An Exploratory Study on the Development Process of Bio-based Alternative Leather from Coconut Husk

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ABSTRACT

This research aimed to explore and develop an alternative material for artificial leather production from coconut husk, focusing on utilizing coconut husks—an agricultural byproduct abundantly found in Thailand—to create sustainable value-added materials. The study investigated the physical and chemical properties of coconut fibers, which were found to be strong, durable, highly absorbent and naturally colored. These fibers were blended with natural rubber latex in appropriate proportions to produce an artificial leather material with a texture and appearance closely resembling genuine leather. The research adopted the principles of the Bio-Circular-Green Economy (BCG), emphasizing environmentally friendly production processes. The study aims to develop an alternative leather material that combines aesthetics, durability, and sustainability, meeting the demands of both domestic and international markets. Furthermore, this innovation aimed to reduce dependence on animal leather, minimize agricultural waste, support community-based economies through continuous income generation, and enhance Thailand's capacity and competitiveness in textile and sustainable material innovation on a global scale.

Keywords: Exploratory study, Process of Producing Alternative Leather, Coconut Husk

Introduction

Coconut (Cocos nucifera L.) is a perennial plant in the palm family (Arecaceae) that plays a significant role in Thailand's economy and is cultivated in all regions of the country, particularly in Prachuap Khiri Khan, Chonburi, Nakhon Si Thammarat, and Samut Sakhon provinces. Every part of the coconut can be utilized for various purposes—food, beverages, handicrafts, and pharmaceuticals. For instance, coconut meat is used in cooking and processed products; coconut water is consumed as a beverage; the shell is crafted into household utensils and decorative items; while the leaves, shoots, and flowers can be transformed into products such as palm sugar.

However, Coconut husks, often discarded as agricultural waste, remain largely underutilized and are often discarded as agricultural waste. Thailand is currently facing challenges in agricultural waste management, particularly in the disposal of coconut husks. Farmers often burn the husks for convenience, a practice that temporarily reduces waste volume but causes severe air pollution, especially particulate matter (PM2.5), which harms both the environment and human health. Landfilling is another disposal method, yet it incurs high transportation costs and requires large landfill areas, leading to the accumulation of coconut waste in many localities.

Meanwhile, Thailand is one of Asia's leading producers and exporters of leather goods but continues to face shortages of high-quality raw materials, relying heavily on imported tanned leather at high costs. Furthermore, the global leather industry raises ethical and environmental concerns, as animal hides are derived from livestock and, in some cases, from rare or endangered species. Despite these concerns, consumer demand for leather products continues to rise worldwide.

In response to both environmental and economic challenges, this study aims to develop an alternative to animal leather by utilizing coconut husk—an agricultural byproduct—as a renewable raw material. Through appropriate processing techniques, coconut fibers can be transformed into artificial leather with physical properties similar to genuine leather in terms of strength, flexibility, and texture. The research is guided by the principles of the Bio–Circular–Green Economy (BCG), emphasizing efficient resource utilization, reduction of animal-based materials, and minimization of environmental impacts.

By blending coconut fibers with other natural materials such as natural rubber latex, a novel eco-friendly material can be produced that exhibits unique characteristics—durability, water absorption, and natural coloration. Moreover, the project seeks to integrate local wisdom from coconut-growing communities into the material development process, creating sustainable economic value and aligning with the Sustainable Development Goals (SDGs).

Therefore, the research titled "An Exploratory Study on the Development of Alternative Leather from Coconut Husk" represents an integration of art, material science, and textile technology to create an innovative material that is environmentally friendly, commercially viable, and capable of replacing conventional animal leather in the modern market.

Research Objectives

1.To find ways to make artificial leather using coconut shell and other natural materials.

2.To analyze the physical and aesthetic properties of the developed coconut shell leather and compare it to conventional synthetic leather.

Research Methodology

This study employed both Experimental Research and Descriptive Research methodologies, focusing on the creation of an innovative alternative leather material made from coconut husk. The research was conducted under the framework of the Bio–Circular–Green Economy (BCG) concept, aiming to develop sustainable approaches for utilizing agricultural waste and enhancing its value through material innovation. (Office of the National Higher Education, Science, Research and Innovation Policy Council, 2021)

The research process consisted of five main phases, as follows:

1. Literature Review and Market Analysis

The researcher studied related documents and previous research on coconut husk fibers, the production of artificial leather from natural fibers, and the theoretical foundation of the BCG model. In addition, both domestic and international market trends of artificial leather were analyzed to identify consumer needs and material properties that meet market demands.

2. Preparation of Materials and Equipment

Coconut husk fibers were cleaned, ground, and blended with natural rubber latex, binders, and additives to improve the material's performance. Necessary tools and equipment were used for mixing, molding, drying, and physical property testing.

3. Prototype Development

Three primary experimental formulas were designed by varying the ratio of coconut fibers to natural rubber latex. Each formula was processed into prototype sheets for comparative evaluation of physical and aesthetic properties.

4. Integration of Local Wisdom

The researcher explored traditional coconut-processing techniques from local communities and integrated selected practices—such as fiber preparation, natural dyeing, and the use of biomass energy—into the production process, thereby connecting scientific knowledge with indigenous craftsmanship.

5. Data Analysis

The experimental results were analyzed using descriptive statistics to compare the physical characteristics of materials from different formulas. Qualitative data obtained from interviews and observations were also synthesized to determine the most suitable approach for developing coconut-husk-based artificial leather.

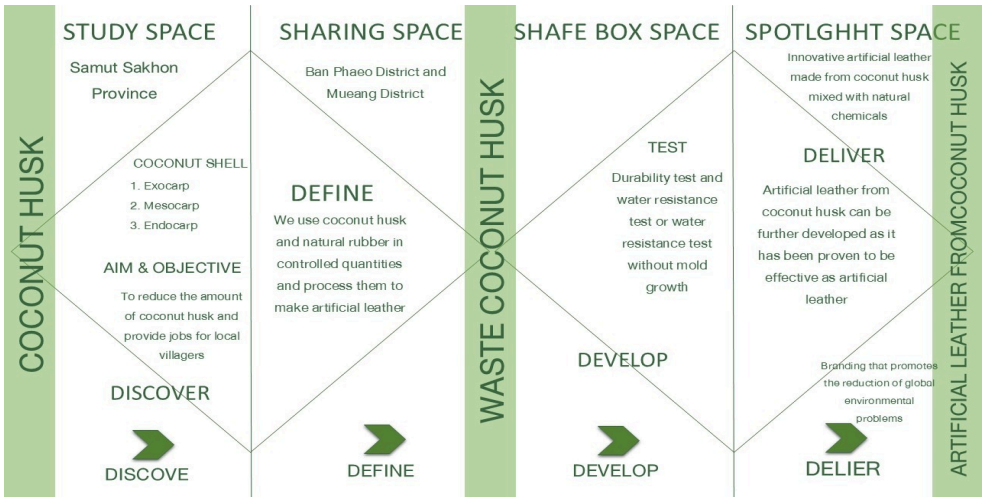


Figure 1. Conceptual Framework of the Research

Findings

This study investigates the production process of faux leather derived from coconut husks, referencing conventional industrial methods, which typically rely heavily on machinery and chemicals throughout all stages—from raw material preparation to the final forming process. Such conventional methods commonly incorporate reinforcing sheets, such as synthetic fibers, paper, or liquid plastics, combined with high pressure and elevated temperatures of approximately 300–350°F to achieve a material with properties and surface characteristics similar to genuine leather. However, the present research focuses on developing a production approach that minimizes chemical and energy usage, emphasizing the use of basic equipment to reduce waste generation and carbon emissions while maintaining the quality and durability of the resulting faux leather. The production process begins with finely separating the fibers from the coconut husks. The extracted fibers are then soaked in water for approximately 5–10 minutes to remove impurities, followed by thorough washing and sun-drying to prepare the fibers for subsequent processing. Once dried, the fibers are cut or ground to the desired fineness, as fiber size significantly affects the tactile surface of the faux leather; finer fibers result in a smoother texture. The prepared coconut fibers are then mixed with natural latex in predetermined ratios and soaked until the fibers fully absorb the latex throughout their structure.

Figure 2. Coconut husk fiber formula1, coconut husk fiber formula2, coconut husk fiber formula 3

The prepared coconut fibers were mixed with natural latex in predetermined ratios and left to soak until the fibers were fully impregnated with the latex. The mixture was then placed into water moistened molds to prevent sticking and compressed to achieve uniform thickness before being air-dried for 12–24 hours to allow the material to begin setting. Subsequently, the sheets of faux leather were re-immersed in latex to coat the surface, enhancing strength and water resistance, and then dried again for another 12–24 hours until the desired dryness and thickness were achieved. The material was then subjected to a curing process at temperatures of 60–100°C, depending on the thickness of the sheets, to consolidate the structure, sterilize the material, and extend its service life. Finally, the faux leather was air-dried for an additional 5–10 minutes to complete the setting process. In the experimental process, the researcher established three primary formulations by varying the ratios of coconut fibers to natural latex to investigate the effects of these ratios on the physical properties of the resulting material, including elasticity, durability, and surface texture. The results indicated that Formula 1, which used finely ground fibers, exhibited the best properties. The latex was efficiently absorbed into the fibers, resulting in a smooth surface and strong adhesion. Formula 2, which used coconut fibers cut to 1–2 cm lengths, demonstrated poor latex absorption, requiring longer soaking times and leading to partial drying before penetration, producing a stiff texture. Formula 3, which used moderately ground fibers, showed good latex absorption but created excessive gaps between the fibers and latex, resulting in a less compact structure and lower elasticity compared to Formula 1. After curing at 60–100°C, faux leather from Formula 1 displayed superior softness, elasticity, and recovery, whereas Formulas 2 and 3 exhibited stiffer textures due to incomplete latex penetration. Additionally, the researcher integrated local traditional knowledge into the production process, including conventional fiber preparation methods, natural dyeing techniques, and the use of biomass energy during curing, to ensure environmentally friendly production and alignment with the community context. Quantitative data from material testing, together with qualitative data from expert interviews, were analyzed to synthesize the most effective approach for producing coconut husk-based faux leather. The findings highlight the potential of coconut husks as a raw material for innovative, high-quality leather alternatives, consistent with the Bio–Circular–Green (BCG) economy concept, reducing environmental impact while adding value to community waste resources.

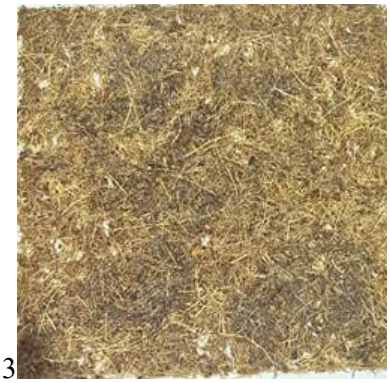
1  2  3 

Figure 3.1. Faux leather, Formula 1, 2. Faux leather, Formula 2 , 3. Faux leather, Formula 3

Conclusions and Discussion

The experimental study on the transformation of coconut husks into synthetic leather materials revealed that Production Formula 1 yielded the best performance compared to other tested formulations. The resulting material exhibited surface texture and flexibility closely resembling genuine leather making it a promising alternative to animal leather. The developed synthetic leather demonstrated strength, tensile resistance, and good water repellency while maintaining its form after prolonged use.

Moreover, it demonstrated high durability against light exposure and color fading, which are essential properties for materials used in the fashion and interior design industries.

During the experimental process, it was observed that the fineness of the coconut fiber significantly affected the surface texture of the synthetic leather. Finely ground fibers produced a smooth and uniform surface, whereas coarser fibers created distinctive patterns and textures with unique aesthetic qualities. This variation offers great potential for creative product design applications, such as handbags, footwear, furniture, and home decor items.

In addition, combining natural latex with coconut fiber enhanced the flexibility and durability of the material without relying on synthetic chemicals, representing an environmentally friendly production method. The findings indicate that developing synthetic leather from coconut husks provides a new approach to adding value to agricultural waste materials in Thailand. This process also helps reduce waste from coconut processing, which is often discarded or burned, causing environmental pollution. Hence, the reuse of such materials aligns with the principles of the Bio–Circular–Green Economy (BCG), which emphasizes efficient and sustainable resource utilization.

Furthermore, a market study of both domestic and international synthetic leather industries revealed an increasing consumer demand for eco-friendly and non-animal leather alternatives. This trend presents an opportunity to expand into new market segments across fashion, product design, and interior industries. The coconut husk–based synthetic leather developed in this research not only demonstrates excellent physical properties comparable to commercial materials but also serves as an innovative and sustainable material that supports environmental conservation and circular economy practices. It has potential for industrial-scale creative product development, generates income for coconut-producing communities, and enhances competitiveness in the global alternative materials market.

The research on synthetic leather made from coconut husks represents a conceptual and process-oriented study aimed at developing Thailand's synthetic leather industry. The study began with an exploration of the structure and properties of coconut husk fibers, followed by experimental processes to create a coconut-based synthetic leather that meets market demands for both quality and functionality.This finding aligns with the study of Kasidis Rattanaporn (2019), "Improvement of Young Coconut Fiber Properties Using Cellulase Enzyme for Yarn Production," which examined the chemical composition and physical properties of treated young coconut fibers. That research found that coconut fibers possess high tensile strength, flexibility, and durability, indicating their potential as raw materials for textile and material innovation. Building upon such findings, the present study further developed an innovative process by incorporating natural latex as a key component to enhance elasticity and strength in coconut husk–based synthetic leather. The resulting material not only meets the functional needs of consumers and the domestic market but also adheres to the principles of the Bio–Circular–Green Economy (BCG) model. This model emphasizes environmentally responsible production, the efficient use of natural resources, and the creation of sustainable value from agricultural by-products. Moreover, the research contributes to knowledge transfer and innovation in material development, serving as a foundation for future studies and applications in the fashion and design industries. By integrating scientific experimentation with sustainable design thinking, the study supports the potential for continued development and knowledge dissemination among younger generations—ensuring ongoing innovation and sustainable progress in the future.

Recommendations

Based on the findings of the study on the production of synthetic leather from coconut husks, the researcher proposes several recommendations for future research and development. Further studies should focus on refining the formulation and manufacturing process to achieve material properties that more closely resemble genuine leather—particularly in terms of softness, flexibility, and long-term durability. It is also recommended that the experimental process be scaled up to the industrial level to evaluate the feasibility of commercial production and identify strategies to reduce manufacturing costs

in the long run. In addition, developing surface coating or natural dyeing techniques using eco-friendly materials should be explored to enhance the diversity of textures and colors, making the product more suitable for the contemporary fashion market. Community engagement should be strengthened through the participation of local coconut farmers in the production value chain. This approach would help generate income, add value to local agricultural resources, and strengthen community-based economies. Future research should emphasize sustainable process improvement by minimizing energy consumption and material waste. Moreover, studies should investigate the potential for exporting coconut husk–based synthetic leather to international markets. Such efforts would contribute to elevating Thailand's alternative materials industry, enhancing global competitiveness, and responding effectively to the increasing demand for environmentally responsible products.

Acknowledgments

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