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ORUBEEX WRAP: Innovation in food packaging based on beeswax and corn husk waste (*Zea mays* L.) as an eco-friendly solution

Fahmi Azrial[1,*], Agung Saputra[1], Eliza Khusnul Dewi Rahmawati[1]
[1] *Department of Biology, Faculty of Science and Technology, Raden Intan Islamic State University of Lampung, Bandar Lampung City, Lampung 35131, Indonesia.*
*Correspondence: fahmiazrial77@gmail.com

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ABSTRACT

Background: The urgent issue of plastic waste has driven innovation in eco-friendly packaging. ORUBEEX WRAP emerges as a solution by utilizing beeswax and corn husk waste (*Zea mays* L.) to replace single-use plastic packaging. Beeswax is chosen for its biodegradable, reusable, and antimicrobial properties, while corn husk waste is used as a filler to enhance mechanical strength and flexibility. This innovation not only reduces environmental impact but also supports the circular economy by transforming agricultural waste into value-added products. **Methods:** This study employs a descriptive-analytical approach, collecting and analyzing data from literature studies, scientific journals, and trusted sources related to beeswax, corn husk waste, and eco-friendly packaging. The writing process includes data collection, analysis of raw material potential, and evaluation of the environmental and economic impacts of ORUBEEX WRAP. **Findings:** ORUBEEX WRAP offers key advantages as a biodegradable and reusable packaging solution that can reduce plastic waste. The antimicrobial properties of beeswax help extend food shelf life, while the utilization of corn husk waste provides economic value to farmers. However, the product faces limitations in mechanical durability and application to wet or oily foods, as well as relatively high initial production costs. **Conclusion:** ORUBEEX WRAP is a sustainable innovation combining the benefits of beeswax and corn husk waste to reduce reliance on single-use plastics. Despite technical and economic challenges, the product holds significant potential to promote eco-friendly practices and the circular economy. **Novelty/Originality of this article:** The originality of ORUBEEX WRAP lies in its innovative combination of beeswax and corn husk waste, which has not been extensively explored in the food packaging industry. This innovation not only offers an eco-friendly solution but also utilizes previously neglected agricultural waste, creating economic value and supporting sustainability principles.

KEYWORDS: agricultural waste; bio-based materials; circular economy; eco-packaging; sustainability.

1. Introduction

Corn (*Zea mays* L.) is believed to have originated in Central America. This plant has been known for a long time, particularly since it was first cultivated by Native Americans in 1779 (Jácome, 2022). Corn is dubbed the "queen of grains" due to its significant potential as a food source and industrial raw material (Rahman et al., 2024). In addition to being used as animal feed worldwide, corn is also an important commodity traded globally, attracting attention in international trade (Mao et al., 2021). Corn can grow in temperate to tropical climates (Shekhar & Singh, 2022). Indonesia, as a tropical country, has geographical conditions that support year-round corn cultivation. Besides rice, corn is also consumed as

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a carbohydrate source in several regions of Indonesia, such as Madura and Nusa Tenggara, and is even used as a staple food.

Corn husks are the outermost layer that protects the inner corn kernels. Morphologically, corn husks have a rough surface with colors ranging from light to dark green (Revilla et al., 2021). The chemical composition of corn husks includes lignin (9.6%), alcohol-cyclohexane solubility (41%), ash (1.5%), and cellulose (36%) (Yupa et al., 2023).

Beeswax is a natural wax produced by honeybees (*Apis mellifera*) (Harman, 2021). This wax is widely used in the cosmetic and pharmaceutical industries due to its emollient, antibacterial, anti-inflammatory, and cytostatic properties (Shahbaz et al., 2024). Additionally, beeswax is used as an edible coating for fruits, as it can extend freshness by preventing water evaporation and shrinkage (Nasrin et al., 2023). Chemically, beeswax consists of fatty acid esters, fatty alcohols, and long-chain alkanes, which play a role in inhibiting water vapor diffusion (Leyva-Gutierrez & Wang, 2021). Beeswax has a melting point of 62.8°C, a saponification value of 88-102°C, and physical properties such as a yellowish-white solid with a characteristic honey aroma (Dube & Masresha, 2022). The chemical composition of beeswax includes 50% resin (flavonoids and phenolic acids), 30% wax, 10% aromatic oils, 5% pollen, and 5% aromatic compounds (Evran et al., 2024).

Beeswax wrap is an eco-friendly food packaging product made from beeswax. This product can be reused by washing it with cold water and alcohol-free soap (Villegas, 2024). Beeswax wrap serves as an alternative to single-use plastic packaging, potentially reducing plastic waste. In addition to being eco-friendly, beeswax wrap also has antimicrobial properties effective against bacteria such as *E. coli* and *Staphylococcus aureus* (Yudina et al., 2024). Research by Bui et al. (2024) shows that beeswax wrap can significantly reduce the growth of Salmonella enteritidis and S. aureus, although its effects on viruses and yeast are less significant. Thus, beeswax wrap can inhibit foodborne pathogens and prevent their spread.

This study aims to develop and evaluate ORUBEEX WRAP as a viable, eco-friendly alternative to single-use plastics by leveraging the synergistic properties of beeswax and corn husk waste. The guiding research question is: How can the combination of beeswax and corn husk waste address the limitations of existing biodegradable packaging materials in terms of functionality, cost, and environmental impact? By exploring this, we seek to provide a sustainable packaging solution that not only reduces agricultural waste but also offers practical benefits over conventional plastics.

Based on these studies, beeswax wrap has positive environmental and economic impacts, particularly in reducing the use of single-use plastic packaging. However, the innovation and application of beeswax wrap are still limited in Indonesia. Therefore, we are motivated to develop a new innovation in the form of beeswax wrap that utilizes corn husk waste, called ORUBEEX WRAP.

2. Methods

2.1 Writing approach

This article uses a descriptive-analytical approach, focusing on presenting the innovative idea of ORUBEEX WRAP as an eco-friendly solution. This is a non-research scientific article aimed at describing the concept, raw materials, and benefits of ORUBEEX WRAP, as well as analyzing its potential applications in reducing plastic waste. Data used in the writing were obtained from literature studies, scientific journals, and trusted sources related to beeswax, corn husk waste, and eco-friendly packaging. Through this method, the authors collected, analyzed, and presented relevant information to support the idea of ORUBEEX WRAP as a sustainable food packaging innovation.

2.2 Writing stages

The first stage is data collection, which includes literature studies on beeswax, corn husk waste, and eco-friendly packaging. References related to the chemical and physical properties of beeswax and corn husks were gathered from scientific journals, textbooks, and indexed publications. Additionally, data analysis was conducted on the environmental impacts of plastic packaging and its alternatives to strengthen the rationale for this innovation. The next stage is data analysis, which includes identifying the potential of corn husk waste as a packaging material, analyzing the advantages of beeswax as the main eco-friendly packaging material, and evaluating the environmental and economic impacts of ORUBEEX WRAP. The results of this analysis formed the basis for developing the idea, where the concept of ORUBEEX WRAP was formulated as a food packaging innovation. Scientific arguments about the benefits and applications of ORUBEEX WRAP were systematically structured to support this idea. The final stage is writing and editing, which involves drafting the article based on the collected data and analysis, followed by revisions to ensure clarity, coherence, and adherence to scientific writing standards.

2.3 Limitations

The limitations of this article include two main aspects. First, the article focuses only on the innovation of ORUBEEX WRAP from the perspective of raw materials, benefits, and potential applications. It does not delve into detailed production processes, laboratory testing, or other technical analyses requiring experimental data. Second, the data used in this article are sourced from available literature, such as scientific journals, textbooks, and trusted publications. Therefore, this article does not involve primary data collection or direct experimentation but relies on qualitative analysis based on relevant literature studies. These limitations were chosen to ensure that the idea of ORUBEEX WRAP is presented scientifically and focused on innovation and environmental impact.

3. Results and Discussion

3.1 Concept of ORUBEEX WRAP

ORUBEEX WRAP is an eco-friendly food packaging innovation that combines two main materials: beeswax and corn husk waste. This concept emerged as a response to increasingly pressing environmental issues, particularly the problem of non-biodegradable plastic waste polluting ecosystems. Conventional plastic, made from petroleum-based materials, takes hundreds of years to decompose and often ends up in oceans, causing marine ecosystem damage and endangering marine life (Dey et al., 2024). Additionally, plastic production contributes to greenhouse gas emissions, exacerbating climate change (Sharma et al., 2023). Therefore, an innovative solution is needed to reduce reliance on single-use plastics while utilizing sustainable resources.

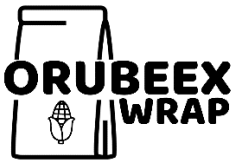

Fig. 1. Logo of ORUBEEX WRAP

ORUBEEX WRAP is designed as an alternative to single-use plastic packaging by utilizing natural, biodegradable, and reusable materials. Beeswax is chosen as the primary material due to its unique properties, such as forming an effective protective layer and having natural antimicrobial capabilities (Huang et al., 2023). Meanwhile, corn husk waste

is used as a filler to enhance the mechanical strength and flexibility of the packaging. The combination of these two materials not only creates an eco-friendly product but also optimizes the use of agricultural waste that has been underutilized.

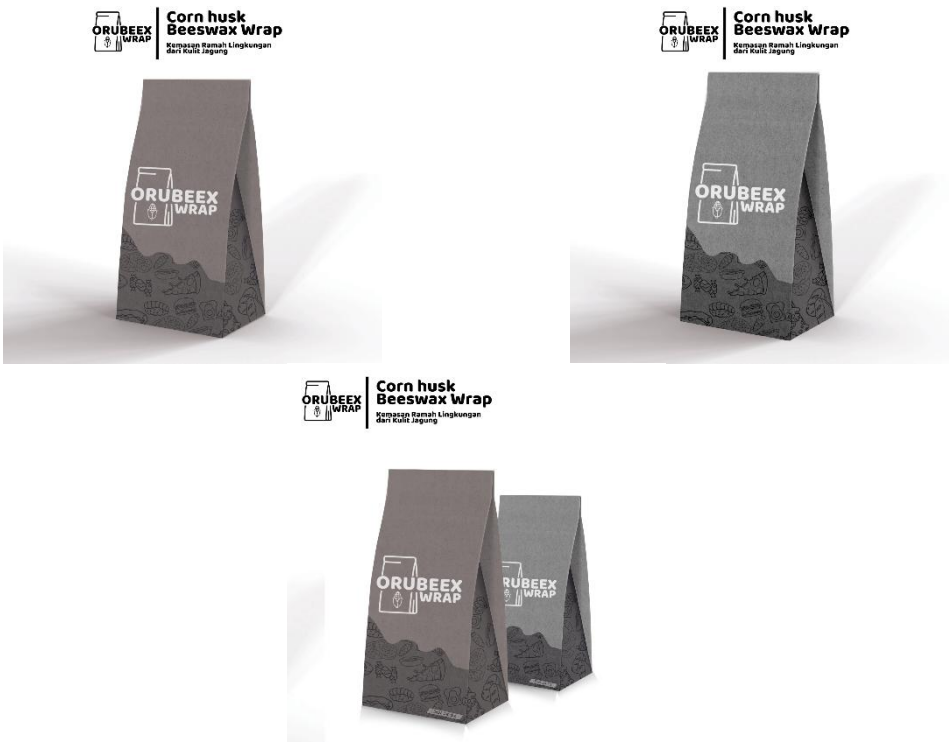

Fig. 2. Proto-type design of ORUBEEX WRAP

3.2 Analysis of main raw materials

3.2.1 Beeswax

Beeswax, or beeswax, is a natural compound produced by honeybees. Chemically, beeswax consists of fatty acid esters, fatty alcohols, and long-chain alkanes, which provide superior properties such as forming a protective layer, inhibiting water vapor diffusion, and having antimicrobial activity (Al-Shehri et al., 2022). These properties make beeswax ideal as the main material in food packaging. Additionally, beeswax has a relatively low melting point and emollient properties, allowing it to coat surfaces effectively without damaging food structures (Keshavshetti, 2021). Another advantage of beeswax is its ability to extend food shelf life by reducing evaporation and preventing microbial contamination, thereby maintaining food freshness longer.

Beeswax has long been used in various applications, including cosmetics, pharmaceuticals, and the food industry. In the context of food packaging, beeswax functions as an edible coating that is safe for food and environmentally friendly. Its antimicrobial properties, particularly against bacteria such as *E. coli* and *Staphylococcus aureus*, make it effective in preventing the growth of microorganisms that can spoil food (Peron et al., 2023). Additionally, beeswax can inhibit water vapor diffusion, reducing moisture loss in wrapped food (Hosseini et al., 2023). This is particularly important for maintaining the freshness of fruits and vegetables, which are susceptible to evaporation and damage from water loss.

Beeswax has a unique chemical composition, consisting of fatty acid esters, fatty alcohols, and long-chain alkanes (Ledjanac et al., 2024). This composition gives beeswax physical and chemical properties that support its function as a packaging material. For example, fatty acid esters provide beeswax with hydrophobic properties, making it effective in inhibiting water vapor diffusion. This property is crucial in food packaging applications, as it can prevent evaporation and maintain food moisture.

Moreover, beeswax has natural antimicrobial activity derived from flavonoids and phenolic acids contained within it (Sawicki et al., 2022). These compounds can inhibit the growth of bacteria and fungi, thereby extending food shelf life. Beeswax also has a relatively low melting point, making it easy to apply as a protective coating on food packaging.

3.2.2 Corn husk waste

Corn husk waste, which has often been overlooked and discarded, has significant potential as an additive in eco-friendly packaging. Corn husks contain cellulose, lignin, and other natural fibers that can enhance the mechanical strength and flexibility of packaging (Manigandan, 2023). Cellulose, as the main component, is known for its strength, lightness, and biodegradability. By utilizing corn husk waste, ORUBEEX WRAP not only reduces reliance on synthetic materials but also adds value to agricultural waste.

The use of corn husk waste in eco-friendly packaging aligns with the principles of the circular economy, where waste is transformed into economically valuable products. Corn husk waste, which is typically burned or discarded, can be repurposed as an alternative raw material, reducing negative environmental impacts. Additionally, utilizing corn husk waste can provide economic benefits to corn farmers, as waste that previously had no market value can now be processed into value-added products.

Corn husk waste contains cellulose, lignin, and other natural fibers. Cellulose is a natural polymer known for its strength, lightness, and biodegradability (Chen et al., 2023). In packaging production, cellulose can enhance mechanical strength and material flexibility. Furthermore, lignin in corn husks has natural binding properties that can improve the structural integrity of packaging.

The use of corn husk waste in ORUBEEX WRAP not only offers technical benefits but also environmental advantages. By utilizing agricultural waste, ORUBEEX WRAP can reduce dependence on synthetic materials derived from petroleum, which are not environmentally friendly. Additionally, the use of corn husk waste can reduce the amount of agricultural waste disposed of in the environment, thereby minimizing negative impacts on ecosystems.

The following table summarizes previous research on these materials and their benefits in sustainable packaging applications.

Table 1. Content of analysis of main raw materials

Material	Properties/characteristics	Benefits/applications	References
Beeswax	Composed of fatty acid esters, fatty alcohols, and long-chain alkanes.	Forms a protective layer, inhibits water vapor diffusion, and exhibits antimicrobial activity.	Al-Shehri et al. (2022)
	Has a low melting point and emollient properties.	Effectively coats surfaces without damaging food structures.	Keshavshetti (2021)
	Unique chemical composition: fatty acid esters, fatty alcohols, and alkanes.	Provides hydrophobic properties, effectively inhibiting water vapor diffusion.	Ledjanac et al. (2024)
	Contains flavonoids and phenolic acids.	Exhibits natural antimicrobial activity, inhibiting the growth of bacteria and fungi.	Sawicki et al. (2022)
	Safe for food and environmentally friendly.	Used as an edible coating in food packaging, extending the shelf life of food.	Peron et al. (2023)
	Inhibits water vapor diffusion.	Maintains the freshness of fruits and vegetables by reducing moisture loss.	Hosseini et al. (2023)

Corn husk waste	Contains cellulose, lignin, and other natural fibers.	Enhances mechanical strength and flexibility of packaging.	Manigandan (2023)
	Cellulose: a natural polymer known for its strength, lightness, and biodegradability.	Serves as an alternative raw material for eco-friendly packaging.	Chen et al. (2023)
	Lignin: possesses natural binding properties.	Improves the structural integrity of packaging.	Chen et al. (2023)
	Agricultural waste typically discarded or burned.	Reduces reliance on synthetic petroleum-based materials.	Manigandan (2023)
	Aligns with circular economy principles.	Transforms waste into economically valuable products, reducing negative environmental impacts.	Manigandan (2023)
	Provides economic benefits to corn farmers.	Waste previously without market value can be processed into value-added products.	Manigandan (2023)

3.3 Advantages of ORUBEEX WRAP

3.3.1 Eco-friendly (Biodegradable and reusable)

One of the main advantages of ORUBEEX WRAP is its eco-friendly nature. Unlike conventional plastic packaging, which takes hundreds of years to decompose (Hussain et al., 2024), ORUBEEX WRAP is made from natural materials that are biodegradable. Beeswax and corn husk waste, as the main raw materials, are organic compounds that can be broken down by microorganisms in nature. This decomposition process leaves no harmful residues, thus not polluting soil or water. Additionally, ORUBEEX WRAP can be reused by washing it with cold water and alcohol-free soap. This not only reduces waste generation but also lowers negative environmental impacts, particularly in terms of plastic pollution.

Conventional plastic packaging, made from petroleum-based materials such as polyethylene and polypropylene, has become a global environmental issue (Kumari et al., 2023). Single-use plastics take up to 500 years to decompose, and during the decomposition process, they release microplastics that pollute aquatic and terrestrial ecosystems (Sipe et al., 2022). These microplastics are not only harmful to marine life but can also enter the human food chain, posing serious health risks. ORUBEEX WRAP, as an eco-friendly alternative, can help reduce reliance on single-use plastics and contribute to global plastic waste reduction.

Moreover, the reusable nature of ORUBEEX WRAP adds economic value. Consumers do not need to purchase new packaging each time they need it, saving costs in the long run. With proper care, ORUBEEX WRAP can be used for up to a year or more, depending on frequency of use and maintenance. This makes ORUBEEX WRAP not only environmentally friendly but also economical.

3.3.2 Natural antimicrobial properties of beeswax

Another advantage of ORUBEEX WRAP is the natural antimicrobial properties of beeswax. Beeswax contains flavonoids and phenolic acids that have antimicrobial activity against various bacteria and fungi (Ertürk et al., 2024). These compounds can inhibit the growth of pathogenic microorganisms such as *E. coli* and *Staphylococcus aureus*, which are often the cause of food spoilage. Thus, ORUBEEX WRAP not only functions as food wrapping but also as a natural protector that maintains food freshness and safety.

This antimicrobial property is particularly important in food packaging applications, especially for foods susceptible to microbial contamination, such as fruits, vegetables, and dairy products. For example, ORUBEEX WRAP can be used to wrap cheese or meat, which

are often contaminated by bacteria during storage. By inhibiting bacterial growth, ORUBEEX WRAP can extend food shelf life and reduce the risk of food poisoning.

Additionally, the antimicrobial properties of ORUBEEX WRAP can reduce the need for synthetic preservatives in food. Synthetic preservatives, such as sodium benzoate and potassium sorbate, are commonly used in the food industry to prevent microbial growth (Gupta & Yadav, 2021). However, long-term consumption of synthetic preservatives can pose health risks, such as allergies and digestive disorders. By using ORUBEEX WRAP, consumers can reduce exposure to synthetic preservatives and choose a more natural and safe alternative.

3.3.3 Reducing plastic waste and utilizing agricultural waste

ORUBEEX WRAP is not only eco-friendly due to its biodegradable and reusable nature but also because of its ability to utilize agricultural waste. Corn husk waste, which is often discarded or burned, can be processed into raw materials for ORUBEEX WRAP. By utilizing corn husk waste, this product adds value to agricultural waste and supports the principles of the circular economy.

Agricultural waste, such as corn husks, often becomes an environmental issue due to its large volume and slow decomposition. In Indonesia, corn husk waste is typically burned or discarded, which can pollute the air and soil (Pramita et al., 2024). By processing corn husk waste into packaging materials, ORUBEEX WRAP not only reduces the amount of waste disposed of in the environment but also creates an economically valuable product.

Moreover, the utilization of corn husk waste can provide economic benefits to corn farmers. Waste that previously had no market value can now be processed into value-added products, increasing farmers' income. This aligns with the principles of the circular economy, where waste is transformed into reusable resources, creating a sustainable production cycle (Velenturf & Purnell, 2021).

3.3.4 Supporting the circular economy

ORUBEEX WRAP is a tangible example of the circular economy in the packaging industry. The circular economy is an economic model aimed at minimizing waste and maximizing resource use by recycling and reusing existing materials (Marinina et al., 2022). In the context of ORUBEEX WRAP, corn husk waste, which was previously considered worthless, is transformed into a useful raw material, while beeswax is used as the primary eco-friendly and renewable material.

By adopting circular economy principles, ORUBEEX WRAP not only reduces negative environmental impacts but also creates economic value from waste. This product can serve as a model for other packaging industries to develop more sustainable and eco-friendly solutions.

3.3.5 Potential for carbon emission reduction

The use of ORUBEEX WRAP also has the potential to reduce carbon emissions from conventional plastic packaging production. The production of petroleum-based plastics requires significant energy and generates substantial greenhouse gas emissions (Nicholson et al., 2021). In contrast, the production of ORUBEEX WRAP uses renewable natural materials, such as beeswax and corn husk waste, which have a lower carbon footprint.

Additionally, the reusable nature of ORUBEEX WRAP can reduce the need for new packaging production, thereby lowering carbon emissions from manufacturing processes. By using ORUBEEX WRAP, consumers can contribute to global efforts to reduce carbon emissions and combat climate change.

3.3.6 Potential applications of ORUBEEX WRAP

ORUBEEX WRAP, as an innovative food packaging solution based on beeswax and corn husk waste, has broad potential applications, particularly in the food industry. This packaging can be used to wrap fruits, vegetables, and dry foods. Beeswax, as the main material, has natural properties that form a protective layer on food surfaces. This layer reduces water evaporation, helping to maintain the freshness of fruits and vegetables for longer. Additionally, the antimicrobial properties of beeswax can prevent bacterial and fungal contamination, which are common causes of food spoilage (Manzoor et al., 2023). Thus, ORUBEEX WRAP not only serves as packaging but also as a tool to extend the shelf life of food products.

The use of ORUBEEX WRAP for dry foods, such as bread, cakes, or snacks, also offers significant benefits. This packaging can maintain optimal moisture levels, preventing dry foods from becoming hard or stale. Furthermore, the reusable nature of ORUBEEX WRAP makes it more economical and eco-friendly compared to single-use plastic packaging. Users only need to wash the packaging with cold water and alcohol-free soap to reuse it. This makes ORUBEEX WRAP a practical and sustainable solution for everyday packaging needs.

3.4 Environmental impact

One of the main positive impacts of ORUBEEX WRAP is the reduction of single-use plastic waste. Conventional plastic, made from petroleum-based materials, takes decades to hundreds of years to decompose. As a result, plastic waste accumulates in the environment, polluting land, water, and marine ecosystems. ORUBEEX WRAP, made from natural materials like beeswax and corn husks, is biodegradable. This means the packaging can decompose naturally in a relatively short time, avoiding long-term environmental issues (Zhou et al., 2023).

Single-use plastics have become a serious global issue. According to data from Ritchie (2021), approximately 300 million tons of plastic are produced annually, with around 8 million tons ending up in the oceans. This plastic waste not only pollutes the environment but also endangers marine life and ecosystems. By switching to ORUBEEX WRAP, consumers can reduce their reliance on single-use plastics and contribute to global plastic waste reduction.

In addition to reducing plastic waste, ORUBEEX WRAP also utilizes agricultural waste, particularly corn husks. Corn husks, often considered worthless and discarded, contain natural fibers that can be used as packaging materials. By processing corn husks into ORUBEEX WRAP, agricultural waste is transformed into a value-added product. This not only reduces the amount of waste disposed of in the environment but also supports the principles of the circular economy, where waste is repurposed as a resource.

The circular economy is an approach aimed at minimizing waste and maximizing resource use (Bimpizas-Pinis et al., 2021). In the context of ORUBEEX WRAP, corn husk waste, which previously had no economic value, can now be processed into useful products. This aligns with the Sustainable Development Goals (SDGs), particularly Goal 12 on responsible consumption and production.

The use of natural materials in ORUBEEX WRAP also contributes to carbon emission reduction. Conventional plastic production involves energy-intensive processes that generate greenhouse gases (Mangal et al., 2023). In contrast, the production of beeswax and corn husk waste has a lower carbon footprint. Thus, ORUBEEX WRAP not only reduces waste but also helps mitigate climate change.

According to research by Chen et al. (2024), conventional plastic production generates approximately 2 kg of CO_2 per kilogram of plastic. In comparison, the production of beeswax and agricultural waste like corn husks has a much lower carbon footprint. By using ORUBEEX WRAP, we can reduce carbon emissions from plastic packaging production, contributing to global efforts to mitigate climate change.

3.5 Economic impact

ORUBEEX WRAP has significant potential to drive the development of small and medium-sized industries (SMEs) based on local materials. Beeswax, as one of the main materials, can be produced by local beekeepers, while corn husks can be sourced from corn farmers across various regions. By utilizing local resources, ORUBEEX WRAP not only becomes an eco-friendly product but also a regional flagship product that supports the local economy. The development of SMEs based on ORUBEEX WRAP can create new jobs, from raw material production to processing and marketing. This will positively impact community income, especially in rural areas with significant agricultural and beekeeping potential (Harianja et al., 2023).

Additionally, ORUBEEX WRAP offers long-term packaging cost savings. Although initial production costs may be higher compared to conventional plastic packaging, the reusable nature of ORUBEEX WRAP makes it more economical over time. Consumers do not need to purchase new packaging each time they use the product, reducing their expenses. For example, one sheet of ORUBEEX WRAP can be used hundreds of times with proper care, such as washing it with cold water and alcohol-free soap. For businesses, using ORUBEEX WRAP can be a value-added feature that appeals to environmentally conscious consumers, enhancing product competitiveness. In the long run, these cost savings can incentivize consumers and businesses to switch to eco-friendly packaging (Huang et al., 2024).

The development of ORUBEEX WRAP can also drive innovation in the agriculture and beekeeping sectors. Corn farmers can earn additional income from selling corn husk waste, which was previously discarded or burned. With the demand for corn husk waste as a raw material for ORUBEEX WRAP, farmers can utilize resources that previously had no economic value. This not only increases farmers' income but also reduces the amount of agricultural waste disposed of in the environment. On the other hand, beekeepers can increase beeswax production to meet market demand. This growth in beeswax production can stimulate the development of the beekeeping industry, which has been limited in scale. Collaboration between farmers, beekeepers, and industry players can create a mutually beneficial and sustainable business ecosystem (Kumar & Anil, 2024).

Beyond direct economic benefits, ORUBEEX WRAP also has the potential to promote green economic growth. The green economy is a development concept focused on environmental sustainability and efficient use of natural resources (Mikhno et al., 2021). By utilizing locally sourced, eco-friendly materials, ORUBEEX WRAP can serve as a tangible example of green economy implementation at the local level. This product not only reduces reliance on petroleum-based synthetic materials but also encourages the use of renewable resources. In the long term, the development of products like ORUBEEX WRAP can lay the foundation for the growth of green industries in Indonesia, aligning with the Sustainable Development Goals (SDGs).

The economic impact of ORUBEEX WRAP can also be seen through increased competitiveness of local products in the global market. Currently, demand for eco-friendly products is rising, especially in developed countries. Global consumers are increasingly aware of the importance of reducing the environmental impact of the products they use, including food packaging (Nguyen et al., 2021). By developing ORUBEEX WRAP, Indonesia can position itself as a competitive producer of eco-friendly packaging in the international market. This not only boosts local product exports but also strengthens Indonesia's image as an environmentally conscious country.

Furthermore, the development of ORUBEEX WRAP can encourage the creation of sustainable supply chains. A sustainable supply chain ensures that every stage of production, from raw material sourcing to product distribution, considers environmental, social, and economic aspects (Yontar, 2023). In the context of ORUBEEX WRAP, a sustainable supply chain can start with corn farmers providing corn husk waste, beekeepers producing beeswax, and processing industries manufacturing eco-friendly packaging. By applying sustainability principles in the supply chain, ORUBEEX WRAP not only delivers economic benefits but also supports environmental conservation and social welfare.

The development of ORUBEEX WRAP can also serve as an attractive business model for investors and entrepreneurs. With increasing awareness of sustainability, many investors are allocating funds to eco-friendly projects (Bhutta et al., 2022). ORUBEEX WRAP, with its large market potential and positive environmental impact, can be an appealing investment choice. Additionally, businesses that adopt ORUBEEX WRAP as part of their strategy can benefit from growing consumer demand for eco-friendly products. This can enhance brand value and customer loyalty, ultimately contributing to business growth.

At the community level, ORUBEEX WRAP can also have positive social impacts. The creation of new jobs through the development of this product can reduce unemployment in rural areas (Mehry et al., 2021). Additionally, increased income for farmers and beekeepers can improve overall community welfare. In the long term, this can drive inclusive and sustainable economic development.

However, to fully realize the economic potential of ORUBEEX WRAP, support from various stakeholders, including the government, industry players, and the community, is needed. The government can provide incentives for the development of eco-friendly products, such as subsidies or tax breaks (Zolfagharinia et al., 2023). Industry players need to invest in research and development to improve the quality and efficiency of ORUBEEX WRAP production. Meanwhile, the community should be encouraged to switch to eco-friendly products through education and awareness campaigns (Singh et al., 2022).

Overall, ORUBEEX WRAP not only offers an eco-friendly solution to food packaging issues but also has significant potential to drive sustainable economic growth. By utilizing local resources, creating new jobs, and fostering innovation in agriculture and beekeeping, ORUBEEX WRAP can serve as a tangible example of how eco-friendly innovations can positively impact the economy, society, and the environment.

3.6 Advantages of ORUBEEX WRAP

3.6.1 Eco-friendly and biodegradable

One of the main advantages of ORUBEEX WRAP is its eco-friendly nature. Unlike conventional plastic packaging, which takes decades to hundreds of years to decompose, ORUBEEX WRAP is made from natural materials like beeswax and corn husk waste that can decompose naturally (biodegradable). Beeswax, as the main material, has natural properties that allow it to decompose in the environment, while corn husk waste is an organic material that can be composted. Thus, the use of ORUBEEX WRAP can reduce the accumulation of plastic waste in the environment, particularly in oceans and landfills (TPA). Additionally, this packaging can be reused (reusable), reducing the need for single-use packaging that potentially pollutes the environment. This positive impact aligns with the principles of the circular economy, where materials used can be returned to nature without causing negative effects (Castro et al., 2022).

Conventional plastic packaging, made from petroleum-based materials like polyethylene and polypropylene, has become a global environmental issue due to its non-biodegradable nature. Single-use plastics often end up in oceans, causing water pollution and endangering marine ecosystems (Chen et al., 2023). According to research by Eriksen et al. (2023), approximately 8 million tons of plastic enter the oceans annually, and without serious action, this number is expected to rise drastically in the coming years. ORUBEEX WRAP, as an eco-friendly alternative, can help reduce reliance on single-use plastics and contribute to global efforts to reduce plastic pollution.

Moreover, the biodegradable nature of ORUBEEX WRAP also reduces the burden on landfills (TPA). In many countries, including Indonesia, landfills have reached maximum capacity, and plastic waste is one of the largest contributors to waste volume (Liang et al., 2021). By using packaging that decomposes naturally, such as ORUBEEX WRAP, we can reduce the amount of waste sent to landfills and extend their operational lifespan.

3.6.2 Utilizing abundant agricultural waste

Corn husk waste is one of the by-products of the corn industry that is often underutilized. In Indonesia, high annual corn production generates large amounts of corn husk waste, which is typically discarded or burned. Burning agricultural waste can cause air pollution and greenhouse gas emissions (Deshpande et al., 2023). By processing corn husk waste into raw materials for ORUBEEX WRAP, we can add value to this waste while reducing the environmental impact of burning agricultural waste. Additionally, utilizing corn husk waste can support the economy of corn farmers by creating a new source of income from previously worthless waste.

Indonesia is one of the largest corn producers in the world, with production exceeding 30 million tons annually (Widana, 2025). However, corn husk waste generated from harvesting and processing is often underutilized. According to data from the Indonesian Ministry of Agriculture, approximately 20-30% of total corn production is agricultural waste, including corn husks. This waste is typically burned or discarded, contributing to environmental issues such as air pollution and greenhouse gas emissions.

By processing corn husk waste into raw materials for ORUBEEX WRAP, we not only reduce negative environmental impacts but also create value from agricultural waste. Corn husk waste contains cellulose and lignin, which can be used as fillers in packaging production. Cellulose, as the main component, has strong, lightweight, and biodegradable properties, making it suitable for eco-friendly packaging (Bhat et al., 2021). Additionally, utilizing corn husk waste can provide economic benefits to corn farmers, as waste that previously had no market value can now be processed into value-added products.

3.6.3 Natural antimicrobial properties

Beeswax, as one of the main components of ORUBEEX WRAP, has natural antimicrobial properties effective in inhibiting the growth of bacteria and fungi. Research by Adeyemi et al. (2021) shows that beeswax has antimicrobial activity against pathogenic bacteria such as *E. coli* and *Staphylococcus aureus*. This property makes ORUBEEX WRAP not only a packaging material but also a natural protector against microbial contamination. Thus, this packaging can extend the shelf life of food, particularly fruits and vegetables, which are prone to spoilage due to microorganisms. Additionally, the natural antimicrobial properties reduce the need for chemical preservatives in food, making it safer for consumers.

The antimicrobial properties of beeswax come from flavonoids and phenolic acids contained within it (Vergel-Alfonso et al., 2025). These compounds can inhibit the growth of bacteria and fungi, preventing food spoilage. Moreover, beeswax also has antioxidant properties, which can prevent oxidation in wrapped food (Martinello & Mutinelli, 2021). This is particularly important for maintaining the quality and freshness of food, especially foods prone to oxidation like fruits and vegetables.

The use of ORUBEEX WRAP as food packaging can also reduce reliance on chemical preservatives. Chemical preservatives, such as sodium benzoate and potassium sorbate, are often used in the food industry to extend product shelf life (Abu Sereh et al., 2024). However, long-term consumption of chemical preservatives can have negative health effects, such as allergies and digestive disorders. By using ORUBEEX WRAP, we can reduce the use of chemical preservatives and offer a safer, more natural alternative to consumers.

3.6.4 Positive impact on consumer health

In addition to being eco-friendly, ORUBEEX WRAP also has positive impacts on consumer health. This packaging is made from natural materials that are safe for food, eliminating the risk of chemical contamination often associated with conventional plastic packaging. Chemicals in plastics, such as bisphenol A (BPA) and phthalates, can migrate into food and pose health risks, including hormonal disruptions and cancer (Ong et al., 2022). By

using ORUBEEX WRAP, consumers can avoid these risks and ensure that the food they consume is safe and healthy.

3.6.5 Support for circular economy principles

ORUBEEX WRAP also supports the principles of the circular economy, where materials used can be recycled or returned to nature without causing negative impacts. In this context, corn husk waste, which was previously considered worthless, can now be processed into useful products, reducing the need for new raw materials. Additionally, the reusable nature of ORUBEEX WRAP supports this principle, as the packaging can be used multiple times before naturally decomposing.

3.7 Comparison of ORUBEEX with other materials

To systematically evaluate ORUBEEX WRAP's advantages as a sustainable packaging solution, Table 2 presents a comprehensive comparison with conventional and alternative materials across six critical parameters: biodegradability, reusability, antimicrobial properties, mechanical strength, raw material sustainability, and carbon footprint. This analysis highlights ORUBEEX WRAP's unique position in combining agricultural waste utilization with functional benefits, while contrasting its performance against single-use plastics, PLA bioplastics, and commercial beeswax wraps. The data reveals how each material addresses key environmental and practical trade-offs in food packaging applications.

Table 2. Comparison of ORUBEEX with alternative packaging materials

Material	Biodegradability	Reusability	Antimicrobial properties	Mechanical strength	Raw material source
ORUBEEX WRAP	High (weeks–months)	Yes (100+ uses)	Yes (flavonoids, phenolic acids)	Moderate (enhanced by corn husk fibers)	Agricultural waste (corn husks), renewable (beeswax)
Single-use plastic	Low (500+ years)	No	No	High	Petroleum-based (non-renewable)
PLA bioplastic	Moderate (industrial composting required)	No	No	High	Corn starch (competes with food supply)
Commercial beeswax wraps	High	Yes	Yes	Low (without reinforcement)	Imported beeswax, organic cotton

3.8 SWOT analysis

Table 3 presents a structured SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of ORUBEEX WRAP, evaluating its potential as an innovative eco-friendly packaging solution. This framework systematically examines internal advantages and limitations, along with external market factors, to provide a balanced assessment of its viability. The analysis reveals how ORUBEEX WRAP's unique material properties and sustainability benefits interact with practical challenges and market dynamics in the transition toward circular economy solutions.

Table 3. SWOT analysis of ORUBEEX

Category	Analysis
Strengths	Eco-friendly: Biodegradable and reusable. Antimicrobial: Extends food shelf life. Circular economy: Utilizes agricultural waste. Local materials: Supports rural economies.
Weaknesses	Durability: Lower mechanical strength than plastics. Application limits: Unsuitable for wet/oily foods. Higher initial cost: Compared to conventional plastics.
Opportunities	Market demand: Rising global interest in sustainable packaging. Policy support: Bans on single-use plastics in multiple countries. Innovation: Potential to blend with other natural fibers for enhanced durability.
Threats	Consumer habits: Resistance to switching from cheap plastics. Supply chain risks: Dependence on local beekeeping and corn production. Competition: Established bioplastics (e.g., PLA) with industrial backing.

3.9 Challenges and recommendations

Despite its many benefits, ORUBEEX WRAP faces several challenges that need to be addressed to ensure successful implementation. One of the main challenges is improving the mechanical durability and functionality of ORUBEEX WRAP. Beeswax, although it has good antimicrobial and water vapor barrier properties, has relatively low mechanical strength compared to conventional plastics. Therefore, further research is needed to optimize the composition of raw materials, particularly in terms of the proportion of beeswax and corn husk, as well as the addition of other natural reinforcing materials such as natural fibers or biopolymers. More efficient production technologies are also required to enhance the quality and durability of ORUBEEX WRAP.

Additionally, public education and awareness about the benefits of eco-friendly packaging are key factors in adopting ORUBEEX WRAP. Although awareness of the importance of reducing plastic waste is increasing, many consumers are still reluctant to switch to eco-friendly products due to cost or lack of knowledge about their benefits (Moshood et al., 2022). Effective education campaigns, through social media, seminars, or collaborations with non-governmental organizations, can help increase public understanding and interest in products like ORUBEEX WRAP. Furthermore, government incentives, such as subsidies or awards for eco-friendly packaging producers, can encourage wider adoption.

Another recommendation is collaboration between academia, industry, and government to support the development and production of ORUBEEX WRAP. Academics can contribute through research and technological development, while industry can provide infrastructure and distribution networks. The government, on the other hand, can play a crucial role in creating policies that support the use of eco-friendly packaging, such as banning single-use plastics or providing fiscal incentives for producers using eco-friendly materials (Ali et al., 2022).

4. Conclusions

ORUBEEX WRAP is an innovative eco-friendly food packaging solution that combines beeswax and corn husk waste as an alternative to single-use plastic packaging. This innovation offers various advantages, such as being biodegradable, reusable, and antimicrobial, which can reduce negative environmental impacts, particularly in terms of plastic pollution. Additionally, ORUBEEX WRAP utilizes agricultural waste, such as corn husks, which are often discarded or burned, thereby providing economic value to corn farmers. This innovation also supports the principles of the circular economy by transforming waste into value-added products and reducing reliance on petroleum-based materials. Despite its great potential, ORUBEEX WRAP still faces several challenges, such as

limited mechanical durability, restrictions on application to wet or oily foods, and relatively high initial production costs.

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Biographies of Authors

Fahmi Azrial, is a young scientist specializing in Botany, Agriculture, and Environmental Science. He holds a Diploma 1 degree from Yogyakarta's Akademi Komunitas Perkebunan. Currently, he is affiliated with Raden Intan Islamic State University (UIN) Lampung, contributing to knowledge development and innovation in his field.

- Email: fahmiazrial77@gmail.com
- ORCID: 0009-0005-3090-606X
- Web of Science Researcher ID: N/A
- Scopus Author ID: N/A
- Homepage: N/A

Agong Saputra, is a botanist affiliated with UIN Raden Intan Lampung. With expertise in botany, he focuses on the study and research of plants, contributing to the advancement of natural sciences.

- Email: agung155saputra@gmail.com
- ORCID: N/A
- Web of Science ResearcherID: N/A
- Scopus Author ID: N/A
- Homepage: N/A

Eliza Khusnul Dewi Rahmawati, is a microbiologist affiliated with UIN Raden Intan Lampung. With a focus on microbiology, she researches and develops an understanding of microorganisms and their roles in various aspects of life.

- Email: elizakhusnulra@gmail.com
- ORCID: N/A
- Web of Science ResearcherID: N/A
- Scopus Author ID: N/A
- Homepage: N/A