INVESTIGATING THE POSSIBILITIES OF ECO - FRIENDLY PACKAGING FROM FOOD BYPRODUCTS

Dissertation submitted to

ST. TERESA'S COLLEGE, ERNAKULAM (Autonomous)

Affiliated to

MAHATMA GANDHI UNIVERSITY

In partial fulfilment of requirement for the

AWARD OF THE DEGREE OF MASTER OF SCIENCE IN

SCIENCE (BRANCH B) HOME MANAGEMENT AND INTERIOR DESIGNING RESOURCE

By

GLENNA CARMELIN

Register No. AM23HRM003

DEPARTMENT OF HOME SCIENCE AND CENTRE FOR RESEARCH

APRIL 2025

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'Certified as bonafide research work'

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I hereby declare that the thesis entitled "**Investigating the possibilities of eco-friendly packaging from food byproducts**" is a Bonafide record work done by me during the course of the study, under the supervision and guidance of Dr. Rose Mary Francis, Associate Professor, Department of Home Science and Centre for Research, St. Teresa's College, Ernakulam.

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CERTIFICATE

This is to certify that the thesis "**Investigating the possibilities of eco-fFriendly packaging from food byproducts**" *is an authentic record of the original research work carried out by Ms. Glenna Carmelin with Reg. No. AM23HRM003 under the guidance of Dr. Rose Mary Francis, Associate Professor, Department of Home Science, St. Teresa's College (Autonomous), Ernakulam.*

Place : Ernakulam

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ABSTRACT

Eco Packaging, which emphasises the creation and application of eco-friendly materials and procedures, is a developing trend in the packaging sector; the benefits being, less trash going to landfills, energy savings, and supporting a more sustainable future all in line with consumer demands for items that are environmentally conscientious. There are several materials available for the generation of eco-packaging i.e. creating sustainable packaging materials in which the byproducts of the food industry can be a valuable resource. The main study objectives are to analyse packaging materials used by small-scale food sellers and to promote the use of eco-packaging, to reduce the issues caused by non-biodegradable packaging materials and to develop eco-packaging products. Inorder to attain the goal the researcher assess the awareness of small-scale food sellers regarding eco-packaging derived from food byproducts and their potential in adopting the same. A small survey conducted among 25 small-scale women home-based food sellers from Ernakulam district extracts data on their current packaging practices, knowledge of eco-packaging, and willingness to adopt sustainable packaging solutions. The findings reveal the extent of their concern about environmental impact, and awareness of eco-packaging options. Alongside the sellers interest in adopting eco-packaging and factors influencing this decision also is identified. The study provides a significant opportunity to promote eco-packaging solutions among small-scale food vendors. Further research is needed to explore specific eco-packaging materials suitable for various food products, as well as to develop strategies to facilitate the adoption of sustainable packaging practices within this sector. Thus, eco packaging as a viable strategy for resolving environmental issues could be promoted among food vendors.

CHAPTER 1 - INTRODUCTION

With the pollution caused by plastic waste, and unsustainable exploitation of resources escalating into a global environmental crisis, there is an urgent need for novel sustainable substitutes for conventional packaging materials. Pervasive use of traditional plastic packaging, especially in the food industry, has come under the scanner for negative ecological impact. Plastics are primarily derived from its non-renewable petroleum-based sources, and hence trigger soil and water pollution, threaten marine and land ecosystem and take hundreds of years to decay. With the rising concern of climate change and environmental degradation, there has been an increased interest amongst researchers, manufacturers, and policymakers in sustainable packaging materials derived from renewable resources, that are capable of biodegradation, composting. " **Sustainable packaging, also known as eco-friendly packaging, lowers the quantity of trash generated during the packaging process and assists enterprises in developing more environmentally friendly product package designs. In an attempt to reduce the impact of packaging materials and processes on the environment, it incorporates recyclable, biodegradable, or compostable materials and minimises waste"** (Hayley Chesshir, 2023). These packaging styles can be used to substitute unsustainable practices in the food industry.

Food byproducts are one of those promising solutions to create sustainable alternatives for packaging. **"Food byproducts are leftovers or byproducts of the main food production process. Materials produced during processing, such as peels, stems, pulp, or seeds, can be considered byproducts. They can be used for a variety of purposes and are frequently regarded as important sources of nutrients and bioactive substances"** (Macdalyna Esther Ronie, 2014) The use of food byproducts as raw ingredients for sustainable packaging is explored in this study.

Statement of the Problem

The demand for sustainable food packaging solutions has escalated in response to growing environmental concerns and consumer preferences for eco-friendly products. Packaging is essential for maintaining safety and quality of food, protecting it from impurities, and increasing

its shelf life. Food packaging materials need to be affordable, long-lasting, and have high barrier qualities. Food packaging's major goal is to preserve food's quality, safety, and wholesomeness. Creating a sustainable, cost-effective, and environment friendly packaging system is one of the biggest issues facing the food business. Conventional materials, which primarily rely on polymers derived from petroleum, are linked to a number of serious issues, including pollution of the environment, resource depletion, the production of single-use waste, chemical leaching into food products, limited recycling potential, and more. Promoting innovative innovations like sustainable food packaging is crucial for sustainable methods as the food industry works to lessen its environmental impact (Khandeparkar et al., 2024). By carefully choosing materials, adhering to Environmental Protection Agency regulations, and reevaluating packaging expectations with sustainability in mind, the negative environmental impacts of packaging waste can be reduced. Understanding the functional properties of packaging will help avoid many well-meaning but poorly thought-out solutions that fail to sufficiently take into account both pre- and post-consumer packaging factors.

Interest in sustainable packaging has been growing, particularly in comparison to conventional packaging. While much research has focused on improving the sustainability of packaging through eco-design tools, limited attention has been given to how sustainable packaging affects consumer behaviour during the purchase and recycling stages. A study by Graca, et al, (2015) examines the factors influencing consumer purchasing and recycling behaviour related to sustainable packaging. Using data from an online survey of 215 respondents in Portugal, the study compares two groups of consumers- one that values environmentally friendly packaging and one that does not consider it in purchase decisions. Key factors that differentiate the two groups include gender, environmental awareness, societal concerns, attitude toward green purchasing, and perceptions of consumer actions. Though the findings offer insights for policymakers, packaging producers, and marketers, ultimately; factors like price still play a crucial role in influencing consumer behaviour toward sustainable packaging adoption (Graca, et al, 2015).

Relevance of the Study

The byproducts of agricultural, food processing, and beverage are often discarded, contributing to environmental pollution and economic inefficiency. But it is rethinkable if these waste matter, including fruit peels, vegetable fibers, shells, husks and even food wastes from dairy and meat industries can be utilized to fine-tune biodegradable and compostable packing materials. Thanks to recent R&D in material science, biotechnology and the trends in circular economy, the efforts to convert these wastes into food packaging that create less dependence on fossil-based polymers, and produce less waste is undertaken.

The development of sustainable packaging solutions aims to address some of the most crucial environmental concerns. These solutions are aimed primarily at mitigating plastic waste through the use of food byproducts, which are biodegradable and can naturally decompose without harming the environment. They also aid in waste management by recycling waste from the food industry, helping to reduce bulk waste so that landfills are filled up less quickly. Moreover, these bio-based packaging lead to lesser carbon emissions than the production of plastics, making their use more environment friendly. Ultimately, sustainable packaging aids in the conservation of resources by making use of raw materials while reducing the waste of agricultural and industrial resources.

Many nations are developing better policies, implementing stricter bans, and creating new incentives to regulate the usage of plastic materials while gradually addressing the need for eco-friendly substitutes. Plastic waste management and greener public opinion are increasingly getting appealing to consumers, which also opens up new business opportunities to capitalize on. This, in turn, necessitates increased investment in innovation and advanced research that aims to design practical, sturdy, and biodegradable packages from renewable resources. The food processing sector is one of the largest contributors to the surge of organic wastes, generating a wide range of byproducts that remain unused. These products encompass peels from fruits and vegetables containing high amounts of cellulose and pectin and are ideal for biobased films; and also corn husks and wheat and rice straw that are fibrous and provide excellent prospects. Repurposing these by-products tackles the issue of waste management, while at the same time affords new developments in sustainable packaging technologies.

The merging of materials science with biotechnology allows for the recovery of valuable macromolecules like starches, celluloses, pectins, and lignins from food processing wastes, which could be turned into biodegradable packaging. The biopolymers derived from macromolecules like starches, celluloses, pectins, and lignins contained in food byproducts, help to maintain the required level of strength needed for packaging while becoming a part of nature's waste to be composted, which helps solve the dire issue of pollution resulting from plastic packaging materials. Utilizing food waste for bio packaging ensures a wide range of advantages including more sustainable ways of controlling pollution and decreased emission of gases leading to global warming. This also brings positive impacts to the economy by creating income opportunities for the food sectors while contributing to a circular economy. Furthermore, natural packaging materials eliminate the health risks associated with harmful chemicals often contained in plastic packaging, ensuring consumer safety. The shift towards biobased packaging does not come without challenges. Scalability and cost are two huge hurdles to overcome, particularly when mass production becomes more expensive than plastic fabrication. Additionally, it is necessary to meet quality benchmark expectations on packaging materials that are developed from food byproducts.

Eco-packaging, which emphasises the creation and application of eco-friendly materials and procedures, is a developing trend in the packaging sector. The idea of eco-packaging is examined in this study; along with its advantages, difficulties, and most current developments. It is crucial for tackling the world's trash problem and encouraging environmentally friendly consumption. There are many benefits to eco-packaging, such as less trash going to landfills, added energy savings, enhanced brand recognition etc. It supports a more sustainable future and is in line with consumer demands for items that are environmentally conscientious. The use of eco-packaging can be fraught with difficulties, including increased expenses, possible compromises to product safety, and the requirement for customer awareness education. Adoption of eco-friendly packages requires careful consideration of factors such as the design, material selection, and required infrastructure for recycling. Though there exist several materials suitable for the creation of eco-packaging, the byproducts of the food industry are a beneficial resource for creating sustainable packaging materials. The present study entitled "**Investigating the possibilities of eco-friendly packaging from food byproducts"** aims to promote the use of eco-packaging among small-scale women home bakers by creating awareness about the drawbacks of plastic and other unsustainable packaging materials. The main objectives is to analyse existing materials used for packaging by

small scale food sellers and to promote eco-packaging styles, to reduce environmental pollution caused by non-biodegradable packaging materials and further to advocate eco-packaging products from food industry byproducts.

To summarise, developing eco-packaging made from food byproducts shows greater significance due to growing emphasis on sustainability which is explained further:

- A major ecological crisis is the massive buildup of plastic trash, especially from packaging. Researching food byproduct packaging provides a practical way to reduce dependency on plastics made from fossil fuels, reducing pollution and fostering a circular economy.
- Customers are becoming more selective and prefer businesses that show a sincere dedication to sustainability.Purchasing and promoting environmentally friendly packaging that are eco-friendly improves a company's brand image and CSR profile.
- This initiative enables companies to demonstrate their commitment to environmental stewardship, drawing in eco-aware investors and customers.
- Investigating and constructing bio-based packaging fosters biotechnology and material science innovation, resulting in the creation of new sectors and employment prospects.
- Reusing food waste to make useful packaging materials encourages resource efficiency and opens up new revenue streams for the food processing sector.
- Demand for environmentally friendly substitutes for conventional packaging is being driven by rising consumer awareness of environmental issues.
- It contributes to a more sustainable and resource-efficient economy by providing a workable solution to the significant waste produced by the food processing sector.

Aim :

The study entitled "**Investigating the possibilities of eco-friendly packaging from food byproducts**" aims to identify the current packaging practices used by home based food producers and to find out the possibilities of developing eco-friendly packaging materials from food byproducts with the detailed objectives to identify the awareness, knowledge and practices in the area of eco packaging.

Detailed Objectives:

- To assess the current packaging practices by small-scale food vendors.
- To find out the level of awareness regarding eco-friendly packaging options by small-scale women food sellers.
- Identification of suitable food byproducts for eco-friendly packaging.
- Developing the models of a few eco-friendly packaging ideas from food byproducts.

CHAPTER 2 - REVIEW OF LITERATURE

A literature review plays an important role in research by helping to grasp the current knowledge landscape, pinpointing areas that require further exploration, and laying the groundwork for new studies. The review pertaining to the study delves into the realm of sustainable food packaging materials and methods, exploring their necessity, applications, and impact on advancing sustainability goals. The review begins by examining commonly used materials in food packaging and their negative environmental impacts, particularly focusing on issues like pollution and non-biodegradability. It then highlights the urgent need for eco-friendly alternatives, emphasizing the necessity to transition towards sustainable materials to mitigate ecological harm.

Review Subheadings are as follows:

2.1 Sustainability in food packaging

2.2 Food packaging developed from biodegradable sources

2.3 Need for developing eco packaging

2.4 Consumer behaviour and perceptions of eco packaging

2.1 Sustainability in food packaging

The demand for sustainable food packaging solutions has escalated in response to growing environmental concerns and consumer preferences for eco-friendly products. In the review of the study Hussain et al, (2024) delves into the realm of sustainable food packaging materials and methods, exploring their necessity, applications, and impact on advancing sustainability goals. The review begins by examining commonly used materials in food packaging and their negative environmental impacts, particularly focusing on issues like pollution and non-biodegradability. It then highlights the urgent need for eco-friendly alternatives, emphasizing the necessity to transition towards sustainable materials to mitigate ecological harm. A historical timeline contextualizes the evolution of food packaging materials, leading into an exploration of various

sustainable options, from general examples to advanced technologies like bio-nanocomposites and antimicrobial packaging.

Packaging is crucial in ensuring the quality and safety of food, protecting it from various contaminants, and extending its shelf life. Materials used for packaging food must be economical, durable, and possess good barrier properties. One of the major challenges faced by the food industry is developing an eco-friendly, economical, and sustainable packaging system. The conventional materials, which majorly depend on petroleum-derived polymers, are associated with several significant problems, such as environmental pollution, depletion of resources, generation of single-use wastes, leakage of chemicals into food products, limited recycling, and so on. As the food sector focuses on reducing its environmental impact, by encouraging revolutionary changes for an effective sustainable food packaging approach (Khandeparkar et al., 2024).

The food packaging sector is increasingly looking for more environmentally friendly ways to use bio-based materials in favour of non-renewable ones like petroleum-based polymers. The food packaging industry may be able to attain sustainability through the recovery of agri-food waste and by-products and the construction of industrial biorefinery units to process and transform such raw materials into biomaterials with high-added value and applicability to produce sustainable packaging

The primary purpose of food packaging must continue to be maintaining the safety, wholesomeness, and quality of food. The impact of packaging waste on the environment can be minimized by prudently selecting materials, following EPA guidelines, and reviewing expectations of packaging in terms of environmental impact. Knowledgeable efforts by industry, government, and consumers will promote continued improvement, and an understanding of the functional characteristics of packaging will prevent much of the well-intentioned but ill-advised solutions that do not adequately account for consumer factors (Marsh, K. (2007).

Interest in sustainable packaging has been growing, particularly in comparison to conventional packaging. While much research has focused on improving the sustainability of packaging through eco-design tools, limited attention has been given to how sustainable packaging affects consumer behaviour during the purchase and recycling stages. This study examines factors influencing consumer purchasing and recycling behaviour related to sustainable packaging. Using data from

an online survey of 215 respondents in Portugal, the study compares two groups of consumers: one that values environmentally friendly packaging and one that does not consider it in purchase decisions. Key factors that differentiate the two groups include gender, environmental awareness, societal concerns, attitude toward green purchasing, and perceptions of consumer actions. The findings offer insights for policymakers, packaging producers, and marketers. However, factors like price still play a crucial role in influencing consumer behaviour toward sustainable packaging adoption (Martinho Graca, et al, 2015).

The United Nations', *"The 2030 Agenda for Sustainable Development"* lists seventeen objectives that are crucial to the global sustainable development agenda. Assuring sustainable patterns of production and consumption is one of these objectives that directly affects the industrial sector. In a world where globalization is becoming more and more prevalent, packaging becomes a link connecting all locations worldwide, enabling the transportation and global marketing of goods from producers to consumers. Studying how the packaging sector is adjusting to the growing market demands while meeting worldwide environmental standards and sustainable development objectives set by international organisations is therefore essential. The study titled Eco-Design and Sustainability in Packaging: a survey. *Procedia Manufacturing*, with the purpose to analyse the food packaging industry specifically in order to determine how package makers deal with the themes of eco-design and sustainability, as well as the critical elements that contribute to the successful implementation of these concepts in their businesses. The industry's characteristics are also provided, including how businesses can set up and get ready to have a decreasing environmental impact, a raw materials sustainability policy, and take environmental factors into account throughout the package life cycle, or eco-design. One might state that not all packaging producers find eco-design to be a significant concern. According to the eco-design index, 30% of the manufacturers scored at or below four, indicating that they lack a deeply ingrained ecological culture. It was also possible to draw the conclusion that certain aspects of purchasing, such the reputation of the supplier, certified suppliers, and the shelf life of materials, are related to the growth of eco-design in businesses (Monteiro, J., et al (2019).

The FMCG (Fast Moving Consumer Goods) sector frequently generates enormous amounts of garbage. Nowadays, every society's top concern is sustainability. Compared to just five years ago, the ordinary customer today is more conscious of the environmental impact of the products they

choose. It is no longer possible to ignore the change because it is genuine and obvious. Customers are more concerned about sustainable packaging than ever before due to growing eco-friendly policies and understanding of sustainability and its importance. The FMCG business needs to make some strategic adjustments in light of the tectonic shift in customer behaviour towards more environmentally friendly and sustainable products. Food preservation and protection during manufacturing, transit, and storage are crucial functions of food packaging. If the packing is improper or mechanically damaged, food can change chemically, physiologically, and physically. Additionally, packaging is a crucial instrument for customer communication and marketing. Finding more environmentally friendly alternatives is crucial given the global issue of microplastic pollution of the environment and the abundance of food waste and by-products from the food industry. To cut down on food waste and steer clear of non-biodegradable plastics, edible and functional food packaging might be a good substitute. To cut down on food waste and steer clear of non-biodegradable plastics, edible and functional food packaging might be a good substitute. The creation and evaluation of edible food packaging from food waste, as well as the uses of fruit and vegetable by-products, are illustrated in this review. Topics include edible films, coatings, active packaging, intelligent packaging, and novel food packaging utilising biopolymers and biocomposites (Bayram, B., et al (2021).

Because of this change in customer attitudes, brands have already begun implementing sustainable marketing. However, we think it's helpful to know the different criteria that buyers consider before making a purchase. What motivates the purchase? What prevents it? To truly understand the consumer and develop businesses, these are crucial questions. Although one may already be aware of the elements that influence the consumer decision-making cycle, it is crucial to comprehend the underlying causes of those elements. The purpose of the study of sustainable packaging in the FMCG industry was to examine how consumers view and behave in relation to sustainable and eco-friendly packaging. We have carefully examined thirty research papers for this study in order to obtain a comprehensive understanding of all previous research. In order to gain a deeper understanding of consumer behaviour with regard to sustainability, and also worked on both moderated and unmoderated focus group conversations. And have a reasonable knowledge of the disconnect between customer behaviour, understanding, and the items that are on the market. The definition of sustainability, consumer-influencing factors, and the reasons why current trends and

activities—as well as practices in other industries outside of FMCG—would be useful correlations or comparisons provide us with a number of insights (Jain, P., & Hudnurkar, M. (2022).

2.2 Food packaging developed from biodegradable sources

The revolutionary potential of upcycling agricultural waste to create environmentally friendly food packaging is examined in this study. The packaging industry's sustainable future may be reversed with the help of agricultural wastes, which are usually disregarded. Examine new studies on plant-based byproducts that are separated from agricultural waste, such as proteins, polysaccharides, lipids, pigments, and minerals. These compounds can be used to create edible and (bio)degradable packaging solutions that can incorporate biobased active ingredients such as flavourings, antioxidants, and antimicrobials. Using plant fibres derived from agricultural waste improves packing efficiency while lowering environmental contamination. The review of study regarding Pyrazines: Synthesis and Industrial Application of these Valuable Flavor and Fragrance Compounds focuses on environmentally friendly packaging options, such as active packaging composed of phenolic compounds and edible coatings and films with antibacterial and antioxidant properties. These inventions meet consumer demand for high-quality foods with longer shelf lives by using a variety of foods and agricultural waste. In view of the global push for sustainability, developing edible materials is a realistic solution to reduce the excessive use of non-biodegradable plastics. Because these formulations are derived from biopolymers and biowastes, they can improve the performance of food packaging. Regulatory frameworks, processing methods, biodegradability metrics, and the characteristics of different byproducts are all to be analysed were included in the wide range. These formulations can enhance food packaging performance because they are made from biopolymers and biowastes. Anin-depth study synthesises existing knowledge to provide insight into the extraction, processing, and application of agricultural byproducts in packaging materials the extensive range includes biodegradability measurements, processing techniques, regulatory frameworks, and the properties of various byproducts (Mortzfeld, F. B., et al (2020).

Due to inadequate treatment of residues, which are frequently thrown away as trash without being utilized in subsequent downstream processes, the worldwide food processing industries pose a challenge and a risk to the environment. While a portion of this biomass is used, a significant

amount is still under- or unutilised, even though these leftovers represent a rich source of important molecules. Biopolymers and other substances with high nutritional value and active biological features, including proteins, polysaccharides, lipids, pigments, micronutrients, and minerals, are present in these biowastes. These substances can be used in a variety of applications, including the creation of environmentally friendly food packaging. The review by provides an update on the latest developments in food byproduct recycling and upgrading towards the creation of edible, (bio)degradable food packaging materials that serve as carriers of biobased active agents like flavouring additives, antioxidants, antimicrobials, and health-promoting substances. This need to be a worldwide endeavour to advance human welfare and attain sustainability while honouring the planet's natural limits. Formulations for edible films and coatings that use biopolymers and active ingredients derived from biowaste have excellent chances to reduce the harmful misuse of packaging made of plastic. The potential benefits of shifting from a fuel-based economy to a circular bio-based economy have become clear. Thus, using food waste in a zero-waste biorefinery setting would minimise waste production, lower pollution, and produce value-added chemicals, all of which would enhance waste management. Most significantly, the creation of edible packaging materials from food waste helps us become less reliant on petroleum-based products while also not competing with food resources. Petroleum is the source of about 99 percent of today's plastics, and their widespread usage has had a disastrous impact on the environment because plastic-derived substances have been found in all trophic levels. Furthermore, reducing food loss and waste by half and converting it into useful goods has become essential to achieving sustainability and economic circularity, as the growing quantities of food by-products pose a socioeconomic and environmental problem. One way to reduce the usage of persistent plastics is to develop new packaging technologies, including edible materials. Because of the bioactivities of their constituents, edible films and coatings made from by-products may also improve the performance of food packaging (Roberto Castro-Muñoz et al, 2021).

Since agro-industrials and by-products are a source of bioactive compounds (BCs) with pertinent biotechnological and nutritional value, such as antioxidants and carbohydrates, their sustainable management is essential to the expansion of the global economy. They have the potential to be used in a variety of industries since they can provide food goods additional value, such as extending their shelf life. Furthermore, the remaining matrices can also be used to create novel and environmentally beneficial bio-composite materials in accordance with the "Zero" principles. This

paper of Food and Bioprocess Technology provides a summary of the various applications for extracts from renewable resources that have been suggested as food ingredients for the creation of novel functional foods with enhanced oxidative stability. It provides a summary of the various applications of extracts from renewable resources that have been suggested as food ingredients for the creation of novel functional foods with enhanced oxidative stability. It also emphasises the use of by-products in packaging, demonstrating how they may be included into active film compositions and utilised as fillers to create novel materials. Additionally, a noteworthy observation regarding safety evaluation is necessary to emphasise the necessity of analytical controls to guarantee health issues (Edmondo Messinese et al 2023).

According to study from"Exploring the potentialities of using lignocellulosic fibres derived from three food by-products as constituents of biocomposites for food packaging" the lignocellulosic fibres derived from solid by-products of the food sector are the most affordable and environmentally friendly. Their repurposing as biocomposites' fillers would also aid in the food industry's waste reduction. In this regard, the European project EcoBioCAP sought to advance the state-of-the-art by creating a new class of food packaging ingredients, such as inexpensive, widely accessible, biodegradable, and useful fibres derived from solid by-products of the beer, oil, and wheat industries. A by-product of the manufacturing of wheat grains, wheat straw is mostly made up of cell walls made of a lignocellulosic network. Traditionally, it has been utilised for low-value purposes, primarily in cattle, animal feeding, or agricultural mulch, with the remainder being burned or thrown away. It is generally available worldwide According to Silva et al. (2011), it is simple to produce Wheat Straw Fibres (WSF) with a regulated size for use in food packaging applications through a series of dry grinding procedures that do not require a washing step. Brányik et al., (2005) states that in Europe, 8 million tonnes of dry Brewing by-products (BSG) are produced annually for a cost of nearly nothing, which could be a potential byproduct. However, because of the restricted utility of the insoluble fibre fraction, refining processes are not widely developed. These moist solid wastes from the beer and olive oil industries are particularly susceptible to microbial deterioration and cannot be stored without further, intense drying, which raises the energy cost(Brozzoli et al., 2010), but the majority of the by-products are thrown away without producing anything of value.The composition, size, and morphology of the fibres will be thoroughly examined, and the polymer chain length and crystallinity will be examined as matrix parameters. The study will concentrate on the fibre dispersion state, which will be evaluated by

microscopic observations in relation to the structural properties of the composites. The mechanical and barrier qualities of the composite will be the last attributes examined; these have a direct bearing on a possible use in food packing (Berthet, M.,et al. (2015).

This study explores how certain food industry by-products, like pig plasma protein (PPP) and soy protein isolate (SPI), can be reused to make superabsorbent materials. It looks at a process called de-hydrothermal (DHT) treatment, which involves heating the materials for a specific time and then soaking them in water. This treatment makes soy protein-based bioplastics stronger and less likely to absorb too much water. The research focuses on testing different PPP/SPI mixes, along with how long the materials are treated, to improve their strength, elasticity, and ability to hold water. Essentially, they're figuring out the best way to make these materials super absorbent while being durable and elastic (Álvarez-Castillo, Et al (2019).

Sustainable edible packaging systems based on active compounds from food processing byproducts: A review. *Comprehensive Reviews in Food Science and Food Safety*, *21*(1), 198–226.) states that due to inadequate treatment of residues, which are frequently thrown away as trash without being utilised in subsequent downstream processes, the worldwide food processing industries pose a challenge and a risk to the environment. Even though a portion of this biomass is used, a significant amount is still underutilised or left unutilised, even though these leftovers represent a rich source of important molecules. Biopolymers and other substances with high nutritional value and active biological features, including proteins, polysaccharides, lipids, pigments, micronutrients, and minerals, are present in these biowastes. These substances can be used in a variety of applications, including the creation of environmentally friendly food packaging. ThFormulations for edible films and coatings derived from biopolymers and active ingredients isolated from biowaste have excellent chances to reduce the harmful misuse of packaging made of plastic. Thus, using food scraps in a zero-waste biorefinery setting would enhance waste management by lowering pollution, producing value-added chemicals, and minimising waste formation. Most significantly, the creation of edible packaging materials from food waste reduces our reliance on petroleum-based goods and does not compete with food supplies (Hamed, I., et al,(2021).

The findings about eco packaging from food byproducts includes, The most common type of food by-products from fruits and vegetables. This amount is largely influenced by industrial operations including the manufacture of sugar, juice, wine, and oil. Although these residues are typically discarded as leftovers and composted or used as feed, they are an excellent source of bioactive substances such as vitamins, minerals, and polyphenols. The amount of residue that can be used after processing has been calculated to be in the millions of tonnes annually. The potential of the by-product to improve the qualities of packaging meant for food applications is of utmost significance. Therefore, the most recent studies on fruit and vegetable by-products utilised to improve the mechanical, antibacterial, antioxidant, and physical qualities of packaging systems A thorough assessment of recent developments in synthetic or bio-based films enhanced with by-product components is conducted, with a focus on the potential applications of by-product extracts in food packaging materials. The literature in 'Sustainable use of Fruit and Vegetable By-Products to enhance food packaging performance' also mentions using fruit and vegetable processing waste to create edible films or coatings as a workable way to lower the cost of making edible films and to enhance food by-products. To enhance the qualities of the finished film, it makes sense to extract the compound of interest and add it to the film forming solution when the by-product is rich in components, oils, or pigments with known qualities. The mechanical characteristics, such as tensile strength, flexibility, and elongation at break, enable the determination of the material's strength for use in culinary applications. Additionally, gas permeability and the capacity to absorb water and water vapour are crucial characteristics for food packing. Additionally, packaging that has antibacterial and antioxidant qualities may be an excellent way to extend the shelf life of perishable goods. In general, customers prefer natural substances when they are included into the polymeric matrix rather than manufactured additions. Therefore, given the size of the worldwide market for plastic food packaging and the large volume of by-products produced during the processing of fruits and vegetables, it is anticipated that their repurposing in food packaging will greatly aid in the development of new competitiveness. (Dilucia, F., et al (2020) suggests sustainable use of fruit and vegetable by-products to enhance food packaging performance.

2.3 Need for developing eco packaging

Growing environmental concerns and consumer preferences for eco-friendly products have increased demand for sustainable food packaging solutions. In the review 'Sustainable Food

Technology' the need, uses, and influence of sustainable food packaging materials and techniques on the advancement of sustainability objectives are explored. An examination of many sustainable solutions, ranging from broad examples to cutting-edge technologies like bio-nanocomposites and antimicrobial packaging, follows a historical history that places the development of food packaging materials in context. Innovative techniques like hybrid nanoparticle coatings and multifunctional bio-nanocomposite films are showcased, along with new developments in sustainable materials and greener production techniques. The review also looks at current advancements in sustainable food packaging, such as humidity-adjustable gelatin hydrogel films and allicin-loaded nanofibrous films, and talks about the use of chemical techniques to improve package qualities. In addition to highlighting the importance of these developments in reducing environmental impact and improving food safety, the closing remarks also provide a view for future developments in sustainable food packaging (Shokat Hussain et al, 2024).

The pivotal moment that must be seized is the complete biodegradation of the food packages into benign, environmentally beneficial products (CO2, H2O, and high-quality compost). The main attention and efforts are needed in the days ahead, even though a total replacement for synthetic plastics may not be feasible or even necessary, at least for a few particular applications of biodegradable packaging. Despite its high cost, bio-packaging satisfies the packaging demands of the future, particularly for a select few value-added items. Additionally, it provides an alluring path to waste management. However, everyone wants to live in a clean, pollution-free world in the future (Srinivasa P.C., et al, 2007).

Just a small number of works have conducted safety evaluation studies, such as physicochemical and microbiological evaluations or the identification of harmful pollutants in the food packaging made from organic food byproducts, despite the large number of applications identified on the value-adding of food by-products. These include the creation of decontamination techniques and processing strategies that prevent the production of such unwanted compounds, as well as successful analytical techniques that have been documented. However, because there isn't any explicit legislation governing the suitability and safety of the new items to ensure consumer safety, the evaluation of outcomes has typically been extremely complex and challenging (Socas-Rodríguez, et al. (2021).

Given that the high organic load in landfills causes methane and leachate to be produced, the composition of organic waste poses a threat to both the environment and human health. In this regard, reducing the amount of organic waste that is, solid waste and wastewater that is disposed of can be achieved through innovation in the management and recovery of food industry waste and by-products by turning them into feedstocks for use as packaging materials. The shift from a linear to a circular economy has significantly changed how people around the world view the utilisation of industrial and agricultural waste for resource conservation. The basic tenet of a circular economy is a closed (circular) loop in which resources are utilised, recycled, and reused while adding value or preserving the material's value over several lifecycles and reducing waste production. By examining biologically-based goods and services, such as valuing agricultural waste and byproducts, the circular bioeconomy model also emerges, which goes beyond simply merging the ideas of the bioeconomy and circular economy to suggest a circular economy as an alternative to linear flows of materials and nonrenewable resources. The circular bioeconomy stands out as a crucial idea for sustainability since it addresses a number of sustainable development goals (Cristofoli, N. L., et al, (2023).

The quantity of food packaging materials has decreased over the past ten years as a result of collaboration between the food and packaging industries. However, when it comes to disposal, the consumer can still clearly see used packing materials. The importance of environmental issues to European consumers is growing. As a result, consumer pressure may lead to the substitution of biobased packaging materials for those made from non-renewable resources. The term "biologically based packaging" refers to packaging made from renewable, biological raw materials like starch and bio derived monomers that come from agricultural sources but most of these substances aren't always biodegradable as one perceives. Biodegradable packaging has received a lot of attention thus far, and many initiatives are being worked on in this area. The promotion of ecologically friendly packaging materials is a major factor in this focus. Furthermore, in nations where landfills are the primary waste management technique, the usage of biodegradable packaging materials has the most potential. Primary and secondary packaging materials, as well as edible films and coatings, are examples of biobased packaging materials. There are already excellent, in-depth studies of edible coatings and films available. Before biobased primary food packaging materials are used commercially, a number of issues need to be resolved. Degradation rates under different settings, changes in mechanical qualities during storage, the possibility of

microbial development, and the release of hazardous substances into the packed food product are some of these issues. Additionally, the bio packaging needs to fulfil the specifications of each food product and serve as food packaging. The appropriateness of biobased packaging for food is assessed in this review. It also highlights the difficulties in utilising biobased packaging for various meals (Petersen, K., et al, (1999).

Food packaging has historically been used to describe products to consumers and enhance food quality. To continuously monitor the characteristics of packaged foods and offer real-time information about their safety, quality, and maturity, a new generation of intelligent (or "smart") packaging materials is being created. This paper provides a summary of current research on the creation, characteristics, and uses of intelligent food packaging materials. We start by going over the many sensing techniques that can be applied to identify changes in food characteristics, including those that are based on variations in temperature, time, humidity, oxygen content, pH, chemical makeup, or microbial infection. The many methods for creating intelligent packaging material such as labels, films, and bar code are then emphasised. The potential of these packaging materials in the food business is then illustrated through a discussion of several applications. Lastly, the difficulties and potential paths of food packing are examined. (Cheng, H., et al (2021)

Packaging is essential for maintaining food's safety and quality, shielding it from impurities, and increasing its shelf life. Food packaging materials need to be affordable, long-lasting, and have high barrier qualities. Creating a sustainable, cost-effective, and environmentally friendly packaging system is one of the biggest issues facing the food business. Conventional materials, which mostly rely on polymers generated from petroleum, are linked to a number of serious issues, including contamination of the environment, resource depletion, single-use waste production, chemical leakage into food products, limited recycling, and more. The food industry is working to lessen its influence on the environment by promoting innovative innovations for a sustainable and efficient food packaging strategy. Developing biodegradable materials, particularly those made from renewable biomass resources, as environmentally benign substitutes for conventional packaging was the main goal of industrial packaging. The manufacturing of bioplastics, which are made from renewable polymers like maize starch, sugarcane, or algae, is one of the major developments. Since these materials are frequently biodegradable or compostable, they present a competitive alternative to conventional plastics derived from petroleum.In order to address

environmental and health problems and functionalize a packaging material, innovative bioplastics with enhanced barrier qualities and durability are becoming more and more popular. The limitations of traditional food industry packaging materials are covered in this review, which also concentrates on the different natural polymers, their physico-chemical characteristics, and their potential use as a sustainable material that lowers carbon emissions, improves food preservation, and guarantees food safety (Khandeparkar, A. S., et al, (2024).

2.4 Consumer behaviour and perceptions of eco packaging

Concerns over packaging's effects on the environment are growing among consumers. Governments and customers alike are putting pressure on companies to package their goods in environmentally responsible ways. It's still unclear, though, what customers consider environmentally friendly packaging, particularly in developing nations. This study looks at how Vietnamese consumers see environmentally friendly packaging in relation to packaged food items. Six focus group conversations were held with a variety of consumers as part of the study. Consumer perceptions of environmentally friendly packaging, namely whether or not consumers would change their purchasing habits to be more ecologically friendly, were the main topic of discussion. Inductive manual coding principles related to interpretivist research were used in the data processing process. The findings show that three main factors—packaging materials, production technology, and market appeal—can be used to classify consumer perceptions of environmentally friendly packaging. Although consumers' opinions on eco-friendly packaging vary, their understanding is narrow and focuses more on packaging attributes like biodegradability and recyclability as well as market appeal like eye-catching graphics and competitive pricing. Despite their lack of understanding of manufacturing technologies, consumers still want environmentally friendly production methods. The findings also imply that a consumer-defined environmentally friendly food product package should be aesthetically pleasing and meet consumers' environmental requirements for the production process and packaging materials. As a result, we suggest a consumer-driven approach to creating environmentally friendly packaging that can be used with sustainable packaging techniques.When choosing food products, consumers take several packaging-related factors into account. While some customers prioritise eco-friendly features of the package (Rokka and Uusitalo, 2008), health-conscious consumers focus on label information (Coulson, 2000). Additionally, when consumers discard packaging, they could think

it is wasteful and have a poor opinion of the product (Roper and Parker, 2013). Therefore, before companies can successfully implement eco-friendly packaging strategies to remain sustainably competitive, it is crucial to address what consumers perceive to be eco-friendly packaging (Nguyen, A. T., et al (2019).

An exploratory study on '*The Influence of Consumers' Perceived Risks towards Eco-Design Packaging upon the Purchasing Decision Process: An Exploratory Study. Sustainability'* ,uses the means-end chain method to try to better understand how customers perceive the hazards associated with eco-design packaging and how that affects their decision to buy. First off, by fusing a consumer perspective (i.e., consumer perceptions) with an industrial perspective (i.e., a Life-Cycle Assessment: LCA), this study improves understanding of the idea of "eco-design packaging." The results show that customers' perceptions of eco-design packaging differ from the LCA findings. Second, by focussing on the "risks" rather than the "benefits," this study provides a different viewpoint on how customers respond to eco-design packaging and encourages package innovation. Five perceived risks—functional, physical, financial, life-standard, and socio-environmental risks—were discovered in this study. Thirdly, this study demonstrates the value of investigating customers' responses and buying patterns towards sustainable products utilising the means-end chain analysis (MEC) methodology. Finally, this study provides managers, packaging designers, and policy makers with a number of practical recommendations (Zeng, T., & Durif, F. (2019).

CHAPTER 3- METHODOLOGY

The study entitled “Investigating the possibilities of "Eco-Friendly Packaging from Food Byproducts” aims to develop eco-friendly packaging materials from food byproducts. The methodology used for the study comprises various steps which have Phase 1 which consists of collecting and analysing the information from the home bakers and Phase 2 was the development of eco-friendly packaging materials from food byproducts.

3.1 PHASE 1 -ONLINE SURVEY AMONG WOMEN SMALL-SCALE FOOD SELLERS REGARDING FOOD PACKAGING PRACTICES

3.2 PHASE 2 - DEVELOPMENT OF ECO-PACKAGING FROM FOOD BYPRODUCTS

3.1 PHASE 1 -Online Survey among Women Small-Scale Food Sellers regarding Food Packaging Practices

- 3.1.1 Selection of Area
- 3.1,2 Selection of Subjects
- 3.1.3 Selection of Technique
- 3.1.4 Selection of Tool
- 3.1.5 Collection of Data
- 3.1.6 Analysis and interpretation of Data

3.1.1 Selection of Area:

The study was conducted in Ernakulam district, conveniently selected for access to the investigator due to time constraints and based on the easy approachability and availability of subjects who are women home bakers.

3.1.2 Selection of sample:

A sample study is when a small group is used. Among 25 women small scale food sellers were selected. The age group is from 18 to 50, because this age group includes more active women entrepreneurs in the food industry. Technically, the entire group from which the sample is derived

is referred to as the entire population, while the exact group chosen for the study is referred to as the sample. The population as a whole should be represented in the sample that is taken. Whether the sample size is adequate will depend on how representative the sample is, Size of the sample- sample of 25 women small scale home based food sellers were selected for the study.

3.1.3 Selection of method- Survey method :

Survey was conducted among women food sellers to assess potential and awareness of small-scale food sellers regarding eco-packaging derived from food byproducts. It was done in online mode using google form. Samples were identified using the snowball sampling method. Where samples were connected through online entrepreneurs groups and personal contacts.

3.1.4 Selection of Tool:

Questionnaire consists of a series of questions to collect information from the respondents. Questionnaire includes both open and close-ended questions to collect data. To evaluate the data on current packaging used by small scale food sellers and awareness of eco-packaging made from food byproducts, a well-structured questionnaire was created. By using a questionnaire, their views about packaging were evaluated. The questionnaire gathers information on name, type of business, products they sell, current packaging styles used etc. are discussed. To gather information from participants, a mixed questionnaire comprising open-ended and closed-ended questions was created. The multiple choice format was used for designing the open-ended questions.

3.1.5 Collection of data:

Collection of data was through online mode by passing google forms with a set of questions. As the age group is from 18 to 50, they were aware of the information shared and actively participated by filling the forms.

3.1.6 Analysis and interpretation of data :

The gathered information was examined and tallied. Each respondent provided their preferences, current packaging styles, awareness about eco packaging as response to a series of questions. The information was utilized to determine what variables influence them to choose packaging styles.

3.2 PHASE 2 - Development of Eco-Packaging from Food By-products

To identify the materials suitable for eco-packaging from food byproducts includes a lot of observations and experiments. It involves a multifaceted approach, which needs consideration of both the byproduct source and the properties needed for the final product.

3.2.1 Assessing the byproducts properties:

- Starch content : starch (which is present in corn, potatoes etc.)
- Cellulose Content: Materials, films, and fibres with a high cellulose content found in many plant-based byproducts can be treated to resemble eco-friendly packaging.

3.2.2 Analysing desired properties of eco-packaging:

- Mechanical strength : It has to be strong enough to hold and protect food during travelling, holding and storage.
- Tensile strength : Resistance to breakdown
- Tear resistance : Ability to endure tearing.
- Compression strength : Strength against force
- Oxygen barrier : Hindering oxygen exposure to avoid spoilage.

These properties are identified by the need of the final product. The protection requirement, storage life etc.

3.2.3 Selection of raw materials

Raw materials were chosen according to the easy availability from the food industry and as byproducts based on the results of Phase I.

3.2.4 Material preparation and processing

1. To improve each food byproduct's pretreatment techniques (such as cleaning, drying, and grinding).

2. To identify the ideal proportions of selected byproduct for the creation of eco packaging

3. To research various processing methods for making eco packaging films or containers.

4. To add potential antioxidants and antibacterial ingredients to the composite matrices. To investigate the use of a reinforcing agent for strengthening the package.

3.2.5 Procedure for developing eco-packaging from food byproducts

Materials required for developing eco packaging:

- Food byproducts (neem leaf, orange peel, coconut husk)
- Corn starch
- Moulds to cast different shapes and sizes
- Drying racks

Procedure for developing eco packaging :

- Collection and Cleaning: Gather food byproducts and provide them a thorough cleaning to get rid of any impurities.
- Drying: To get rid of extra moisture, thoroughly dry the byproducts. Here I used sun drying.
- Grinding: Grind the dried byproducts into powder.
- Combining: Combine the powdered byproduct and cornstarch in an appropriate proportion (1: 2 byproduct:cornstarch).
- Adding Water: To get a workable consistency, gradually add water to the mixture.

The food byproducts that provide numerous environmental benefits in order to make eco-friendly packaging. Using agricultural waste, such as corn stalks and coconut husks, for example, lowers the need for virgin resources while also reusing items that could otherwise end up in landfills. In the same way, taking into account substances like milk protein and seaweed enables the production of edible and biodegradable packaging, reducing the long-term environmental impact. The byproducts that are plentiful, need less energy to produce than conventional packaging materials, and ideally have built-in features like antioxidants or antimicrobials that can even improve food preservation are given priority throughout the selection process. The ultimate objective is to

maximise the potential of these underutilised resources in order to develop packaging solutions that are useful and support a more sustainable food chain.

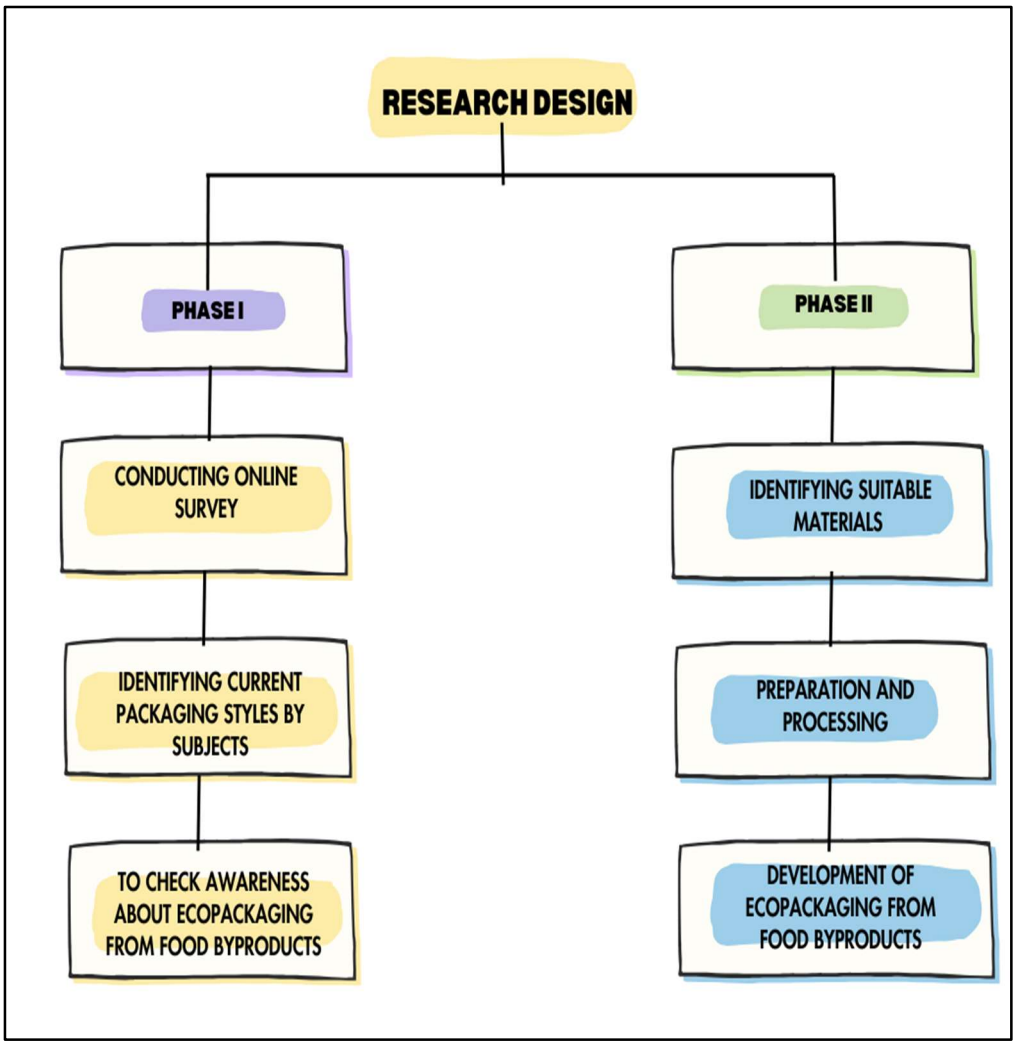


Fig No 3.1: Research Design

CHAPTER 4 - RESULTS AND DISCUSSION

Eco Packaging developed from food byproducts promises sustainability and reduction of food waste to some extent. Developing eco packaging from food byproducts includes various stages and experiments. The study titled **"Investigating the possibilities of eco-friendly packaging from food byproducts"** is conducted using the planned research design. In the Chapter 4 "**Results and Discussion,"** the data are compiled and presented.

4.1 PHASE I -ONLINE SURVEY AMONG WOMEN SMALL-SCALE FOOD SELLERS REGARDING FOOD PACKAGING PRACTICES

4.2 PHASE II - DEVELOPING ECO PACKAGING FROM FOOD BYPRODUCTS

4.1. Phase I - Online survey among women small-scale food sellers regarding food packaging practices

Online survey among women small-scale food sellers were conducted to analyse their business and awareness about eco packaging. The study was conducted among Ernakulam districts, based on the easy accessibility and availability of case study subjects. The study subjects were classified as cases due to the small sample size. A total of 25 women who owned food outlets were selected for the study. Non-probability purposive sampling was used to identify the target group of female food vendors. Since the investigator was directly involved in the related field, she was able to easily identify the cases, despite the small size of the population. Individual survey was conducted among women in the field of home based food production inorder to assess potential use and awareness of these small-scale food sellers regarding eco-packaging especially those derived from food byproducts. To evaluate the data on current packaging used by home bakers and awareness of eco-packaging made from food byproducts, a well-structured questionnaire consisting of open and closed-ended questions. The multiple choice format was used for designing the open-ended questions. The questionnaire gathered information on personal data, type of business, products dealt with, current methods of food packaging used etc. The gathered information was available in excel format. It was tabulated and discussed based on the objectives. Each respondent provided their preferences, current packaging styles, awareness about eco packaging as response to a series of questions. The information was utilised to determine what variables influenced them to choose packaging styles

4.1.1 Age of the 25 subjects participated in the survey

TABLE 4.1 Age of the subjects participated in the study

Age in Years	No. of Home Bakers
Up to 20	2
21 - 39	11
31 - 40	4
41 - 50	5

The study was conducted among 25 women small scale food sellers. The age of the respondents is from 18 to 50 years of age. This category of respondents were selected due to their active participation in the food selling sector.

4.1.2 Analysing type of business and products

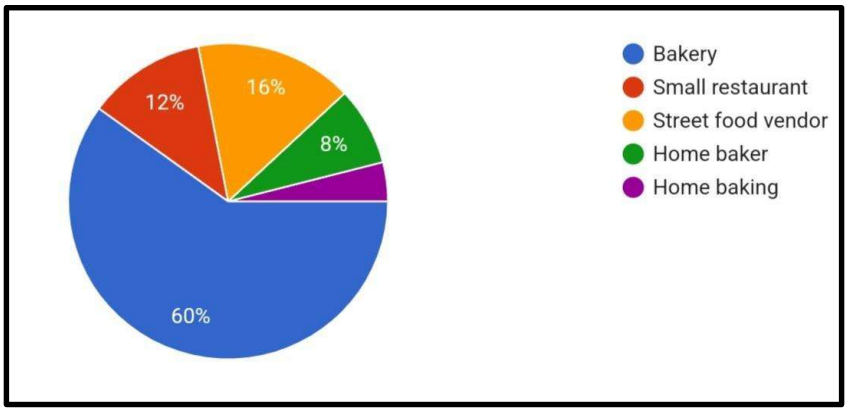


FIGURE 4.2. Type of business pursued

To know about the type of business pursued by the respondents, the business run by them was analysed. From figure 4.2, most of the respondents, about 60 percent, were having small bakery.

16 percent were street food vendors, 12 percent were having small restaurants and 8 percent were home bakers.

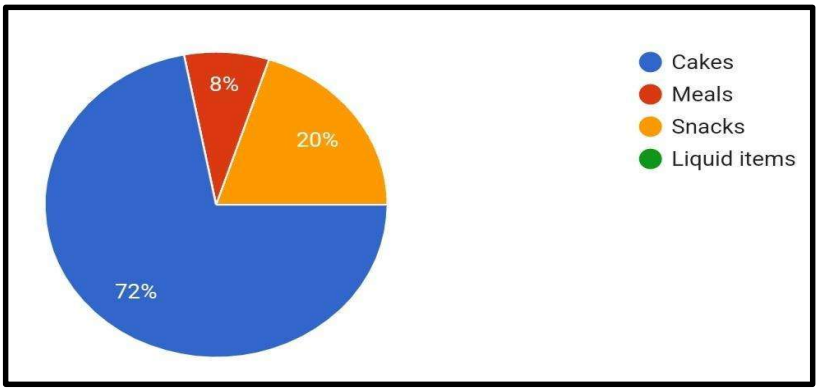


Figure 4.3. Type of Food Product prepared and sold

In figure 4.3, the type of food product sold by the respondents were identified. This identification is helpful in deciding the properties needed for the final product. 72 percent of the subjects were selling cakes, 20 percent of them selling snack items and 8 percent were selling meals.

4.1.3 Identifying current packaging styles used by the subjects

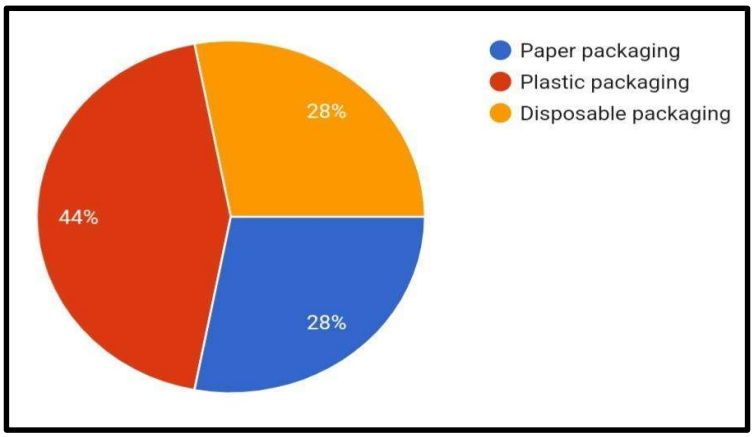


Figure 4.4. Current packaging style adopted

It is necessary to find the current packaging styles used by the respondents, as it has a great influence on adopting eco packaging in their work. From figure 4.4, it was seen that 44 percent of the respondents used plastic packaging, paper packaging and disposable packaging were used by 28 percent of rest of the respondents.

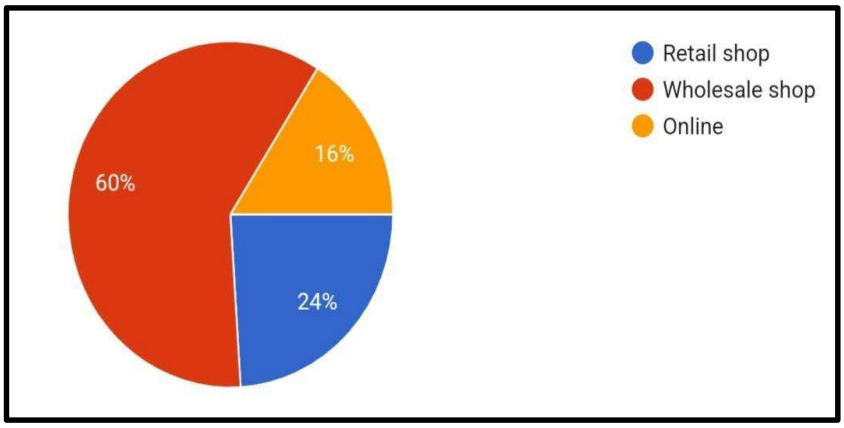


Figure 4.5. Source of Food Packaging Materials

From figure 5, the sources for purchasing packaging materials were analysed, 60 percent of them purchased from wholesale shops, 24 percent of them were purchased from retail shops and 16 percent of them were purchased from online stores.

4.1.4 Checking awareness about eco packaging

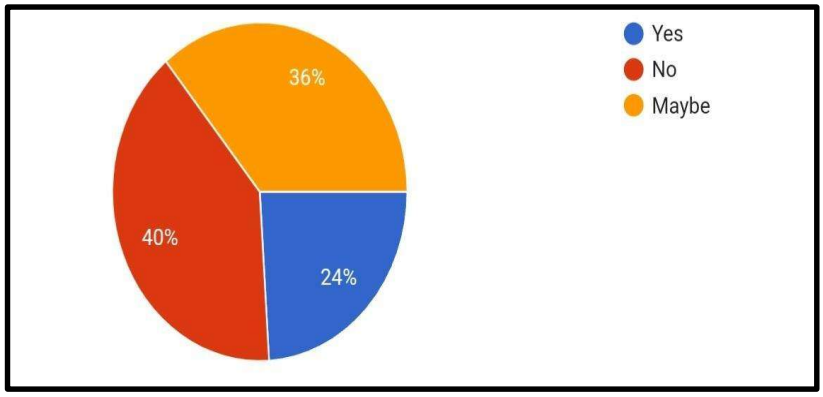


Figure 4.6: Awareness about Eco Packaging

Awareness about eco packaging made from food byproducts among samples where discussed, the subjects were asked whether they heard about eco packaging made from food byproducts, in the samples about 40 percent were not aware about eco packaging made from food byproducts, and 24 percent of them were only aware of eco-packaging. Most of them were aware about eco packaging from the media like newspapers, tv, and social media.

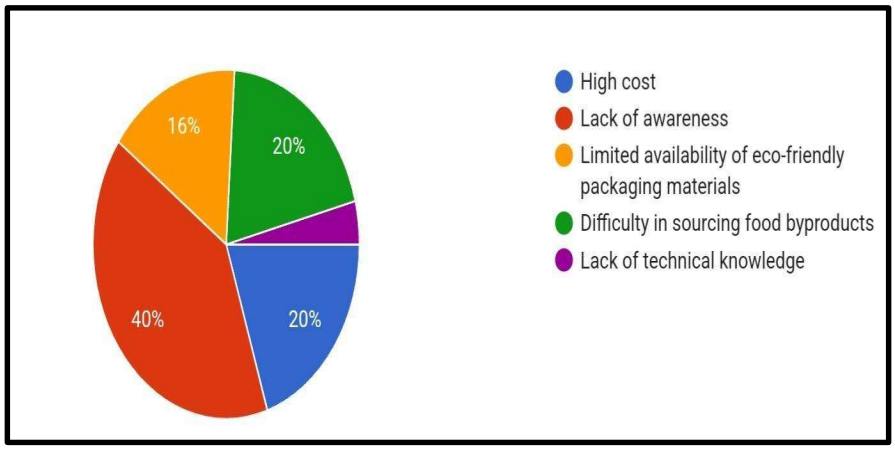


Figure 4.7 : Challenges in adopting Eco-Packaging

By analysing challenges faced by food sellers in adopting eco-packaging from figure 7, 10 percent of the respondents said they were having lack of awareness. 20 percent of them were having difficulty in sourcing food byproducts and another 20 percent of them were facing high cost of eco-packaging materials and 16 percent of them were having limited availability of eco-friendly packaging materials.

4.1.5 Perception and Adoption of Eco-Packaging

Figure 4.8. Benefits of Eco-Packaging

While evaluating the perception and adoption for eco-packaging among small scale food sellers, from fig 9, it shows that they gave an average rating of 3.60 about potential benefits of eco-packaging. It shows there is a partially positive attitude among food sellers for eco packaging.

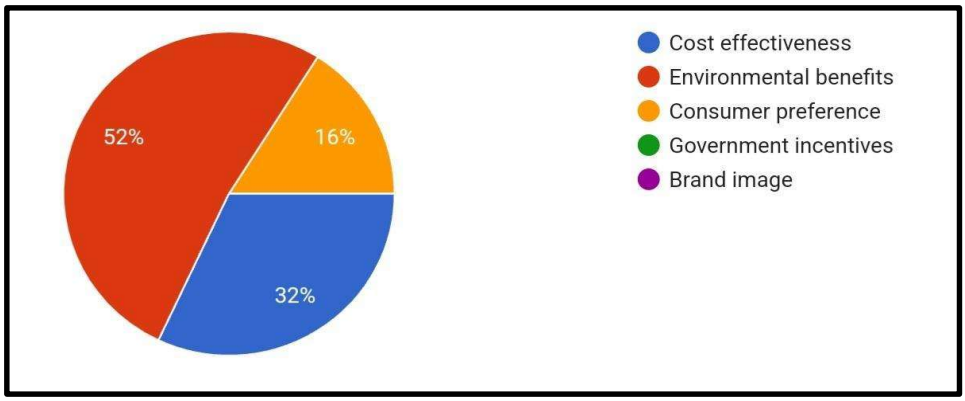


Figure 4.9. Factors influencing use of eco-packaging

To promote the use of eco packaging among small sellers, the factors that influence them to adopt eco-packaging were also discussed and 52 percent of them selected eco packaging for environmental benefits, 32 percent of them selected for cost effectiveness and 16 percent of them selected for consumer preferences.

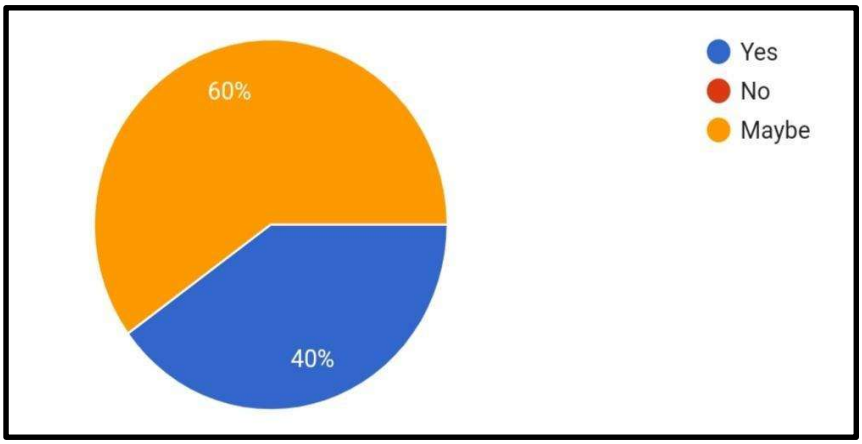


Figure 4.10. Willingness to adopt Eco-packaging

For acceptability of eco packaging among small scale food sellers the willingness of respondents were enquired. 60 percent of them were not sure that they are willing to pay for eco packaging and 40 percent agreed to pay for the implementation of eco-packaging.

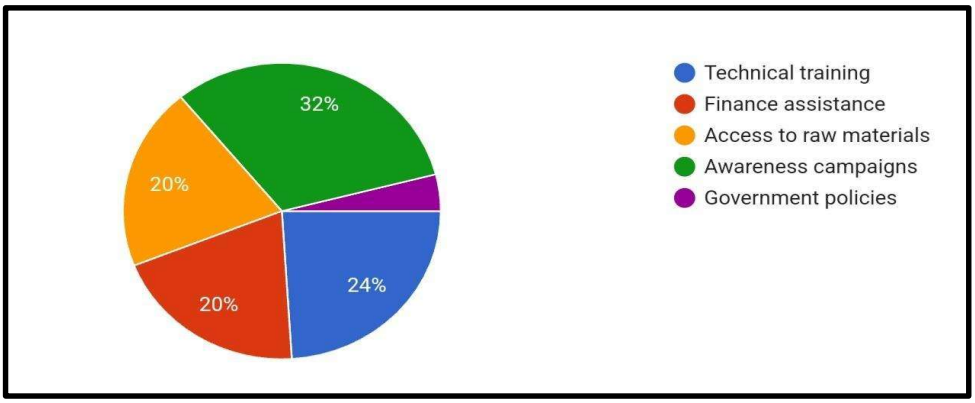


Figure 4.11. Support needed for Eco-packaging

The type of support needed for samples were discussed in figure 11, 32 percent of them needed awareness campaigns, 24 percent of them needed technical training, 20 percent of them needed financial assistance and another 20 percent needed access to raw materials.

4.2 PHASE II - Development of eco packaging from food byproducts

The development of eco-packaging from food byproducts offers a viable path towards sustainability, based on the investigation of source materials such as corn leaf, coconut husk, neem, orange peel and eggshell, as well as the use of cornstarch as a binding agent. By examining several mixing ratios and manufacturing processes like casting and compression moulding, this study aims to develop eco packaging from food byproducts and processing of these easily accessible agricultural and food wastes in order to produce useful packaging materials. Important components of this development include the use of eggshell powder as a strengthening agent, orange peel for possible antioxidant and structural benefits, and neem for its antibacterial qualities. In order to develop eco packaging solutions that may find use in the food industry and promote a more circular economy, the resultant materials will undergo thorough characterisation that will assess their mechanical, thermal, barrier, biodegradability, and physical characteristics.

A systematic and methodical strategy was used to successfully build eco-friendly packaging solutions from food byproducts, utilising the plentiful supply of orange peel, neem leaf, and coconut husk, with cornstarch acting as a binding agent.

While orange peel added potential antioxidant and structural enhancement qualities, neem leaf's inherent antimicrobial properties which have been well-documented in scientific literature were strategically incorporated to enhance the material's overall performance. To maximise the material's performance, an array of mixing ratios and development procedures were carefully investigated. This ensured a delicate balance between the material's mechanical, physical, and barrier qualities all of which are critical for efficient packaging. The thermal and biodegradability characteristics of the resultant materials were assessed by a thorough characterisation, which offered important insights into their possible uses and environmental impacts. By reducing waste, conserving resources, and encouraging sustainable habits, the results show how widely these eco-packaging solutions may be used in the food industry and greatly contribute to a more circular economy. This creative method uses food waste to provide a promising, cost-effective, and environmentally acceptable substitute for conventional packaging materials while also lessening their environmental impact. The created materials showed promising qualities that made them appropriate for a range of food packaging uses, such as baked goods, and snacks. They also opened the door for additional study, commercialisation, and environmental advantages that can benefit the food industry and the environment.

TABLE NO - 4.2 List of selected materials and estimated cost for an eco-package developed from food byproduct-Corn Starch.

Sl No:	Major ingredients needed	Measure / Quantity	Price (Rs.)
1	Corn starch	100 gm	18/-
2	Xanthan gum	50 gm	120/-

The food byproduct can be sourced freely. So the total cost can be estimated to be around Rs.130/- approximately.

Products developed include, materials like neem leaf extract in figure 11, orange peel in figure 12, and coconut husk in figure 13 respectively.

Figure 12 . Eco Packaging developed from Neem Leaf Paste

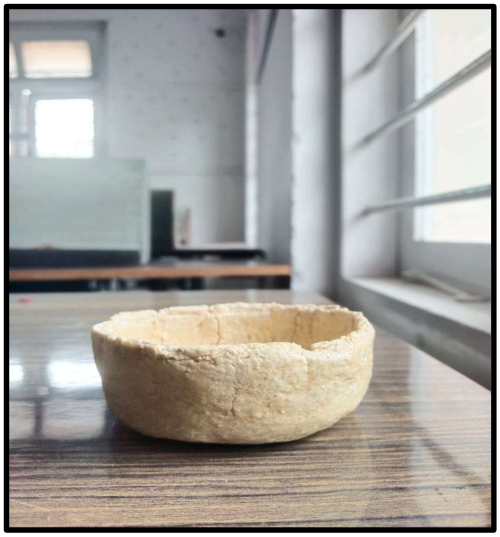


FIGURE 13. Eco Packaging developed from Orange Peel

Figure 14. Eco packaging developed from Coconut Husk

Evaluation of product developed:

Evaluation of developed products done with the help of Likert 5-point scale. The developed products are evaluated based on nine criteria such as aesthetics, mechanical strength, ease of bulk, durability, tensile strength, compression strength, oxygen barrier, tear resistance and cost involvement. And each of the criteria is assigned 1 to 5 points, which denotes excellent, good, average, poor and very poor.

TABLE NO - 4.2.2 Investigators evaluation of products developed.

Products	Aesthetics	Mechanical strength	Ease of bulk	Durability	Tensile strength	Compression strength	Oxygen barrier	Tear resistance	Cost involvement
Neem leaf	3	3	4	3	3	3	4	3	3
Orange peel	4	4	3	5	4	4	5	4	3
Coconut husk	3	4	5	4	3	3	4	3	3

According to evaluation from likert scale, neem leaf paste eco package has scored high in cost involvement, ease of bulk. But considering aesthetics, mechanical strength, durability, tensile strength, compression strength, oxygen barrier, tear resistance, orange peel eco package has scored high. Evaluating the mechanical strength, ease of bulk, and cost involvement coconut husk eco package has also scored high. Comparing all these products, the orange peel eco package has scored high.

CHAPTER 5 - SUMMARY AND CONCLUSION

"Investigating the possibilities of eco-friendly packaging from food byproducts" was the study entitled to investigate the possibility of developing eco packaging from food byproducts . The aim of the project was to analyse current packaging styles used by small scale food sellers, their awareness about eco packaging from food byproducts and to develop an eco packaging from food byproduct .

SUMMARY

The following headings were used to describe the approach used for this study :

- The current packaging practices by small-scale food vendors.
- Level of awareness regarding eco-friendly packaging options by small-scale women food sellers.
- Identification of suitable food byproducts for eco-friendly packaging.
- Developing an eco-friendly packaging from food byproducts.

5.1 The current packaging practices by small-scale food vendors.

To know about the current packaging practices used by the small scale food sellers snow sampling method was used to find the women small scale food sellers. An online survey with questionnaire as a tool was used to identify the current packaging practices used by them. 25 women small scale food sellers were identified. By the findings it was shown that most of them opted for plastic packaging, and an equal proportion of disposable and paper packaging were used.

5.2 Level of awareness regarding eco-friendly packaging options by small-scale women food sellers.

To introduce eco packaging developed from food byproducts among small scale food sellers it is necessary to know about the awareness and willingness to adopt eco packaging developed from food byproducts. Most of them didn't have awareness about eco packaging from food byproducts.

Lack of awareness was also the challenge faced by them to adopt eco packaging from food byproducts. They are also willing to adopt eco packaging but they mentioned the challenge as they are unaware of the eco packaging developed from eco packaging.

5.3 Identification of suitable byproducts for eco packaging

Identification of Materials suitable for eco-packaging from food byproducts includes a lot of observations and experiments. The properties of byproducts like starch content, binding strength etc. were analysed. The desired properties of eco packaging like holding strength, storage etc. were also considered. The byproducts like orange peel, coconut husk, neem leaf etc. were identified to develop eco packaging.

5.4 Developing an eco-friendly packaging from food byproducts.

This study mainly focuses on the possibilities to develop an eco packaging from food byproducts. The development of eco packaging from food byproducts, includes different processes to identify mixing ratios, methods etc. here, moulding, casting were done to make the process easier and convenient for the small scale food sellers to adopt this kind of eco packaging.

The following objectives were identified:

- Most of the small scale food sellers were using plastic packaging, and also same number of disposable packaging and paper packaging were also found using the survey
- The small scale food sellers selected for the study also stated the willingness of adopting eco packaging developed from food byproducts.
- The challenge was the unawareness of eco packaging developed from food byproducts.
- The identification of materials from food byproducts were identified according to the properties of materials and desired properties of the final product.
- The development of eco packaging includes steps like casting, moulding and drying of prepared elements.
- Evaluation and suggestions for improvement

CONCLUSION

The utilization of plastics is rising every day, and the growth of various businesses, particularly in the food industry, is accelerating. This prompts the need for the advancement of sustainable practices in the packaging we utilize. Recent trends and research supporting the adoption of eco-friendly packaging are on the rise. Given this context, there is a greater opportunity to conduct a study on eco packaging that can be created from food byproducts, which are readily available from food production.

The survey aimed to find the potential of eco-packaging made from food byproducts and assess the awareness of small-scale food sellers. The areas explored included the current packaging practices, perceptions of eco-friendly packaging, and willingness to adopt sustainable alternatives. The survey shows a significant gap in awareness regarding eco-packaging among small-scale food sellers. Despite a positive attitude towards sustainability, practical challenges like cost, availability, and durability hinder the adoption of eco-packaging. To promote eco-packaging, awareness campaigns, government incentives, and collaborations with packaging manufacturers are crucial. By addressing these factors, the transition to sustainable packaging can be facilitated, benefiting both the environment and the food industry

Based on the data gathered and the findings, eco-friendly packaging was created using food byproducts that food vendors require. Considering accessibility and various characteristics, three products were developed from neem paste, coconut husk, and orange peel. This packaging can be readily produced by small-scale food vendors and can serve as an additional source of income by selling eco-friendly packaging.

LIMITATIONS

- Can only develop small sized packages due to production cost
- Time consuming
- Sourcing can be difficult
- Climatic changes can affect

SUGGESTIONS

- Further studies should be take over to adopt eco packaging
- Advancement in technologies for preparing byproducts for eco packaging shou;d be developed
- Food sellers need different types of package according to different purposes, this should be taken into consideration for developing eco packaging

BIBLIOGRAPHY

- Monteiro, J., Silva, F., Ramos, S., Campilho, R., & Fonseca, A. (2019). Eco-Design and Sustainability in Packaging: a survey. *Procedia Manufacturing*, *38*, 1741–1749.
- Valorization and application of Fruit and Vegetable Wastes and By-Products for food Packaging materials. *Molecules*, *26*(13), 4031.)
- Sustainable packaging in the FMCG industry. *Cleaner and Responsible Consumption*, *7*, 100075.)
- Pyrazines: Synthesis and Industrial Application of these Valuable Flavor and Fragrance Compounds. *Biotechnology Journal*, *15*(11)
- Comprehensive Reviews in Food Science and Food Safety 21 (1), 198-226, 2022)
- Food and Bioprocess Technology 17 (3), 606-627, 2024)
- Exploring the potentialities of using lignocellulosic fibres derived from three food by-products as constituents of biocomposites for food packaging. *Industrial Crops and Products*, *69*, 110–122.)
- Álvarez-Castillo, E., t alBengoechea, C., & Guerrero, A. (2019). Composites from by-products of the food industry for the development of superabsorbent biomaterials. *Food and Bioproducts Processing*, *119*, 296–305.
- Sustainable edible packaging systems based on active compounds from food processing byproducts: A review. *Comprehensive Reviews in Food Science and Food Safety*, *21*(1), 198–226
- Sustainable Food Technology 2 (5), 1297-1364, 2024
- Socas-Rodríguez, Álvarez-Rivera, G., Valdés, A., Ibáñez, E., & Cifuentes, A. (2021). Food by-products and food wastes: are they safe enough for their valorization? *Trends in Food Science & Technology*, *114*, 133–147.
- Food reviews international 23 (1), 53-72, 2007
- Cristofoli, N. L., et al Lima, A. R., Tchatchouang, R. D. N., Quintino, A. C., & Vieira, M. C. (2023). Advances in the Food Packaging Production from Agri-Food Waste and By-Products: Market Trends for a Sustainable Development. *Sustainability*, *15*(7), 6153

- Petersen, K., Nielsen, P. V., Bertelsen, G., Lawther, M., Olsen, M. B., Nilsson, N. H., & Mortensen, G. (1999). Potential of biobased materials for food packaging. *Trends in Food Science & Technology*, *10*(2), 52–68
- Recent advances in intelligent food packaging materials: Principles, preparation and applications. *Food Chemistry*, *375*, 131738.
- Khandeparkar, A. S., Paul, R., Sridhar, A., Lakshmaiah, V. V., & Nagella, P. (2024). Eco-friendly innovations in food packaging: A sustainable revolution. *Sustainable Chemistry and Pharmacy*, *39*, 101579.
- Nguyen, A. T., et al Parker, L., Brennan, L., & Lockrey, S. (2019). A consumer definition of eco-friendly packaging. *Journal of Cleaner Production*, *252*, 119792
- Zeng, T., & Durif, F. (2019). The Influence of Consumers' Perceived Risks towards Eco-Design Packaging upon the Purchasing Decision Process: An Exploratory Study. *Sustainability*, *11*(21), 6131
- Jain, P., & Hudnurkar, M. (2022). Sustainable packaging in the FMCG industry. *Cleaner and Responsible Consumption*, *7*, 100075.
- Dilucia, F., Lacivita, V., Conte, A., & Del Nobile, M. A. (2020). Sustainable use of Fruit and Vegetable By-Products to enhance food packaging performance. *Foods*, *9*(7), 857.
- Cristofoli, N. L., Lima, A. R., Tchonkouang, R. D. N., Quintino, A. C., & Vieira, M. C. (2023). Advances in the Food Packaging Production from Agri-Food Waste and By-Products: Market Trends for a Sustainable Development. Sustainability, 15(7), 6153.
- FAO Food Waste Footprint: Impacts on Natural Resources. 2013. Available online: https://www.fao.org/sustainable-food-value-chains/library/details/en/c/266219/

APPENDICES

APPENDIX-1

SURVEY/QUESTIONNAIRE CONSENT FORM

INFORMED CONSENT FORM

This informed consent form is for participants

Part 1:- Information sheet

Dear participant,

I am Glenna Carmelin, PG student in Resource Management and Interior Designing from the Dept. of Home Science, St. Teresa's College, Ernakulam . I am doing research in the area of eco friendly packaging with the purpose of assessing the Potential and awareness of small-scale food sellers about eco packaging.

In this survey you will be asked to complete this short questionnaire, starting with some personal details, including name address, age, and business details, mode of packaging etc. I assure that the information that is collected from this research project will be kept strictly confidential and will be used purely for the research purpose. No payment is required to participate in this study. Participation in this study is voluntary and you may discontinue participation in the study at any time without any difficulty.

Part II: Certificate of Consent

I have read the foregoing information, or it has been read to me. I understand the purpose of the study and I agree to participate.

Name :

Date of participation :

APPENDIX - 2

QUESTIONNAIRE

Questionnaire on " Investigating possibilities of Eco-Packaging Developed from Food Byproducts".

Section 1: Demographic Information

1. Name of the Respondent:
2. Age:
3. Gender:
4. Type of Food Business: (e.g., street food vendor, small restaurant, bakery)
5. Location of Business: (Urban/Rural/Semi-Urban)

Section B: Analyzing current packaging styles in your business

1. What are the products you sell?

- Cakes
- Snacks
- Liquid items
- Meals
- Others

2. From where did you purchase packaging materials?

- Retail shop
- Wholesale markets
- Online

Section C: Awareness of Eco-Packaging

1. Have you heard of eco-packaging made from food byproducts?
    - Yes
    - No
2. If yes, please specify the sources of your information:
    - Media (newspapers, TV, social media)
    - Government initiatives
    - Industry associations
    - Other (please specify)
3. Do you think eco-packaging is important for sustainable food businesses?
    - Yes
    - No
    - Unsure
4. What are the primary challenges faced by small-scale food sellers in adopting eco-packaging?
    - High cost
    - Lack of awareness
    - Limited availability of eco-friendly packaging materials
    - Difficulty in sourcing food byproducts
    - Lack of technical knowledge
    - Other (please specify)

Section D: Perception and Adoption of Eco-Packaging

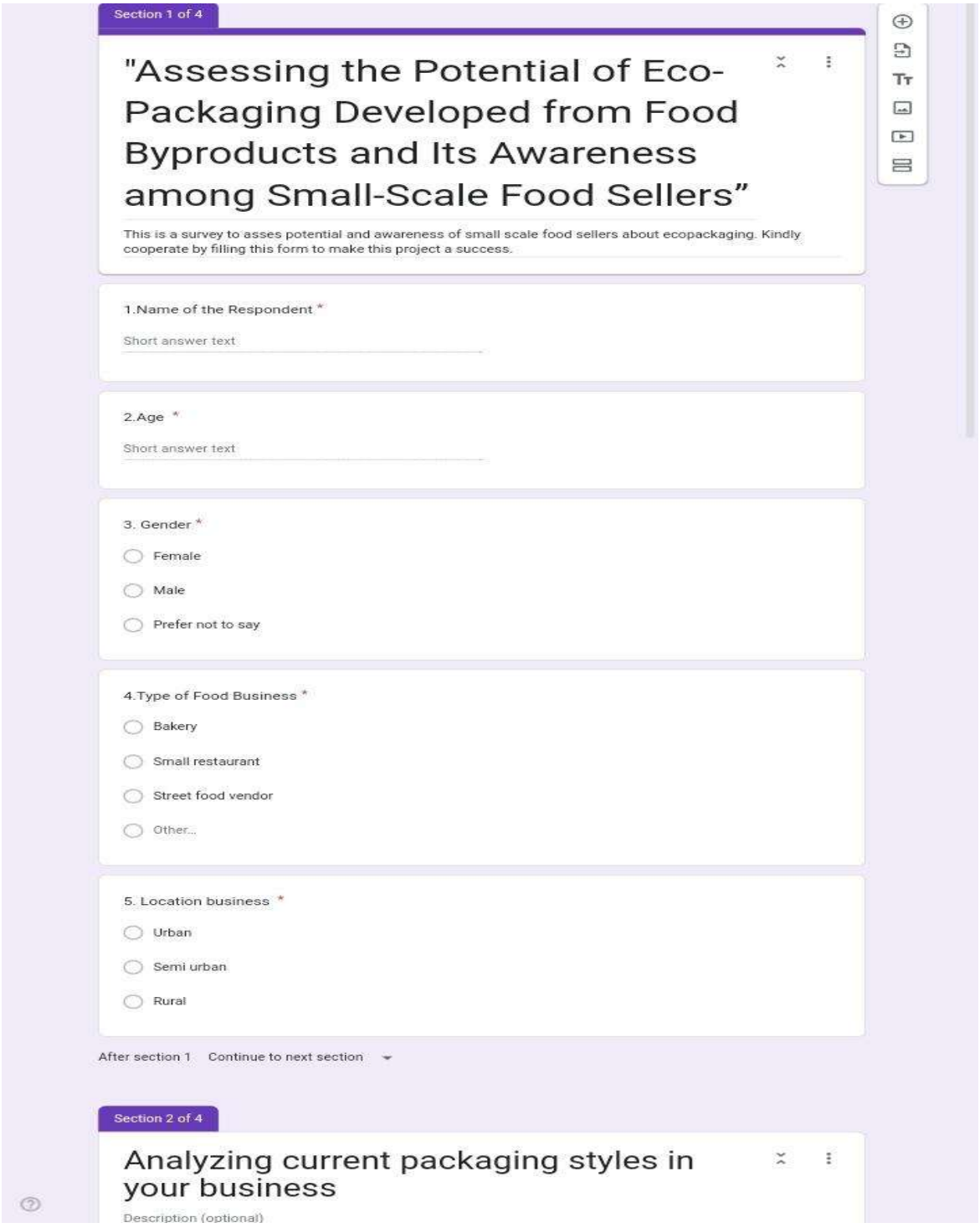
1. How would you rate the potential benefits of eco-packaging for your business? (1-5 scale, 1 being low and 5 being high)
2. What factors would influence your decision to adopt eco-packaging?
    - Cost-effectiveness
    - Environmental benefits
    - Consumer preference

- Government incentives
- Brand image
- Other (please specify)

3. Would you be willing to pay for eco-friendly packaging?
    - Yes
    - No
    - Unsure
4. What kind of support would you need to adopt eco-packaging? (Please check all that apply)
    - Technical training
    - Financial assistance
    - Access to raw materials
    - Awareness campaigns
    - Government policies
    - Other

APPENDIX - 3

Google form for survey



Section 1 of 4

"Assessing the Potential of Eco-Packaging Developed from Food Byproducts and Its Awareness among Small-Scale Food Sellers"

This is a survey to asses potential and awareness of small scale food sellers about ecopackaging. Kindly cooperate by filling this form to make this project a success.

1.Name of the Respondent *

Short answer text

2.Age *

Short answer text

3. Gender *

- Female
- Male
- Prefer not to say

4.Type of Food Business *

- Bakery
- Small restaurant
- Street food vendor
- Other...

5. Location business *

- Urban
- Semi urban
- Rural

After section 1 Continue to next section

Section 2 of 4

Analyzing current packaging styles in your business

Description (optional)

APPENDIX - 4

Evaluation form of developed eco-packagings samples

Products	Aesthetics	Mechanical strength	Ease of bulk	Durability	Tensile strength	Compression strength	Oxygen barrier	Tear resistance	Cost involvement
Neem leaf									
Orange peel									
Coconut husk									