



# Production and Evaluation of Potato-Starch Based Biodegradable Plastic

<sup>1</sup> Umesh Kudale, <sup>2</sup> Archana Nawale, <sup>3</sup> Kalyani More

<sup>1, 2, 3</sup> Assist. Prof.

<sup>1, 2, 3</sup> Dept. of Microbiology, P. V. P. College, Pravaranagar, Ahmednagar,

Email – <sup>1</sup>kudaleumesh5@gmail.com, <sup>2</sup>archu199205@gmail.com, <sup>3</sup>kalyanimore9292@gmail.com

**Abstract:** Industrial waste disposal is a major contributor to environmental pollution. In modern society, life is almost inconceivable without plastics; however, concerns associated with petroleum-based plastics have become increasingly prominent. As a result, researchers are investigating safer and more sustainable alternatives. The objective of this study is to produce a starch-based bio plastic derived from potatoes. The initial process for obtaining potato starch involves weighing, peeling, dicing, blending to form a slurry, and filtering to extract the maximum amount of starch. In the subsequent stage, the extracted starch is converted into bio plastic by incorporating glycerol, vinegar, and citric acid as binding and plasticizing agents. The produced bio plastic is then evaluated through tensile strength analysis and a plastic identification test to assess its biodegradability. This research highlights the potential of starch-based bio plastics as an eco-friendly alternative to conventional plastics.

**Keywords:** Biodegradable, Eco-friendly, Bio plastic, Starch-based materials.

## 1. INTRODUCTION:

The primary aim of producing biodegradable plastic from potato starch is to provide an eco-friendly alternative to traditional petroleum-based plastics. By utilizing potato starch—a renewable, abundant, and widely available resource—this approach seeks to reduce dependence on fossil-fuel-derived materials and minimize the environmental impact associated with plastic waste. Developing biodegradable plastics from potatoes supports a more sustainable future by creating materials that can degrade naturally, lowering long-term environmental harm and promoting a circular economy. The objectives of producing biodegradable plastic from potato starch include several key goals. Firstly, it aims to offer a sustainable replacement for conventional plastics by employing renewable raw materials such as potatoes. Secondly, the objective is to develop a manufacturing process that is effective, scalable, and cost-efficient for potential large-scale production. Ultimately, this initiative strives to create a viable, environmentally responsible solution for plastic production and usage, contributing to a more sustainable future. The scope of producing biodegradable plastic from potato starch is broad and multidisciplinary. It involves researching and developing efficient methods for starch extraction, optimizing the plasticization process, and identifying potential applications for starch-based biodegradable plastics. Additionally, the scope includes evaluating mechanical properties, biodegradability, and environmental impact compared to traditional plastics. Economic feasibility studies and market potential assessments also play an essential role. Overall, this field integrates aspects of chemistry, materials science, engineering, and environmental sustainability, making it an exciting area with significant potential for innovation and positive environmental impact.

This topic is important for several reasons. First, it directly addresses the global issue of plastic pollution and its detrimental effects on ecosystems. By producing biodegradable plastics, the amount of persistent plastic waste in the environment can be reduced. Moreover, this research encourages innovation in materials science and engineering, fostering the development of environmentally friendly alternatives to conventional plastics. Thus, producing biodegradable plastic from potato starch contributes to sustainability, environmental protection, and scientific advancement—representing a meaningful step toward a greener future. The production process generally involves extracting starch from potatoes and transforming it into a plastic-like material. Typical steps include washing, grinding, and separating the starch from potato cells. Once extracted, the starch can be further processed to form a plastic resin or polymer. Plasticizers and other additives are incorporated to enhance flexibility, strength, and other desirable properties. The resulting biodegradable plastic can be used in various applications, including packaging materials, disposable utensils, and agricultural films. One of the major advantages of using potato starch in biodegradable plastic production is its renewable nature. Potatoes are both sustainable and widely cultivated, helping reduce reliance on fossil fuels



required for traditional plastic manufacturing. However, challenges remain. The production cost of starch-based biodegradable plastics can be higher than that of conventional plastics due to additional processing steps. In addition, the mechanical properties of starch-based plastics may require further optimization to meet the performance standards of commercial plastics.

## 2. OBJECTIVES:

The aim of this research project is to investigate the feasibility of producing eco-friendly plastic from potato starch and to determine the most effective method for creating biodegradable plastic materials that degrade easily in the environment.

The key objectives of the study are as follows:

- To evaluate the extraction and processing methods for potato starch to determine their effectiveness in producing eco-friendly bio plastic.
- To assess the mechanical and chemical properties including tensile strength, flexibility, and biodegradability of potato-starch-based plastic.
- To compare the environmental impacts of potato-starch-based bio plastics with those of conventional plastics using a life cycle assessment.

## 3. METHODOLOGY:

### A. Extraction of Starch from Potatoes

#### 1. Extraction Process

**Weighing:** Accurate measurement of potato starch is essential, as it ensures consistency in the bio plastic production process and helps determine the correct proportions of all components.



Figure 1.

**Washing:** Washing the potatoes thoroughly with water removes these impurities and ensures the quality of the extracted starch. If necessary, the potatoes are peeled to eliminate contaminants and damaged areas, allowing only clean potato flesh to be used for extraction.

**Dicing:** After washing and peeling, the potatoes are diced or chopped into smaller pieces to increase surface area and facilitate efficient starch extraction.



Figure 2.

**Blending and Slurring:** The diced potatoes are blended with water to form slurry. Blending breaks down potato cells and releases the starch granules into the water, producing a homogeneous mixture containing suspended starch particles.

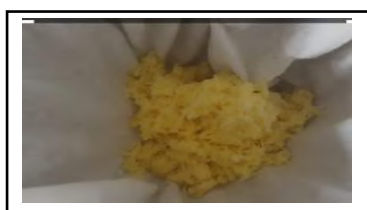


Figure. 3.

**Water Slurring:** Additional mixing ensures uniform distribution of starch particles within the slurry. Proper slurring enhances starch separation from other potato components.



Figure 4.

**Filtration:** The slurry is then filtered to separate starch from insoluble materials such as fibers, cellulose, and residual potato matter. Filtration may be performed using sieving, sedimentation, or centrifugation, depending on project scale and available resources.



Figure 5.

**Final Starch:** The extracted starch undergoes further processing such as drying, centrifugation, or other purification methods to remove excess water and reach the desired purity. The purified starch serves as the raw material for bioplastic production through methods such as extrusion or casting.

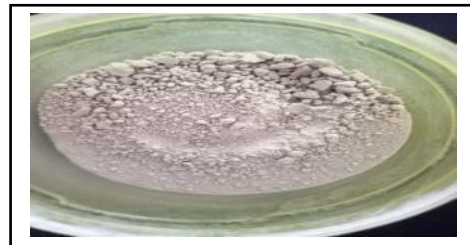


Figure 6.

#### **B. Selection of Potato:**

The potatoes used for starch extraction were sourced from a local vegetable market in Shirdi.

#### **C. Preparation of Potato Strach:**

Several preparatory steps—including washing, peeling, dicing, and blending were conducted prior to starch extraction.

#### **D. Production of Starch based bio-Plastic**

##### **Preparation of Mixture**

Weighed 13.5 g of potato starch.

Added 135 mL of tap water, 16.2 mL of vinegar, and 10.8 mL of glycerine.

Mixed thoroughly until a uniform, homogeneous mixture was formed.

##### **Heating the Mixture :**

The mixture was placed on a hot plate and heated to 100°C

The temperature was maintained for 20 minutes to allow the mixture to cook and undergo gelatinization.

##### **Air Drying:**

After heating, the mixture was left to air-dry for approximately 48 hours.

During this time, water and other volatile components evaporated, resulting in the formation of a solid bioplastic sheet.

##### **Bioplastic Production**

The drying process produced a bio plastic sheet that can serve as an environmentally friendly alternative to traditional plastics.



This method uses simple materials and equipment, demonstrating a sustainable approach to bioplastic production.

### Biodegradable test

Below table show that day wise weight of biodegradable plastic

#### BIODEGRADABILITY TEST:

The biodegradability of the produced bio plastic was evaluated by measuring its weight daily over a period of 15 days. A gradual decrease in weight was observed throughout the testing period, indicating continuous degradation of the bio plastic material. The maximum weight was recorded on Day 1, while the minimum weight was observed on Day 15. This progressive reduction in weight confirms the biodegradable nature of the starch-based bio plastic.

Days	weight
1st	1.24
3rd	1.13
6th	1.01
9th	0.91
12th	0.83
15th	0.71

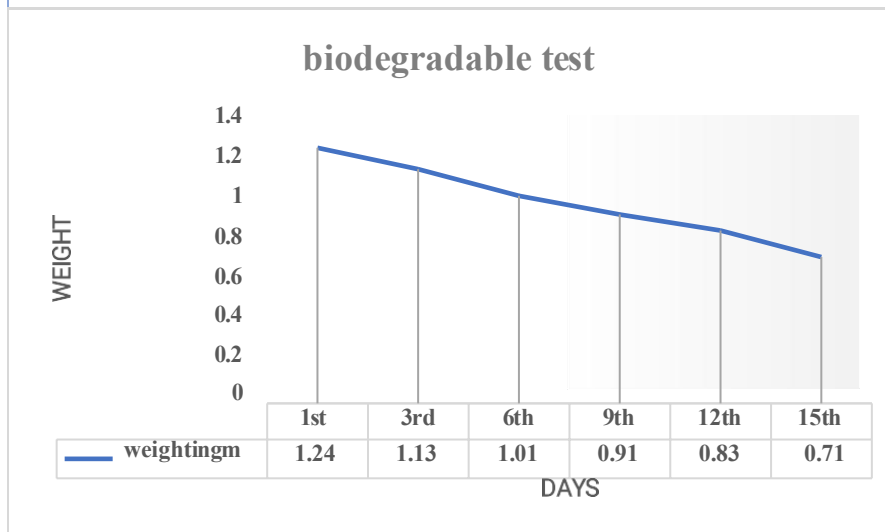


Table.1.

The decreasing weight over time demonstrates that the bio plastic is capable of biodegrading under natural conditions.

#### OTHER CHARACTERIZATION TESTS:

##### Visual Inspection;

Colour- Transparency/Opaqueness: The bio plastic was found to be transparent



Figure 7.

**Surface Texture;** The surface of the bio plastic was observed to be smooth.



Figure 8.

**Burn Test;** A small portion of the bio plastic was ignited.

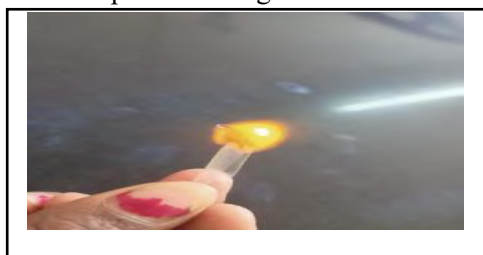


Figure 9.

**Solubility Test** A small piece of the bio plastic was placed in acetone.

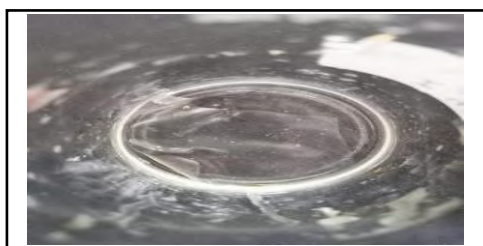


Figure 10.

**Hot Needle Test:** A heated needle was pressed against the bio plastic.

## 6. RESULTS:

Table.2.

Name of test	Result
Visual inspection	<b>Color:</b> Transparent
Surface Texture	Smooth
Burn test	<b>Flame colour:</b> orange, less smoke, ash formation
Solubility test	No change
Hot needle test	Melted
Biodegradable test	Weight decreased gradually over 15 days

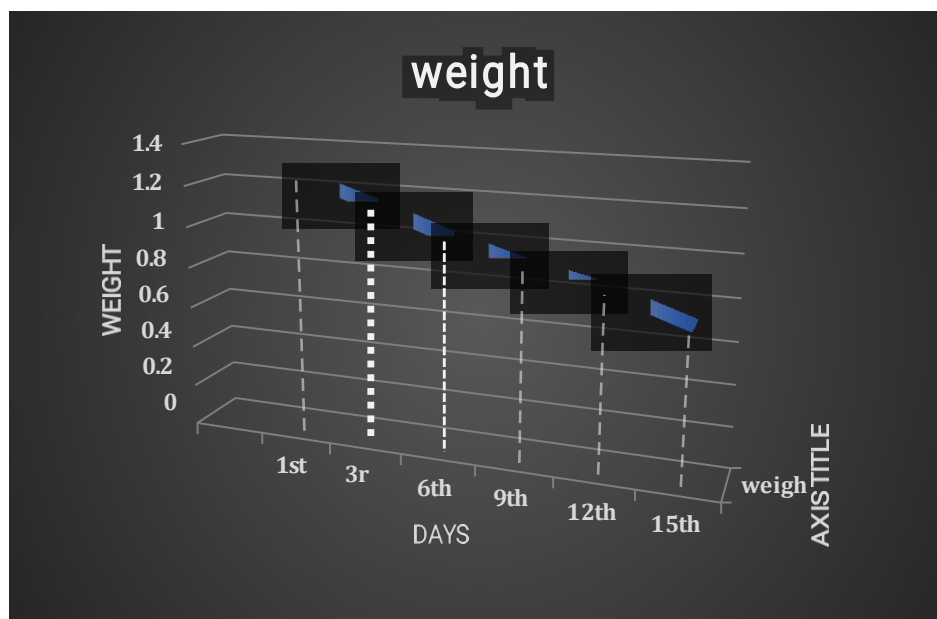
## 7. DISCUSSION:

The evaluation of biodegradable plastic produced from potato starch highlights several important findings. The biodegradability test confirmed a consistent decrease in weight over time, indicating active microbial degradation. Increased moisture content was found to enhance this degradation process by creating favorable conditions for microorganisms present in soil. Additionally, the presence of glycerol further accelerated biodegradation, as glycerol readily absorbs water and promotes the availability of hydroxyl groups. An analysis of biodegradable plastic production also revealed several critical areas related to sustainability, including environmental policy implementation, feedstock production, and manufacturing processes. However, the study acknowledges certain limitations. Data collection was restricted to Scopus and Web of Science databases and was based on predefined inclusion criteria. As a result, some



relevant publications may have been excluded, potentially affecting the comprehensiveness and generalizability of the findings. Although subjective judgment may offer additional insights, this study employed metadata and content analysis for consistency. Future research could integrate citation analysis and network-analytic tools for broader and more robust evaluations. Overall, the results indicate that potato-starch-based bio plastics possess promising characteristic transparency, smooth texture, partial thermal sensitivity, and biodegradability making them viable alternatives to conventional plastics.

## 8. CONCLUSION



## CONCLUSION

Table.3.

This research highlights the potential of utilizing potato peel waste for bio plastic production, resulting in materials capable of fully biodegrading within 15 days—making them suitable for packaging applications. While the results demonstrate promising biodegradability, further investigation into mechanical properties is necessary to support wider industrial use. Additionally, broader research is needed to assess the versatility, performance, and applicability of these bio plastics in various environmental conditions. The degradation tests conducted in this study revealed encouraging outcomes, with nearly one-quarter of the bio plastic decomposing within just 15 days, marking a significant milestone in the advancement of biodegradable materials.

## REFERENCES:

1. Bayer, I.S.; Guzman-Puyol, S.; Heredia-Guerrero, J.A.; Ceseracciu, L.; Pignatelli, F.; Ruffilli, R.; Cingolani, R.; Athanassiou, A. (2014). Direct transformation of edible vegetable waste into bioplastics. *\*Macromolecules\**, 47, 5135–5143.
2. Emadian, S.M.; Onay, T.T.; Demirel, B. (2017). Biodegradation of bioplastics in natural environments. *\*Waste Management\**, 59, 526–536.
3. Jain, R.; Tiwari, A. (2015). Biosynthesis of planet-friendly bioplastics using renewable carbon sources. *\*Journal of Environmental Health Science & Engineering\**, 13, 11.
4. Azahari, N.; Othman, N.; Ismail, H. (2011). Biodegradation studies of polyvinyl alcohol/corn starch blend films in solid and solution media. *\*Journal of Physical Science\**, 22, 15–31.
5. Siakeng, R.; Jawaid, M.; Ariffin, H.; Sapuan, S.; Asim, M.; Saba, N. (2019). Natural fiber reinforced polylactic acid composites: A review. *\*Polymer Composites\**, 40, 446–463.



6. Muscat, D.; Adhikari, B.; Adhikari, R.; Chaudhary, D. (2012). Comparative study of film-forming behaviour of low- and high-amylose starches using glycerol and xylitol as plasticizers. *\*Journal of Food Engineering\**, 109, 189–201.
7. Johansson, C.; Bras, J.; Mondragon, I.; Nechita, P.; Plackett, D.; Simon, P.; Svetec, D.G.; Virtanen, S.; Baschetti, M.G.; Breen, C. (2012). Renewable fibers and bio-based materials for packaging applications: A review of recent developments. *BioResources*, 7, 2506–2552.
8. Abidin, M.Z.A.Z.; Julkapli, N.M.; Juahir, H.; Azaman, F.; Sulaiman, N.H.; Abidin, I.Z. (2015). Fabrication and properties of chitosan with starch for packaging applications. *\*Malaysian Journal of Analytical Sciences\**, 19, 1032–1042.
9. Gadhave, R.V.; Das, A.; Mahanwar, P.A.; Gadekar, P.T. (2018). Starch-based bioplastics: The future of sustainable packaging. *\*Open Journal of Polymer Chemistry\**, 8, 21–33.
10. Edhirej, A.; Sapuan, S.; Jawaid, M.; Zahari, N.I. (2017). Cassava/sugar palm fiber–reinforced cassava starch hybrid composites: Physical, thermal, and structural properties. *\*International Journal of Biological Macromolecules\**, 101, 75–83.