted bioplastic (acid test, alkali test, solubility test, biodegradability test by flame test and FTIR analysis). The bioplastic preparation takes place by banana peel . The research result concluded that the synthesis of starch based bioplastic from Banan peel was feasible solution. The analysis of functional group by FTIR shows the presence of functional group of C=C H, Aromatic hydrocarbon, α, β, NH, C=C, C=N, C-S stretching.

Keywords: Musa paradisiaca, bioplastics, FTIR Analysis, Glycerol

1. Introduction

Our society today is facing many challenges. One of them is related to the extensive and reckless usage of single-use conventional plastics, which creates a shortage in the supply of valuable oil, kills numbers of species, contaminates our oceans, increases greenhouse gas emissions is responsible for aesthetic nuisances, and pollutes the food chain; plastics are considered the major toxic pollutants of the present time (Ajay *et al*., 2018).

Plastics are however, too useful to be phased out; they have many advantageous properties, which resulted in the acceleration of plastics production to 335 million tonnes in 2016 with in the last 70 years. They are durable, lightweight, easy to produce. Plastics are easy to recycle, and various separation systems are available today, however, often they are not recycled. Most of the plastic waste still ends up in landfills, and if the current trend continues until 2050, we will have more plastics than fish in our oceans. Due to the durability of plastics they require hundreds of years to degrade they inevitably accumulate in the ecosystem (Aline and Marcelo, 2018).

Plastic have achieved a dominant position in agriculture, this a direct consequence of their transparency lightness in weight, impermeability to water and their resistance to microbial attack. The major source of land pollution include plastic, metal and glass containers, food wrapping, worn-out machinery, old furniture, garbage plastics have became a large environmental problem (Emedian *et al*., 2017). The plastics in excess produced will be deposited as a land fill and are degraded very slowly, which can cause the original products to remain in landfills for hundreds (or) even two thousands of years. The prominence of plastics pollution is correlated with plastics being economical and durable, which lends to high levels plastics used by humans. However, it is slow to degrade and plastic pollution can cause unfavourable affect to lands, water ways and oceans, living organism which include both the flora and fauna, can also be affected through entanglement, direct assimilation of plastic waste (or) through contact with chemicals with in the plastic and cause interruptions in bio functions of the living organisms.

Even human are also not free from the hazardous plastic pollution; they suffer from the distruption of the thyroid harmone levels. Plastic reduction efforts have occurred in some areas in attempts to reduce plastic consumption and pollution and promote plastic recycling. Due to the excessive chemical additives during plastic production, plastics have potentially toxic and that could prove to be carcinogenic, some of the principle additives are used as phthalate plasticizers and brominated flame retardant. Therfore, nowadays scientists are looking at potential alternative to be traditional plastics derived from petrochemical source (Jayachandra *et al*., 2016).

Biodegradable and biocompatible polymers are nowadays gaining importance worldwide in both basic and applied research fields such as pharmacological, biomedical and environmental applications. These biopolymers exhibit the characteristic features of highly functionalized globular nature, interstellar polymers exhibit different properties from those of their linear counterparts, such as less entanglement in the solid state, high solubility in numerous solvents, low melt viscosity and fast molecular motion (Kalia *et al*., 2000).

A large part the plastic that we see around us is made of three-dimensional cross linked networks, so called thermoset plastics. Classic example being Bakelite, the phenol formaldehyde- based resin invented in the early 20th century. Most of the plastics today, still use the same basic compounds.

As of 2018, a staggering 380 million tons of plastic is produced worldwide eachyear. That's nearly equivalent to the weight of the entire human population. This project aims to present a workable substitute to replace petroleum based plastics, while providing all the usable attributes of it minus the negative, non-ecofriendly toxic behaviour of it. Banana peels contain starch and its ability to conform into a polymer was exploited to manifest a biodegradable form of plastic. The degradation of this plastic was tested to judge its nature –friendliness and it can be safely said that it does not leave traces behind after a reasonable amount of time.

2. Materials and Method

2.1 Starch

Starch or amylum is a carbohydrate consisting of a large number of glucose units jointed by glycosides bonds. This polysaccharide is produced by most green plants as an energy store. Starch consists of two different types of polymer chains, called amylase and amylo pectin, made up of adjointed glucose molecules. Starch is a soft, white, tasteless powder that is insoluble in cold water, alcohol or other solvents.

2.2 Sodium meta bisulphate

It is used as antioxidant and preservative. This would increase the biodegradation period of bio-bag.

2.3 Hydrochloric acid

Hcl is an inorganic acid, a clear, colourless, highly pungent solution of hydrogen chloride in water. It is a highly corrosive, strong mineral acid with many industrial uses.

2.4 Sodium hydroxide

Sodium hydroxide, also known as lye and caustic soda, is an inorganic compound .It is a white solid and highly caustic metallic base and alkali salt of sodium which is available in pellets, flakes and used to neutralize the solution.

2.5 Glycerol

The compounds containing three hydroxyle groups are known as Tri hydric alcohols. These hydroxyl groups are attached to three different carbon atoms for stability of the compound. The most important compound. The most important compound of the serried series is glycerol. This is also known as propane -1,3,3-triol in IUPAC system .This was first discovered by Scheele in1779 by the hydrolysis of olive oil. It is a colourless liquid. It is a highly viscous and the hydroscopic liquid with high boiling point(536k). The latter properties can be explained on the basis of intermolecular hydrogen bond leading to complex polymeric structure. It is miscible with water and alcohol in all proportions but insoluble in organic solvents.

2.6 Banana peel

Banana peel (Nedran Banana) contain fairly complete nutrient, like carbohydrate,fat, protein, phosphorous vitamin C and water. Banana peel contain starch ,can be used in making film.

3. Methodology

3.1 Collection of banana peel

Banana fruit peels were collected from local market of Coimbatore and were used for this study.

3.2. Preparation of Banana peels

Three varieties of banana were collected and the peels were removed using a stainless knife and cut into small pieces. Approximately 100 g of each banana peel were dipped in sodium meta bisulphite (0.2M) solution for 45 minutes. It is used as antioxidant and preservative. This would increase the biodegradation period of bio-bag.

An 1000 ml beaker was filled with distilled water and placed over a Bunsen burner. The banana peels were placed in the beaker and were boiled for 30 minutes. After the boiling process,

the beaker was removed from the Bunsen burner and the peels were decanted off and placed on the filter paper, left to dry for 30 minutes. This was done for removing impurities and making the peels soft for easy preparation of paste.

3.3. Preparation of banana paste

After the peels are dried, they are placed in a beaker and using a hand blender, the peels are pureed until a uniform paste is formed.

3.4. Preparation of Bioplastic Flim

Banana paste was taken 25 g and placed in a 50 ml beaker. Now 3 ml HCL was added and the mixture was mixed using a glassrod. 2ml glycerol was added, 0.5N NAOH was adding to pH desired. The mixture was poured into petridish and put in the oven at 130◦C about 30 minutes.

3.5. Testing of bioplastic:

- Acid Test
- Alkaline Test
- Solubility Test
- Flame Test
- Fourier Transforms Infra ray Spectroscopy

3.5.1. Acid Test Method

The acid test was done with Sulphuric acid (strong acid) and acetic acid (weak acid). 40 ml of 0.5M sulphuric acid and acetic acid was taken and 1g of bioplastic was placed in the acid, The time taken for the bioplastic to dissolve in the sulphuric acid and acetic acid was noted.

3.5.2. Alkaline Test Method

The alkaline test was done with sodium hydroxide. 40 ml of 0.5M of sodium hydroxide was taken and 1 g of bioplastic was placed in the acid. The time taken for the bioplastic to dissolve in the sodium hydroxide was noted.

3.5.3. Solubility Test Method

The solubility test was done with distilled water. 40ml of distilled water was taken and 1g of bioplastic was placed in the acid. The time taken for the bioplastic to dissolve in the distilled water was noted.

3.5.4. Flame Test Method

The flame test was conducted in front of the water. 1g of bioplastic was taken and kept on wire gauze and burnt with Bunsen Burner. The time taken for the bioplastic to form ash was noted.

3.5.5. FTIR-Fourier Transform Infra-Red analysis

Fourier Transform Infra-Red (FTIR) is a tool used to identify the types of chemical compound in the sample. Prepared Bioplastic was used for FTIR. The sample was loaded in the FTIR with the scan range from 400-4000cm-1 with a resolution of 4cm-1 and the results were recorded.

4. Result and discussion

As the world need plastic for our daily purposes, about 265 million tonnes of plastics were produced worldwide in 2010, of which 57 million tonnes were produced in Europe alone. Polymer film is selected as the best packaging materials due to its versatility, low cost ,and permeability .Low-density polythene and polyvinyl chloride are some of the most commonly available plastic polymers in the packaging industry. However, these synthetic materials are unable to be degraded by present natural microorganisms. As a result, these non-biodegradable pollutant for a long time cause an increase in solid waste production.

Starch is one of the source in the development of bio plastic. Many previous studied have been conducted by using starch as a natural biopolymer. Starch consists of a long chain of two glucose units jointed together, namely branched polymerized amylopectin and amylose ,which gives its granular structure. Due to its low cost, biodegradability and large availability, starch are commonly used in the production of bioplastics (Kumar *et al* ., 2019).

One of the most common waste form of starch is the banana peels, Several industries produced banana based products and they discard the peels into the waste at end of the process. The disposal of these large amounts of wet organic waste can eventually harm the environment and lead to health problems such as respiratory disorders. Banana peels consists high sources of starch, which is about 18.5%. Banana peel still contain fairly complete nutrients such as, carbohydrates, fat, protein, phosphor, vitamin c and water (Sofiah *et al*., 2019). Composition of banana peel contains lots of water that is 68.9%. Many groups of researchers have used starch from different sources to make films and coatings. It has indicated that starch is a promising material for biodegradable films.Banana peel starch films prepared in the present work are completely soluble in acetic acid, sulphuric acid, Sodium hydroxide, distilled water and becomes ash in flame.From the above test, the bio plastic made from starch can be used for making bio plastic products like films, bags, etc.,As this preliminary study, it is recommended to conduct more tests in future for a better performance of the film, particularly in terms of mechanical properties. Addition of co-plasticizers such as citric acid is suggested to improve the tensile strength of the films. Thus, new formulations can be developed in the future to achieve the standard bioplastic requirements (Reddy *et.al*., 2013).

Environmental pollution problems caused by using synthetic polymers based on petrochemical, the development of environmental friendly polymeric materials has attracted extensive interest. Starch is a potentially useful material for biodegradable plastics because of its natural abundance and low cost. Starch is the major carbohydrate in plant tubes, and seed endosperm, and peels (Shankar *et al*., 2017).

Ripened fruit of Banana were collected from the local markets and the peels were removed using stainless knife, cut into small pieces and soaked in the Sodium meta Bisulphitesolution for 45 minutes. After the peels were boiled in the beaker using distilled water for about 30minutes. The peels were filtered in the filter paper and dried. Then the peels were transferred into a beaker,using pestle and mortargrained into paste. The paste were poured into a beaker . 25 gm of banana paste was taken in the petriplate,added 2ml of glycerol,3ml HCL and added NaOH to neutralize to pH 7. The banana paste is spread over the aluminium foil and petriplateis kept in the hot air oven for about 130° C for 4hr and 30° C for 2days. After 2 days dried film (Figure 1) was scraped from aluminium foil and petriplate (Sharon *et al*., 2018).

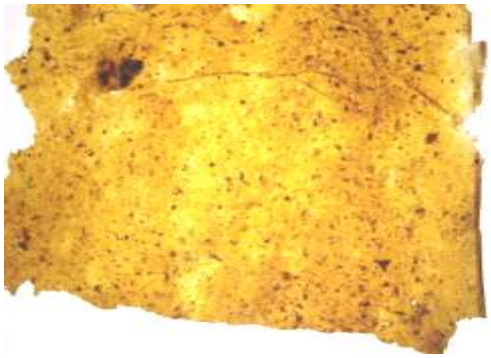

Figure 1. synthesized bioplastic from banana peel

The acid test was done with sulphuric acid (strong acid) and acetic acid (weak acid). The time taken for the bioplastic to dissolve in the sulphuric acid is 218 mins and acetic acid was 120 mins. The alkaline test was done with sodium hydroxide .The time was taken for the bioplastic to dissolve in the sodium hydroxide was 52 mins. The solubility test was done with distilled water. The time taken for the bioplastic to dissolved in the distilled water is 330 mins. The flame test was conducted and the time taken for the bioplastic to form (Figure 2) ash is 5 mins.

Figure 2 Flame test

Fourier Transform Infra-Red (FTIR) is a tool used to identify the types of chemical compound in the sample. Prepared Bioplastic was used for FTIR analysis. The sample was loaded in the FTIR with the scan range from 400-4000cm-1 with a resolution of 4cm-1 and the results were recorded. FTIR analysis also performed for characterization of some peaks showing the presence of functional group like, C-OH, C-O, C-O-C, C-H,H-H, Which are also present in starch and glycerol.

S.no	Standard(nm)	Bond	Wave number	Functional group
1	3500-4000	O-H Bond of α-cellulose	-	-

2	3700-3500	N-H stretching (amine)	-	-
3	3500-3300	C=C H Stretching	-	-
4	3500	N-H Stretching	-	-
5	3100-3300	C=C-H Stretching	-	-
6	2970-2850	C-H Stretching (alkanes)	**2976.16**	+
7	2830-2695	H-C=O; C-H Stretching	-	-
8	2590-2540	S-H Stretching	-	-
9	1750-1735	C=O Stretching	-	-
10	1740-1720	C=O Stretching of hemicellulose	-	-
11	1685-1655	αβ unsaturated stretching	-	-
12	1680-1650	N=O Stretching	-	-
13	1650-1630	OH (absorbed water)	**1656.85**	+
14	1600	C=O Stretching (amide)	-	-
15	1600,1580,1500	C=C Stretching	-	-
16	1450-1400	CH2 Symetric bending	**1408.85**	+
17	1567-1380	NO2 Stretching	-	-
18	Above 1500	C=O,NH2,NH,C=C,C=N Functional group stretching	-	-

5. Conclusion

Plastic pollution is a worldwide concern today. Various scientists, researchers have been trying to find alternatives to the plastic that we use today, that's highly toxic on burning, is non biodegradable, and a huge burden on this planet. Finding other non toxic, biodegradable materials that can fulfil the use of plastic, has been used so for, and is still economical, is very important for mankind today. The bioplastic made from banana peels in this experiment was able to be molded and used in a way that plastic was used. If further processing will be possible sometimes in the future, this bioplastic seems a promising replacement to the toxic form of petroleum-based plastic.It was completely easy to make, and the eco-friendly nature of it can be portrayed by the fact that moong plants were able to grow healthily in the same soil in which it was degraded, with the advantages of increased carbohydrate and protein levels. This bioplastic also, does not require a very heavy manufacturing system. Considereing the economic aspect, the cost went into producing this plastic is less because it practically uses waste to produce something useful.The present study was concluded that the synthesis of starch based from banana peel was a feasible solution as a substitute for petroleum based plastics. As they were prepared from merely natural sources, making them being decomposed more easily by microbes and therefore environmentally friendly, After all, it's our future, and it's our responsibility to make it secure, peaceful and safe.

References

Ajay Arora., Divyachodary., GauravAgarwal,,and Virender Pal Singh,(2018). Compositional variation in β-carotene content, carbohydrate and antioxidant enzymes in selected banana cultivars ,International journal journal of food science and Technology. 43.1913-1921.

Aline Pereira and Marcelo Maraschin, (2015). Banana (Musa spp) from peel to pulp: Ethnopharmacology, source of bioactive compounds and its relevance for human health, Journal of Ethnopharmacology, 160. 149-163.

Emadian, S. Mendi, Turgut T. Onay, BurakDemirel, (2017). Biodegradation of bioplastics in natural environment, Waste Management, 59, 526-536

JayachandraYaradoddi, VinayPatil, SharanabasavaGanachari, NagarajBanapurmath, AnandHunashyal, Ashok Shettar, (2016). Biodegradable Plastic Production From Fruit Waste Material And Its Sustainable Use For Green Applications, International Journal of Pharmaceutical Research & Allied Sciences, 5(4), 56-66

Kalia, V.C, NeenaRaizada& V Sonakya,(2000). Bioplastics,journal of scientific&Industrial Research,59, 433-445

Kumar, P.S., S. Durgadevi, A. Saravanan, S. Uma, (2019). Antioxidant Potencial and Antitumour Activities of Nendran Banana Peels in Breast Cancer Cell Line, Indian Journal of Pharmaceutical Sciences, 81(3), 464-473

Reddy, R.Laxmana, V. Sanjeevani Reddy, G. Anusha Gupta, (2013). Study of Bio-Plastics As Green & Sustainable Alternative to Plastics, International Journal of Emerging Technology and Advanced Engineering, 3(5), 82-89.

Shankar, Gowari, Jeevitha P, Shadeesh L, (2017). Nutritional Analysis of Musa Acuminata, Research & Reviews: Journal of Food and Dairy Technology, 5(4), 27-29

Sharon Keziah V,R Gayathri and V Vishnu Priya (2018). Biodegradable plastic production from corn starch. Drug invention today. 7.1315-1317.

Sofiah, Yuniar, Martha Aznury, Melianti, (2019). Mechanical Properties of Bioplastics Product from Musa ParadisicaFormatypica Concentrate with Plasticizer Variables, Journal of Physics: Conference Series, 1167(1), 1-7.