IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 10, March 2025
Impact Factor: 7.67

Making Biodegradable Material Like Plastic Using Starch

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Abstract: *Plastics are hazardous to environment as they are as they are not decomposable because they are derivatives of strongly bonded long chain petrochemical based materials. However bio plastics can be seen as the solution to the problem. Bio plastics are made from biomass derived from plants such as cellulose, sugarcane, or rice. Starch is a natural biopolymer having mainly two types of polymer glucose. In this research work bio plastic is made using potato starch as its abundant and easily available. However, poor physico-mechanical properties like low tensile tear strength, high stiffness, elongation at break and poor moisture stability are observed in most of the starch-based materials. Development of starch-based bio plastic properties is being endeavoured by starch alteration. The physical and mechanical properties of the biodegradable plastic have been improved through some well-designed processes. Raw materials and chemicals used for production of potato starch based bio plastic are Potato, distilled water, Acetic Acid, glycerine. Different composition of the above ingredients were used to make bio degradable bio plastic. The growing environmental impact of conventional petroleum-based plastics has driven the need for sustainable, biodegradable alternatives. Starch, a naturally abundant and renewable polymer, has emerged as a promising base material for developing environmentally friendly plastics. This study focuses on the formulation and synthesis of biodegradable plastic-like materials using starch derived from sources such as corn, potato, and cassava. By incorporating plasticizers like glycerol , the brittleness of native starch is reduced, resulting in improved flexibility and usability. The addition of crosslinking agents and natural fillers further enhances the material's mechanical strength, thermal stability, and moisture resistance. The research explores the production process, Including gelatinization, blending, and casting, to create biodegradable films and composites. The biodegradability of the material is evaluated through soil burial and enzymatic degradation tests, demonstrating its ability to decompose into environmentally harmless byproducts. Potential applications of starch- based bioplastics include single-use packaging, agricultural mulch films, disposable utensils, and medical products. This work aims to contribute to the global effort in mitigating plastic waste pollution, promoting renewable resource utilization, and advancing the development of sustainable materials for a circular economy. By leveraging the inherent properties of starch, the study presents a viable pathway for reducing the ecological footprint of plastics while addressing the growing demand for sustainable alternatives.*

Keywords: Bio plastic, starch, properties, biodegradable

I. INTRODUCTION

Plastics derived from petroleum-based sources contribute significantly to environmental pollution due to their non-biodegradable nature. In response to this issue, biodegradable plastics have emerged as an eco-friendly alternative. One such material is starch-based bioplastic, which is made from natural, renewable resources like cornstarch or potato starch. Starch, a polysaccharide, can form a gel-like structure when mixed with water and heated. By adding plasticizers such as glycerol, the starch structure becomes more flexible, making it a suitable material for biodegradable plastic production. Additionally, vinegar (acetic acid) helps break down the starch chains, improving its consistency. This project explores a simple method to produce biodegradable plastic using starch, water, glycerol, and vinegar. The

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resulting material can degrade naturally in the environment, reducing plastic waste and its harmful impact on ecosystems. Plastics play a crucial role in modern life, being used in packaging, medical devices, construction, and countless other applications. However, conventional plastics, derived from fossil fuels, are non-biodegradable and contribute significantly to environmental pollution, especially in the form of plastic waste in oceans and landfills. This has led to an urgent need for sustainable and biodegradable alternatives. One promising solution is starch-based bioplastics, which are made from renewable, plant-derived materials like cornstarch, potato starch, or tapioca starch. Starch is a natural polymer that can form a gel-like structure when heated in water. However, in its raw form, starch lacks the flexibility and durability required for plastic-like applications. To enhance its properties, plasticizers such as glycerol are added, making the material more flexible and elastic. Additionally, vinegar (acetic acid) helps break down the starch molecules, improving the texture and workability of the final product. This experiment focuses on a simple and cost- effective method for producing biodegradable plastic using starch, water, glycerol, and vinegar. By understanding the process and properties of starch-based plastics, we can contribute to a more sustainable future while reducing our dependence on traditional plastics.

II. METHODOLOGY

This study aims to develop biodegradable plastic using starch, an abundant and renewable biopolymer. The methodology involves formulation, processing, and characterization of starch-based bioplastic using natural ingredients such as cornstarch, water, glycerol, and vinegar.

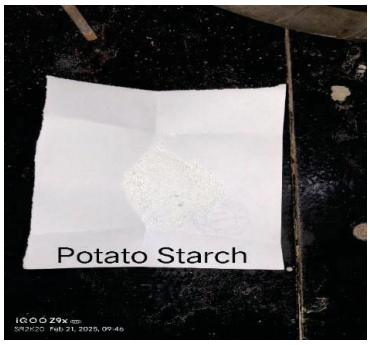

Fig 1

Selection of Raw Materials: Starch (potato starch) serves as the primary polymer, water acts as a solvent to dissolve and gelatinize the starch, glycerol functions as a plasticizer, enhancing flexibility. Vinegar modifies the starch structure for better consistency.

Preparation of Bioplastic Formulation: The starch is mixed with water in specific proportions to create a homogeneous solution. Plasticizer (glycerol) and vinegar are added to alter the mechanical properties.

Heating and Gelatinization Process: The mixture is heated on a hot plate while being stirred continuously. The heating process enables gelatinization, where starch granules swell and form a thick, paste-like structure.

Casting and Molding: The thickened mixture is poured onto a mold or a flat surface to achieve the desired shape. The material is spread evenly to maintain uniform thickness.

Drying and Solidification: The bioplastic film is left to dry at room temperature for 24–48 hours. The drying process allows water evaporation, solidifying the material into a flexible, plastic-like sheet. This methodology provides a systematic approach to producing biodegradable plastic, demonstrating a sustainable alternative to conventional petroleum-based plastics

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Fig 2

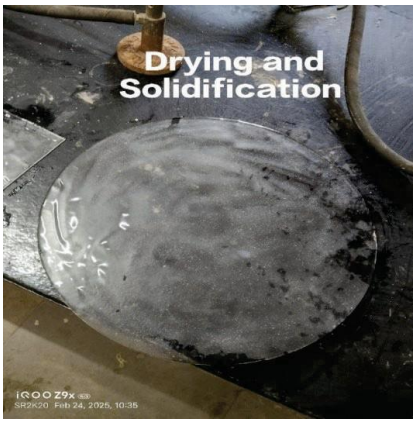

Fig 3

III. LITERATURE REVIEW

The growing environmental concerns associated with petroleum-based plastics have led to increased interest in biodegradable alternatives, particularly starch-based bioplastics. Several studies have explored the properties, processing techniques, and applications of starch-based bioplastics, highlighting their potential as a sustainable material.

Starch as a Biopolymer: Starch, a naturally occurring polysaccharide found in plants, has been widely studied as a raw material for bioplastic production. According to Avérous and Halley (2009), starch is an abundant and renewable polymer capable of forming biodegradable films. However, native starch has poor mechanical properties and high-water sensitivity, which necessitates modifications through plasticization or blending with other biopolymers (Shah et al., 2015).

Plasticization of Starch-Based Bioplastics: To improve the flexibility of starch bioplastics, plasticizers such as glycerol, sorbitol, or polyethylene glycol are commonly used. Research by Mali et al. (2006) found that glycerol effectively reduces starch film brittleness by increasing polymer chain mobility. However, an excess of plasticizer may weaken the material, making it overly soft and sticky (Krochta & De Mulder-Johnston, 1997).

Influence of Acetic Acid on Bioplastic Properties: Acetic acid (vinegar) is often incorporated to break down starch granules and enhance gelatinization. Studies by Pelissari et al. (2012) indicate that acid modification improves starch dispersion, film transparency, and mechanical properties. However, excessive acid content may lead to excessive hydrolysis, weakening the bioplastic structure (Ma et al., 2008).

Environmental Impact and Biodegradability: One of the major advantages of starch-based plastics is their biodegradability. Research by Thakur et al. (2014) demonstrated that starch bioplastics degrade within weeks to months, depending on environmental conditions. Unlike synthetic plastics, which persist for centuries, starch-based materials can be decomposed by microorganisms, making them a viable solution to plastic pollution (Narayan, 2010)

IV. RESULT AND DISCUSSION

RESULT:

Biodegradability: The starch-based plastic samples decomposed significantly faster than conventional plastic when exposed to natural conditions such as soil and water. Within a few weeks, visible degradation was observed, confirming their biodegradability.

Mechanical Properties: The tensile strength and flexibility of the starch-based plastic were lower compared to traditional petroleum-based plastics. However, blending starch with plasticizers like glycerol improved flexibility.

Production Feasibility: The plastic was successfully synthesized using simple and cost-effective methods, making it a viable option for small-scale and industrial production.

Environmental Impact: The material showed no toxic effects during degradation, confirming its eco- friendliness.

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Fig 4

Fig.5

DISCUSSION

Sustainability and Eco-Friendliness: The results confirm that starch-based bioplastics are a sustainable alternative to conventional plastics. Since starch is biodegradable and derived from renewable sources, it offers a reduced carbon footprint.

Challenges and Improvements: While the material showed promise, its mechanical strength and water resistance remain key challenges. Future improvements can focus on blending starch with other biodegradable polymers (such as PLA or PHA) and optimizing plasticizer concentrations.

Industrial and Commercial Potential: The ease of production and availability of raw materials make starch-based plastics a strong candidate for replacing conventional plastics in packaging, disposable cutlery, and agricultural applications. However, large-scale production requires cost-effective modifications to enhance durability. Future Prospects: With continuous research and technological advancements, starch-based bioplastics can be further developed to meet industrial standards. Government policies and consumer awareness will play a crucial role in promoting their adoption.

V. CONCLUSION

Biodegradable plastics made from starch offer a sustainable alternative to conventional plastics, reducing environmental pollution and dependence on fossil fuels. Starch-based bioplastics are biodegradable, renewable, and can be produced from agricultural sources like corn, potatoes, and cassava. While they have limitations such as lower durability and water resistance, these challenges can be addressed by blending starch with other biodegradable polymers and additives. With advancements in technology and increased adoption, starch-based addressed through further research and innovation. With increasing awareness, government regulations, and technological advancements, starch-based bioplastics have the potential to revolutionize packaging, agriculture, and various industries, ultimately leading to a cleaner and greener planet. bioplastics have the potential toto significantly reduce plastic waste and contribute to a more sustainable future. Starch-based biodegradable plastics present a promising solution to the global plastic pollution crisis. As a renewable, eco-friendly alternative, they can help reduce reliance on petroleum-based plastics while promoting sustainability. These materials decompose naturally, minimizing environmental harm and supporting a circular economy. However, challenges such as mechanical strength, water resistance, and cost-effective

ACKNOWLADGEMENT

It gives us pleasure to present my project on **"Making Biodegradable Material Like Plastic Using Starch".** The able guidance of all teaching staff of department made this study possible. I express my deep sense of gratitude and respect to my **guide Dr. Jayashree Shailesh Patil (Assistant professor),** Department of chemistry, J.S.M College, Tal.Alibag, Dist.Raigad for her inspire guidance on constructive criticism and constant encouragement during the completion of this project. I place my sincere thanks to **Head of Chemistry Department and Principal Dr. Sonali Patil, J.S.M COLLEGE ALIBAG** for giving me opportunity to complete this work and providing the necessary facilities. I would

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also like to appreciate all teaching and non-teaching staff of J.S.M. College, Alibag. My special thanks to my all friends M.Sc.-II for their friendly suggestion and timely help during preparation of soap. I must like to thanks University of Mumbai and Chemistry Department for giving us an opportunity to explore this subject by conducting this project. Finally, I would like to thank everybody who played a very important role towards the completion of this work, as well as expressing of this work, as well as expressing my apology that I could not mention all the names one by one.

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