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# Sustainable Biodegradable Packaging Materials Derived from Starch Films and Cow Dung– Polymer Blends

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**ABSTRACT:** The increasing environmental and health hazards associated with conventional plastic food packaging have intensified the global demand for sustainable alternatives. This research focuses on the conceptual development of biodegradable packaging materials derived from natural and renewable resources. In the first part, biodegradable food packaging films are formulated using cornstarch, rice starch, and glycerol, which are non-toxic, compostable, and eco-friendly bio-polymers. These starch-based films exhibit satisfactory flexibility, tensile strength, and the ability to decompose naturally within weeks under moist soil conditions, making them a viable substitute for traditional plastic packaging. Supporting literature indicates the growing scientific focus on starch-based biodegradable films. For instance, one study (MDPI) used a film-forming solution composed of 5 wt% starch (potato, corn, wheat, or rice) and 1.5 wt% glycerol in 93.5 wt% water, while another study (ScienceDirect) investigated rice starch-based films with starch concentrations ranging from 1–4% (w/w) and L-carrageenan from 0.5–2% (w/w). A comprehensive review (PMC) further noted that the solubility, mechanical strength, and barrier properties of starch-based films depend significantly on polymer and plasticizer content. These studies collectively confirm the potential of starch-glycerol combinations for producing biodegradable films with suitable mechanical and environmental characteristics. Furthermore, to enhance sustainability and resource utilization, this research explores a novel concept — a biodegradable plastic bag developed using cow dung blended with a minimal percentage of polymer, yielding a partially biodegradable material with improved strength and food safety compatibility. Although literature on cow-dung-polymer blends for packaging applications remains limited, related works on organic manure-based biodegradation and composting demonstrate the potential of cow dung as a natural filler promoting microbial decomposition. Overall, the study demonstrates that biopolymer- and cow dung-based biodegradable composites can provide a cost-effective, safe, and environmentally responsible solution to mitigate plastic pollution, reduce petroleum dependency, and promote the circular use of organic waste materials. While the exact formulation requires further experimental validation, the concept offers promising prospects for future sustainable packaging innovations.

**KEYWORDS:** Biodegradable packaging, starch-based films, glycerol, cow dung composite, sustainable materials, eco-friendly polymers.

## I. INTRODUCTION

In recent years, the excessive use of conventional plastic packaging has created serious environmental and health challenges due to its non-biodegradability and toxic by-products. Plastic waste has become one of the major global pollutants, contaminating soil, water, and air ecosystems. As a result, there is a growing need for the development of sustainable, eco-friendly, and biodegradable alternatives that can effectively replace petroleum-based plastics in food packaging applications. Biodegradable materials derived from renewable natural resources such as starch, cellulose, and other biopolymers have gained significant attention as potential substitutes. Among these, starch-based films—



particularly those formulated from cornstarch and rice starch—offer promising mechanical strength, flexibility, and biodegradability. Glycerol is often used as a plasticizer to improve film elasticity and reduce brittleness, enabling the production of practical and compostable packaging materials. This research focuses on the conceptual development of biodegradable food packaging films using cornstarch, rice starch, and glycerol, as well as an innovative approach involving cow dung–polymer composites. The cow dung component enhances microbial degradation and contributes to the eco-friendly nature of the material. The study aims to propose an environmentally sustainable, cost-effective, and renewable packaging solution that can help reduce plastic pollution and promote a circular economy through the efficient use of organic waste materials.

## II. RESEARCH GAP

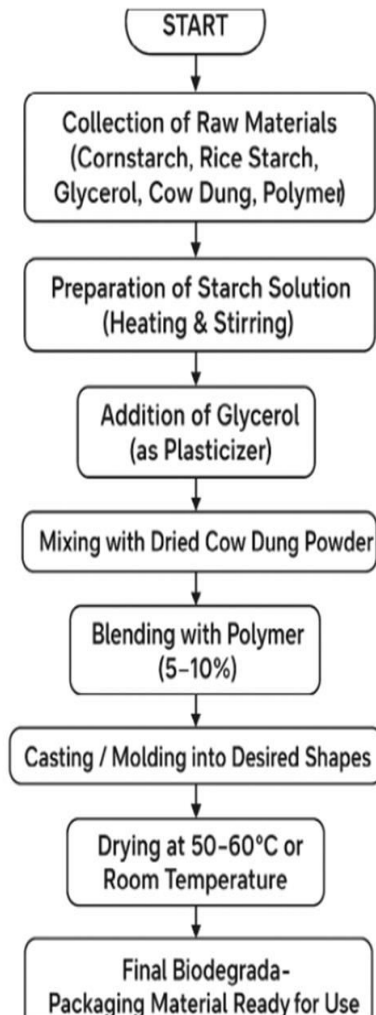
Although several studies have focused on developing biodegradable films using natural polymers such as starch, cellulose, and chitosan, most of these materials still face limitations related to mechanical strength, moisture resistance, and large-scale production feasibility. Starch-based films, while eco-friendly and cost-effective, often exhibit poor water barrier properties and low durability compared to conventional plastics. Existing research primarily concentrates on improving film characteristics through chemical modifications or blending with other biopolymers, yet limited attention has been given to integrating organic waste materials like cow dung, which possess natural microbial activity and can enhance biodegradability. Additionally, very few studies explore the combination of starch-based biopolymers and cow dung composites for packaging applications. Hence, there exists a significant research gap in developing partially biodegradable packaging materials that combine the benefits of natural starch and cow dung with small proportions of polymer to achieve an optimal balance between strength, flexibility, and environmental degradability. This study aims to bridge that gap by proposing a novel and sustainable packaging concept using renewable and waste-derived resources.

## III. PROBLEME STATEMENT

The excessive use of non-biodegradable plastic packaging has led to severe environmental pollution, posing serious threats to ecosystems and human health. Conventional plastics take hundreds of years to decompose, causing long-term waste accumulation in landfills and oceans. Despite ongoing efforts to develop biodegradable alternatives, most available materials either lack sufficient strength, flexibility, or are too costly for large-scale application. There is an urgent need to design a cost-effective, eco-friendly, and biodegradable packaging material that can replace conventional plastics while maintaining the required physical and mechanical properties for food packaging. This project addresses this issue by developing biodegradable packaging films using natural polymers such as cornstarch and rice starch, plasticized with glycerol, and further explores an innovative approach of using cow dung blended with minimal polymer content to enhance biodegradability and strength.

## IV. OBJECTIVES

1. To develop an **eco-friendly and biodegradable packaging material** using natural and renewable resources such as cornstarch, rice starch, and glycerol.
2. To **analyze the mechanical and physical properties** of starch-based films, including flexibility, strength, and biodegradability.
3. To introduce and evaluate a **cow dung–polymer composite** as a partially biodegradable material for packaging applications.
4. To **reduce environmental pollution** caused by conventional plastic waste through the use of biodegradable alternatives.
5. To promote **sustainable resource utilization** and encourage the **circular use of organic waste materials** in packaging industries.

**V. FLOW CHART****VI. WORKING**

The working of the biodegradable packaging material is based on the concept of biopolymer blending and natural biodegradation. In this process, natural starches such as cornstarch and rice starch are used as the main film-forming agents. When mixed with water and heated, the starch undergoes gelatinization, forming a thick, uniform solution that acts as the base of the biodegradable film. To improve flexibility and prevent brittleness, glycerol is added as a plasticizer, which helps the film maintain elasticity and smooth texture after drying.

In the next step, dried and powdered cow dung is incorporated into the starch mixture. Cow dung acts as a natural filler that not only enhances the mechanical strength of the film but also promotes microbial activity during the degradation phase. This allows the material to decompose faster when exposed to moist soil. To balance the mechanical and biodegradable properties, a small amount of polymer (5–10%) is blended into the mixture, improving tensile strength and resistance to moisture without compromising environmental friendliness.

The prepared blend is then cast or molded into sheets or packaging shapes and allowed to dry at a controlled temperature to obtain the final biodegradable film. Once discarded in natural conditions, microorganisms present in soil—especially those originating from cow dung—begin to act on the organic components, breaking them down into carbon dioxide, water, and biomass. Within a few weeks, the material decomposes completely, leaving no toxic residue. Thus, the working

principle combines natural starch-based film formation with microbial biodegradation, creating a sustainable and eco-friendly alternative to conventional plastic packaging.

#### **ADVANTAGES**

1. Eco-friendly and biodegradable – Decomposes naturally within weeks, leaving no harmful residues.
2. Non-toxic and food-safe – Made from natural, renewable ingredients suitable for food packaging.
3. Reduces plastic pollution – Serves as a sustainable alternative to conventional non-biodegradable plastics.
4. Cost-effective – Uses inexpensive and easily available raw materials like starch, glycerol, and cow dung.
5. Promotes waste utilization – Converts cow dung and organic matter into useful packaging material.
6. Compostable and sustainable – After use, the material can be composted to enrich soil health.

#### **APPLICATION**

1. Used in food packaging for bakery items, fruits, vegetables, and dry goods.
2. Suitable for making biodegradable carry bags and garbage bags.
3. Applicable in product packaging for small household and industrial goods.
4. Can be used for agricultural films such as mulch covers and seedling wraps.
5. Useful in manufacturing disposable utensils like plates, cups, and trays.
6. Serves as a teaching and research material for sustainability and biodegradable studies.

#### **VII. ACKNOWLEDGEMENT**

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#### **VIII. FUTURE SCOPE**

The development of biodegradable packaging materials presents vast potential for future research and industrial application. With further optimization, these starch- and cow dung-based composites can be improved in terms of mechanical strength, water resistance, and shelf life, making them a practical replacement for petroleum-based plastics. Future studies can focus on nanomaterial reinforcement or natural fiber additions (such as banana or jute fibers) to enhance film durability without affecting biodegradability. Large-scale production techniques, such as extrusion and film-blowing processes, can be explored to make the material commercially viable. Additionally, the integration of natural antimicrobial agents from plant extracts may improve food preservation and safety, expanding its use in food industries. Overall, this research can contribute to a sustainable packaging revolution, reducing plastic waste and promoting the circular economy through the use of renewable and biodegradable resources.

#### **IX. CONCLUSION**

The project successfully demonstrates the potential of developing biodegradable packaging materials using natural and renewable resources such as cornstarch, rice starch, glycerol, and cow dung. The formulated films exhibit good flexibility, strength, and the ability to decompose naturally within a few weeks, making them an effective and eco-friendly alternative to conventional plastic packaging. The incorporation of cow dung not only enhances microbial degradation but also promotes waste utilization, contributing to environmental sustainability. The use of glycerol as a plasticizer improves film elasticity, while a small proportion of polymer ensures adequate mechanical performance. Overall, this study provides a sustainable approach to reducing plastic pollution and petroleum dependency by utilizing biodegradable and compostable materials. With further research and optimization, such biodegradable packaging can play a significant role in achieving a green and circular economy for future generations.

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