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REVIEW

Biodegradable packaging from rice husks: a sustainable solution for Villavicencio

Empaques biodegradables a partir de cascarilla de arroz: una solución sostenible para Villavicencio

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ABSTRACT

Introduction: the article addressed the environmental problems caused by the massive use of plastics and expanded polystyrene, highly polluting materials. The creation of biodegradable packaging using rice husks, an agricultural waste available in large quantities in the department of Meta, especially in the municipality of Villavicencio, was proposed as an alternative. This proposal sought to reduce both plastic waste and rice husk waste, thus integrating sustainability and the use of local resources.
Development: the study was geographically framed in Villavicencio, a strategic region due to its location and rice production. The Colombian legal framework that supports the transition to biodegradable materials was reviewed, highlighting regulations such as Law 1407 of 2018 and Bill 010 of 2020. Likewise, the concept of biodegradable packaging, its characteristics and advantages were analyzed. It was highlighted that rice husks have been investigated for their multiple uses, including the production of fertilizers, construction materials and, in this case, as raw material for ecological packaging.
Conclusions: the article concluded that the manufacture of biodegradable packaging from rice husks represented a viable and sustainable solution to mitigate plastic pollution. The initiative was aligned with the Sustainable Development Goals and offered environmental, economic and social benefits. It also positioned Villavicencio as a city with the potential to lead green innovations at the national level.

Keywords: Rice Husk; Biodegradable Packaging; Sustainability; Plastic Waste; Villavicencio.

RESUMEN

Introducción: el artículo abordó la problemática ambiental ocasionada por el uso masivo de plásticos y poliestireno expandido, materiales altamente contaminantes. Se propuso como alternativa la creación de empaques biodegradables utilizando la cascarilla de arroz, un residuo agrícola disponible en gran cantidad en el departamento del Meta, especialmente en el municipio de Villavicencio. Esta propuesta buscó reducir tanto los residuos plásticos como el desperdicio de la cascarilla de arroz, integrando así la sostenibilidad y el aprovechamiento de recursos locales.
Desarrollo: el estudio se enmarcó geográficamente en Villavicencio, una región estratégica por su ubicación y producción arrocera. Se revisó el marco legal colombiano que respalda la transición hacia materiales biodegradables, resaltando normativas como la Ley 1407 de 2018 y el Proyecto de Ley 010 de 2020. Asimismo, se analizó el concepto de empaque biodegradable, sus características y ventajas. Se destacó que la cascarilla de arroz ha sido investigada por sus múltiples usos, entre ellos la elaboración de abonos, materiales de construcción y, en este caso, como materia prima para empaques ecológicos.
Conclusiones: el artículo concluyó que la fabricación de empaques biodegradables a partir de la cascarilla de arroz representó una solución viable y sostenible para mitigar la contaminación plástica. La iniciativa se alineó con los Objetivos de Desarrollo Sostenible y ofreció beneficios ambientales, económicos y sociales.

Además, posicionó a Villavicencio como una ciudad con potencial para liderar innovaciones verdes a nivel nacional.

Palabras clave: Cascarilla De Arroz; Empaques Biodegradables; Sostenibilidad; Residuos Plásticos; Villavicencio.

INTRODUCTION

To replace one of the most polluting materials in the world, such as plastic and expanded polystyrene, a solution is being sought to mitigate the impact of such waste. Plastic pollution is a global environmental challenge, and to provide a viable solution to this ecological catastrophe, it is proposed to replace various single-use containers with a biodegradable and environmentally friendly material.(1,2,3)

Environmental pollution from solid waste has been a global problem for many years, leading people to seek solutions to mitigate the environmental impact, from raising awareness to projects that reduce the carbon footprint.(4,5,6) Rapid population growth has led to an accelerated increase in plastic, causing mountains of garbage to grow daily.(7,8,9) The aim is to solve two main problems in Colombia, mainly in Villavicencio, Meta: the generation of plastic waste and the pollution caused by the final disposal of rice husks.(10,11,12)

There is an opportunity to create containers derived from rice husks, such as plates and/or packaging, which in the short term will reduce waste generation. Initially, this project will face challenges, such as entering the single-use materials market and gaining acceptance in the department.(13,14,15,16,17)

The aim is to achieve excellence and improve processes that allow all citizens to contribute to the fulfillment of SDGs 13, 14, and 15 by taking action for the climate and caring for marine life and terrestrial ecosystems.(18,19,20,21,22,23,24) Given that the department of Meta is one of the largest rice producers, the waste generated from this product can be exploited through the sustainable use of this natural waste, thereby contributing to the population of the department of Meta becoming a pioneer in the use of natural waste for the production of biodegradable containers and generating an impact on the rest of the country and the world, along with the reduction of other products that pollute the environment.(25,26,27,28,29)

DEVELOPMENT

Geographical framework

The proposal focuses on the municipality of Villavicencio, which is located at an average altitude of 467 m above sea level. Villavicencio is situated in the foothills of the Eastern Cordillera, in the northwestern part of the department of Meta, on the right bank of the Guatiquía River.

Legal framework

- Bill 010 of 2020: "Establishing measures to reduce the production and consumption of single-use plastics in the national territory, regulating a transition regime to progressively replace them with reusable, biodegradable, or other alternatives whose degradation does not generate pollution, and enacting other provisions."
- Law 1407 of July 26, 2018, "Regulating the environmental management of waste from paper, cardboard, plastic, glass, and metal packaging and containers, and making other determinations."
- Resolution 683 of 2012: "Issuing the Technical Regulations on the health requirements to be met by materials, objects, containers, and equipment intended to come into contact with food and beverages for human consumption."
- Resolution 4143 of 2012: "Establishes the technical regulations on the health requirements to be met by plastic and elastomeric materials, objects, packaging, and equipment and their additives intended to come into contact with food and beverages for human consumption in the national territory."

In 2014, the Ministry of the Environment stipulated in another article entitled "Industrial Eco-products" that the objective of systematizing the support provided during 2015 to different Environmental Authorities (A.A.) is to multiply learning and disseminate knowledge of a tool that encourages the generation of Green Businesses, establishing that the purpose of systematization is to develop a "step-by-step" methodology for the implementation of Regional Green Business Programs (PRNV).(30,31,32,33)

Conceptual theoretical framework.

Packaging: at a basic level, the function of packaging and containers is to protect, contain, and identify products and materials when transported from point A to point B. Other packaging functions are also mentioned, but these functions are considered additions to its primary and simplest function. These additions, in one case,

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can be created by designers as extra elements that allow a product to be positioned more easily in the market, as a method of preserving food under specific temperature parameters until it reaches its final destination, or even to protect the product from theft or other more complicated problems.[34,35,36,37,38]

Biodegradable packaging: this can be defined as packaging that, when introduced into an industrial composting plant along with other organic material, biodegrades and has no consequences for the process, the product, or the environment.[15]

Types of biodegradable packaging: it can be made from any food containing starch (rice, sugar cane, etc.) and lactic acid waste (corn, potatoes, etc.).[39]

Types of packaging: there are currently several types of packaging that can be classified as primary packaging; these are all those that come into direct contact with the product and whose primary function is to protect it and keep it in good condition. Secondary packaging groups several primary packages, facilitating their handling and transport.[40]

Packaging: the primary function of packaging is to protect products from physical damage or adverse conditions during transport or storage. It can be specified as easy to close, open, or store packaging.[41]

Studies have been conducted in different fields, and rice husks are helpful in the following applications:

- As organic fertilizer
- When mixed with cement, it improves the mechanical properties of durability and compression of the cement.
- “Kaolinized” rice husks improve moisture retention as a substrate for hydroponic crops.
- Fuel used to dry cereals is a substitute for fossil fuels.
- Variation in the thermal conductivity of rice husks agglomerated with vegetable fibers.
- Use of SIO2 obtained from rice husks in the synthesis of calcium silicates
- Commercialization of husks
- Rice husks are an input for infrastructure construction.
- Solar panels with silicon from rice husks.

CONCLUSIONS

The environmental problems caused by the excessive use of single-use plastics, combined with the inadequate disposal of agricultural waste such as rice husks, represent one of the main sustainability challenges in Colombia and, in particular, in the municipality of Villavicencio, Meta. In response to this situation, an innovative and environmentally responsible alternative has been proposed: the production of biodegradable packaging and containers from rice husks, a widely available by-product in this region.

This article showed that rice husks can not only contribute to reducing plastic waste but also offer a sustainable use for a commonly discarded agro-industrial waste product. The proposal is aligned with the Sustainable Development Goals (SDGs), specifically with goals 13 (Climate action), 14 (Life below water), and 15 (Life on land), which promote more responsible practices in environmental, social, and economic terms.

At the legal level, an analysis of Colombian regulations shows growing support for this type of initiative, as evidenced by Law 1407 of 2018 and Bill 010 of 2020, which promote the progressive reduction of single-use plastics and encourage the use of alternative and biodegradable materials. This legitimizes the proposal and provides a solid foundation for its development and implementation in the market.

In terms of geography, Villavicencio stands out for its climatic and geographical characteristics, as well as its role as a rice-producing area. These factors offer optimal conditions for implementing this type of project. Access to local raw materials and growing interest in the circular economy and green business initiatives make this city a strategic location to lead this type of transformation.

Finally, it is concluded that manufacturing biodegradable packaging from rice husks represents a viable and sustainable solution to current environmental problems. The aim is not only to reduce pollution, but also to raise ecological awareness, create new economic opportunities, and position Villavicencio as a benchmark in environmental innovation at the national and international levels.

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