Synthesis and Characterization of Biopolymer

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***Abstract*—This study investigates the viability of utilizing potato starch as a sustainable, biodegradable alternative to conventional petrochemical plastics. Bioplastic films were successfully prepared through a gelatinization and drying process using glycerol as a plasticizer. Physical evaluations revealed that the resulting films possess favorable characteristics: they are thin, smooth, transparent to pale white, and flexible.**

However, mechanical and barrier assessments indicated notable limitations, including a relatively low tensile strength and limited water resistance due to the hygroscopic nature of starch. These drawbacks stem structurally from glycerol inserting itself between starch polymer chains, which diminishes intermolecular hydrogen bonding and increases chain mobility—successfully imparting flexibility at the expense of stiffness and tensile durability.

While potato starch bioplastics offer significant environmental and economic benefits, such as biodegradability and low production costs, optimizing their mechanical strength and moisture resistance remains crucial. Recent literature suggests that overcoming these limitations requires structural reinforcement through the incorporation of specialized fillers or nanocomposites to distribute stress uniformly and create denser polymer networks.

***Index Terms*—Potato starch, bioplastics, glycerol plasticizer, mechanical properties, tensile strength,**

I. INTRODUCTION

Plastic has become an important part of our daily life because it is lightweight, inexpensive, strong, and easy to manufacture into different shapes (Andrady & Neal, 2009). It is used in packaging materials, shopping bags, bottles, food containers, agricultural materials, household products, and many other items (Geyer et al., 2017). However, most conventional plastics are made from petroleum-based raw materials and do not decompose easily under natural environmental conditions (Thompson et al., 2009). Plastic waste can remain in the environment for many years, causing pollution of soil and water (Barnes et al., 2009). It can also harm animals and aquatic organisms when they swallow plastic pieces or become trapped in plastic waste (Gall & Thompson, 2015). The increasing use of plastic and the difficulties involved in managing plastic waste have created a need to develop alternative materials that have a lower environmental impact (Niaounakis, 2019).

One possible alternative is bioplastic, which is produced using natural or renewable raw materials such as starch, cellulose, vegetable oils, and other biological resources (Yadav & Nikalje, 2024). Some bioplastics can break down under suitable environmental conditions, although not all bioplastics are biodegradable (Bismarck et al., 2016). Compared with conventional petroleum-based plastics, bioplastics made from renewable materials can reduce dependence on fossil resources (Hahladakis, 2020). Their environmental benefits, however, depend on the raw materials used, the manufacturing process, the product's useful life, and the conditions required for disposal or biodegradation (Luz et al., 2015). Therefore, researchers are studying different natural materials to find affordable and practical ways to produce bioplastics (Ragaert et al., 2017).

Potato starch is one such material that can be used for bioplastic production. Potato is a widely available food crop, and its starch has useful properties for forming films (Patel, 2022). Starch is a natural carbohydrate made up mainly of two components, amylose and

amylopectin (Mehyar & Han, 2004). These components are responsible for many of the film-forming properties of starch (Melo et al., 2003). When potato starch is heated in water, the starch granules absorb water, swell, and undergo a process known as gelatinization (Bastioli, 2005). During this process, the mixture becomes thicker and forms a paste (Singh et al., 2025). When the paste is spread into a thin layer and dried, it can form a solid film (Belahcene, 2025).

The production of bioplastics from potato starch involves preparing an aqueous starch mixture and incorporating specific additives to optimize its structural and mechanical properties (Avérous & Halley, 2009). Water serves as a vital solvent that facilitates the dispersion and gelatinization of starch granules during the heating process. To counteract the inherent brittleness of native starch films which tend to harden, crack, or fracture under stress—plasticizers such as glycerol are commonly integrated into the formulation (Mali et al., 2006). Glycerol functions by embedding between starch molecules, thereby enhancing polymer chain mobility and internal flexibility. However, precise optimization of ingredient proportions is critical; insufficient glycerol yields a fragile film, whereas excessive amounts can produce a material that is overly soft, sticky, or mechanically weak (Krochta & De Mulder-Johnston, 1997). Consequently, balancing the ratios of starch, water, and glycerol dictates the overall quality and functionality of the final bioplastic product.

The preparation process usually begins by mixing potato starch with water until a uniform mixture is obtained (Prakoso et al., 2023). Glycerol is then added, and the mixture is heated with continuous stirring (Chen et al., 2021). Heating allows the starch granules to swell and gelatinize, producing a thick and relatively uniform paste (Frangopoulos et al., 2023). The hot mixture is poured onto a flat surface or mould and spread evenly (Prakoso et al., 2023). It is then allowed to cool and dry. As water evaporates, the mixture forms a thin solid layer that can be removed and examined (Chen et al., 2021). The thickness, smoothness, flexibility, and appearance of the bioplastic depend on the composition of the mixture and the heating and drying conditions (Frangopoulos et al., 2023). Careful preparation is therefore necessary to obtain a film with consistent properties.

Potato starch-based bioplastic is interesting because the main raw material is renewable and can be obtained from a common agricultural crop (Singh et al., 2025). Potato starch is also useful for student projects because the basic preparation method is relatively simple and does not require highly specialised equipment. In some cases, starch can also be recovered from potato-processing residues, although the suitability of such materials depends on their starch content and purity (Singh et al., 2025). Using agricultural by-products may offer an opportunity to make better use of available resources. However, food-grade potato starch is also used in food products, so the availability, cost, and intended use of the raw material should be considered when evaluating the practical value of this process.

Although potato starch can form a plastic-like material, it does not have exactly the same properties as conventional plastic. Starch-based films may absorb moisture because starch is naturally hydrophilic (Othman et al., 2021). As a result, they can become soft, swell, or lose strength when exposed to high humidity or water (Othman et al., 2021). They may also have lower mechanical strength and durability than some commercial plastics. These limitations can restrict their use in applications that require high strength, long-term water resistance, or long storage life (Othman et al., 2021). Researchers can try to improve these properties by adjusting the plasticizer concentration, adding natural fibres or other compatible materials, and modifying the preparation conditions (Othman et al., 2021). Any improvement must be tested to determine whether it provides the desired performance.

Another important aspect of bioplastic production is biodegradation (Chaisuwan et al., 2023). Under suitable conditions, microorganisms may break down biodegradable materials into simpler substances (Chaisuwan et al., 2023). However, the rate and extent of biodegradation depend on the composition of the material and environmental factors such as temperature, moisture, oxygen availability, and microbial activity (Chaisuwan et al., 2023). A starch-based film should not automatically be considered fully biodegradable in every environment merely because it is made from natural starch. Its degradation should be assessed under defined conditions. For a student project, changes in the appearance, shape, texture, or mass of the prepared film during a simple soil-burial observation can provide preliminary information, but such observations alone do not prove

complete biodegradation or establish the material's environmental safety.

The study of potato starch-based bioplastic is useful for understanding the relationship between natural raw materials and material properties by changing the amount of glycerol or starch, students can observe how the composition affects flexibility, hardness, thickness, and resistance to handling. The resulting samples can be compared to identify which formulation gives the most suitable properties for the intended use. If the project includes more than one formulation, keeping the heating time, drying conditions, and sample size similar will make the comparison more meaningful. Recording observations systematically can also help identify sources of variation and improve the preparation method (Charles et al., 2022).

The main purpose of this project is to prepare bioplastic from potato starch using a simple and practical method and to study the properties of the material obtained. The project focuses on the film-forming ability of potato starch, the role of glycerol as a plasticizer, and the effect of preparation conditions on the final product. The prepared samples can be examined for their appearance, flexibility, strength during handling, and behaviour when exposed to moisture. Where suitable facilities and time are available, further tests can be carried out to compare different formulations or observe changes during degradation under specified conditions.

In conclusion, the production of bioplastic from potato starch is a useful way to explore the possibility of making plastic-like materials from renewable natural resources. It provides a practical example of how a common agricultural material can be converted into a useful film through a relatively simple process. Although potato starch-based bioplastic has limitations, especially regarding water resistance and mechanical strength, studying its preparation and properties can help identify ways to improve its performance. This project also creates awareness about plastic pollution and encourages the investigation of alternative materials. With further research and suitable improvements, starch-based materials may be useful in selected applications where their properties meet the required needs of daily life because it is lightweight, inexpensive, strong, and easy to manufacture into different shapes. It is used in packaging materials, shopping bags, bottles, food containers, agricultural materials, household products, and many other items. However, most conventional plastics are made from petroleum-based raw materials and do not decompose easily under natural environmental conditions. Plastic waste can remain in the environment for many years, causing pollution of soil and water. It can also harm animals and aquatic organisms when they swallow plastic pieces or become trapped in plastic waste. The increasing use of plastic and the difficulties involved in managing plastic waste have created a need to develop alternative materials that have a lower environmental impact (Arias et al., 2024).

History of Plastic:

The history of bioplastic production from potato starch began with the development of natural polymer-based materials as alternatives to conventional plastics. Traditional plastics are mainly produced from petroleum and can remain in the environment for many years. Due to increasing plastic pollution, scientists began exploring renewable and biodegradable materials obtained from natural sources such as starch, cellulose, and proteins (Stanley et al., 2025).

Potato starch is an important natural raw material used in bioplastic production. It contains two major components, amylose and amylopectin, which can form a plastic-like material under suitable conditions. Potato starch is obtained from potatoes and is considered a renewable, easily available, and low-cost resource for producing biodegradable materials. During the twentieth century, researchers started investigating starch-based materials for industrial applications. Later, the development of biodegradable plastics received greater attention because of increasing environmental concerns and the need to reduce dependence on petroleum-based plastics. Potato starch became one of the materials studied for producing environmentally friendly alternatives to conventional plastics (Jayarathna et al., 2022).

The production of potato starch bioplastic generally involves mixing potato starch with water and a plasticizer such as glycerol. The mixture is heated while stirring until the starch gelatinizes and forms a thick paste. The paste is then spread into a thin layer and dried to produce a flexible, plastic-like sheet. Glycerol helps improve the flexibility of the material and reduces its brittleness (Charles et al., 2022).

In recent years, potato starch-based bioplastics have gained attention in research and educational projects because they can be prepared using simple laboratory methods. These materials may be useful for applications such as packaging films, disposable items, and agricultural products, depending on their properties. However, their strength, water resistance, and durability may be lower than those of conventional plastics (Arias et al., 2024).

At present, potato starch bioplastic production is an important area of sustainable material research. Scientists are working to improve its mechanical strength, flexibility, and resistance to moisture. The development of potato starch-based bioplastics may help reduce the use of petroleum-based plastics and support environmentally responsible waste management (Arias et al., 2024).

Bioplastics:

Bioplastics are a type of plastic made from natural materials such as corn, potatoes, rice, sugarcane, and other plant materials. They are developed as an alternative to normal plastics, which are mostly made from petroleum. Nowadays, bioplastics are becoming popular because plastic waste is increasing and causing harm to the environment (Arias et al., 2024).

Bioplastics are made using different natural materials. Some are produced from starch, cellulose, vegetable oils, and other plant-based substance. Some bioplastics are also produced with the help of microorganisms. The properties of bioplastics depend on the materials used to make them. They can be soft, hard, flexible, or strong according to their composition (Jayarathna et al., 2022).

One of the main benefits of bioplastics is that they can be made from renewable resource. Plants can be grown again, so these materials can reduce the use of fossil fuels. Some bioplastics can also break down naturally with the help of microorganisms under suitable conditions. This can help reduce plastic waste. However, all bioplastics are not biodegradable, and some need special conditions to break down (Costa et al., 2023).

Bioplastics are used in many areas of daily life. They can be used to make shopping bags, food packaging, bottles, disposable plates, cups, agricultural products, and other useful items. They are also being studied for use in medical products and other industrial applications (Costa et al., 2023).

Another advantage of bioplastics is that they can sometimes be made using agricultural waste. Waste materials such as banana peels, rice husks, and sugarcane bagasse can provide useful substances for making bioplastic materials. In this way, waste can be used to develop new products instead of being thrown away (Visco et al., 2022).

Although bioplastics have many advantages, they also have some disadvantages. Their production may be costly, and some types are not as strong or water-resistant as ordinary plastics. Some bioplastics also need special conditions for proper decomposition. Therefore, they must be disposed of correctly to get their environmental benefits (Visco et al., 2022).

Today, many researchers are studying bioplastics to improve their strength, flexibility, durability, and production methods. They are also looking for cheaper raw materials and better ways to produce bioplastics from natural resources and waste materials.

In conclusion, bioplastics are a useful alternative to conventional plastics in certain applications. They can help reduce the use of petroleum-based materials and make better use of renewable resources. With further research and improvement, bioplastics may play an important role in reducing plastic waste and protecting the environment.

Types of bioplastics:

Starch-based bioplastic is produced using natural starch obtained from corn, potatoes, rice, or tapioca (Arias et al., 2024). Starch is typically mixed with water and plasticizers such as glycerol to form a flexible material (Charles et al., 2022). It is relatively inexpensive and easy to prepare, making it highly suitable for academic research projects (Singh et al., 2025).

Polysaccharide-based bioplastics are biodegradable plastic materials produced from natural polysaccharides such as starch, cellulose, chitin, and pectin, which are obtained from renewable biological sources like plants and agricultural waste (Jayarathna et al., 2022). They can be effectively utilized as eco-friendly alternatives to conventional petroleum-based plastics (Costa et al., 2023).

Aliphatic polyesters represent a category of bioplastics made from biodegradable aliphatic polyester polymers, prominent examples being polylactic acid (PLA) and polycaprolactone (PCL) (Visco et al., 2022). These polymers provide favourable mechanical

properties and degradation characteristics for diverse applications.

Chitosan-based bioplastic is manufactured from chitosan, which is commonly obtained from crustacean shells or fungal sources (Othman et al., 2021). Because it readily forms thin films and protective coatings, it is extensively studied for food packaging and biomedical applications (Othman et al., 2021).

Protein-based bioplastics are produced using various plant and animal proteins, such as soy protein, wheat gluten, and gelatine. These materials are investigated for sustainable food packaging, edible coatings, and specialized biodegradable products (Charles et al., 2022).

Cellulose acetate is produced by chemically modifying cellulose derived from plant materials. It is widely utilized in fibres, films, coatings, and various plastic products, with its rate of biodegradability depending heavily on its specific chemical composition and environmental conditions (Arias et al., 2024).

Algae-based bioplastics utilize algae or seaweed as primary sources of biomass and natural polymers. They are actively researched for sustainable packaging solutions and their potential to significantly reduce dependence on petroleum-based plastics (Costa et al., 2023).

Pectin-based bioplastic is made from pectin found within fruit cell walls, with citrus peels and apple pomace serving as common extraction sources. It can be used to form biodegradable films and offers an effective method to reuse fruit-processing waste within a circular economy framework (Visco et al., 2022).

Gelatin-based bioplastic is produced using gelatine mixed with water and typically a plasticizer such as glycerol. Upon drying, it forms a thin, plastic-like sheet that is exceptionally useful for studying material properties such as flexibility, tensile strength, and water absorption (Charles et al., 2022).

Lignin is a natural polymer found abundantly in plant cell walls, especially wood. It can be blended with other compatible polymers to develop composite materials, allowing researchers to study attributes like structural stiffness, ultraviolet resistance, and thermal stability (Othman et al., 2021).

Agricultural-waste-based bioplastics are developed using various organic waste materials, such as banana peels, rice husks, and sugarcane bagasse. They help valorize agricultural waste and reduce disposal challenges, with their overall performance and mechanical properties depending closely on the chosen raw materials and preparation methods (Visco et al., 2022).

Cellulose-based bioplastics are sourced from wood pulp, cotton, and other plant materials. They are inherently renewable and can be fully biodegradable, depending on the extent of chemical modification and protective coatings applied (Arias et al., 2024).

II. REVIEW OF LITERATURE

Niu et al., (2021) conducted a study entitled Preparation and Characterization of Biodegradable Composited Films Based on Potato Starch/Glycerol/Gelatin. The researchers prepared biodegradable films using potato starch, glycerol, and gelatin. They optimized the composition to improve the physical and mechanical properties of the films. Their results showed that the combination of starch, glycerol, and gelatin could produce flexible biodegradable films with measurable tensile strength and elongation. The study demonstrated the potential of potato starch as a raw material for biodegradable packaging materials.

Charles et al., (2022) investigated A Comprehensive Characterization of Biodegradable Edible Films Based on Potato Peel Starch Plasticized with Glycerol. The researchers used starch extracted from potato peels to prepare biodegradable films. They evaluated the films' physical, mechanical, and biodegradation properties. Their findings indicated that potato peel waste could be utilized as an inexpensive starch source for producing biodegradable films. The study also demonstrated the potential of these films for food-packaging applications and highlighted the environmental benefits of converting agricultural waste into useful products.

Patel et al., (2022) studied Potato Starch-Based Bioplastics Synthesized Using Glycerol–Sorbitol Blend as a Plasticizer: Characterization and Performance Analysis. The researchers prepared potato starch-based bioplastic films using different concentrations of glycerol and sorbitol. They investigated the effects of plasticizers on the mechanical, structural, and thermal properties of the films. The results indicated that combining glycerol and sorbitol could improve certain properties,

including flexibility and thermal stability. The study highlighted the importance of selecting suitable plasticizers to obtain bioplastic materials with desirable characteristics.

Charles et al., (2022) also demonstrated that potato peel starch-based films could undergo biodegradation under the soil and seawater conditions examined in their study. Their research emphasized the potential of potato-processing waste as a sustainable raw material. This approach may help reduce agricultural waste while providing a renewable source for biodegradable film production. However, the rate of degradation depends on the material's composition and environmental conditions.

Imoisili and Jen (2023) investigated Synthesis and Characterization of Bioplastic Films from Potato Peel Starch: Effect of Glycerol as Plasticizer. The researchers prepared bioplastic films using starch obtained from potato peels and different amounts of glycerol. They evaluated tensile strength, percentage elongation, and water absorption. Their results showed that changing the glycerol concentration influenced the flexibility and mechanical properties of the films. The study confirmed that potato peel starch could be used to develop low-cost bioplastic materials and highlighted the importance of optimizing the plasticizer concentration.

A study published in 2024 compared the physical and mechanical properties of starch-based bioplastics produced from potato pulp and potato peels. The researchers extracted starch from both sources and varied the quantities of water, glycerine, and acetic acid during film preparation. They examined characteristics such as density, opacity, water absorption, moisture content, tensile strength, and biodegradability. Their findings demonstrated that both potato pulp and potato peels could serve as raw materials for bioplastic production. The study also highlighted the importance of formulation in determining the final properties of the films.

A study published in 2025 investigated the structural, optical, and biodegradation properties of potato starch-based bioplastics prepared using different treatment conditions. The researchers examined the effects of neutral, acidic, and alkaline treatments on the resulting materials. Their findings showed that preparation conditions influenced the properties and degradation behaviour of the bioplastics. The research further supported the potential of potato starch as a renewable raw material for developing biodegradable materials.

The above studies demonstrate that potato starch is a promising raw material for producing biodegradable plastic films. Researchers have shown that glycerol and sorbitol can improve flexibility, while gelatin and other additives can modify the mechanical and physical properties of the final product. Potato peels are also a valuable alternative source of starch because their utilization can help reduce agricultural waste.

However, starch-based bioplastics have certain limitations, including sensitivity to moisture, water absorption, and relatively low mechanical strength in some formulations. Therefore, further studies are required to optimize starch concentration, plasticizer quantity, and preparation conditions to improve the quality and performance of potato starch-based bioplastics.

This project, "Bioplastic Production from Potato Starch," aims to prepare bioplastic using potato starch and evaluate its basic physical properties and biodegradation behaviour. This project may contribute to the development of low-cost, renewable alternatives for selected applications where conventional plastics are commonly used.

III. MATERIAL AND METHOD

Preparation of Bioplastic Films

The bioplastic films were formulated using two distinct methods: a starch-based formulation and an agar-starch composite formulation.

Method I: Potato Starch-Based Bioplastic Formulation

The potato starch-based bioplastic was prepared using 10g of potato starch, 100 mL of distilled water, 7 mL of vinegar, and 10 mL of glycerine. Initially, 10g of potato starch were dispersed in 100 mL of water in a glass beaker and stirred continuously until a uniform, lump-free suspension was formed. Seven milliliters of vinegar were then added to the mixture and thoroughly blended, followed by the incorporation of 10 mL of glycerine as a plasticizer, and the mixture was stirred until all components were homogeneously distributed. The beaker was subsequently heated gently under continuous mechanical stirring for approximately 10 to 15 minutes until the mixture underwent gelatinization, gradually transforming into a thick, glossy, and translucent gel while care was taken to avoid overheating, burning, or dehydration. The warm

gel was carefully poured onto clean, flat Petri dishes and silicon moulds, ensuring an even distribution to achieve a uniform thin layer. The cast films were allowed to dry undisturbed at room temperature in a clean, well-ventilated environment for 4 to 7 days, depending on ambient humidity and temperature conditions. Once completely dried, the films were carefully peeled from the casting surface and stored for subsequent physical and mechanical evaluation.

Method II: Agar-Based Bioplastic Formulation

Method II involved the preparation of an agar-based bioplastic using 1g of potato starch, 2.67g of agar powder, 2.67 mL of glycerine, and 100 mL of water. Potato starch (1g) was mixed thoroughly with 100 mL of water until completely dissolved without forming aggregates. Agar powder (2.67 g) was then added to the starch suspension and mixed uniformly. The mixture was heated gently with continuous agitation until the agar fully dissolved and the starch gelatinized into a uniform viscous solution, while minimizing excessive evaporation. Glycerine (2.67 mL) was added as a plasticizer and stirred thoroughly into the hot mixture.

The resulting mixture was poured onto clean, levelled Petri plates or flat moulds, and the samples were dried at room temperature or under controlled gentle warming until film formation was complete and the films could be peeled off cleanly.

Physical and Mechanical Characterization Methods

To evaluate the structural and mechanical performance of the synthesized bioplastic films, specific analytical procedures were performed.

Thickness Measurement The thickness of the dried bioplastic films was measured using a Vernier calliper with a least count of 0.001cm, with instrument zero-error corrections factored into the readings. Measurements were taken across multiple distinct points on each sample to ensure consistency, and mean thickness values were recorded for further analysis.

Elasticity Test (Mechanical Strength) Additionally, the mechanical properties, including elasticity and deformation behavior, of the bioplastic samples were assessed by measuring their physical dimensions, such as length, initial width, and thickness. Samples were subjected to a controlled tensile or mass-loading setup, and the applied mass, gravitational acceleration, initial length, cross-sectional area, and resulting elongation (Delta L) under load were recorded to calculate the Young's modulus (elasticity) of the bioplastic films.

IV. RESULT

Bioplastic was successfully prepared from potato starch and its properties were studied. The film was thin, transparent and flexible. Also, it had low tensile strength. And other properties were also studied.

Bioplastic was successfully prepared from potato starch. After drying, it formed a thin, smooth, slightly glossy film that was transparent to pale white in colour. The film was flexible and could be bent without breaking, owing to the glycerol added as a plasticizer. Its strength was moderate, and it tore when pulled hard, so it was weaker than conventional petroleum-based plastic. Overall, the potato starch bioplastic is low-cost, flexible and eco-friendly, though it has lower strength and water resistance than synthetic plastic.

Table 1: Bioplastic physical properties

Sr. No.	Property	Observation
1.	Appearance	Translucent, smooth, slightly glossy
2.	Flexibility	Bends without breaking
3.	Thickness	About 0.6 mm
4.	Tensile strength	Low, tears easily when stretched

2: Thickness of Biofilms

Sample	Mean Thickness (cm)
Sample 1	0.06
Sample 2 (ABP-1)	0.061
Sample 3 (Agar-based)	0.006

The thickness of three distinct samples was measured using a vernier caliper accounting for an instrumental error of −0.010 cm:

Sample 1: The corrected thickness readings were 0.085 cm, 0.045 cm, and 0.050 cm, resulting in a mean thickness of 0.060 cm.

Sample 2 (ABP-1): The corrected thickness readings were 0.060 cm, 0.056 cm, and 0.067 cm, yielding a mean thickness of 0.061 cm.

Sample 3 (Agar-based): The corrected thickness readings were 0.005 cm, 0.009 cm, and 0.003 cm, giving a mean thickness of 0.006 cm.

V. DISCUSSION

The successful preparation of bioplastic film from potato starch suggests the viability of utilizing starch as a sustainable alternative to conventional petrochemical plastics. Following the gelatinization and drying process, the resulting film exhibited favorable physical characteristics specifically, being thin, smooth, transparent to pale white, and flexible. Glycerol, functions as an effective plasticizer by inserting itself between the starch polymer chains, reducing intermolecular forces, and enhancing chain mobility (Patel et al., 2022).

However, mechanical evaluation revealed that the potato starch-based bioplastic possesses a relatively low tensile strength, rendering it prone to tearing under high stress compared to synthetic plastics. This behavior aligns with findings reported in previous literature, where starch-based films exhibit lower tensile strength and higher elongation depending on plasticizer concentrations (Singh et al., 2025). The inherent hygroscopic nature of starch and polyol plasticizers also contributes to lower water resistance, limiting the material's application in high-moisture environments. Overall, while potato starch bioplastics offer significant environmental advantages such as biodegradability, low production cost, and eco-friendliness enhancing their mechanical strength and moisture barrier properties remains a crucial area for further optimization (Singh et al., 2025; Patel et al., 2022).

The moderate to low tensile strength observed in starch-based bioplastics stems from the inherent structural characteristics of native polysaccharides and the inclusion of plasticizers like glycerol (Rahim et al., 2020). Glycerol inserts itself between polymer chains, diminishing intermolecular hydrogen bonding and enhancing chain mobility, which successfully imparts flexibility but inherently reduces tensile strength and stiffness (Jayarathna et al., 2022).

To overcome limitations related to mechanical strength and water resistance, recent literature emphasizes structural reinforcement through the incorporation of specialized fillers or nanocomposites (Marta et al., 2022). Introducing reinforcing agents helps distribute stress more uniformly across the matrix, creating denser networks that improve both tensile resistance and durability (Marta et al., 2022; Jayarathna et al., 2022).

VI. SUMMARY

Biopolymer films were synthesized from natural and renewable raw materials such as potato starch, with glycerol added as a plasticizer to improve flexibility. The mixture was heated and stirred, poured onto a flat surface and dried to obtain thin films. Different samples were prepared, including an agar-based sample. The films were then characterized by their appearance, thickness, flexibility, water absorption and biodegradability. Thickness was measured with a screw gauge at three positions for each sample, and the mean value was calculated.

VII. CONCLUSION

Biopolymer films were successfully synthesized from low-cost, renewable materials. The films were thin, smooth and flexible, and their thickness was fairly uniform, though it varied slightly between samples depending on composition. Compared with petroleum-based plastics, they showed lower strength and water resistance, but they are biodegradable and eco-friendly, which makes them a promising alternative to conventional plastic. Their properties can be improved further by optimizing the plasticizer content, adding other biopolymers or additives, and using advanced characterization techniques such as FTIR and tensile strength testing.

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