



Production of Bioplastics from Various Plant Parts

Divya Anna Thomas

Department of Chemistry, Sophia Girls' College (Autonomous), Ajmer, India
divyaannathomas1997@gmail.com

How to cite this paper: D. A. Thomas, "Production of Bioplastics from Various Plant Parts," *Journal of Mechanical and Construction Engineering (JMCE)*, Vol. 03, Iss. 01, S. No. 007, pp. 1–7, 2023.

<https://doi.org/10.54060/jmce.v3i1.32>

Received: 22/01/2023

Accepted: 25/03/2023

Published: 25/04/2023

Copyright © 2023 The Author(s).
This work is licensed under the
Creative Commons Attribution
International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

The extensive existence of plastic in the environment has a serious effect on the living organism. In this study, the synthesis will be done in small quantity within the lab. Long lifetime, good barrier property, stiffness, tensile strength and tear strength make petrochemical plastics more popular in society. In spite of many advantages the plastic is proved to be more threatening for the mankind survival. The expected outcome of this project will be the biodegradable plastic which will be a great relief for society. Life begins from birth in which the play toy of newborn baby is plastic then as they grow up everything surrounding them is plastic, the plastic glass, plastic bottles, plastic buckets, plastic box etc. The research work on production of bio plastic using different plant parts will act as substitute for the plastic substances. For the betterment of living creatures and also for the betterment of the environment bioplastics formed from plant parts are better as compared to that of the plastics formed by traditional method. Due to the non-biodegradability of the plastics, they will be ominous for the whole system as the whole system depends on the plastic. Plastic pollution is responsible for the worsening of the habitat of organisms and the human lifestyle. With the help of this study, we will also analyze the properties such as water absorption capacity and bio- degradability. Mass production of bioplastic will be a great solution for plastic pollution.

Keywords

Biodegradable, Bioplastic, Starch, Pollution, Plastic

1. Introduction

In this modern era human needs are increasing day by day which results in different type of problems and one of the most alarming problems is the pollution [1]. Plastics have transformed everyone's life. Human life is revolving around the plastic. Life starts from birth in which the play toy of newborn baby is plastic then as they grow up everything surrounding them are plastics the plastic glass, plastic bottles, plastic buckets, plastic box etc. The extensive existence of plastic in the environ-



ment has serious effects on the living organisms. A huge amount of plastic has been accumulated in water bodies. According to Central Pollution Control Board (CPCB) Delhi report [2] (2019-20) the total annual plastic waste generation in India at humungous 3.5 million metric tons per year. India is the fifth highest generator of plastic waste. In the whole world, including the ocean is full of plastic wastes [3]. Pollution can be of different types, but the most destructive pollution is due to the PLASTIC which is considered as a daily commodity [4]. The whole universe is getting worsen day by day due to the excess production and usage of plastic and its products. Plastic is a type of polymer which can easily become soft on heating and can be given any kind of shape.

Plastics have long lifetime, economically cheap production, easy usage and all these properties increase plastic usage. There are different types of polymers like natural polymer, synthetic polymer, linear or branched polymer etc. plastic can fit itself in all the types depends on the monomer unit, its joining, its characteristics etc. There are different types of polymers such as Polyethylene Terephthalate (PET), High Density Polyethene (HDPE), Low Density Polyethene (LDPE), Polyvinyl Chloride (PVC), Polypropylene (PP), Polystyrene. These polymers are used to make different types of plastics. Many researchers have been done on the effect of plastics on the surrounding environment and human health [5] which shows the contribution of plastics in raising Carbon Footprint. There are many shortcomings of plastic utilization. The production of excessive Plastic usage result in the decrement of the land space as the plastic waste is increasing day by day in different forms even the waterbodies are full of plastic wastes [6] which is also disturbing the aquatic life. The most important characteristic of plastic is the non – biodegradable nature which is not able to recycle as a result it will release harmful gases to the environment on getting burned in order to decompose. These gases will affect the climate which is an alarming situation to save our environment from plastic pollution.

Mass production of bioplastics will serve as the alternative to plastic pollution. Bioplastics are defined as the formation of plastics using different plant and animal sources such as starch, cellulose, fish scales etc. The first produced bioplastic was Polyhydroxy butyrate (PHB) discovered in 1926. Bioplastics also have the similar characters as that of commercial plastic [7]. It will never cause any kind of pollution as it will easily biodegrade in nature.

Basically, there are 5 different types of Bioplastics-

- Starch Based - Bioplastics produced from Starch, which is obtained from different sources such as Potato, Tapioca etc.
- Cellulose Based - Bioplastics produced from cellulose derivatives like cactus leaves.
- Protein Based - Bioplastics developed from protein sources such as wheat gluten, casein and milk.
- Bio-Derived Polyethene – Bioplastics derived from raw agricultural material like eggshell.
- Aliphatic Polyesters- Bioplastics derived from Polylactic acid, Polyglycolic acid.

In this modern era the human is making many efforts to safeguard the environment from degradation and as a part of this the polyethene are replaced by cloth's bag, Plastic Straw are replaced by paper straw, Plastic Cans are replaced by paper can. With this project also we are trying to save the environment by producing the bio plastic within the laboratory with the help of waste materials which is produced in day-to-day life. We have used Potato Peel, Banana Peel, Egg Shells, Corn Starch etc. In the whole degradation process of the plastic material, toxic chemicals like polystyrene are released into the water bodies [8] causing the whole water bodies to be more polluted. Polyethylene Terephthalate (PET) is a plastic which synthesized by the condensation of terephthalic acid and ethylene glycol. It has resistance towards heat and moisture. It can be used in the preparation of fibers of clothes, magnetic tapes etc. It acts as an anti- air in nature. Polyvinyl Chloride [PVC] formed by the polymerization of Vinyl Chloride. It is colorless, odorless, non – combustible, chemically inert powder. It is used to form synthetic plastic, pipes etc. [10]. Its decomposition can cause various damages to the living organism [11]. According to a survey approximately 10% of household waste is plastics and mostly end up in landfill [12-14].

Since, the above information is talking about the bioplastic: the alternate to the commercial plastic, to understand this process in detail the below methodology helps the individual to take the understanding of scientific manner for the bioplastic

production and future it leads by conclusion and references. Hence it will be supposed that this small sample can help them to produce some fruitful results for further investigation at a large scale.

2. Research Methodology

2.1. Sample Collection

The sample was collected from different sources. Total 8 Samples was collected for the investigation.

Sample 1- Russet Potato – The sample under investigation was purchased from Ajmer Market.

Sample 2- Cavendish Banana and Plantain Banana- The sample under investigation was Purchased from Ajmer Market.

2.2. Sample Preparation

The Collected samples were washed with distilled water to remove different adhering impurities. These Samples were subjected to extract the Starch withing them.

Sample 1 – RUSSET POTATO –1 Kg Sample was taken for the extraction of starch. The potatoes were peeled of and were subjected to grinding which results in the formation of semi solid potato. On filtering the resultant Semi Solid Potato, the liquid containing starch will be separated from semi solid potato. The liquid will be kept for rest for 1 hr. As a result, all the starch will be settled down at the bottom and we can easily filter it for the experimental purpose.

Sample 2- CAVENDISH BANANA AND PLANTAIN BANANA – The banana Peel was taken and mashed for the production of bioplastic.

2.3. Materials Required

Banana peel, Starch, Glycerol, HCl (Hydrochloric acid), NaOH (sodium Hydroxide), Na₂S₂O₅(Sodium meta bisulphite), Distilled water, Glycerol, Vinegar, Silicon Coaster Mould, Potato, Distilled Water.

2.4. Procedure

2.4.1. Sample 1- Russet Potato

- a. The potatoes were washed properly with distilled water to remove all the impurities present on it. For the investigation here we took 2 Kg potatoes.
- b. The potatoes were grated with the help of a grater and after that it was grinded in the mixer grinder to make a semi solid thick paste.
- c. The semi solid paste of potato is then filtered. The filtrate is kept separate in a beaker to rest for 1 Hrs.
- d. In the filtrate after the rest time, it was observed that all the starch was settled at the bottom of the beaker.
- e. This Starch is filtered and dried and here 2.3 gm of Starch was obtained.
- f. After the continuous repetition of the above procedure, we got 23 gm of Starch.
- g. Now we have to take 20 gm of Starch in a beaker. Now add 20ml of Vinegar into it. Add 5ml of Glycerin and 50ml of distilled water into it.
- h. Add coloring agents like saffron, Coffee Powder, Artificial Food coloring.
- i. Now turn on the heating plate and start heating the beaker with constant stirring.
- j. Heat should be done consistently until the whole content becomes denser and viscose in nature.
- k. Now spread the whole content evenly into a Foil paper Sheet. Now in order to protect it from insects cover the product with the help of a butter paper.

I. After 3 Day it will be dried Properly and will obtain a bioplastic.



Figure 1. Potatoes Washes with distilled water



Figure 2. Peeled Potatoes



Figure 3. Extraction of Starch from potato and its Peel



Figure 4. Heating the content



Figure 5. Final Product (Bioplastic) Kept to cool (Starch+Glycerol+ Vinegar)

2.4.2. Sample 2- Cavendish Banana, Plantain Banana

a. Cut the banana peels into small pieces and put it in 500ml beaker.

- b. Now add the Aqueous Sodium Metabisulphite to the beaker containing the banana peel and put it to rest for 1 minute.
- c. Decant off the Sodium Metabisulphite from banana peels.
- d. Add 375 ml of distilled water and transfer the peel into another beaker.
- e. Boil the banana peel for 30 minutes and remove the distilled water from it.
- f. Place the banana peel on the butter paper and put it in an oven for drying for 30 minutes.
- g. Now blend it and make a thick paste of it and weigh 25 gm of the paste.
- h. Add 0.5 M 3 ml HCl to the paste and mix it properly. Add 2 ml of Glycerin to it and mix it properly. Glycerin acts as a plasticizer.
- i. Spread it on butter paper and put it in mould.



Figure 6. Sample Collected



Figure 7. Sample Collected



Figure 8. Sample Collected



Figure 9. Heating the content (Banana peel paste + HCl+Glycerin)



Figure 10. Final Product (Bioplastic)

3. Results and Discussion

The environment is facing different types of pollution and land pollution is one of the types among all the pollution which is majorly caused due to the utility of plastics, metals and glass etc. A major part of the land is occupied by plastic waste material, around 25% of the total volume of land. As the life of a human being is revolving around the plastic which is resulting in the destruction of the environment safety. Scientists are working on the worldwide plastic production and the pollutions caused due to the Plastic waste which is a crucial environmental issue. The side effects of Plastic Material on the Marine

ecosystem and Terrestrial Ecosystem are increasing day by day which is a major issue faced by the present as well as future generation. For a clean and safe environment, the production and usage of plastics and their materials should be minimized. According to studies it has been proved that Decomposition of plastic will take place years and years in land as well as in water which is affecting the lives of different living creatures. On burning the plastic waste, it produces very hazardous gases which create a lot of air pollution. Because of the air pollution, it is creating a black hole in the atmosphere, also resulting in greenhouse effect, melting of the glaciers and many more destruction in the universe. In this study we concluded that food waste and plants parts could be used for bioplastic production. In this study the bioplastics were produced from different materials and the following observations were made –

Bioplastics are biodegradable in nature.

- a. Bioplastics produced from Russet potato peels completely biodegraded within 28 days, and it was suggested that these bioplastics can be used in packaging industry.
- b. Bioplastics produced from the banana Peels were completely biodegraded within 1 month.
- c. Bioplastics produced from the corn were completely biodegraded within 2months.
- d. Bioplastics produced from the Egg shell were completely biodegraded within 1 month.
- e. Bioplastics produced from the Tapioca were completely biodegraded within 1 month.

On the other hand, the commercial plastic did not biodegrade in 28 days.

Bioplastics doesn't produce any kind of toxic material to the atmosphere while burning. Bioplastics strength depends on the content of starch. The bioplastics are obtained from potato peel, banana peel, eggshells, corn, tapioca. The maximum strength was present within the bioplastic produced from tapioca because of the large content of Starch within it. As the amount of starch increases the strength also increases.

Here in the investigation the Glycerine will be acting as a plasticizer which is an organic molecule, that is added to polymers, to reduce the brittleness, reduce crystallinity, improve durability, toughness, and their lower melting temperature. To prevent bacterial and fungal growth during the production Sodium Meta bisulphite was used. The glycerine was used as a plasticizer. Plastics produces many environmental problems, so we have to focus more on bioplastics which completely degrade after a specific time interval in environment by microbial action. The main advantage of bioplastics over commercial plastic is that they degrade easily into the environment without creating pollution. Bioplastics is one of the best alternatives over commercial plastic.

4. Conclusion

Plastic plays a vital role in everyone's life. This excessive usage of plastic and its products has proved to be a danger for the upcoming generation. Plastic is very good to use in our daily life, but we should know about how to recycle it also. In order to save the ecosystem from polluting we are synthesizing Bioplastics from the waste remains of plants and animals. Since the whole world is struggling with plastic and its side effects. As the usage of plastics and their products is increasing in day-to-day life and this increment leads to pollution. Synthetic plastics are a long chain of polymers which take millions of years to degrade. Because of its non-bio-degradable nature it is polluting the nature. They also produce harmful gases on burning. Without disposing of the plastics properly, the animals may feed them which will affect their health. Long lifetime, good barrier property, stiffness, tensile strength and tear strength make petrochemical plastics more popular in society. In spite of these advantages the plastics are most dangerous thing for the mankind survival This study conclude that bioplastics can be produced from the food waste material. The 3 R (reduce, reuse, recycle) can keep the earth cleaner and greener. All these years scientists are doing their best to preserve the earth by producing bioplastic. The topic of bioplastics has been a field with extensive research during the last 20 years. The bioplastic produced with the help of Plant parts and biomass could

be substantial and the biodegradability is one of the most important challenges in the developed bioplastic material. Certainly, the research is a long way for both economically and environmentally friendly products using bioplastic materials or bio polymer. Bioplastics are easy to degrade and reduce environmental pollution. In a society where each and everything is a product of plastic it will be a great solution. There can be the production of plates, spoons, bottles, packing materials etc. from bioplastics. These bio plastics materials will result in a greener world with less pollution. Under this investigation here we have synthesized the bioplastics from the waste remains of the plant part like banana peel, potato peel, casava peel etc. We will also test the properties like Solubility in different solvents, durability, thickness etc. of synthesized bioplastic and have compared with the bioplastics from different sources and also with the synthetic plastic. Bioplastics are less harmful for living beings as it can easily be degraded, as well as not forming any harmful smokes on burning etc. Bioplastics will be a solution for the decreasing pollution in society. They have different properties like chemical resistance, durability over other synthetic plastics, they can be formed from Agricultural and Food Waste.

References

- [1]. M. Ghamande, A. Kulkarni, N. Shah, et al., "bio-plastic (generating plastic from banana peels)," In International Conference on New Frontiers of Engineering Management, Social Science and Humanities Pune India, 2018.
- [2]. E. B. Arukan, H. D. Bilgen, "production of bioplastic from potato peel waste and investigation of its biodegradability," In International Advanced Researches and Engineering Journal", vol.3, no.2, pp.93-97, August 2019.
- [3]. R. C. Thompson, C. J Moore, F. S. Y. Saal, et al., "plastic environment and human health; current consensus and future trends," Philosophical Transactions of the Royal Society B. Biological, vol. 364, no.1526, pp.2153-2166, July 2009.
- [4]. G. Knight, "Plastic Scrap, in plastic pollution," London: Raintree, vol.1, 2012.
- [5]. O. A. Alabi, K.I. Ologbonjaye, O. Awosolu, et al., "public and environmental health effects of plastic wastes disposal: a review," in Journal of Toxicology and Risk Assessment, vol.5, 2019.
- [6]. H. Venkatachalam & R. Palaniswamy, "bioplastic world: a review," in Journal of advanced scientific research, vol.11, no.3, pp.43-53, Aug 2020.
- [7]. J. Hopewell, R. Dvorak, E. Kosior "Plastics recycling: Challenges and opportunities," in Philosophical Transactions of the Royal Society B, vol.364, no.1526, pp.2115-2126, July 2009.
- [8]. J. Yaradoddi, V. Patil, S. Ganachari, et al., "biodegradable plastic production from fruit waste material and its sustainable use for green applications," in International Journal of Pharmaceutical Research & Allied Science, vol.5, no.4, pp.56-66, 2016.
- [9]. R. K. Beevi, S.A.R Fathima, T. Fathima. et al., "bioplastic synthesis using banana peels and potato starch and characterization," in International Journal of Scientific & Technology Research, vol.9, no.1, pp.1809-1814, January 2020.
- [10]. S.N. Swain, S.M. Biswal, P.K Nayak, "biodegradable soy-based plastic: opportunities and challenges," in Journal of Polymers and the Environment vol.12, no.1, pp.35-42, 2004.
- [11]. H. Fessena, & F.Abebe, "degradation of plastic materials using microorganisms : a review," in Public Health Open Journal , vol.4, no.27,pp.57-63, 2009.
- [12]. M. Shah, S. Rajhans, H. A. Pandya et al., "bioplastic for future: a review then and now," in World Journal of Advanced Research and Reviews (WJARR), vol.9, no.2, pp.56-67, 2021.
- [13]. M. R. Sokele & A. Pilipovic, "challenges and opportunities of biodegradable plastic: a mini review," in Waste Management & Research, vol. 35, no.2, pp.132-140, 2017.
- [14]. P. Prasteen, Y. Thushyanthy, T. Mikunthan, et al., "bioplastic-an alternative to petroleum based plastic," in International Journal of Research Studies in Agricultural Sciences, vol.4, no.1, pp.1-7, 2018.

