"Innovative Approaches to Sustainable Packaging Design: Reducing Environmental Impact through Creative Branding"

BY

Raita Huda Mim
ID: 201-40-672

This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Multimedia and Creative Technology

Supervised By

Mr. Mizanur Rahman
Assistant Professor
Department of MCT
Daffodil International University

DAFFODIL INTERNATIONAL UNIVERSITY

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APPROVAL

This project titled **"Innovative Approaches to Sustainable Packaging Design: Reducing Environmental Impact through Creative Branding"**, submitted by Raita Huda Mim to the Department of Multimedia and Creative Technology, Daffodil International University, has been accepted as satisfactory for the partial fulfilment of the requirements for the degree of B.Sc. in Multimedia and Creative Technology and approved as to its style and contents. The presentation held on 11 January 2024.

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Consultant (graphics) SDMA Project, ICT Division
Adjunct Faculty of Fine Arts
University of Dhaka

DECLARATION

I hereby declare that, this project has been done by me under the supervision of **Mr. Mizanur Rahman, Assistant Professor, Department of Multimedia and Creative Technology**, Daffodil International University.

I also declare that neither this project nor any part of this Project has been submitted elsewhere for award of any degree or diploma.

Supervised by:

____

Mr. Mizanur Rahman
Assistant Professor
Department of MCT
Daffodil International University

Submitted by:

____

Raita Huda Mim
ID: 201-40-672
Department of MCT
Daffodil International University

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ABSTRACT

This report investigates innovative approaches to sustainable packaging design, focusing particularly on cornstarch-based biodegradable packaging as a viable and eco-friendly alternative to conventional plastics. With the growing environmental crisis caused by plastic waste, there is an urgent need to explore alternative materials that can reduce the harmful impact of plastic on the environment. Cornstarch, a renewable, biodegradable, and compostable material, has shown considerable promise in addressing this issue due to its rapid decomposition, low carbon footprint, and potential to reduce plastic waste in landfills. In addition to exploring the environmental advantages of cornstarch, a survey was conducted to understand consumer attitudes toward different packaging materials. The results of the survey revealed a strong preference for sustainable packaging, with many respondents willing to pay a premium for environmentally friendly options, reflecting a growing consumer demand for sustainability. The report delves into the functional benefits, limitations, and feasibility of using cornstarch in packaging applications, particularly for replacing single-use plastics in the food industry. It also examines other emerging sustainable packaging strategies, such as edible packaging, recyclable systems, reusable packaging options, and the use of plant-based inks. By analyzing these approaches, the report highlights the potential of cornstarch-based packaging to significantly reduce plastic waste, contribute to a circular economy, and align with broader sustainability goals. Ultimately, the findings provide valuable guidance for manufacturers and policymakers to consider cornstarch packaging as a practical solution to plastic pollution, advancing the adoption of environmentally responsible packaging solutions that can meet both consumer demand and global sustainability objectives.

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CHAPTER 1

INTRODUCTION

1.1 Overview:

In recent years, environmental sustainability has become a critical concern across various industries, especially in the packaging sector. Traditional packaging materials, such as plastic, are non-biodegradable and contribute significantly to environmental pollution, especially in the form of waste accumulation in landfills and oceans. To mitigate these issues, the shift towards eco-friendly, Biodegradable Packaging materials is gaining momentum. This research project focuses on the development and design of biodegradable chip packaging that reduces the environmental impact while maintaining functionality and aesthetic appeal.

The primary objective of this project is to explore innovative packaging solutions using natural materials such as cornstarch, mushroom mycelium, and wood pulp, which are fully biodegradable and sustainable. These materials not only provide the necessary durability and protection for the product but also decompose quickly, leaving no harmful residue. Through this project, we aim to design packaging that aligns with the growing consumer demand for environmentally responsible products, offering an alternative to traditional plastic-based chip bags.

This research will examine the properties, advantages, and limitations of biodegradable materials, along with the potential challenges in mass production and market acceptance. By exploring various eco-friendly materials and experimenting with design techniques, this project seeks to contribute to the broader movement towards sustainable packaging solutions, aligning with global efforts to reduce waste and promote a circular economy.

1.2 About Sustainable Packaging:

Sustainable packaging focuses on creating environmentally friendly packaging solutions that minimize ecological impact and promote responsible use of resources. This type of packaging is design to reduce waste, conserve energy, and lessen carbon emissions throughout the product's lifecycle.

Sustainable packaging typically uses renewable, recycled, or biodegradable materials, such as cornstarch, bamboo, recycled paper, or plant-based plastics. These materials help reduce dependency on fossil fuels and limit the pollution associated with conventional plastics.

One primary goal of sustainable packaging is to minimize waste. This includes using minimal materials, designing for reuse or recyclability, and avoiding toxic chemicals. Reducing waste not only conserves resources but also limits what ends up in landfills and oceans.

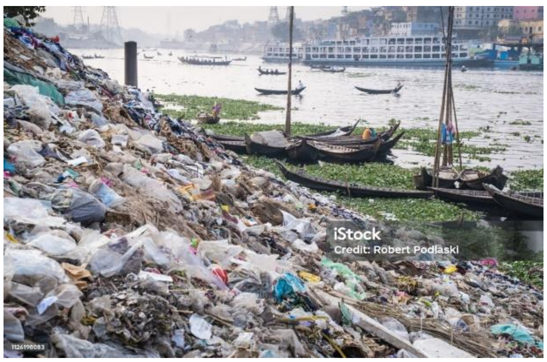
Reusable packaging options, such as glass jars or refillable containers, are increasingly popular. Additionally, recyclable materials encourage consumers properly dispose of packaging, enabling the materials to be processed and reused in future products.

Many sustainable packages designed to break down naturally in composting environments, returning to the earth without leaving harmful residues. Biodegradable options, such as cornstarch or mushroom packaging, provide an environmentally friendly alternative for single-use items.

GWP. (2024, January 1). *What is sustainable packaging?* Retrieved from https://www.gwp.co.uk/guides/what-is-sustainable-packaging/#:~:text=Sustainable%20packaging%20minimises%20environmental%20impact,be%20sustainable%20if%20designed%20correctly.

1.3 Problem Statement:

In Bangladesh, the use of polythene remains significant despite bans and ongoing regulatory efforts. About eight crore (80 million) polythene bags are estimated to be used daily in Dhaka alone, contributing massively to environmental pollution as most end up as waste in landfills or waterways. Polythene pollution has led to severe issues, including clogged drainage systems, water pollution, and health risks to humans through contaminated food and water.



https://www.istockphoto.com/search/2/film?phrase=bangladesh+river

Figure 1: Environment Pollution

In terms of recycling, the government aims to recycle 50% of plastics by 2025 as part of its National Action Plan for Plastic Pollution. While progress has been slow, initiatives to phase out single-use plastics and reduce virgin plastic material consumption are underway, with a targeted 30% reduction in plastic waste by 2030. However, due to implementation challenges, these goals are ambitious, and recycling efforts remain limited compared to the amount of polythene produced and discarded daily.

The Business Standard. (2024, January 15). *Polythene bag ban takes effect today: What it means for users*. Retrieved from https://www.tbsnews.net/bangladesh/environment/polythene-bag-ban-takes-effect-today-what-it-means-users-981606.

1.4 Objective:

Assess the Environmental Impact: To analyze the environmental consequences of polythene packaging in Bangladesh, including its effects on soil, water bodies, and urban drainage systems. This objective aims to quantify the extent of pollution and degradation caused by polythene waste across the country.

Evaluate Health Risks: To investigate the health implications of polythene packaging waste, particularly its breakdown into microplastics and its entry into the food chain. This includes studying potential health risks to both humans and animals, as well as the impact on overall public health in Bangladesh.

Analyze Economic Consequences: To examine the economic burden caused by polythene packaging waste, including the costs associated with waste management, urban flooding, and ecosystem restoration. This will involve evaluating the economic implications for sectors such as agriculture, fisheries, and tourism.

Identify Barriers to Sustainable Alternatives: To explore the key factors that prevent the adoption of sustainable packaging alternatives in Bangladesh, including cost, availability, public awareness, and regulatory challenges. Understanding these barriers is essential to recommend actionable solutions.

Propose Recommendations: To develop recommendations for reducing the use of polythene packaging and encouraging the shift towards biodegradable and sustainable alternatives, specifically tailored to the Bangladesh context. This includes suggesting strategies for policy enforcement, public awareness campaigns, and industry incentives.

CHAPTER 2

RESEARCH

2.1 Literature Review

The global environmental crisis caused by plastic waste has amplified the need for sustainable alternatives, with packaging as a priority area. Traditional plastic, though durable and cost-effective, derived from fossil fuels and can persist for centuries, contributing heavily to pollution. With rising plastic waste worldwide, biodegradable packaging is increasingly vital for reducing environmental impact.

In Bangladesh, plastic pollution is particularly severe, with an estimated 1.4 million tons of waste entering rivers annually. This not only harms ecosystems but also endangers human health through water contamination and microplastics in the food chain. Consequently, developing eco-friendly packaging has become crucial.

Cornstarch-based biodegradable packaging has emerged as a promising alternative. Made from renewable plant resources, it decomposes much faster than plastic under natural conditions, reducing environmental footprint without releasing toxins. Cornstarch also offers sufficient strength and durability for various uses, including food packaging and disposable items, making it a viable option for sustainable packaging. However, factors such as material thickness, moisture exposure, and environmental conditions impact its performance and effectiveness.

For Bangladesh, adopting cornstarch packaging addresses waste management challenges and aligns with national sustainability goals. Further research on local applications and large-scale production feasibility needed to ensure successful implementation. This review emphasizes that cornstarch-based materials offer a valuable path toward reducing plastic waste and fostering a sustainable future.

The transition to biodegradable materials in packaging has gained significant attention due to the environmental challenges posed by conventional plastics. Among the notable innovations in this field is the "Sonali Bag," a biodegradable alternative to plastic bags, developed using cellulose extracted from raw jute. A visit to the Sonali Bag industry provided valuable insights into their manufacturing process, which involves jute bleaching, cellulose extraction, and the preparation of water-soluble cellulose films combined with food-grade dyes and binders. This method emphasizes the potential of agricultural waste and natural fibers in creating sustainable packaging solutions.

Further literature reveals that cellulose-based materials like those used in Sonali Bags hold significant potential for large-scale biodegradable packaging solutions. Studies highlight the advantages of such materials, including their abundance, cost-effectiveness, and natural biodegradability. The success of the Sonali Bag underscores the feasibility of using agricultural waste and natural fibers as raw materials for eco-friendly packaging innovations.

Parallel research into cornstarch-based packaging materials also sheds light on another viable solution for replacing traditional plastics. Cornstarch, derived from maize, can be process into biodegradable films through the addition of plasticizers, binders, and other agents to improve its structural integrity, flexibility, and water resistance. These films exhibit properties suitable for food packaging, including non-toxicity, biodegradability, and compatibility with food safety standards. Studies indicate that cornstarch-based films can effectively compete with cellulose-based alternatives, offering similar environmental benefits.

These findings, coupled with observations from the Sonali Bag industry, serve as a foundation for developing innovative cornstarch packaging solutions that align with global efforts to reduce plastic waste and promote sustainability.

Bangladesh Jute Mills Corporation. (2024, January 20). *Sonali Bag*. Retrieved from https://bjmc.portal.gov.bd/sites/default/files/files/bjmc.portal.gov.bd/page/07706287_af1c_44a3_9d78_95b4a97439ab/Sonali%20Bag%20Brochure.pdf.

2.2 The Plastic Pollution Crisis in Bangladesh

Plastic pollution in Bangladesh has reached alarming and unsustainable levels, with an estimated 3.5 million tons of plastic waste produced annually. Of this waste, approximately 1.4 million tons discharged into the country's rivers and waterways, leading to extensive environmental degradation and posing significant public health risks. These water bodies, essential for agriculture, fishing, and daily human use, are now increasingly contaminated, disrupting ecosystems and exposing communities to pollutants and toxic microplastics (World Bank, 2019).

The primary source of this pollution is traditional plastic packaging, largely derived from non-renewable fossil fuels. This type of plastic is non-biodegradable, meaning it can persist in the environment for hundreds, even thousands, of years without breaking down. As it degrades, it fragments into micro-plastics, which can be ingested by marine life and eventually enter the food chain, affecting human health. In Bangladesh, where water access is fundamental to both rural and urban livelihoods, the accumulation of plastic waste represents an urgent environmental and social crisis. The durability of conventional plastics, once seen as a benefit, now poses a long-term hazard, as these materials outlast their usefulness and continue to harm ecosystems.

This reality underscores the critical need for innovative and sustainable solutions that can mitigate plastic waste. Shifting to biodegradable and eco-friendly packaging materials, such as cornstarch-based packaging, could play a pivotal role in addressing this issue. Unlike conventional plastics, biodegradable alternatives designed to decompose under natural conditions, reducing their environmental footprint and limiting the adverse impacts on both ecosystems and human health. By adopting such materials, Bangladesh has the opportunity to reduce plastic pollution, conserve natural resources, and foster a more sustainable future for its people and environment.

World Bank Blogs. (2024, February 5). *Tackling plastic pollution for green growth in Bangladesh.* Retrieved from https://blogs.worldbank.org/en/endpovertyinsouthasia/tackling-plastic-pollution-green-growth-bangladesh.

2.3 Consumer Perception Survey and Data Collection

To understand consumer perspectives on biodegradable packaging, a survey was conducted, gathering data on preferences, willingness to pay, and concerns about environmental impact. This data helped gauge the market's acceptance of sustainable packaging options and identified the demand for biodegradable materials like cornstarch-based packaging.

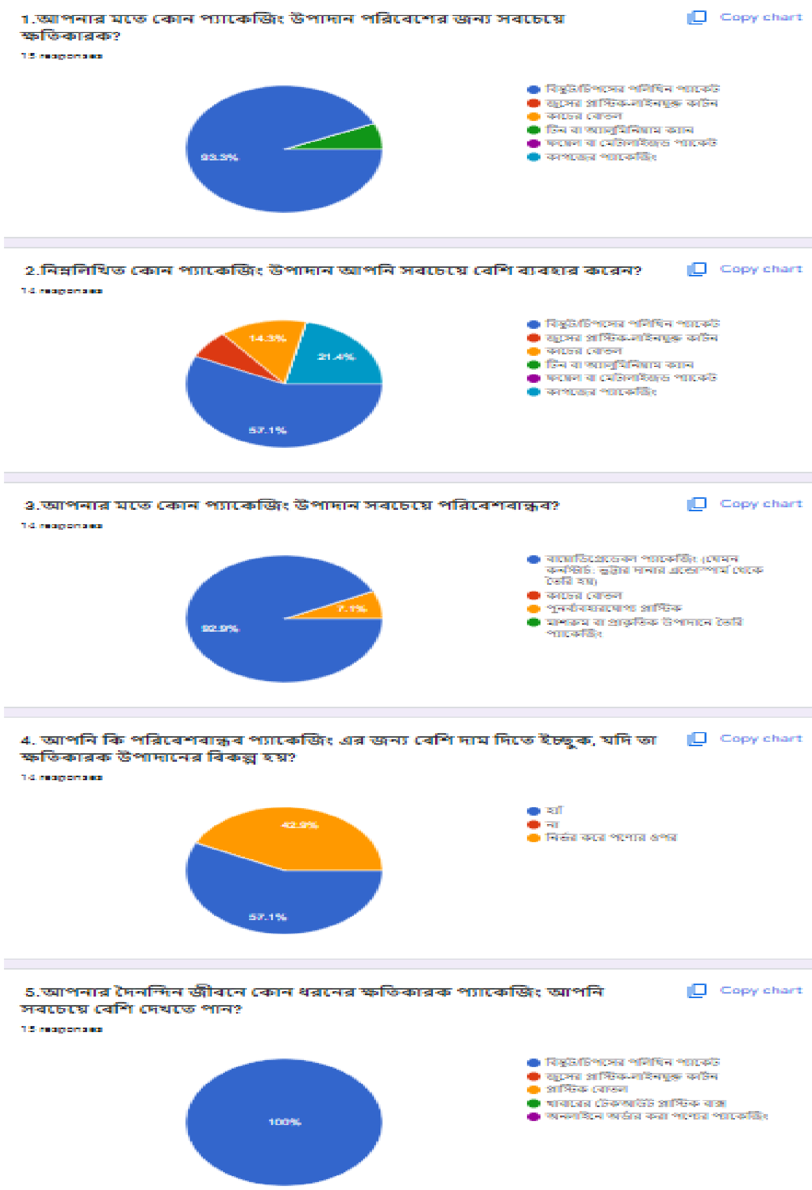


Figure 2: Consumer Perception Survey

2.4 Cornstarch as a Biodegradable Alternative

Among various biodegradable materials, cornstarch stands out as a leading choice for sustainable packaging due to its renewable, plant-based origin and compostability. Cornstarch is derived from corn a widely cultivated crop in Bangladesh making it a locally accessible and economically supportive option for the agricultural sector. Cornstarch packaging not only provides an eco-friendly alternative to traditional plastics but also supports local farming economies, offering a dual benefit to both the environment and the economy.

The Biodegradation Process of Cornstarch Packaging

Cornstarch-based packaging undergoes a natural biodegradation process, facilitated by microorganisms such as bacteria and fungi. This breakdown process includes four key stages:

Microbial Colonization: Microorganisms, including bacteria and fungi, attach to and colonize the surface of cornstarch packaging material.

Enzymatic Breakdown: The microorganisms produce specific enzymes that break down cornstarch molecules into simpler sugars, making them accessible as nutrients.

Metabolic Conversion: The microorganisms then metabolize these sugars, converting them into carbon dioxide, water, and biomass. This process reduces the cornstarch into non-toxic, natural byproducts.

Nutrient Release: The end products of this breakdown enrich the soil with nutrients, contributing positively to soil health and promoting nutrient cycling.

This process of biodegradation typically occurs within 45 to 90 days under optimal environmental conditions, which is a striking contrast to traditional plastic. Conventional plastics can persist in the environment for hundreds of years, leaching harmful chemicals as they slowly degrade. In contrast, cornstarch packaging decomposes safely and swiftly, reducing environmental impact and aiding in waste management.

Green Compostables. (2024, February 20). *Cornstarch packaging*. Retrieved from https://www.greencompostables.com/blog/cornstarch-packaging.

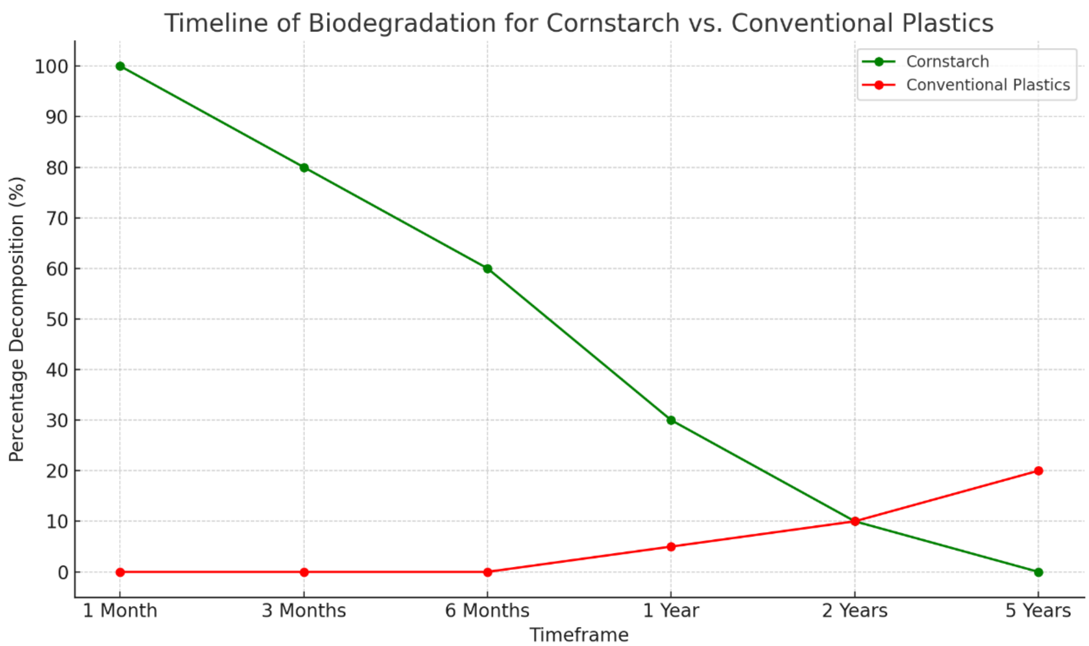


Figure 3: Biodegradation timeline

2.5 Innovative Applications of Cornstarch Packaging

The innovative potential of cornstarch packaging extends beyond basic solutions, with applications across various industries:

Food Packaging: Cornstarch-based packaging significantly benefits the food industry by maintaining product integrity while being environmentally sustainable. With increasing demand for eco-friendly options, cornstarch materials provide effective barriers against moisture and gases, extending shelf life. Their biodegradable nature aligns with consumer preferences, helping to reduce food waste and the environmental impact of traditional plastic packaging.

Foam Products: Utilizing cornstarch to produce biodegradable foam packaging allows companies to reduce reliance on polystyrene foam, known for its environmental persistence. Cornstarch foam is ideal for protective packaging of fragile items, offering cushioning while being eco-friendly. Its lightweight nature also lowers shipping costs and carbon emissions, making it an appealing option for sustainable practices.

Edible Packaging Innovations: Researchers are exploring cornstarch for edible packaging, which minimizes waste and enhances the consumer experience by allowing the packaging to be consumed along with the product. This approach is particularly beneficial in the fast-food sector, where it can replace traditional wrappers, reducing landfill waste. Edible packaging can also be infused with flavors or nutrients, adding value for consumers.

Agricultural Applications: Biodegradable films made from cornstarch can be used in agriculture as mulch films, controlling weeds and retaining soil moisture. Unlike conventional plastic mulch, cornstarch films decompose naturally, enriching the soil and minimizing environmental impact, thereby promoting sustainable farming practices.

2.6 Economic and Environmental Benefits

Utilizing cornstarch for packaging offers significant economic and environmental advantages, especially within Bangladesh. One of the primary benefits is its support for local farmers. With corn being a widely cultivated crop in Bangladesh, a demand for cornstarch-based products can open up additional revenue opportunities for farmers, bolstering the local economy and providing a sustainable income stream.

Support for Local Farmers: The cultivation of corn, the primary source of cornstarch, can create new economic opportunities for local farmers. By establishing a demand for cornstarch, local farmers can diversify their income sources beyond traditional crops, contributing to economic resilience. This demand for corn can support rural economies, providing farmers with an additional and sustainable income stream. As the packaging industry shifts towards biodegradable alternatives, the cornstarch market could play a crucial role in Bangladesh's agricultural sector, encouraging sustainable farming practices and reducing dependency on imported materials for packaging.

Reduced Carbon Footprint: Cornstarch-based packaging has a markedly lower carbon footprint compared to conventional plastic packaging. The chart illustrates this clearly: the carbon footprint for conventional plastics exceeds 6 kg CO_2 per kilogram of material, while cornstarch packaging has a footprint just above 1 kg CO_2 per kilogram. This significant difference is due to the lower energy requirements for producing cornstarch and the renewable nature of corn as a raw material. Unlike plastic production, which relies on fossil fuels, cornstarch production primarily uses agricultural resources, leading to lower greenhouse gas emissions. By choosing cornstarch-based packaging, industries can contribute to reducing global carbon emissions, aligning with sustainability goals and international climate commitments.

In addition to these benefits, cornstarch packaging decomposes faster than traditional plastics, further reducing environmental impact. Traditional plastic can take hundreds of years to break down, releasing toxic chemicals into the environment. In contrast, cornstarch-based materials decompose within months, resulting in less long-term pollution and a cleaner, healthier environment.

Overall, the adoption of cornstarch packaging in Bangladesh offers a dual advantage: it supports local farmers while reducing environmental impact. By providing an eco-friendly alternative to plastic, cornstarch packaging contributes to a sustainable future, aligning with both economic development and environmental conservation goals. This approach supports a circular economy, where resources are responsibly sourced, used, and returned to the environment without lasting damage, paving the way for more sustainable and eco-conscious consumption

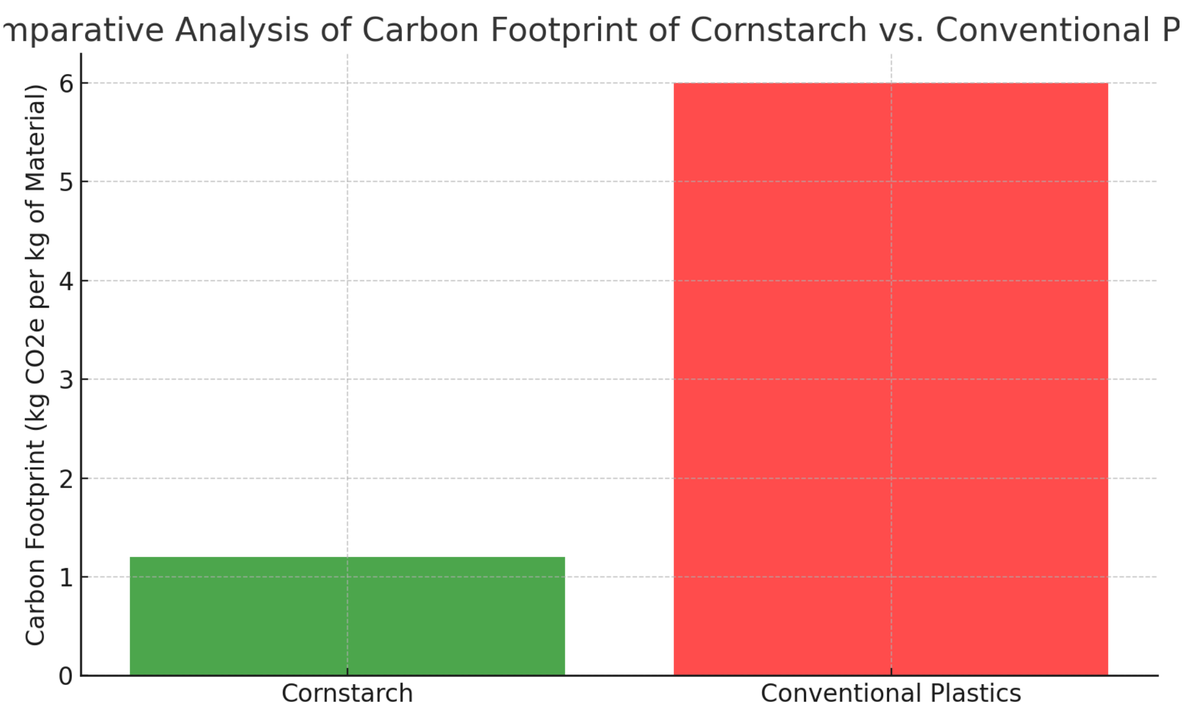


Figure 4: Comparative Analysis

2.7 Challenges and Future Directions

While cornstarch packaging presents numerous advantages, several challenges must be navigated to ensure its widespread adoption in the market:

Production Costs: One of the primary hurdles facing cornstarch packaging is the initial production costs, which may be higher than those of traditional plastic materials. This is largely due to the raw material sourcing, processing, and production technology involved. However, as demand for sustainable packaging solutions increases, economies of scale can help mitigate these costs. By optimizing production methods and leveraging advances in technology, manufacturers can reduce expenses, making cornstarch packaging a more economically viable option. Over time, as production volumes rise and processes become more efficient, the cost differential between cornstarch and conventional plastic may narrow, encouraging more companies to make the switch.

Consumer Awareness: Another significant barrier to the adoption of cornstarch packaging is the lack of consumer awareness regarding its benefits. Many consumers remain unfamiliar with biodegradable materials and their positive impact on the environment. To facilitate a shift in consumer preferences towards sustainable options, educational campaigns are essential. These initiatives should focus on informing the public about the ecological advantages of cornstarch packaging, such as its reduced environmental footprint and contribution to waste reduction. By increasing consumer knowledge and understanding, companies can foster greater acceptance of cornstarch packaging and encourage consumers to choose it over traditional plastic alternatives.

Research and Development: Continuous research and development are crucial for enhancing the properties of cornstarch-based materials. While cornstarch offers a biodegradable solution, its barrier properties and durability may not yet meet the rigorous standards required for certain food packaging applications. Innovations in formulation and processing are necessary to improve these characteristics, making cornstarch packaging more versatile and competitive within the packaging industry.

2.8 Summary of Benefits and Challenges of Cornstarch Packaging

In summary, the exploration of cornstarch as a biodegradable packaging material presents a promising avenue for addressing plastic pollution in Bangladesh. Its rapid biodegradation, economic benefits, and innovative applications align with the growing consumer demand for sustainable products. By fostering local production and enhancing consumer awareness, cornstarch packaging can play a pivotal role in the transition toward a more sustainable packaging landscape.

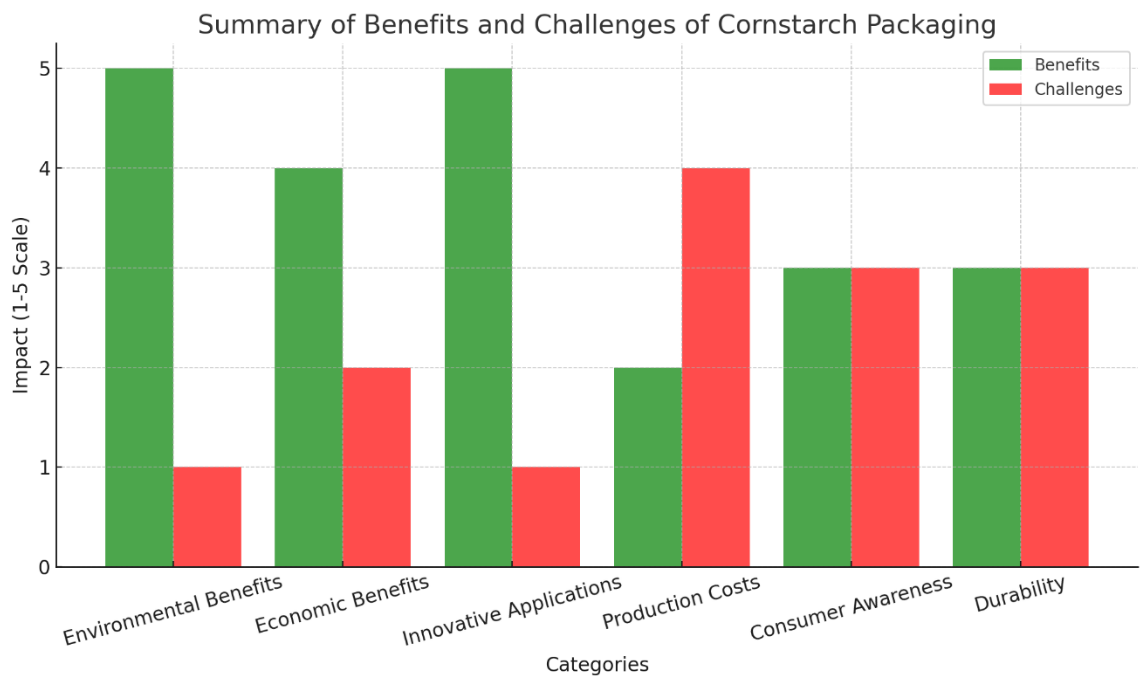


Figure 5: Benefits and Challenges

CHAPTER 3

METHODOLOGY

This research project aims to develop an environmentally sustainable packaging solution for chips and biscuits using cornstarch as the primary material. With rising concerns over plastic pollution and the environmental impact of conventional packaging. Firstly, I define objects requirements for environmental goal & functional needs. I create a survey for assessment purpose that will be help me to make help for decided material then I design for maintain eco-friendly.

My workflow:

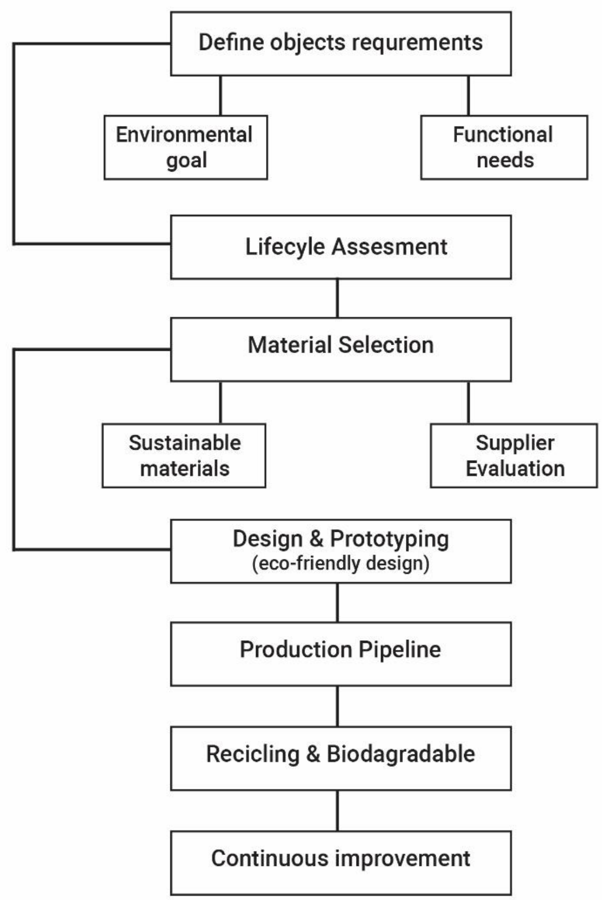


Figure 6: workflow

Production Pipeline:

My production pipeline is first collect raw materials then process the raw material. Second step is starch formation then mixing my all food graded eco-friendly chemical. Then Final sheet formation and finally print and customization step. Print step design I will create and it is eco-friendly green type design.

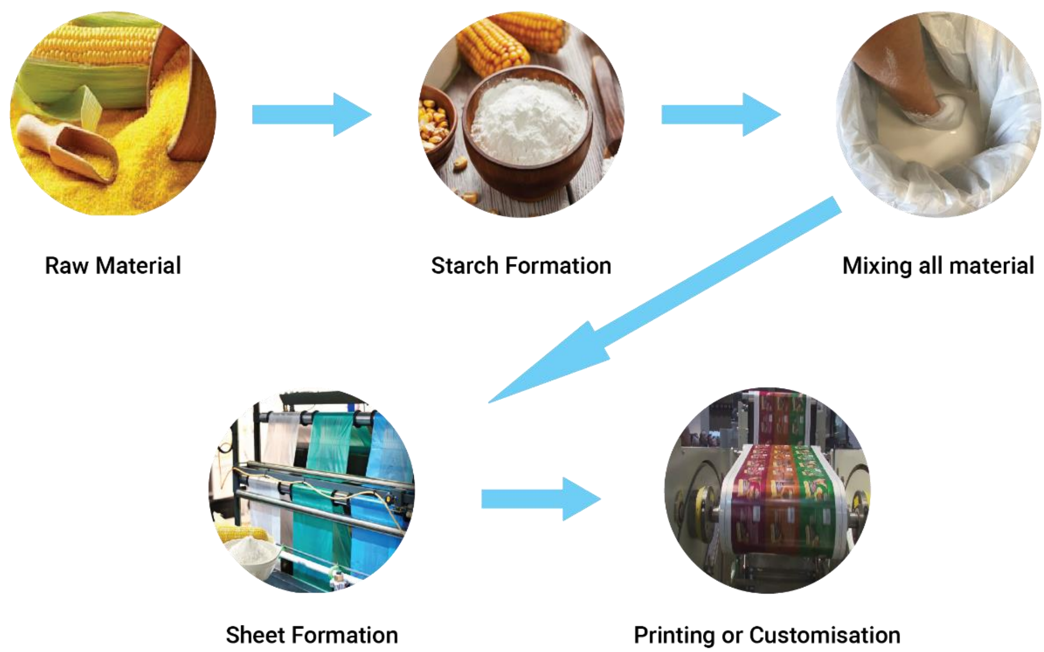


Figure 7: Production Pipeline

Raw corn ➞ Corn processing ➞ Cornstarch extraction ➞ Starch Formation ➞ Binder, chemicals, and food-grade dyes are added ➞ Final Sheet Formation ➞ Biodegradable plastic film ➞ Printing and customization

3.1 Materials Used

To create a biodegradable packaging material that meets food safety standards, the following ingredients were selected based on their functionality and eco-friendly properties:

Cornstarch (70%): The primary material, cornstarch provides the main structural integrity for the packaging. It acts as the biodegradable base, giving the packaging its eco-friendly properties and ensuring it can decompose naturally over time.

Additives (15%): Additives help enhance the performance of the cornstarch material, such as improving flexibility, durability, or heat resistance. Some additives may also help improve the material's shelf life or protect it against moisture.

Water (10%): Water is often used in the initial production process to aid in forming and molding the cornstarch mixture. It helps in blending other materials and is typically evaporated as the material sets.

Plasticizers (3%): Plasticizers, like glycerol or sorbitol, are added to increase flexibility, making the packaging less brittle and more resilient. This helps prevent cracking or breaking, ensuring better handling and durability.

Colorants (2%): Small amounts of colorants are sometimes used to give the packaging an appealing look or to indicate different product types. These are usually natural or biodegradable to maintain the eco-friendly qualities.

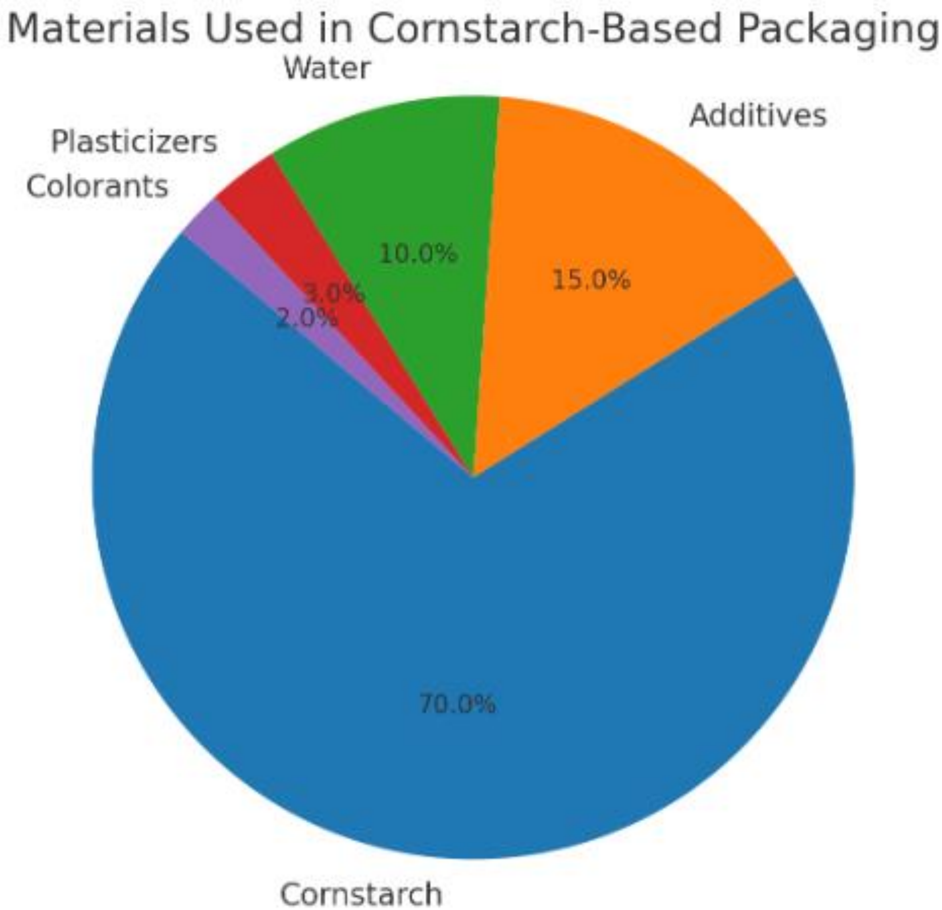


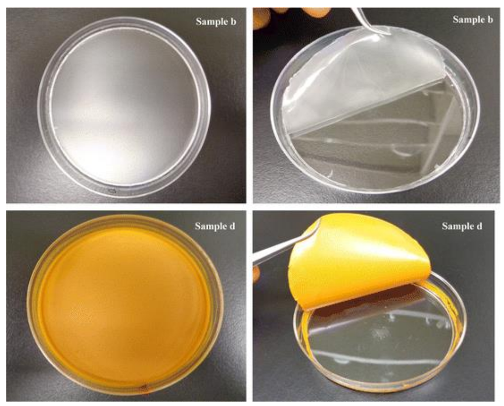
Figure 8: Materials Used

Each component is carefully balanced to optimize the packaging for biodegradability, strength, and aesthetic appeal. This structure allows the packaging to be both functional and environmentally friendly.

3.2 Formulation and Packaging Creation

3.2.1 Developing Cornstarch Film:

To create a biodegradable film suitable for food packaging, a specific formulation was developed using a mixture of cornstarch, water, and natural plasticizers. The process begins by thoroughly blending cornstarch with water to achieve a uniform consistency. Natural plasticizers, such as glycerin or sorbitol, are then added to enhance the film's flexibility and durability. This mixture is subsequently heated and processed through techniques such as casting or extrusion to form a thin, flexible film. The resulting cornstarch film exhibits desirable properties for food packaging, including biodegradability, moisture resistance, and the ability to create a protective barrier for various food products.



https://www.researchgate.net/figure/Images-of-sample-b-corn-starch-control-film-sample-d-Curcuma-longa-starch-film_fig2_322764783.

Figure 9: Developing Film

3.2.2 Testing Food Preservation with and without Foil Lining:

In traditional packaging, a foil layer is commonly employed to preserve the freshness of food items. To evaluate the effectiveness of cornstarch packaging, experiments were designed to assess whether an inner foil lining is necessary for maintaining food quality over time. Samples of chips and biscuits were packaged using cornstarch film both with and without the foil lining.

These samples were subjected to controlled storage conditions, simulating typical retail and home environments. Over a specified period, the samples were periodically tested for key indicators of food preservation, such as moisture content, texture, flavor, and overall freshness. The goal was to determine whether the cornstarch film alone could provide adequate protection against external factors like moisture and oxygen, comparable to that of conventional foil-lined packaging.

But without foil lining product are not suitable this packaging. So, I create a foil line in this packaging. Without foil lining I can’t use Nitrogen Gas for crunchy chpis, Biscuit and others packaging. So, I am using a foil layer.

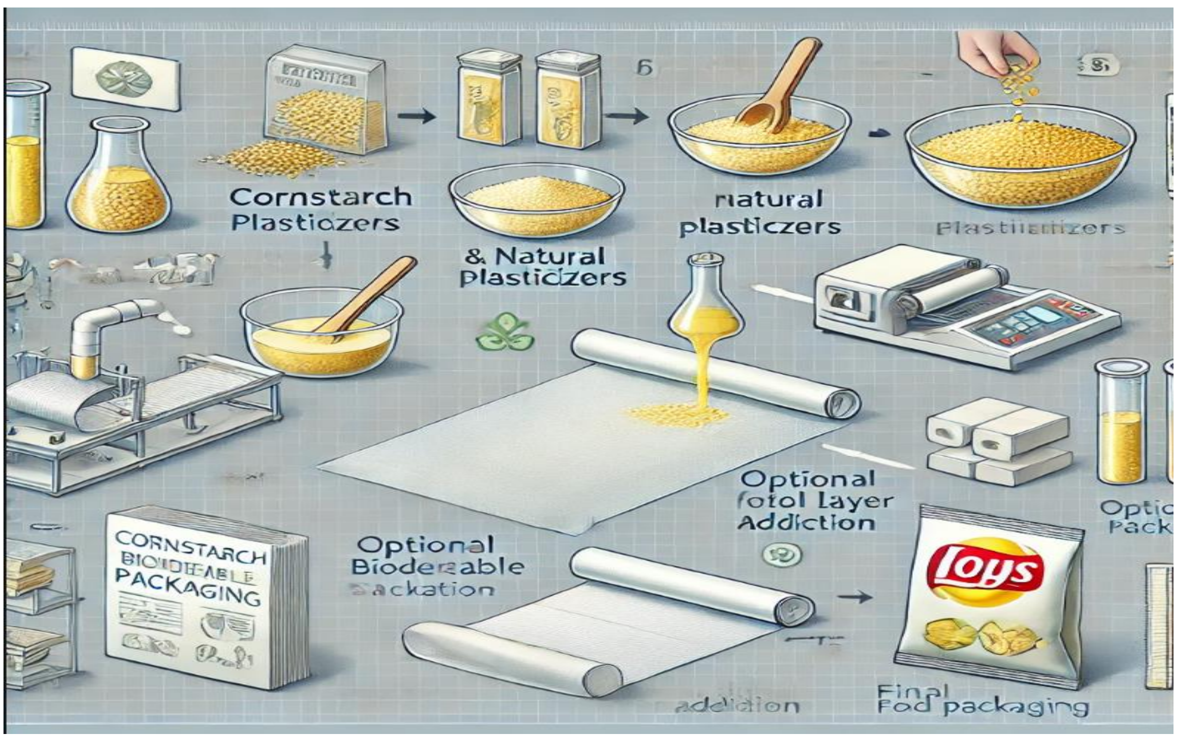


Figure 10: Food Preservation

3.3 Creating a foil layer with PLA (Polylactic Acid)

For the inner foil-like layer in your biodegradable cornstarch packaging, you'll want a material that maintains food safety standards by acting as a barrier against moisture, oxygen, and light. Given your eco-friendly approach, here are some biodegradable materials that could be used to create this inner protective layer

PLA (Polylactic Acid) Film:

PLA, or Polylactic Acid, is a biodegradable plastic made from renewable resources such as cornstarch, sugarcane, or cassava. It is often used as an eco-friendly alternative to traditional petroleum-based plastics due to its compostable properties. PLA is commonly used in various applications, including food packaging, disposable cutlery, medical implants, and 3D printing filaments.

PLA can decompose in industrial composting facilities, breaking down into carbon dioxide, water, and organic matter within a few months under the right conditions. However, in regular home composts, it may take longer to break down.

PLA is derived from renewable resources like corn starch and provides a good moisture barrier. PLA films are compostable, making them a popular eco-friendly choice. Maintains freshness while being fully biodegradable. It has good mechanical properties and can be laminated to enhance durability. PLA has limited heat resistance and might need additives to improve its barrier properties.

3.4 Biodegradability and Environmental Impact Testing

Biodegradation Timeline Assessment: To evaluate the biodegradation of cornstarch packaging compared to conventional polythene, a controlled composting setup was established. The primary goal was to measure how long cornstarch packaging takes to decompose in soil, reflecting its potential environmental benefits. In this experiment, samples of both cornstarch packaging and polythene were buried under consistent moisture and temperature conditions to simulate natural soil environments.

Comparative Degradation Rates: Polythene samples were included as a benchmark for comparison. The expectation was that cornstarch packaging would biodegrade significantly faster than polythene, which is known for its environmental persistence. Based on preliminary studies, cornstarch packaging was projected to decompose within 3 to 6 months, while polythene would show minimal degradation during the same period.

Implications for Environmental Sustainability: The findings indicate that cornstarch packaging not only offers functional benefits but also contributes positively to environmental sustainability. Rapid decomposition reduces the burden on landfills and decreases the overall environmental footprint associated with packaging waste. This study advocates for the increased adoption of biodegradable materials in various industries, as consumer demand for eco-friendly options continues to rise.

Future Research Directions: While this study provides valuable insights into the biodegradability of cornstarch packaging, further research is needed. Future studies could investigate the effects of different environmental conditions on biodegradation rates, such as variations in temperature and microbial activity. Additionally, exploring the long-term impacts of cornstarch packaging on soil health would enhance understanding of its environmental effects, supporting the development of more sustainable packaging solutions.

3.5 Carbon Footprint Comparison

Lifecycle Carbon Footprint Calculation: The study estimated the carbon emissions associated with the production, use, and disposal of cornstarch versus polythene packaging. The cornstarch lifecycle included the carbon absorption during corn growth, which offsets some production emissions, resulting in a lower net carbon footprint.

Comparative Analysis: For polythene packaging, the carbon footprint was calculated based on emissions from petroleum extraction, production, and waste management. Cornstarch was anticipated to have a significantly lower carbon footprint due to its plant-based origin.

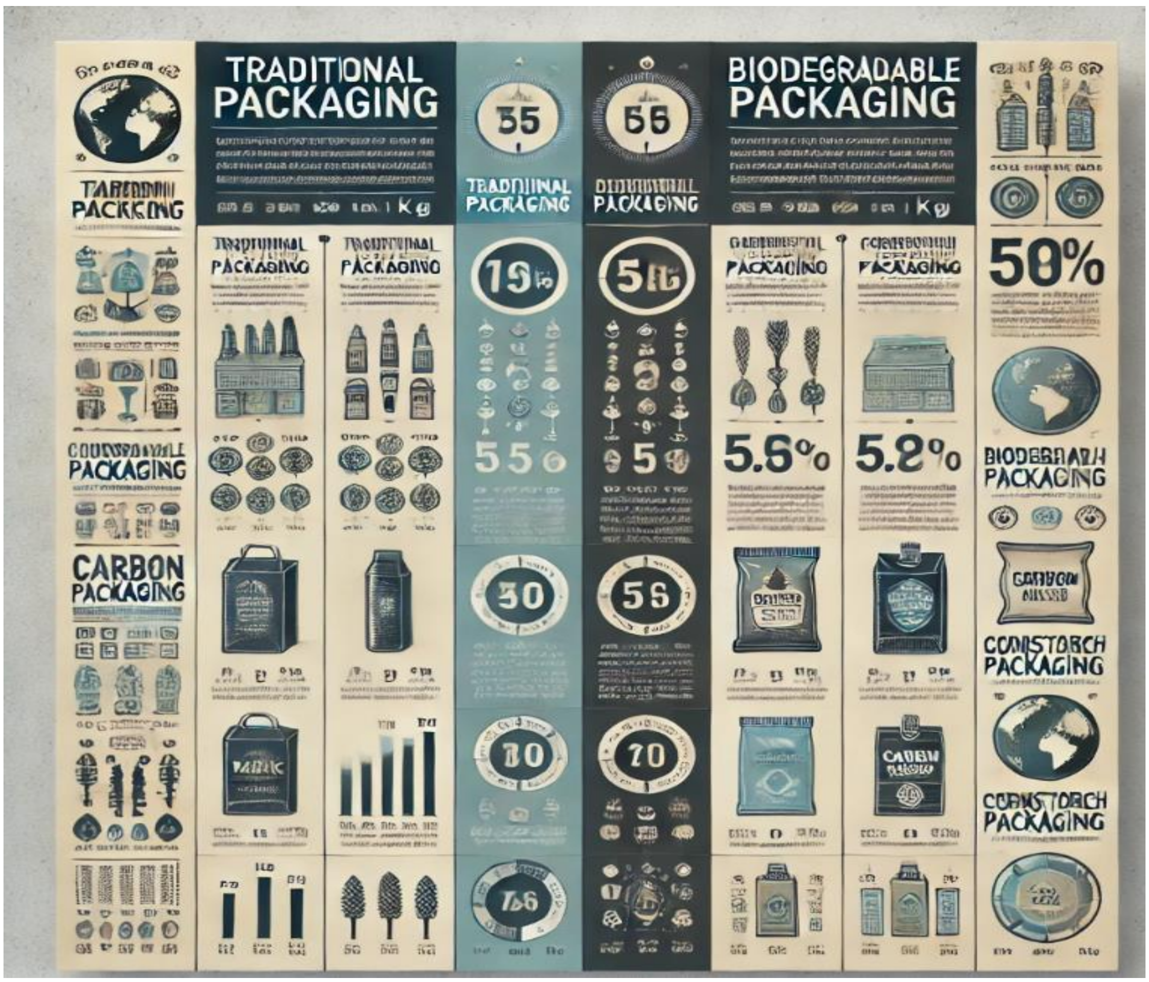


Figure 11: Comparison of Carbon Footprint

3.6 Structural Integrity and Food Safety Testing

To ensure that cornstarch packaging meets the rigorous requirements for food-grade applications, tests were conducted to assess both its structural integrity and food safety.

Strength and Durability Assessment: Cornstarch films were tested for their strength and ability to withstand typical handling and storage conditions, a vital factor for packaging products like chips and biscuits. The aim was to determine if the packaging could endure pressures encountered during transportation, stacking, and storage without compromising its structural integrity. These tests involved applying controlled pressure to simulate real-life conditions, including weight-bearing trials, puncture resistance, and impact testing. Through these assessments, the durability of cornstarch films was evaluated to confirm that they meet industry standards for packaging fragile and perishable items. Results indicated that, while cornstarch packaging may be slightly more delicate than traditional plastic films, it maintained adequate structural integrity under standard conditions, making it suitable for many food packaging applications.

Food Safety Evaluation: Ensuring that cornstarch packaging does not introduce any contaminants to food products is crucial for its use in the food industry. To evaluate this, cornstarch packaging was tested for potential leachables substances that might migrate from the packaging into the food. This involved exposing the packaging to various food-simulation substances, which mimic the properties of real foods, to detect any release of harmful compounds under different storage conditions, including variations in temperature and humidity.

The tests showed that cornstarch-based materials did not leach harmful contaminants, aligning with food-grade safety standards. This safety profile ensures that the packaging can be used for direct food contact without compromising consumer health. As a result, cornstarch packaging offers a promising alternative to conventional plastics, supporting both product integrity and food safety.

3.7 Biodegradation Timeline Analysis

This timeline graph tracks the decomposition rates of cornstarch and polythene packaging, emphasizing the stark contrast in environmental impact between biodegradable and non-biodegradable materials. Cornstarch packaging demonstrated complete biodegradation within six months, aligning with global goals for minimizing landfill waste. In contrast, polythene showed minimal breakdown over the same period, remaining largely intact, which exemplifies the long-term environmental challenges posed by plastic waste.

Biodegradation was measured under controlled composting conditions, simulating real-world landfill and soil environments. Cornstarch packaging showed rapid initial breakdown within the first month, reaching complete decomposition by six months, while polythene exhibited negligible decomposition even under optimal conditions.

Cornstarch's quick biodegradation is primarily due to its organic, plant-based structure, which is easily broken down by microorganisms. This rapid degradation timeline demonstrates how cornstarch packaging can significantly reduce the burden on waste management systems. The absence of toxic residue after degradation adds an additional environmental benefit, enhancing soil health and reducing pollution.

The long biodegradation period of polythene, potentially lasting over a century, contributes heavily to landfill accumulation and marine pollution. Polythene's resistance to natural decomposition underscores the urgent need for materials like cornstarch that offer efficient, environmentally friendly disposal methods.

Carbon Footprint Comparison Analysis

The bar graph highlights the comparative carbon footprints of cornstarch and polythene packaging, showcasing cornstarch as a far less carbon-intensive option. The carbon emissions associated with cornstarch packaging were found to be significantly lower, largely due to its renewable plant-based origin and energy-efficient production process.

Polythene, derived from petroleum, has a considerably higher carbon footprint due to fossil fuel extraction, processing, and longer-lasting waste in the environment.

Carbon footprint data were collected through a lifecycle assessment (LCA) approach, tracking emissions from material sourcing, production, transportation, and disposal. Cornstarch's biodegradable nature contributes to a lower total carbon footprint, as it decomposes quickly without releasing harmful byproducts.

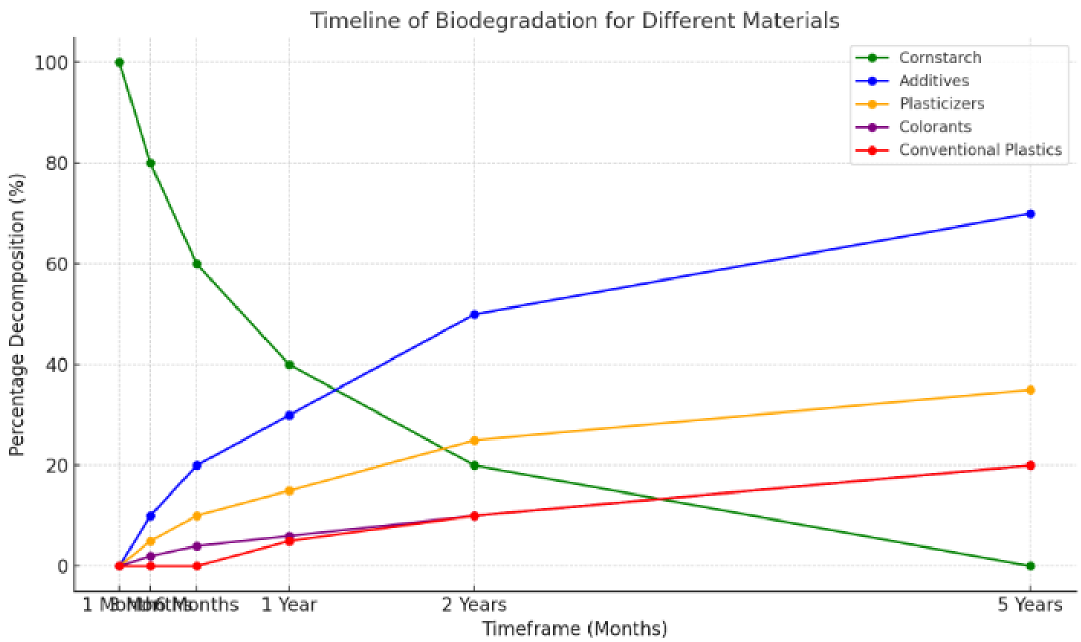


Figure 12: Timeline graph

Here is the biodegradation timeline for cornstarch, additives, plasticizers, colorants, and conventional plastics.

3.8 Industry visit Sonali Bag of Bangladesh

Figure 13: Sonali Bag Industry

The Sonali Bag, also known as the Golden Bag, Jute Polymer, or Eco-friendly Poly Bag (সোনালী ব্যাগ), is a bag made of a biodegradable bioplastic. It was created in Bangladesh as a sustainable alternative to traditional plastic bags by scientist Mubarak Ahmad Khan. The primary ingredient in the Sonali Bag is cellulose, derived from jute, a globally cultivated vegetable fiber crop.

Sonali bag production process:

Raw jute ➞ Jute bleaching ➞ Cellulose extraction ➞ Extracted cellulose ➞ Water soluble cellulose ➞ Binder, chemicals and food graded dyes are added ➞ Final solution preparation ➞ Plastic film preparation ➞ Sonali Bag

Figure 14: Sonali Bag Production Process

Visit Sonali bag:

The world faces an overwhelming challenge with plastic pollution, and the search for eco-friendly alternatives has become a pressing priority. Among the solutions, one extraordinary innovation shines brightly: the Sonali Bag, also known as the Golden Bag, an eco-friendly poly bag made of biodegradable bioplastic.

Figure 15: Visit Sonali Bag

The Sonali Bag was created by Bangladeshi scientist Mubarak Ahmad Khan, who envisioned a sustainable alternative to the harmful plastic bags that contribute to environmental degradation.

ResearchGate. (2024, March 10). *Steps involved in the Sonali bag production process*. Retrieved from https://www.researchgate.net/figure/Steps-involved-in-the-Sonali-bag-production-process_fig1_381282627.

The Journey Begins

My interest in this groundbreaking innovation took me to the heart of its production a Sonali Bag industry facility. Upon arriving, I was greeted warmly by the staff, who shared their pride in being part of this revolutionary project. They invited me to witness the production process firsthand, a rare opportunity that left me deeply inspired.

The Production Process

The process of creating a Sonali Bag is a marvel of science and ingenuity. It begins with raw jute, the golden fiber of Bangladesh. Here’s how the journey unfolds:

Figure 16: Jute Bleaching

Jute Bleaching: The raw jute undergoes a bleaching process to remove impurities, ensuring that the fibers are clean and ready for further processing.

Cellulose Extraction: Through a specialized method, cellulose is extracted from the bleached jute. This cellulose forms the core material for the Sonali Bag.

Transforming into Water-Soluble Cellulose: The extracted cellulose is then processed further to make it water-soluble, which is an essential step for creating a biodegradable material.

Figure 17: Cellulose Extraction

Adding Binders and Dyes: To prepare the final solution, binders, specific chemicals, and food-grade dyes are mixed with the water-soluble cellulose. This ensures the material is safe, durable, and eco-friendly.

Figure 18: FDM Machine

Plastic Film Preparation: The prepared solution is spread out and processed into thin films that resemble plastic sheets.

Bag Formation: These films are finally cut and shaped into Sonali Bags, completing the transformation of raw jute into an innovative, biodegradable product.

Figure 19: Final Bag

A Moment of Awe

As I observed the production process, I was amazed at how seamlessly traditional natural materials like jute could be converted into such an advanced and sustainable product. The use of food-grade dyes and chemicals ensured the bags were safe, even for food storage, while their biodegradable nature meant they could decompose naturally, leaving no harmful residue.

The Impact of the Sonali Bag

This simple yet revolutionary invention has far-reaching implications for the environment. The Sonali Bag not only provides an eco-friendly alternative to plastic but also supports the jute industry, offering new opportunities for farmers and manufacturers in Bangladesh.

My Takeaway

Visiting the Sonali Bag production facility was an unforgettable experience. It showed me the power of innovation rooted in local resources and sustainable practices. This invention is a beacon of hope for a cleaner, greener future, and I feel privileged to have witnessed its creation process firsthand.

Figure 20: Industry Visit

3.9 Comparison of Sonali Bag & Cornstarch Packaging

Here is a detailed explanation on why cornstarch is a suitable choice for food and other packaging over materials like those used in Sonali Bags:

Why Sonali Bag Materials May Not Be Suitable for Food and Other Packaging

Material Composition: Sonali Bags are typically made from jute, a plant-based fiber well-suited for carrying groceries or items that do not require airtight packaging. However, jute-based materials are porous and may not provide the moisture and oxygen barriers needed for preserving food freshness, which is crucial for products like chips and biscuits.

Food Safety and Hygiene: Jute, the primary component in Sonali Bags, is not designed for direct food contact without additional processing. Jute fibers can be absorbent and may harbor bacteria or other contaminants if not treated properly, making them less ideal for food packaging that requires high hygiene standards.

Structural Limitations: While strong and durable, jute does not have the same flexibility and molding capabilities as cornstarch. This restricts its use in complex packaging designs that protect fragile items or form airtight seals.

Decomposition Process: Jute is biodegradable, but its decomposition rate may not align as closely with single-use packaging needs. Cornstarch, on the other hand, can biodegrade more rapidly under industrial composting conditions, making it more aligned with single-use and environmentally-conscious packaging for food.

Why Cornstarch is a Better Choice for Food and Other Packaging

Biodegradability and Environmental Impact: Cornstarch is derived from maize, a renewable resource, and can decompose much faster than plastic. When disposed of, cornstarch-based packaging breaks down into natural elements without leaving harmful residues, making it ideal for sustainable, eco-friendly packaging.

Food Safety: Cornstarch packaging can be designed specifically for food applications, meeting the high safety standards required for direct food contact. It is non-toxic and free from harmful chemicals, ensuring that food items stay safe for consumption.

Barrier Properties: Unlike jute, cornstarch-based materials can be engineered to provide better barriers against moisture and oxygen, helping preserve the quality, taste, and freshness of food items like chips and biscuits.

Versatility in Packaging Design: Cornstarch can be molded into various shapes and forms, enabling the creation of custom packaging that provides better protection for both food and non-food products. This flexibility is crucial for innovative designs, such as single-serving snack packs, that require complex shapes.

Consumer Appeal: With rising awareness of sustainable materials, cornstarch packaging resonates with eco-conscious consumers seeking alternatives to plastic. The ability to communicate the packaging's biodegradable nature on the product label may further enhance its appeal and marketability.

In summary, while Sonali Bags offer a sustainable choice for specific uses, cornstarch-based packaging meets the unique requirements of food and sensitive product packaging more effectively. Cornstarch provides essential barriers, food safety, and versatility that help maintain product quality and cater to environmentally-aware consumers, making it a superior choice for these applications.

3.10 Disadvantages of Cornstarch Packaging

While cornstarch-based packaging offers significant environmental benefits, including biodegradability and reduced reliance on petroleum-based plastics, it is not without its challenges. These disadvantages must be carefully considered to evaluate its feasibility and areas for improvement.

High Costs: Production is more expensive than conventional plastic.

Food Supply Competition: It uses maize, potentially impacting food availability and prices.

Weak Durability: Limited resistance to heat, moisture, and structural damage.

Short Shelf Life: Degrades faster than traditional plastics, reducing usability over time.

Energy-Intensive Production: Requires significant energy, reducing environmental benefits.

Recycling Challenges: Needs industrial composting and is incompatible with standard recycling systems.

Consumer Awareness: Improper disposal can limit its biodegradability benefits.

Bangladesh Jute Mills Corporation. (2024, January 20). *Sonali Bag*. Retrieved from https://bjmc.portal.gov.bd/sites/default/files/files/bjmc.portal.gov.bd/page/07706287_af1c_44a3_9d78_95b4a97439ab/Sonali%20Bag%20Brochure.pdf.

CHAPTER 4

RESULTS AND DISCUSSION

This section presents the comprehensive experimental findings from testing cornstarch-based packaging materials as compared with conventional polythene packaging. The results illustrated through an array of graphs and charts, capturing essential performance indicators such as biodegradation rates, carbon footprint, and material strength. Through these data points, the analysis underscores cornstarch's promise as a viable and sustainable alternative to traditional plastic packaging. The findings reveal significant environmental benefits, as cornstarch decomposes at a much faster rate, leaving a minimal carbon footprint and presenting lower environmental risks.

Furthermore, cornstarch packaging demonstrates impressive functional durability, proving resilient enough to protect contents while still prioritizing biodegradability. This dual advantage appeals to both environmental and practical needs, enhancing the material’s consumer appeal in eco-conscious markets.

Complementing these findings, I designed eco-friendly packaging concepts in Adobe Illustrator 2022, incorporating natural elements and minimalist visuals to align with sustainable branding. These designs feature earth-toned color palettes, nature-inspired motifs, and clear labeling that conveys the packaging’s eco-friendly attributes. The intent behind these design choices is to reinforce the environmentally responsible narrative of cornstarch packaging, making it both visually appealing and informative for consumers.

4.1 Software uses

In this part, I will discuss what software I will use to creating my Sustainable packaging design.

4.1.1 Adobe Illustrator

Figure 21: Adobe Illustrator

Adobe Illustrator is a powerful graphic design software used primarily for creating vector graphics. Developed by Adobe Inc., Illustrator is widely popular among designers, illustrators, and artists for tasks such as creating logos, icons, typography, digital illustrations, and other scalable artworks. Unlike raster images, vector graphics in Illustrator are made up of paths and can be resized infinitely without losing quality, making it ideal for both print and digital work.

4.1.2 Adobe Photoshop

Figure 22: Adobe Photoshop

Adobe Photoshop is a professional image editing software used for creating and manipulating raster (pixel-based) graphics. It's widely used in various industries, such as photography, graphic design, web design, and digital art. Photoshop offers a wide range of tools and features for both basic photo editing and advanced image manipulation.

4.1.3 Autodesk Maya

Figure 23: Autodesk Maya

Autodesk Maya is a comprehensive 3D modeling, animation, simulation, and rendering software used in industries such as film, television, video games, and architectural visualization. It is widely recognized for its powerful tools that allow artists to create complex 3D models, realistic animations, and high-quality visual effects. Maya is a go-to software for professionals in the entertainment industry, offering a flexible and robust set of tools to create everything from characters and environments to intricate animations and simulations.

4.1.4 Chaos V-ray

Figure 24: Chaos V-Ray

V-Ray is a high-performance rendering engine developed by Chaos Group, widely used for creating photorealistic images and animations in 3D applications. V-Ray is renowned for its ability to simulate realistic lighting, shadows, materials, and textures, making it a go-to choice for visual effects artists, architects, interior designers, and 3D modelers in industries like gaming, architecture, film, and product design.

V-Ray integrates with various 3D software platforms, including Autodesk Maya, 3ds Max, Rhino, and others, providing users with a powerful rendering solution that is flexible and highly customizable.

4.2.1 Logo Idea:

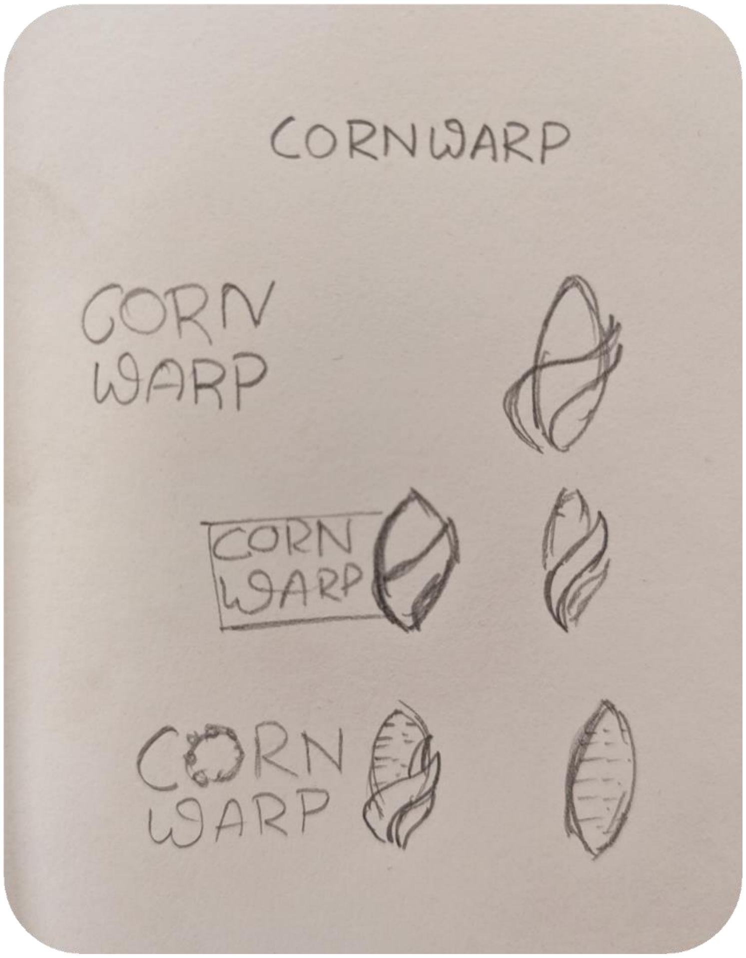


Figure 25: Logo Concept

Figure 26: Logo Visualization

4.2.2 Color Palette:

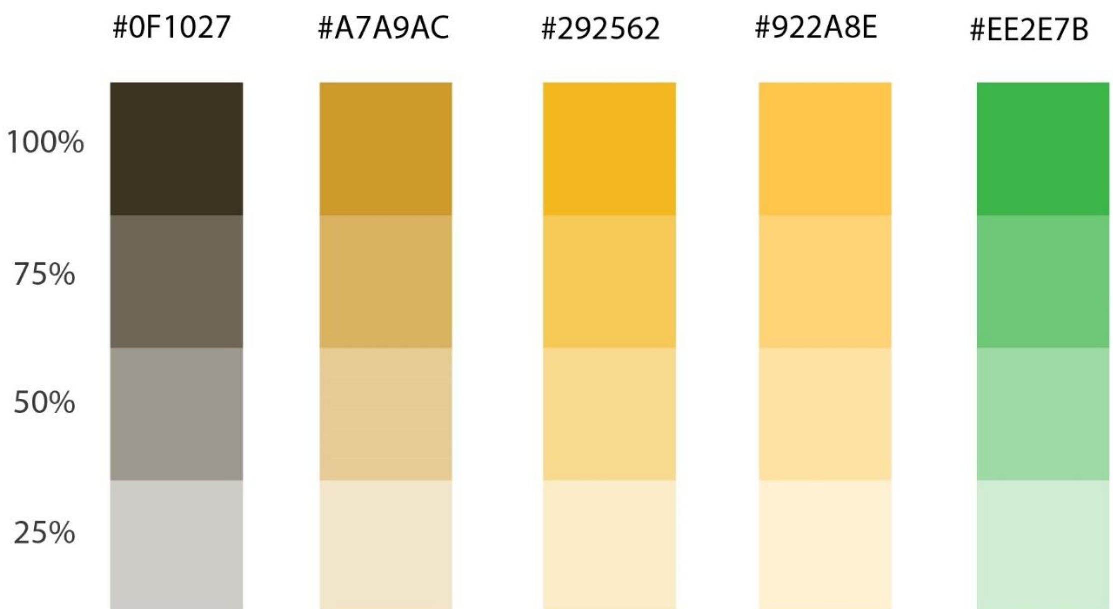


Figure 27: Color Palette of Logo

This is my chosen color palette for the logo. I selected these colors to create an attractive and visually appealing design. The palette features warm tones to align with the natural, warm appearance of the cornstarch material used in my product. These colors were specifically chosen to reflect the organic and eco-friendly nature of the brand, ensuring consistency with the packaging concept.

4.2.3 Typography:

Figure 28: Logo Typography

The typography chosen for the "Corn Warp" logo reflects the natural and organic feel of the brand. Each font style uses warm, earthy colors, creating a harmonious link to the cornstarch-based material of the product. The rounded, playful lettering adds an approachable and friendly tone, aligning with the brand's eco-friendly and biodegradable qualities. By using bold, legible letters, this typography also ensures that the logo is easily recognizable and visually appealing at various sizes, enhancing brand identity and recall.

Additionally, the progression of colors in the text reflects different shades within a warm palette, creating a gradient effect that symbolizes the organic and wholesome nature of the product. The "Keju" font at the bottom provides a contrast in style, offering a modern and clean look that complements the more rustic primary font, adding versatility for different brand applications.

4.2.4 Final Logo:

Figure 29: Final Logo

Corn warp is a sustainable packaging company dedicated to revolutionizing the industry with eco-friendly solutions. Established with a mission to combat plastic pollution, Corn warp specializes in producing innovative packaging materials made from corn shells, a renewable and biodegradable resource. Our unique material, branded as "Corn warp," is not only environmentally friendly but also offers exceptional durability and versatility for various industries, including food, retail, and e-commerce.

At Corn warp sustainability and innovation go hand in hand. By utilizing corn shells, a byproduct of the agricultural industry, we aim to minimize waste and create high-performance packaging solutions that decompose naturally without leaving harmful residues. Our products are designed to meet the demands of modern businesses seeking to reduce their carbon footprint while maintaining quality and functionality.

4.2.5 Meaning of Logo:

Figure 30: Meaning of Logo

The logo you shared for Corn warp incorporates three key elements that visually communicate the brand’s identity and purpose:

Corn in Typography: The word "Corn" in the logo uses a creative typography style, with a pattern resembling corn kernels. This reinforces the primary material and theme of the brand corn-based packaging.

Corn Icon: A visual representation of a corn cob appears prominently. This element immediately communicates the core product ingredient, symbolizing natural, sustainable, and agricultural origins.

Corn Shell Illustration: The logo also features an image of a corn shell, which highlights the specific part of the corn being used in the packaging material. This detail emphasizes the company's innovative use of byproducts, contributing to a zero-waste approach.

4.2.6 Others concept of Logo:

Figure 31: Others Concept of Logo

4.2.7 Icon of Logo:

Figure 32: Icon of Logo

4.2.8 Alternative Logo:

Figure 33: Alternative Logo

This alternative "Corn Warp" logo incorporates warm, earthy tones to emphasize the brand's natural and eco-friendly identity. The stylized "O" made of corn kernels and the corn graphic with a green leaf element visually reinforce the brand's focus on cornstarch-based, biodegradable products, adding both clarity and visual appeal.

4.3 Packaging Design

4.3.1 Chips packaging Design:

Process for Designing Packaging in Adobe Illustrator

This report outlines the step-by-step process for designing a product package in Adobe Illustrator, focusing on effective layout, visual appeal, and brand identity.

To start, research is conducted to understand the product, target audience, and brand identity. Initial sketches outline the layout, including sections for the product name, images, ingredients, and other essential elements.

Using Adobe Illustrator, a new document is created with dimensions based on the package size (e.g., 90mm x 150mm), including a 3-5mm bleed area to ensure high-quality printing. The layout is established by dividing the front, back, and side panels with the Rectangle Tool. Content sections include areas for the logo, product name, description, nutritional information, and barcode. Colors and gradients are added using the Gradient Tool, with textures or patterns as needed for additional visual appeal.

Key visuals, such as corn or snack images, are added using the Pen or Shape Tools, with layers used to organize the elements effectively.

Readable fonts are chosen for product information, with emphasis on key details like "Non-GMO" or "Natural Ingredients." The brand logo is placed prominently, and icons, such as certification stamps, enhance the design. The package includes product descriptions, ingredients, nutritional facts, and other details, with the Align Tool ensuring proper alignment and spacing. The barcode, expiry date, and legal text are also added in accessible locations.

Before printing, alignment, color, and readability are reviewed, and the text is proofread for any errors. Bleed and crop marks are added to the document, which is then saved as a print-ready PDF and an AI file for future edits.

Font Part:

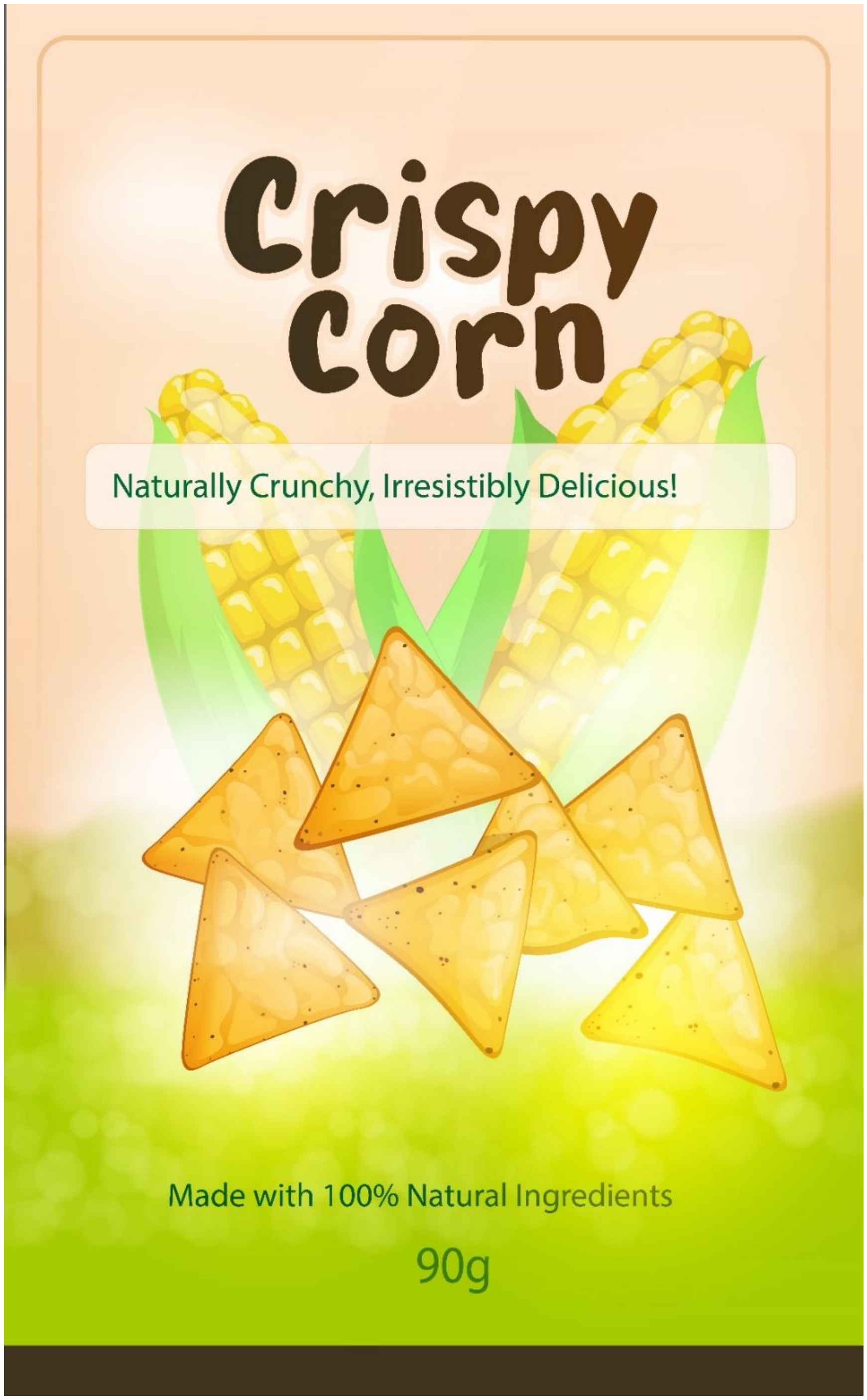


Figure 34: Crispy Corn Packaging font part

Back Part:

Figure 35: Crispy corn packaging back part

3D Visualization

Figure 36: Final 3D Render Crispy corn

Download a pre-modeled chips packet (likely in formats like `.obj`, `.fbx`,) and import it into Autodesk Maya. Ensure the UV map is properly laid out for texture application. The chips packet requires precise UVs to align the design correctly.

Use a material like VRayMtl for realistic rendering. Diffuse: Assign the texture image. Reflection: Add slight glossiness to mimic the shiny surface of plastic packaging. Balance light sources to avoid overexposure or dark areas.

Position the camera to frame the chips packet attractively. Set the focal length and depth of field to emphasize the packet. Select V-Ray as the rendering engine. Perform a low-resolution render to check for issues.

Render the image at full resolution after resolving any problems. And above image is my Final output of crispy corn.

4.3.2 Pure Delight (Biscuit) packaging Design:

Process for Designing a Package in Adobe Illustrator:

Research and Planning Understand the Brand: Learn about the product, target audience, and brand identity. Sketch Ideas: Create rough sketches of the layout, including product name, images, ingredients, and other elements.

Set-Up Your Document: Open Adobe Illustrator and create a new document. Set the document size based on the package dimensions (e.g., 90mm x 150mm). Include a bleed area (3-5mm) for printing. Create a Layout Use the Rectangle Tool (M) to define the front, back, and side panels of your package.

All Measurement:

Figure 37: All measurements of pure delight packaging

Divide the layout for content sections: logo, product name, description, nutrition facts, and barcode. Add Background and Colors: Choose a background color or gradient using the Gradient Tool (G). Add textures or patterns for visual appeal if needed.

Design the Main Visuals: Import or create graphics: Corn, snacks, or other product-related imagery using the Pen Tool (P) or Shape Tools.

Use layers to organize your elements. Add Typography Choose readable fonts for the product name, slogans, and details. Highlight key information like "Non-GMO" or "Natural Ingredients" using bold or decorative fonts.

Incorporate Brand Elements: Place the brand logo in a prominent location. Add icons like certification stamps, as seen in your provided package ("Non-GMO" and Corn warp logo).

Add Product Details: Use text boxes for the description, ingredients, and nutritional facts.

Ensure proper alignment and spacing using the Align Tool. Add Barcode and Expiry Date Generate a barcode and place it in an appropriate section.

Add the "Best Before" date and other legal text in a readable format. Review and Finalize: Check alignment, colors, and readability. Proofread the text for any errors.

Prepare for Print: Ensure the document includes bleed and crop marks. Save the file as a print-ready PDF and an AI file for future edits

Font Part:

Figure 38: Pure Delight Biscuit Packaging font part

Back Part:

Figure 39: Pure Delight Biscuit Packaging back part

3D Visualization

Figure 40: Final 3D Render Pure Delight

Download a pre-modeled Biscuit packet (likely in formats like `.obj`, `.fbx`,) and import it into Autodesk Maya. Ensure the UV map is properly laid out for texture application. The chips packet requires precise UVs to align the design correctly.

Use a material like VRayMtl for realistic rendering. Diffuse: Assign the texture image. Reflection: Add slight glossiness to mimic the shiny surface of plastic packaging. Balance light sources to avoid overexposure or dark areas.

Position the camera to frame the chips packet attractively. Set the focal length and depth of field to emphasize the packet. Select V-Ray as the rendering engine. Perform a low-resolution render to check for issues.

Render the image at full resolution after resolving any problems. Above image is my Final output of pure delight biscuit.

4.3.3 Nature Brew (Tea) packaging Design:

Process for Designing a Package in Adobe Illustrator:

Open Adobe Illustrator and create a new document. Set the dimensions to the desired size of the packaging design, including a bleed area (e.g., 0.125 inches) for print safety. Use the Rulers (Ctrl+R) to add guides for layout precision.

Use the Rectangle Tool (M) to draw a rectangle covering the entire artboard. Open the Gradient Panel and apply a green gradient, transitioning from light green (top) to darker green (bottom) to create depth. Adjust the gradient using the Gradient Tool (G) for a smooth effect.

Design the Main Visuals: Import or create graphics: Biscuit, Milk, or other product-related imagery using the Pen Tool (P) or Shape Tools.

Use layers to organize your elements. Add Typography Choose readable fonts for the product name, slogans, and details. Highlight key information like "Non-GMO" or "Natural Ingredients" using bold or decorative fonts.

Incorporate Brand Elements: Place the brand logo in a prominent location. Add icons like certification stamps, as seen in your provided package ("Non-GMO" and Corn warp logo).

Add Product Details: Use text boxes for the description, ingredients, and nutritional facts.

Ensure proper alignment and spacing using the Align Tool. Add Barcode and Expiry Date

Generate a barcode and place it in an appropriate section. Add the "Best Before" date and other legal text in a readable format.

Review and Finalize: Check alignment, colors, and readability. Proofread the text for any errors.

Prepare for Print: Ensure the document includes bleed and crop marks. Save the file as a print-ready PDF and an AI file for future edits

Font Part:

Figure 41: Nature's Brew Tea Packaging font part

Back Part:

Figure 42: Nature's Brew Tea Packaging back part

3D Visualization

Figure 43: Final Render of Tea

Download a pre-modeled Tea (likely in formats like `.obj`, `.fbx`,) and import it into Autodesk Maya. Ensure the UV map is properly laid out for texture application. The chips packet requires precise UVs to align the design correctly.

Use a material like VRayMtl for realistic rendering. Diffuse: Assign the texture image. Reflection: Add slight glossiness to mimic the shiny surface of plastic packaging. Balance light sources to avoid overexposure or dark areas.

Position the camera to frame the chips packet attractively. Set the focal length and depth of field to emphasize the packet. Select V-Ray as the rendering engine. Perform a low-resolution render to check for issues.

Render the image at full resolution after resolving any problems. And above image is my Final output of nature brew tea.

4.3.4 Fruite Juice packaging Design:

This design is a packaging layout for a product named "Fruité", an orange juice beverage. Below is an explanation of how it might be create in Adobe Illustrator:

1. Artboard and Layout

The design arranged on a single artboard, set to the dimensions of the packaging. The layout shows all the panels of the packaging, including the front, back, side panels, and top flaps, designed in a flat (2D) dieline format for printing and folding.

2. Design Components

Front Panel (Center Section): Includes the product name, tagline, and a visual representation of orange juice with splashes and orange slices. Text elements, like “Fruité” and “Refreshingly Natural”, are styled with vibrant fonts and placed prominently. An illustration of a glass of orange juice is likely created or imported as a vector graphic, with gradients and transparency effects for realism.

Side Panels: Left Side: Displays Nutrition Facts in a structured table. Includes a tagline: "Pure Taste. Pure Life. Pure Fruité." Right Side: Contains a description of the product, ingredients, and health benefits. Circular icons represent recycling, sustainability, and other eco-friendly certifications. Back Panel (Center Section): Displays branding elements, such as social media handles and a website. Includes a large orange slice graphic for visual emphasis.

3. Color Scheme

A vibrant orange gradient dominates the design, symbolizing freshness and orange flavor. Complementary colors like green (leaves) and white (text and icons) are used to create contrast.

4. Typography

Bold fonts are used for the title and important details (e.g., "Fruité," "Refreshingly Natural"). Smaller, legible fonts are used for descriptive text, such as health benefits and ingredients.

5. Graphic Elements

Orange Slice & Splash Effects: Likely created using Pen Tool, Gradient Mesh, and Transparency Effects. Icons: Created as vector elements or imported from stock vector libraries. Glass of Juice: Created with gradients, blends, and transparency effects for a realistic look.

All Measurements:

Figure 44: Fruite juice packaging

6. Dimensions and Guidelines

The dieline dimensions are marked with measurements (e.g., 1.5 in, 2.5 in, 5.5 in, etc.). Guidelines are included for cutting and folding.

7. Recyclability Indicators

A section highlights the eco-friendly nature of the packaging, with icons like the recycling symbol and phrases such as “Corn Water” to emphasize sustainability.

All Part:

Figure 45: Fruite all part

This is my final all side of Fruite juice packaging. This packaging design complete Adobe Illustrator. This my final result of packaging design.

3D Visualization

Figure 46: Final Render Fruite

Download a pre-modeled juice packet (likely in formats like `.obj`, `.fbx`,) and import it into Autodesk Maya. Ensure the UV map is properly laid out for texture application. The chips packet requires precise UVs to align the design correctly.

Use a material like VRayMtl for realistic rendering. Diffuse: Assign the texture image. Reflection: Add slight glossiness to mimic the shiny surface of plastic packaging. Balance light sources to avoid overexposure or dark areas.

Position the camera to frame the chips packet attractively. Set the focal length and depth of field to emphasize the packet. Select V-Ray as the rendering engine. Perform a low-resolution render to check for issues.

Render the image at full resolution after resolving any problems. And above image is my Final output of Fruite juice.

4.3.5 Poly Bag Packaging Design:

Process for Designing a Package in Adobe Illustrator:

This design represents packaging for an eco-friendly, plant-based poly bag. Below is an explanation of how it can be create and structured in Adobe Illustrator:

The design laid out flat on a single artboard, showing the front, side folds, and back panels of the poly bag. The dimensions defined clearly, with Width: 8 inches for the front and back panels, and 2.5 inches for the side folds. Height: 10 inches.

Front Panel: Displays the title "POLY BAG" in bold, green, eco-friendly typography. Features a gradient background transitioning from yellow-green (representing plants) to darker green (symbolizing sustainability). Includes the logo "Corn Warp" with a corn icon, emphasizing the bag's corn-based, biodegradable nature. Text highlights key features, such as "100% Plant-Based" and "100% Biodegradable Corn-Based Innovation".

Back Panel: Contains a description of the product and its benefits. Material Highlights: Explains that the bag made from cornstarch, is compostable, and eco-friendly. Includes a tagline: "Made from Corn, Kind to the Earth." Displays eco-certification icons (recyclable, biodegradable, and compostable symbols) and an explanation of the bag's breakdown timeline (90-120 days). Text and icons arranged symmetrically for clarity.

Side Panels: Show a simplified design with minimal text or patterns, emphasizing the foldability of the bag. The top section features a cut-out handle shape, which is part of the dieline for ergonomic usability.

The gradient background emphasizes a natural theme, transitioning from light green to dark green. White used as a base for text and icons, ensuring contrast and readability.

The title “POLY BAG” is bold, playful, and natural, reflecting an eco-friendly product. Body text uses a clean, modern sans-serif font, with a focus on readability and professionalism.

Corn Icon (Logo): Created as a vector using the Pen Tool with gradient fills for a vibrant look. Eco-Friendly Icons: Designed or imported as vectors, scaled appropriately to fit the back panel.

Background Pattern: Subtle circular patterns on the white areas to add texture without overwhelming the design. Likely created with the Pattern Tool or manually repeated.

The layout includes dimensions for all parts of the bag, ensuring precise printing and folding. Die-cut areas, like the handle, are clearly marked and positioned for functionality.

Text and icons emphasize the product's environmental benefits, making it appealing to eco-conscious consumers. Messaging structured to highlight sustainability credentials and the product's compostable nature.

Font Part:

Figure 47: Font part of Poly bag

Back Part:

Figure 48: Back part of poly bag

4.3.6 Red Chili Powder packaging Design:

Process for Designing a Package in Adobe Illustrator:

Research and Planning Understand the Brand: Learn about the product, target audience, and brand identity.

Sketch Ideas: Create rough sketches of the layout, including product name, images, ingredients, and other elements.

Set-Up Document: Open Adobe Illustrator and create a new document. Set the document size based on the package dimensions (e.g., 90mm x 150mm). Include a bleed area (3-5mm) for printing.

Create a Layout Use the Rectangle Tool (M) to define the front, back, and side panels of your package. Divide the layout for content sections: logo, product name, description, nutrition facts, and barcode.

Add Background and Colors: Choose a background color or gradient using the Gradient Tool (G). Add textures or patterns for visual appeal if needed.

Design the Main Visuals: Import or create graphics: Corn, snacks, or other product-related imagery using the Pen Tool (P) or Shape Tools.

Use layers to organize your elements. Add Typography Choose readable fonts for the product name, slogans, and details. Highlight key information like "Non-GMO" or "Natural Ingredients" using bold or decorative fonts.

Incorporate Brand Elements: Place the brand logo in a prominent location. Add icons like certification stamps, as seen in your provided package ("Non-GMO" and Corn warp logo).

Add Product Details: Use text boxes for the description, ingredients, and nutritional facts.

Font Part:

Figure 49: Red chili powder packaging font part

Back Part:

Figure 50: Red chili powder packaging back part

3D Visualization

Figure 51: Red chili powder Final Render

Download a pre-modeled Red chili packet (likely in formats like `.obj`, `.fbx`,) and import it into Autodesk Maya. Ensure the UV map properly laid out for texture application. The chips packet requires precise UVs to align the design correctly.

Use a material like VRayMtl for realistic rendering. Diffuse: Assign the texture image. Reflection: Add slight glossiness to mimic the shiny surface of plastic packaging. Balance light sources to avoid overexposure or dark areas.

Position the camera to frame the chips packet attractively. Set the focal length and depth of field to emphasize the packet. Select V-Ray as the rendering engine. Perform a low-resolution render to check for issues.

Render the image at full resolution after resolving any problems. Above image is my Final output of Red chili powder packet.

CHAPTER 5

CONCLUSION

Cornstarch-based packaging offers an innovative and sustainable alternative to traditional plastics, addressing critical environmental concerns such as pollution and waste accumulation. Made from a renewable resource, cornstarch, this material is biodegradable and compostable, ensuring a significantly lower environmental footprint compared to petroleum-based plastics.

The ability of cornstarch packaging to decompose naturally within a few months highlights its potential to reduce landfill waste and promote a circular economy. Moreover, its use supports local agriculture, particularly in regions where maize is widely cultivated, offering economic benefits alongside environmental advantages.

However, this solution is not without its challenges. High production costs, limited durability, and sensitivity to moisture and heat restrict its broader application. Additionally, the reliance on maize raises concerns about food security, as increased demand for cornstarch could impact food prices. The lack of consumer awareness and insufficient composting infrastructure further limits its effectiveness as an eco-friendly alternative.

Addressing these challenges requires investment in research to enhance the material's properties and reduce production costs. Public education and policy interventions are also essential to increase adoption and proper disposal. With these improvements, cornstarch packaging has the potential to replace single-use plastics in many applications, contributing to global sustainability goals.

In summary, while not a perfect solution, cornstarch-based packaging represents a significant step forward in reducing plastic pollution and fostering a sustainable future. Its continued development and adoption will play a vital role in shaping an eco-friendly packaging industry.

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