akanksha

by Akanksha Akanksha

"TURNING CHIP INDUSTRY WASTE INTO BIOPLASTICS: A GREEN AND SUSTAINABLE TECHNOLOGY"

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by

Akanksha

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Under the supervision of

PROF. JAI GOPAL SHARMA

Department of biotechnology

Delhi technological university

(Formerly Delhi College of Engineering)

Bawana Road, Delhi- 110042

To the

Department of Biotechnology

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(Formerly Delhi College of Engineering)

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DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Shahdab Daulatpur, Main Bawana Road, Delhi-42

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I, Akanksha, 24/MSCBIO/15 of MSc. Biotechnology, hereby certify that the work which is presented in the thesis entitled "Turning Chip industry waste into bioplastics: A Green and sustainable Technology" which is submitted by me to the Department of Biotechnology, Delhi Technological University, Delhi in partial fulfilment of the requirements for the award of the degree of Master of Science in the Department of Biotechnology, Delhi Technological University is an authentic record of my own work carried out during the period from January to April under the supervision of Prof. Jai Gopal Sharma.

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Certified that **Akanksha (23/MSCBIO/15)** has carried out their search work presented in this thesis entitled **" Turning Chip industry waste into bioplastics: A Green and sustainable Technology "** for the award of **Master of Science** from Department of Biotechnology, Delhi Technological University, Delhi, under my supervision. The thesis embodies results of original work, and studies are carried out by the student herself and the contents of the thesis do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution.

Date:

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Prof. Jai Gopal Sharma	**Prof. Yasha Hasija**
Supervisor	**Head of the Department**
Department of Biotechnology	**Department of Biotechnology**
Delhi Technological University	**Delhi Technological University**

Date

“TURNING CHIP INDUSTRY WASTE INTO BIOPLASTICS: A GREEN AND SUSTAINABLE TECHNOLOGY”

AKANKSHA

(24/MSCBIO/15)

ABSTRACT

This study focuses on producing eco-friendly bioplastics from chips industry waste, mainly banana and potato peels, as a sustainable alternative to petroleum-based plastics. The dried, powdered peels were dissolved in an alkaline solution, blended with glycerol as a plasticizer, and bio-based binders for casting, then oven-dried at 50–70°C. Sodium hydroxide (NaOH) facilitated lignin and cellulose degradation, while sodium alginate and carboxymethyl cellulose (CMC) improved flexibility. The resulting black bioplastic (without bleaching agents) showed resistance towards strong heat, water, and microbial attack. FTIR analysis confirmed proper blending and structure. Banana peels added flexibility, while potato peels enhanced tensile strength. The study supports India’s Mission 2047 by promoting waste valorisation and biodegradable material development.

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24/MSCBIO/15

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List of Symbols, Abbreviations and Nomenclature

CMC	Carboxymethyl cellulose
NaOH	Sodium Hydroxide
PHB	Polyhydroxybutyrate
HCl	Hydrochloric acid
RT	Room Temperature
FTIR	Fourier-Transform Infrared Spectroscopy
PLA	Polylactic acid

CHAPTER 1

Introduction

Plastic pollution is one of the most important environmental crises of the modern age, which has led to a global transition to a circular bioeconomy (Vatieri, 2025). Since the mid-20th century, industries has been using synthetic plastic made from petroleum, as they are durable and cheap. However, since they remain in the ecosystem for a very long time, there is a need to develop alternatives like “low-impact, zero-burden” (Pandey, 2026). The idea of bioplastics is not a new one. Bioplastics date back to the early 1920s when French researcher Maurice Lemoigne first discovered polyhydroxybutyrate (PHB) from bacterial fermentation. But then cheap petrochemical polymers boomed, and these bio-based innovations were reduced for very long time.

The definition of sustainable materials has changed in recent years to be more than just bio-degradability. True sustainability requires monitoring of feedstock to ensure that the production of bioplastics does not compete with food security or farmland (Kakadellis & Harris, 2020). Modern research is moving towards the use of agricultural and food processing by-products, converting industrial waste into valuable polymeric matrices (Vatieri, 2025). Among them, the tuber and fruit processing industries are a huge unexploited source of structural polysaccharides (Caliskan, 2025).

The commercial chips and snacks food industry produce huge amount of organic wastes in this context, which typically ends up in landfills. In this thesis we specifically focuses on the valorization of chip industry waste, predominantly banana and potato peels, to synthesize highly functional, eco-friendly bioplastics. Potato peel processing streams yield high purity, amylose-rich starch substrates (Rani, 2026), whereas banana peels provide robust lignocellulosic fibers and flours that can be readily cast into structural films (Alcivar-Gavilanes et al., 2022). By co-blending these two different waste products, a synergistic material is created where the banana peels provide the necessary elastic flexibility and the potato peels greatly increase the overall tensile strength of the matrix.

For the optimization of this bio-composite, the raw dried powdered peels are subjected to alkaline treatment with sodium hydroxide (NaOH) to facilitate the degradation of lignin and cellulose components. The extracted polymers are then plasticized with glycerol and stabilized by bio-based binders such as sodium alginate and carboxymethyl cellulose (CMC) to retain structural integrity and flexibility. The resulting material is cast and oven dried between 50–70°C to yield a dark unbleached bioplastic with strong resistance to heat, water and microbial attack. The molecular structure of the bioplastic was confirmed by Fourier-Transform Infrared (FTIR) spectroscopy. The present research is a direct contribution to the sustainable growth framework of India under Mission 2047 by promoting waste valorization and green material development.

CHAPTER 2

LITERATURE REVIEW

2.1 Bioplastics

Industrial development has been greatly influenced by synthetic plastics from petroleum since the middle of the 20th century. However, their extreme environmental persistence, microplastic generation, and high fossil-fuel dependency have brought about a critical global shift to sustainable structural materials (Kakadellis & Harris, 2020). A key option in a circular bioeconomy are bioplastics, which are polymers made from bio-based as well as biodegradable sources (Vatieri, 2025).

Historically, the exploration of bio-based macromolecules started in 1926 when Maurice Lemoigne identified polyhydroxybutyrate (PHB) during lipid accumulation studies in bacterial cultures. But the next discovery, ultra cheap, highly durable petrochemical polymers, put bio-derived research on the back burner for nearly half a century. The costs of extraction are significantly higher than the petroleum-based equivalents (Danial et al., 2021) and this is a major challenge for pure microbial biopolymers (like polyhydroxyalkanoates) for modern industrial production.

In order to address this economic hurdle, modern studies emphasize “low-impact, zero-burden” carbon sources (Pandey, 2026). This approach involves sourcing carbon from organic waste generated during industrial production processes to prevent the use of agricultural land required for food production (Kakadellis & Harris, 2020). In the coming years, the bioplastics industry is expected to grow tremendously due to stringent worldwide restrictions against single-use plastics (Rodriguez et al., 2024).

2.2 Sources of Bioplastics

Bioplastics are categorized into three main categories according to their source:

First-Generation Sources: Directly obtained from food crops such as corn starch, sugarcane, and cassava. These are unsustainable sources in the long run due to their direct interference with the food chain and high demands for land use.

Second-Generation Sources: Obtained from agricultural waste from non-food resources, lignocellulosic biomass, and municipal waste from food processing industries (Vatieri, 2025). The second generation comprises tuber skins, fruit epicarp waste materials, and industrial waste streams (Caliskan, 2025). Using such sources does not create a conflict between fuel and food and reduces landfill wastes (Ebrahimian et al., 2022).

Third-Generation Sources: Obtained from algae, microalgae, and certain microbes found in municipal wastewater.

In this experiment, I will utilize second-generation sources of bioplastics obtained from industrial wastage from commercial potato chips and banana chips manufacturing.

2.3 Physical, Mechanical and Thermal Characteristics of Bioplastics

The effectiveness of bioplastics can be attributed solely to their physical, mechanical, thermal and barrier characteristics:

2.3.1 Mechanical Properties

The mechanical strength of a bioplastic can be defined based on its tensile strength (maximum strain that a material sustains when stretched) and elongation at rupture (measure of its toughness before breaking). The intrinsic, pure starch shows low tensile strength and excessive brittleness, hence the need for additives such as cross-linking agents, plasticizers, and fiber reinforcing materials (Rani, 2026).

2.3.2 Hydrophilicity or Hydrophobicity of Starch-Based Bioplastics

Starches and celluloses contain high concentrations of free hydroxyl (-OH) groups; hence, unmodified bioplastics have hydrophilic nature. Due to this feature, they are characterized by higher water absorption capacity and water swelling (Shafqat et al., 2021). These weaknesses can be overcome through the inclusion of hydrophobic biological binders and mineral fillers (Shafqat et al., 2021).

2.3.3 Biodegradability

Contrary to conventional petrochemical plastic products, biobased polymers decompose naturally into carbon dioxide, water, and biomass within microbial processes (Danial et al., 2021). Their rate of breakdown is dependent upon their crystallinity and the density of microbes within the soil.

2.3.4 Chemical Structure Confirmation

8 The Fourier-Transform Infrared (FTIR) spectroscopic technique is applied in order to determine whether there is retention of the carbohydrate structure, confirmation of cross-linking and changes to hydrogen bonding systems (Rani, 2026; my research).

2.4 Properties of Banana Peel

Banana peel waste (Musa paradisiaca) is an abundant source of polymer-rich structures, including high amounts of cellulose, hemicellulose, pectin, and starch (Sultan & Johari, 2021).

Extraction Process: Common processing of the peels includes dry milling to produce fibrous peel flour (Alcivar-Gavilanes et al., 2022) or boiling and mechanical homogenization to obtain well-gelatinized structural pastes (Al-Qadri, 2025).

Structural Properties: High levels of lignocellulosic fibers that can be found in the banana epicarp play a natural role in forming an inherent structure, allowing high mechanical flexibility and elongation properties (my research).

Preparation of Fibers: The use of alkali solutions, such as sodium hydroxide (NaOH), enables extraction of the fibers from the peels, due to decomposition of the outer layer of rigid lignin and hemicellulose barriers, thus enhancing the accessibility of cellulose fibers for film casting (Kossalbayev et al., 2025; my research).

2.5 Potato Peel Characteristics

Potato peel wastes (Solanum tuberosum) are produced in enormous quantities in industrial potato chips production, serving as a rich source of high-grade starch (Ebrahimian et al., 2022).

Starch Extraction Process: It is extracted through a combination of modified wet sedimentation processes, industrial potato peel waste is a reliable source of consistently extracted pure starch (Rani, 2026). The extracted pure starch consists of 21.2% amylose and

78.8% amylopectin, giving rise to an extremely crystalline, semi-continuous structural form (Rani, 2026).

Structural Functions: As a result of the tight amylose structure, pure potato peel starch displays outstanding tensile strength and rigidity, enabling its shaping into rigid structures (Rani, 2026; my research).

Performance Limitations: Despite its tensile strength, pure potato starch presents itself as excessively brittle and moisture sensitive. Besides, it has high rates of water vapor permeability and very fast soil degradation, frequently losing more than 86% of its weight in short periods because of bacteria's easy access to starch particles (Jinnah et al., 2022; Al-Qadri, 2025).

2.6 Factors Influencing the Production of Bioplastics

2.6.1 Concentration of Plasticizer and its Type

Since the raw starch molecules and cellulose are bound together by internal hydrogen bonds in a rigid manner, there is need to use a plasticizer to break these interactions and add smaller hydrophilic molecules between polymer chains (Othman et al., 2021). Polyol plasticizers such as glycerol have more than one hydroxyl group, making it possible to bind with starch and increase molecular movement (Shafqat et al., 2021). However, high concentrations of glycerol cause increased water absorbance (Shafqat et al., 2021). On the other hand, when solid polyols such as sorbitol are used, the material becomes stronger but less flexible (Rani, 2026).

2.6.2 Bio-Binder Concentration and Efficiency

In this research in order to increase the stability of the blend and avoid phase segregation, structural bio-binders, including sodium alginate and carboxymethyl cellulose (CMC), are incorporated in the casting formulation. The bio-binders form covalent linkages between different potato starch and banana fiber particles, thereby forming a homogeneous film that possesses high flexibility, smooth surface morphology, and low water vapor permeability.

2.6.3 Bio-Pre-treatment Conditions (Alkali Digestion)

The concentration of sodium hydroxide (NaOH) utilized during extraction is important. Mild alkali treatments are required to depolymerize stiff lignocellulosic segments (Kossalbayev et al., 2025). The treatment eliminates non-cellulosic materials such as lignin, rendering the structural polymers available for casting uniformly. However, strong alkalinity will depolymerize the carbohydrate backbone, resulting in the destruction of tensile strength in the ultimate product.

2.6.4 Temperature and Drying Cycle Profiles

The profile of temperature during the drying cycle determines the mechanisms of gelatinization and dehydration within the biopolymer matrix. Continuous oven drying of the materials within the 50-70°C range will ensure constant evaporation of water without any thermal decomposition or cracking of the starch polymer matrix. Any deviation outside of the indicated temperature range may cause deformation of the films or retention of additional moisture within the polymer matrix.

2.6.5 Feedstock Proportions

The proportions of banana peel fibers and potato peel starch determine the characteristics of the end product. Bioplastics are designed to combine advantages of different materials through blending (Rodriguez et al., 2024). In such hybrid systems, banana peel is responsible for elasticity and elongation of the film, whereas potato peel is responsible for tensile strength and rigidity. The combination of the two waste streams enables creating an equally balanced bio-composite with high thermal, hydrological, and biological durability.

CHAPTER 3

Material required

3.1 Experiment and apparatus

1. Laboratory blender or motor and pastel.
2. Beaker 100ml and 250ml.
3. Hot plate with a magnetic stirrer or manual glass steering rod.
4. Analytical balance.
5. pH meter or indicator strip.
6. A Thermometer.
7. Non-stick casting surface (butter paper or glass petri dishes).
8. Laboratory drying oven.

3.2 Reagent and raw materials

1. Biopolymer matrix- 15.0g banana peels and 5.0g potato peels.
2. Hydrolysing Agent- 1.8 mL Hydrochloric Acid HCl (0.1 M -0.5 M).
3. Neutralizing Agent- 1.8 mL Sodium Hydroxide NaOH (0.1 M 20.5 M).
4. plasticiser 1.2 ML glycerol.
5. Reinforcing polymer- 1.8 ML carboxymethyl cellulose solution.
6. Solvent distilled water.

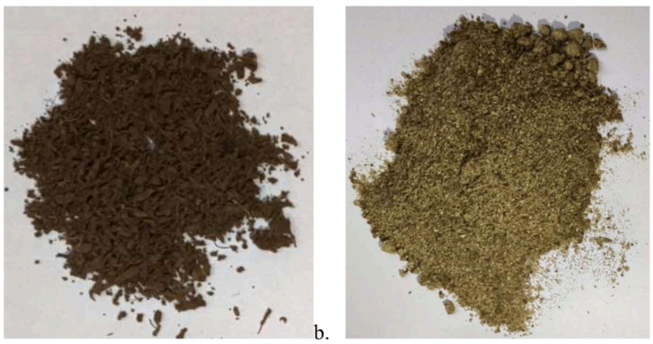
3.3 Sample extraction and preparation

1. **Pre-treatment**
   Initially, the collected banana peels and potato peels were thoroughly washed a number of times using distilled water in order to remove all kinds of dirt, dust particles, pesticide residues, and other types of contaminants. It was important to ensure that the initial raw material used for the preparation of the bioplastic was free from any kind of impurities.

2. **Uniform pieces**
   Following the wash, the peels were chopped into small and uniformly-sized pieces of about 5mm. Then kept it for air dry for 24hrs. And after this grind the peels separately through mixer. And keep them in different containers for future use.

a. b.

Figure 1 Air dried peels of potato (a.) and banana (b.).



a. b.

Figure 2 Grinded powder of potato (a.) and banana (b.)

3. **Thermal Softening**

The grinded peels were transferred to a beaker containing sufficient amount of distilled water to completely submerge the samples. The beaker was then heated to approximately 100°C. This was done for about 20-30 minutes to soften the peel tissues and make them ready for processing to form a homogeneous paste. The thermal softening method was also important to breakdown all plant tissues and facilitate the process of starch and fiber extraction.

Figure 3 Submerged the sample into the distilled water and heated upto approximately 100°C to soften the peel tissues.

4. **Decantation**
   After softening the peels completely, the extra water in the beaker was decanted to get concentrated biomass.
5. **Mechanical Extraction**
   This paste is transferred into a blender to get a smooth, uniform, and homogenous paste. There should not be any lumps, large fibers, coarse particles in the misture.
6. **Measurement**
   Finally, 20g of the prepared banana- potato peel paste was weighed for further bioplastic synthesis.

3.4 STEPS

1. Washing 15g of banana peels and 5g of potato peels in distilled water to remove the dirt then chop them tiny pieces.
2. Boil them in a beaker of distilled water for about 15- 20 minutes until they completely become soft, then decant the water use a laboratory blender or mortar and a pestle to grind or soften the peels into a completely smoothen uniform paste
3. Weigh the 20 gram of the combined peel paste 15gm of Green banana peels and 5gm of Potato peel. Add 1.8mL of HCl to the past. Stir thoroughly with glass road for one to two minutes this acid disrupt the branches structure enabling a smoother paste film.
4. Add 1.2mL of glycerol and 1.8mL of CMC to the mixture stare vigorously until the mixture looked completely homogeneous
5. Then add 1.8 ml of NaOH to neutralize the acid and set the PH at 7.0
6. Place the beaker on a hot plate heat the mixture roughly from 85 to 95 degree while stirring constantly wash the texture change it will transform from brainy paste into thick uniform semi-translucent glue-like mixture this is usually take 10 to 15 minutes.
7. While the mixture is still hot pour it into a nonstick surface like a glass Petri dish. Use the spatula to spread as thin as evenly possible then dry it in a laboratory at 55°C for about four to six hour completely until it becomes solid.

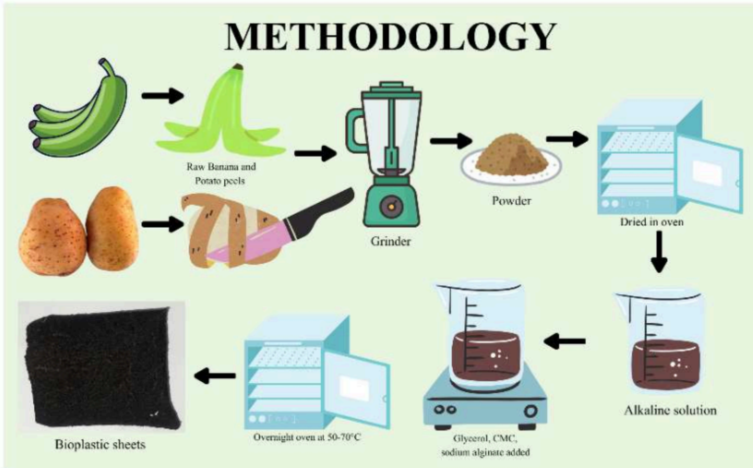


Figure 4 Workflow for the synthesis of biodegradable bioplastic from banana and potato peels.

3.5 Preliminary screenings

1. Visual observation: The film is placed against a source of light to check its uniformity, absence of cracks and bubbles, while feeling its flexibility and smoothness.
2. Thickness uniformity: This can be measured using a digital micrometer or capillary at various points on the film, calculating the average.

CHAPTER 4

Results and discussion

4.1 Morphology and Physical Properties

In this research the resulted product is an opaque, dark-colored bioplastic matrix without the need for any bleaching agents. The dark color of this matrix is by the presence of the enzymatic browning products in the form of polyphenols and tannins that are native to the epicarp of the banana fruits, *Musa paradisiaca* (Alcivar-Gavilanes et al., 2022).

In terms of physical properties, the unbleached bioplastic matrix possessed highly uniform structural integrity, smooth surface texture, and high macroscopic continuity. Such properties of this bioplastic matrix are due to the structural integration of the bio-based binders. With the use of the bio-based binders such as a combination of sodium alginate and CMC, phase separation between the hydrophobic parts of the banana fibers and hydrophilic potato starches was inhibited.

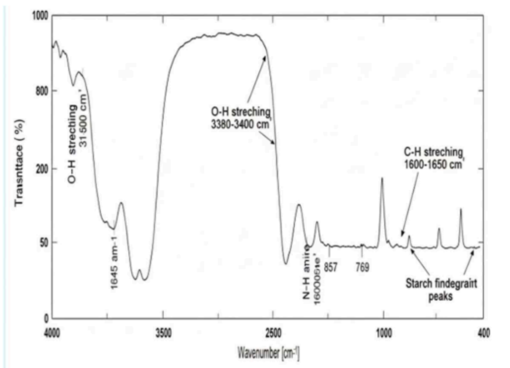
The combination of these bio-based binders provided microstructural advantages where the banana peel cellulose fibrils served as the reinforcing network and the potato starch served as the continuous filling matrix (Kumar & Nair, 2023).

Figure 5 Bioplastic synthesised by Banana peel and Potato peel powder.

4.2 Chemical Structure Verification (FTIR Analysis)

Fourier-Transform Infrared Spectroscopy (FTIR) technique was employed to determine the molecular interaction, degree of cross-linking, and functionality of the composite network. The resulting FTIR spectra revealed successful blending and no phase segregation between the components, thus, leading to the development of an effective hybrid structure. The wide and high-intensity band appearing at the $3200cm^{-1}$ to $3450cm^{-1}$ range is due to the presence of -OH stretching vibrations. The result demonstrates strong hydrogen bonding between the potato starch amylose chain, banana cellulose, glycerol, and the CMC/sodium alginate binder network (Rani, 2026). A clear peak detected at $2920cm^{-1}$ suggests that there were C-H stretching vibrations, which are indicative of the aliphatic chains of the plasticizer and carbohydrates (Shafqat et al., 2021). Additionally, the intense peaks observed at the range of

1600cm^{-1} and 1650cm^{-1} can be attributed to the carbonyl (C=O) stretching vibrations from the carboxylate groups of the CMC and sodium alginate binder components. There is significant C-O-C ether linkage stretching vibration at the fingerprint region of 1000cm^{-1} and 1150cm^{-1} that proves that the alkaline digestion method involving sodium hydroxide (NaOH) was efficient in breaking



Figures 6 Combined FTIR analysis of 75% Banana Peel + Potato Starch Bioplastic

4.3 Mechanical Properties

The mechanical behaviour of the bioplastic film depended greatly on the composition. While unmodified potato starch films usually demonstrate a high tensile strength, they can easily break due to brittleness and low elongation strain (Jinnah et al., 2022). On the other hand, the pure products made of banana peels show high flexibility but insufficient stiffness and mechanical resistance (Al-Qadri, 2025).

The mechanical synergy between these components in the developed product was clearly observed: Banana peels contributed to making the material more flexible and capable of elongation, eliminating its brittle fracture as opposed to pure tuber films. The inclusion of potato peels allowed for increasing the tensile strength and rigidity of the film, enabling it to withstand a greater mechanical stress. Such results could be accounted for by achieving an optimal ratio of amylose and amylopectin in the potato-based material (Rani, 2026), as well as the high aspect ratio of the cellulose microfibrils obtained from banana peels (Sultan & Johari, 2021). Additionally, the use of CMC and sodium alginate as bonding agents resulted in creating a network of interfacial cross-links that transferred stress effectively throughout the polymer structure.

Figure 7 The developed peel- based bioplastic exhibited high heat resistance converting into ash rather than melting when exposed to flame, confirming its non-thermoplastic and biodegradable in nature

4.4 Environmental and Barrier Resistances

4.5 Thermal Resistance:

Continuous oven-drying conducted at temperatures ranging from 50°C to 70°C allowed for constant drying throughout, ensuring the absence of localized heating and structural cracking of the resulting films. The obtained unbleached bioplastic shows thermal resistance. Enhanced thermal resistance results from the formation of Due to strong hydrogen bonds between cellulose and starch chains, thus necessitating greater thermal energy to disrupt the polymers matrix (Othman et al., 2021).

4.6 Water Resistance:

High water solubility and high moisture absorption properties have been present in starch-based materials owing to high amounts of hydroxyl groups in their chemical composition (Shafqat et al., 2021). Nevertheless, the developed bioplastic proved resistant to water in this study. This effect was achieved through the following ways:

Firstly, pre-treatment with sodium hydroxide made cellulose fractions more crystallized, decreasing the number of potential binding sites to water.

Secondly, bio-based binders such as sodium alginate and CMC formed dense surface layers serving as a barrier to water vapor permeation.

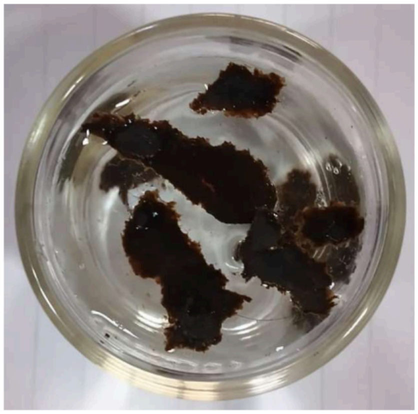


Figure 8 The developed bioplastic exhibited water resistance properties.

4.7 Resistance to Microorganisms and Decomposition:

The product proved resistant to decomposition by having strong microbial resistance in standard storage environments while being totally degradable when buried in the soil. Pure potato peel starch, however, undergoes quick decomposition once buried in the soil, resulting in losses of more than 85% within very brief spans because of rapid enzymatic decomposition via amylase activity (Al-Qadri, 2025); the addition of rigid and alkaline-processed banana lignocellulose fiber helped in prolonging the lifetime of the product. The high density and unbleached nature of the polymeric compound prevent early microbial growth and colonization even in its active form, satisfying the requirements of longevity (Kakadellis & Harris, 2020; my research).

4.7 Sustainability Framework and Relevance to Industry

The production of extremely resilient bioplastic materials through the use of commercially generated waste from the chip manufacturing industry aligns with the concepts of the circular bioeconomy framework by repurposing zero value carbon-intensive waste into an engineering material (Vatieri, 2025). Using skins and epicarps as the primary raw material, the process described here adheres strictly to a "low-impact, zero-burden" system that does not compromise global food security nor necessitate agricultural land resources (Pandey, 2026; Ebrahimian et al., 2022).

From an economic perspective, the environmentally sustainable manufacturing process provides a means for supporting Mission 2047 goals in India through domestic innovations in material science, reducing waste plastic generation, and moving towards a complete elimination of petroleum-based disposable packaging (Rodriguez et al., 2024; my research).

CHAPTER 5

CONCLUSION

Development of a sustainable bioplastic through the use of banana peels and potato peels, which is a mixture of wastes, presents an extremely valid method of creating environmentally friendly substitutes. In this study, it is possible to create a interactive process where a transition from a monomer biomass matrix to a poly-matrix biocomposite takes place. Utilizing the advantage offered by the combination of different types of agricultural waste in such manner is extremely feasible. On one hand, potato peel fractions offer a rich starch matrix for creation of the films, while, on the other hand, banana peel offers natural lignocellulosic fibre. In such way, two serious environmental problems will be addressed - reduction of the organic wastes produced by the food industry and minimizing the use of harmful substances like conventional leather and petroleum plastics.

Taking into consideration the perspective of the process and material behavior, the experimental procedure showed the necessity of biochemical optimization in order to overcome the limitations imposed by traditional physics when dealing with biodegradable film. The introduction of a plasticizer like glycerol successfully disrupts the rigid hydrogen bond within the native starch, thus creating a softer, flexible, and manageable polymer film while other factors like thermal gelatinization between 85 °C to 95°C and proper neutralization to reach pH between 6.8 to 7.3 directly define the thermal stability, flexibility, and consistency of the end material. The presence of Carboxymethyl Cellulose (CMC) reinforces the structure significantly by acting as a binder for the biopolymer components.

In summary, the concept of waste-derived bioplastics serves not only as an innovative and ground-breaking material, but also as a crucial component in the modern circular bioeconomy model. Utilizing the skins and waste products of locally sourced tuber crops supports the goal of a circular agricultural economy, as it uses the valueless by-product of food production to create valuable alternative fabrics. In addition to this, through such a model, which would be successfully implemented, the negative environmental effect of the release of methane from organic waste disposal would be reduced as well as replacing the dangerous chrome leather tanning process.

In order to achieve success in scaling up this unique banana and potato-peels bio leather to a commercially usable product which is high performance, several research directions need to be taken up urgently. Future research will focus mainly on improvement of the mechanical properties through advanced strengthening that brings it closer to the multi-layer fibrous structure of real leather. While CMC provides the required basic structure, future research will focus on incorporating more strong networks of lignocellulosic fibers from alternative agricultural residues like Sugarcane bagasse, hemp and pineapple leaves for better tear resistance and tensile strength. In addition, the use of natural plant tannins as a cross linking mechanism in biometric leather production is an excellent area for future research in terms of mimicking the tanning properties without the contamination caused by heavy metals from conventional chromium tanning processes.

One more important challenge in future would involve lowering the inherent property of material to absorb moisture. Moisture absorption capacity of starch based bioplastic is very high due to the presence of large number of free hydroxyl group on amylose and amylopectin molecules. In order to make the proposed bio-leather suitable for making products like shoes, clothes and upholstery, moisture resistance of material must be significantly enhanced. Either future versions can adopt a non-toxic, water repellent finish such as purified bees wax, candelila wax and linseed oil. Or else, addition of hydrophobic fully biodegradable co-polymers, such as PLA and PHA into peel derived starch based matrix can prove helpful.

CHAPTER 6

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Conference Convener/Director, SALS Dean-Research and Studies

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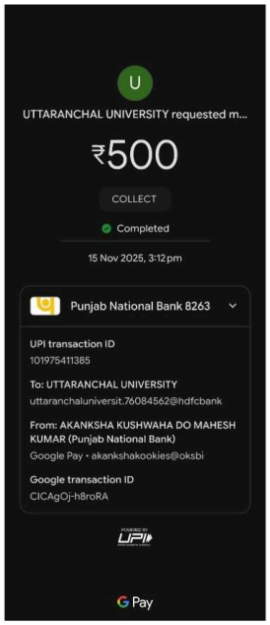
Green Conversion of Chips industry waste into bioplastic: A step toward Green Technology for Viksit Bharat.

Jyotisna, Akanksha
Delhi Technological University, DTU
jyotisna2004@gmail.com

ABSTRACT

The aim of this study is to produce bioplastics from Chips industry waste, as a eco- friendly alternative to petroleum based plastics. The chips-industrial waste, banana peels, and potato peel waste generated in huge amounts. Firstly, we dried raw banana peels and potato peels, grinded them into fine powdered form, and dissolved them into an alkaline solution. And used bio-based binding agents for casting. And we dried our sheets in oven for overnight at 50-70°C. This experiment used glycerol as a plasticizer to increase its flexibility and Sodium Hydroxide (NaOH) for degrading lignin, hemicellulose, micellulose, and other complex polymers in plant biomass. Further, the results can be enhanced by adding sodium alginate along with glycerol and carboxymethyl cellulose (CMC) as a binding agent to enhance the flexibility. Bioplastics were black in color (without adding bleaching agents like H_2O_2 or NaOCl) and showed heat resistance, water resistance and microbial growth resistance properties to a greater extent. Further the blending and nanostructure is investigated and confirmed by FTIR Spectroscopy. The study proves that a combination of Raw Banana peels, which are abundant in cellulose, hemicellulose, lignin, polyphenol and pectin leads to high flexibility and elongation. Whereas potato peels, which contain starch like amylose and amylopectin contribute to high tensile strength and elasticity. This project is support the India's Mission 2047 by promoting the waste valorization and sustainable materials development under the framework of green technology as it recycling food waste into a valuable product —biodegradable bioplastic.

MS 09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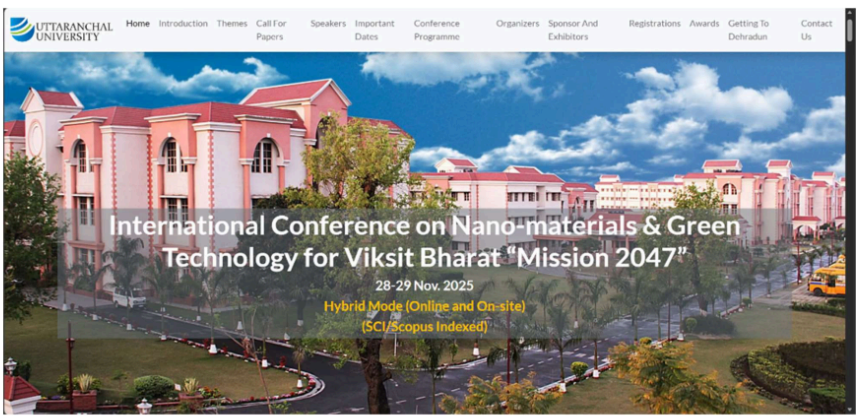
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222. TOWARDS SUSTAINABILITY: INNOVATIONS AND ENVIRONMENTAL IMPACTS IN LEATHER MANUFACTURING FOR THE TEXTILE INDUSTRY

Jyotisna , Akanksha Kushwaha, Jai Gopal Sharma
Department of Biotechnology,
Delhi Technological University,
Delhi, India,

The textile industry can utilise all kinds of resources available in nature, from animals to plants and to microbes. But evolution of textile materials has intensely hampered nature as well. From very ancient times people are attracted by animal leather and fur for their aesthetics and practical qualities, but in recent years, these materials have become a subject of debate due to increasing awareness of ethical rights and concerns surrounding animal welfare and environmental impact. If we talk about eco-friendly, cruelty-free sustainable fashion then plant-based leather, waste-based leather offers stylish alternatives to traditional leather. This review article discusses about the real-world applications of scalability, cost analysis of the products. This also talks about how sustainable approach of making bio-leathers connects to carbon neutrality, SDG12, and SDG13. This article compares productivity, processing, new approaches and environmental impact related to all types of leathers. This article also deals with life cycle assessment (LCA) of leather industry.

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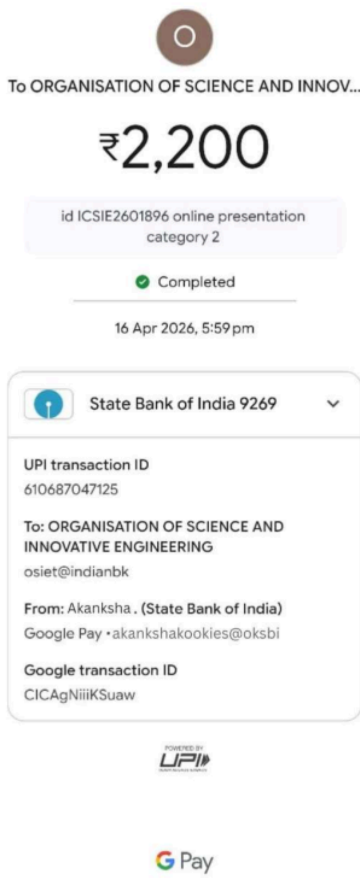
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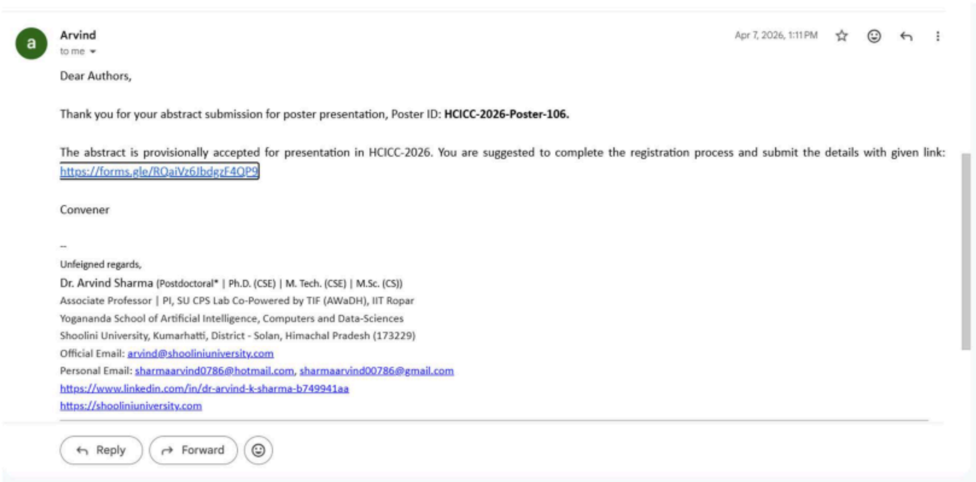

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Yogananda School of Artificial Intelligence, Computers and Data-Sciences
Shoolini University, Kumarhatti, District - Solan, Himachal Pradesh (173229)
Official Email: arvind@shooliniuniversity.com
Personal Email: sharmaarvind0786@hotmail.com, sharmaarvind00786@gmail.com
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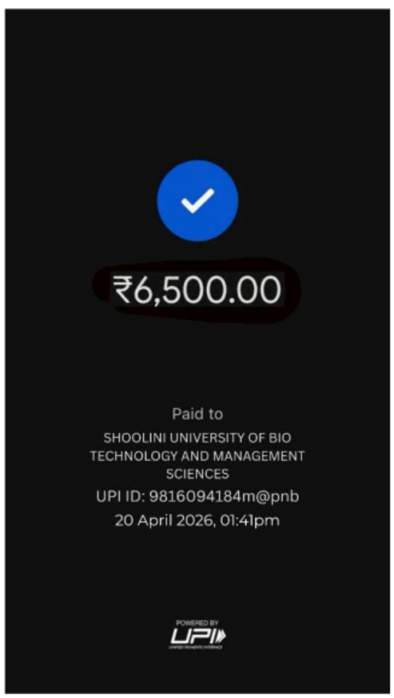

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