



Economical Considerations On Biodegradable Plastics By Using Lagenaria Siceraria (Calabash): A Research

¹Gaanashri Rangasamy, ²G.Lalitha

¹Student, ²Assistant Professor

DEPARTMENT OF BIOCHEMISTRY,

DR.NGP ARTS AND SCIENCE COLLEGE, COIMBATORE, TAMILNADU, INDIA

Abstract: The increasing concern over plastic pollution has driven research into sustainable alternatives, with calabash-based biodegradable plastics emerging as a promising solution. It has a fibrous gourd, is transformed into game-changing bioplastic, boasting strength, flexibility, and eco- friendly. Which is mainly plays a crucial role in creating environmental impact of calabash derived biodegradable plastics. The calabash pulp serves as the fibrous content in the bioplastic, which combined with natural plasticizers such as glycerol with this add acetic acid for gel formation, flexibility and mechanical strength. Additionally, calabash bioplastic offers potential applications in packaging, disposable items and films. The sustainable solution biodegrades rapidly, tackling plastic pollution and paving the way of greener industry.

Keywords - Calabash, Bioplastic, Starch, Glycerol, Gel Formation, Mechanical Strength, Sustainable Solution, Disposable Item, Greener Industry.

I. INTRODUCTION

Calabash bioplastic films are an innovative, sustainable alternative to traditional plastic films, derived from the calabash plant (*Lagenaria Siceraria*), which is known for its hard outer shell. Traditionally, the calabash fruit has been used in various cultures to create bowls, utensils, and musical instruments. Recently, however, it has gained attention in the field of bioplastics as a source of natural polymers that can be processed into biodegradable and eco-friendly films (Alva, S. S., et al., vol. 23, no. 21, 2016, pp. 21924-21939). The process of making calabash bioplastic films begins with the harvesting of the calabash fruit once it reaches maturity. The outer hard shell is removed, leaving behind the inner pulp and fibres, which contain valuable natural polymers, such as cellulose and starch, essential for bioplastic production. These natural polymers are then extracted from the pulp through a process of grinding and heating, where water is added to break down the cell walls, releasing the starch and cellulose (Aug 2024 ,DOI: 10.1016/j.jics.2024.101301 ,ISBN: 0019-4522Ayesha Sultan). This mixture is then filtered to separate the desired polymers from the remaining plant matter. Once extracted, the starch and cellulose are purified, and they form the base for the bioplastic solution.

The bioplastic solution is created by mixing the extracted starch and cellulose with water and plasticizers, such as glycerol or sorbitol, which help improve the flexibility and workability of the material. Plasticizers are crucial, as they prevent the bioplastic from becoming too brittle. Additional additives, such as natural resins or vegetable oils, may be included to enhance properties like moisture resistance, transparency, or durability, depending on the intended application. The resulting solution is heated and stirred to ensure a smooth, homogeneous mixture. Once the bioplastic solution is ready, it is poured onto a flat surface or mold, where it is spread evenly to form a thin layer. This layer is then left to dry at room temperature or in a controlled environment, where the moisture gradually evaporates, and the bioplastic solidifies into a flexible, transparent film. The drying time depends on the thickness of the film and the surrounding environmental conditions, typically taking several hours or more.

Once the bioplastic film has fully dried, it is carefully peeled off the mold and inspected for any imperfections such as wrinkles or air bubbles. The film is then cut into the desired shapes or sizes, which could vary based on its intended use, such as packaging, food storage, or single-use items like cutlery and straws (Siracusa, Vincenzo, et al. vol. 12, 2017, pp. 41-50). Finally, the bioplastic films undergo quality control testing to ensure they meet necessary standards for strength, flexibility, and biodegradability. These tests assess the film's mechanical properties, such as tensile strength, and evaluate its performance in terms of moisture, oxygen resistance, and degradation in natural environments. The quality control process ensures that the films are both functional and environmentally friendly. By using renewable resources like the calabash fruit, these bioplastic films offer an alternative to petroleum-based plastics, reducing reliance on fossil fuels and contributing to a more sustainable and circular economy. As research and technology continue to develop, calabash bioplastics may become a key player in tackling plastic pollution and reducing environmental harm.

II. AIM:

To produce biodegradable plastic from calabash pulp as a substitute for conventional plastic and to prove that the starch in the Calabash pulp could be used in the production of the biodegradable plastic.

III. METHODOLOGY:

Materials required:

Calabash pulp, Plate, Knife, 500 ml beaker – 2, Hot plate (for boil), Hot Air Oven (for drying). Funnel (for decant the water), Hand blender (to make paste), Baking sheet, Timer, Electronic balance (weight machine), 150 ml beaker, 10ml measuring cylinder, Glass rod, 1000 ml micro pipette, small aluminum petri dish.

IV. CHEMICALS:

- 1) 3g of Agar
- 2) 3 ml of Acetic acid at 0.5 M
- 3) 2ml of Glycerol
- 4) Sodium Meta-bi-sulphate

Glycerol as a Plasticizer:

Plasticizers or dispersants were additives that increase the plasticity or fluidity of a material. These plasticizers make it possible to achieve improved compound processing characteristics, while also providing flexibility in the end-use product. Glycerol (also called glycerin) was a simple polyol (sugar alcohol) compound. It was a colorless, odorless, viscous liquid that was sweet-tasting and non-toxic.

Sodium metabisulfite as an Antioxidant:

The sodium meta bisulfite ($\text{Na}_2\text{S}_2\text{O}_5$) was used as an antioxidant. It prevents the microbial growth in the peels. It was used as a disinfectant, antioxidant and preserving agent. It was very soluble in ethanol and water.

V. EXPERIMENTAL PROCEDURES:

PREPARATION OF CALABASH PULP:

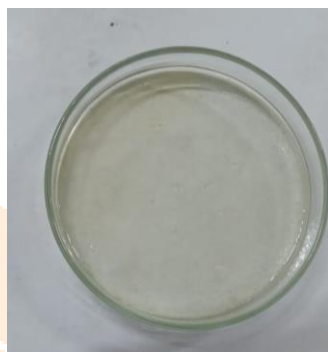
- The matured calabash is selected for rich starch content.
- Then it is dip in the Sodium meta bisulphite solution for 45 minutes.
- It is used as an antioxidant and preservatives, this would increase the biodegradation period of the plastic.
- The water was decanted from the beaker and the pulp were left to dry on the filter paper for about 30 minutes.
- After the pulp dried they were made into a uniform paste with the help of the blender.

PREPARATION OF BIOPLASTICS:

- The first experimental procedures were performed by mixing up the calabash pulp paste with chemical-based materials and glycerol as plasticizer. For the second experimental by mixing up the calabash pulp paste with natural-based materials and glycerol as plasticizer.

PREPARATION OF CALABASH PULP BIOPLASTIC WITH CHEMICAL BASED:

- 100 gram of calabash pulp paste was placed in a beaker and weighted
- 8 g of Agar were mixed with the paste and stirred using glass rod.
- 8 ml of glycerol were added which act as a plasticizer and stirred using glass rod.
- 12 ml of Acetic acid were added to balance the pH value of the mixture and also stirred using glass rod. The mixture was stirred for 5 minutes in the hot plate.
- The mixture was stretched and pressed on oven paper and was dried in the oven with a temperature of 60°C .
- Pour the mixture in the into the mold or any desired shape & let it dry at the room temperature for 24-48 hour.



SWELLING TEST:

Measures the expansion of soil when exposed to water. This is important for understanding how soil behaves in different conditions, particularly in construction and engineering. A sample of soil is placed in a container, and water is added. The volume of the soil is then measured at regular intervals to determine the extent of swelling.

SOLUBILITY TEST:

To assess the solubility of active pharmaceutical ingredients (APIs) in various solvents (usually water or other physiological fluids) to ensure proper absorption and efficacy of the drug.

1. A known quantity of the drug substance is added to a solvent (usually water or an appropriate medium).
 2. The mixture is stirred or agitated.
 3. After a set period, the solution is filtered to remove any undissolved solids.
 4. The concentration of the dissolved substance is measured (often by spectrophotometry or other analytical techniques).
- Outcome:** Helps determine how well a drug will dissolve in the body and its bioavailability.

WATER ABSORPTION TEST:

Calabash pulp based bioplastic of natural based and chemical based were showed in water absorption capacity.

SHELF LIFE OF THE PREPARED BIOPLASTIC :

On the 12th day of observation, fungal action was observed on bioplastic prepared based on the chemical based. But in sample incorporated with natural based, fungal action was observed only on the 10th day. The presence of chemicals could enhance the shelf-life of the bioplastics.

SOIL DEGRADATION METHOD :

Biodegradability test or the level of biodegradability of bioplastic that was produced was very important in the bioplastic production. This test was done by bioplastic samples in the soil and left for 12 days. Bioplastic samples were weighed with initial and final weight. The more weight lost during testing in the soil, the higher the level of biodegradability of the bioplastic. the results of bioplastic produced based on natural methods showed biodegradability on the day of 6th whereas the chemical based bioplastic shown the biodegradability on the day of 10th (Table 5). Hence the results of the study showed that the natural based bioplastic were better when comparing with chemical based bioplastic production.

TABLE : BIODEGRADABILITY TEST OF SYNTHESIZED BIOPLASTIC USING CHEMICAL METHOD:

BIOPLASTICS	INITIAL WEIGHT	FINAL WEIGHT	TOTAL NO DAYS
CALABASH	9 GM	6 GM	12 DAYS

CONCLUSION:

Creating biodegradable plastic using calabash (also known as bottle gourd) is a promising approach to addressing the environmental issues caused by traditional plastics. Calabash-based bioplastics offer several advantages, including reduced reliance on fossil fuels, lower carbon footprint, and the ability to decompose naturally, thus minimizing plastic pollution. The development of calabash-based bioplastics involves extracting and processing the natural polymers found in the calabash plant. However, challenges remain in optimizing the properties of calabash bioplastics for mass production. Improvements in mechanical strength, moisture resistance, and other qualities will be necessary to make them more competitive with conventional plastics. Additionally, scaling up production and managing costs will be key to making calabash bioplastics commercially viable. These bioplastics can be engineered to have desirable mechanical properties, making them suitable for various applications, such as packaging, agricultural films, and disposable items. These bioplastic plays a pivotal role in maintaining the ecological balance and health of the ecosystem.

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