Rivar
REVISTA IBEROAMERICANA DE VITICULTURA, AGROINDUSTRIA Y RURALIDAD

Editada por el Instituto de Estudios Avanzados de la Universidad de Santiago de Chile

ELABORACIÓN DE UNA GALLETA ENRIQUECIDA CON FIBRA DE COCO *(COCOS NUCIFERA* L.)

Development of a Cookie Enriched with Coconut Fiber (Cocos nucifera *L.)*
Elaboração de um biscoito enriquecido com fibra de côco (Cocos nucifera *L.)*

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Vol. 12, N° 36, 94-101, julio de 2025
ISSN 0719-4994

Artículo de investigación
https://doi.org/10.35588/fgscd483

Recibido
3 de enero de 2024

Aceptado
8 de enero de 2025

Publicado
6 de agosto de 2025

Cómo citar
De La Espriella-Angarita et al. (2025). Elaboración de una galleta enriquecida con fibra de coco *(Cocos nucifera* L.). RIVAR, 12(36), 94-101.
https://doi.org/10.35588/fgscd483

ABSTRACT
Functional foods are products that offer specific health benefits in addition to their basic nutritional components. Cookies, popular for their variety of flavors and long shelf life, allow for the incorporation of high fiber content. However, while some components of traditional foods are associated with health benefits, few experimental studies support these effects. Fiber, noted for its impact on intestinal health, prevention of colon cancer and cardiovascular diseases, and weight maintenance, is recommended by the WHO at a minimum intake of 30 g per person per day, of which at least 30% should be soluble. This study evaluated the physicochemical and functional properties of cookies enriched with coconut mesocarp fiber *(Cocos nucifera* L.). The results showed that cookies with coconut fiber, in a 5% proportion, maintained a sensory acceptability similar to traditional wheat cookies, constituting a high-quality food alternative. In conclusion, the use of coconut fiber in cookies is promising for the food industry, offering a healthy product without sacrificing taste or quality.

KEYWORDS
Agribusiness, food, fiber, food industry, cookie.

RESUMEN
Los alimentos funcionales son productos que ofrecen beneficios específicos para la salud, además de sus componentes nutricionales básicos. Las galletas, populares por su variedad de sabores y larga vida útil, permiten la incorporación de alto contenido en fibra. Sin embargo, aunque algunos componentes de alimentos tradicionales están asociados con efectos saludables, pocas investigaciones experimentales respaldan dichos beneficios. La fibra, destacada por su impacto en la salud intestinal, prevención del cáncer de colon y enfermedades cardiovasculares, y mantenimiento del peso, es recomendada por la OMS en una ingesta mínima de 30 g por persona al día, de los cuales al menos el 30% debe ser soluble. Este estudio evaluó las propiedades fisicoquímicas y funcionales de galletas enriquecidas con fibra de mesocarpio de coco *(Cocos nucifera* L.). Los resultados mostraron que las galletas con fibra de coco, en una proporción del 5%, mantuvieron una aceptabilidad sensorial similar a las galletas tradicionales de trigo, constituyendo una alternativa alimenticia de alta calidad. En conclusión, el uso de fibra de coco en galletas es prometedor para la industria alimentaria, ofreciendo un producto saludable sin sacrificar el sabor ni la calidad.

PALABRAS CLAVE
Agroindustria, alimento, fibra, industria alimentaria, galleta.

RESUMO
Os alimentos funcionais são produtos que oferecem benefícios específicos para a saúde, além dos seus componentes nutricionais básicos. Os biscoitos, populares por sua variedade de sabores e longa vida útil, permitem a incorporação de alto teor de fibras. No entanto, embora alguns componentes dos alimentos tradicionais estejam associados a benefícios para a saúde, poucos estudos experimentais apoiam esses efeitos. A fibra, destacada por seu impacto na saúde intestinal, prevenção do câncer de cólon e doenças cardiovasculares, e manutenção do peso, é recomendada pela OMS com uma ingestão mínima de 30 g por pessoa por dia, dos quais pelo menos 30% deve ser solúvel. Este estudo avaliou as propriedades físico-químicas e funcionais de biscoitos enriquecidos com fibra de mesocarpo de coco *(Cocos nucifera* L.). Os resultados mostraram que os biscoitos com fibra de coco, em uma proporção de 5%, mantiveram uma aceitabilidade sensorial semelhante aos biscoitos tradicionais de trigo, constituindo uma alternativa alimentar de alta qualidade. Em conclusão, o uso de fibra de coco em biscoitos é promissor para a indústria alimentícia, oferecendo um produto saudável sem sacrificar o sabor ou a qualidade.

PALAVRAS-CHAVE
Agronegócio, alimentos, fibra, indústria alimentícia, biscoito.

Introduction

Colombia has a large coastal area that is ideal for planting the coconut tree, evidencing a high production of this in these regions. Currently it has been proven that a large part of the island or coastal population has as their main source of income the production and distribution of coconut and its derivatives such as water and pulp. However, this activity generates a lot of waste, because the coconut shells that are processed are thrown on the shores of the beach and the streets, mainly generating an increase in the accumulation of waste that is generated, becoming a serious environmental problem, since they are the main cause of proliferation of insects and rodents, also harming the health of the inhabitants of the area and generating visual pollution harmful to any type of tourist enterprise that you want to start (Granados and López, 2002; Iragorri, 2014; Beltrán, 2016).

However, in order to reduce the environmental impact that is being generated by this waste, the industrial sector has begun to use coconut fiber as an input, being Colombia one of the countries where it begins to gain importance for the creation of new products, since this raw material has long been wasted due to the lack of knowledge on the part of coconut growers about the different uses of this, in the same way, results of various investigations conclude that coconut fiber, in addition to its characteristics of renewable and recyclable origin, presents excellent mechanical, chemical and physical properties that surpass polyester fibers. Therefore, coconut fiber is emerging as a versatile material and perfectly suitable for the development of new ingredients in the food industry (Granados and López, 2002; Iragorri, 2014; Beltrán, 2016).

It is important to note that functional foods can be described as food products that, in addition to their nutritional value, contain biologically active components that provide some added and beneficial effect on health and reduce the risk of contracting certain diseases (Román and Valencia 2006; Fuentes-Berrío et al., 2015). Several researchers indicate that the future of food lies in the consumption of healthy foods. Among these, fiber occupies a relevant place, since it has been associated with intestinal health, prevention of rectal colon cancer and cardiovascular diseases and weight maintenance (Rodríguez-Sandoval et al., 2012; Cerón et al., 2014). Therefore, the objective of this research work was to develop a cookie enriched with coconut fiber (*Cocos nucifera* L.).

Methodology

The coconut shells were collected in the city of Cartagena, located in the department of Bolívar (10°25°25”N 75°31°31”W).

Biscuit making

The formula for the preparation of the cookies was taken from the Colombian Technical Standard (NTC-1241) for the preparation of cookies. The process of making the biscuit based on wheat flour enriched with coconut fiber, consisted of subjecting the selected ingredients to a process of mixing, filtering and drying at a temperature of 180 ºC, then the rolling and winding of the dry dough, and finally proceeded to cut, cooling and packaging, using 5% coconut fiber as a functional ingredient.

RIVAR Volumen 12, número 36, 2025: 94-101 • ISSN online 0719-4994
Instituto de Estudios Avanzados, Universidad de Santiago de Chile

Bromatological characterization of coconut fiber and cookie enriched with coconut fiber

The chemical characterization of the coconut fiber and biscuit enriched with coconut fiber was carried out, to which the content of nutrients and micronutrients was determined by means of the tests described below: protein; the Kjeldahl method was used according to AOAC 955.04; ashes; using the direct method according to AOAC 924.05; moisture; by means of the drying method at 100+2 ºC according to AOAC 925.09; fiber (Torrenegra et al., 2016); by the gravimetric enzymatic method; carbohydrates (Cerón et al., 2014); fat (Leon-Mendez et al., 2020); by the Soxhlet method according to AOAC 936.15, minerals using the instrumental technique of atomic absorption spectrophotometry (Granados et al., 2021; AOAC, 1990, 1995).

Instrumental measurements

To determine the color of the cookies, four measurements were taken with a Hunter Lab tristimulus colorimeter, recording the values of L* [lightness, from 0 (dark) to 100 (light)], a* [from -60 (green) to +60 (red)], and b* [from -60 (blue) to +60 (yellow)]. The texture of the cookies was determined using a universal texture analyzer, recording the maximum cutting force in Newtons (Delgado et al., 2013).

Sensory analysis

To evaluate the degree of acceptance and sensory attributes of the formulation, the 5-point Hedonic scale corresponding to: acceptability, where 1 (I don't like anything), 2 (I do not like), 3 (Indifferent), 4 (I like), 5 (I loved), by a panel made up of 50 experts. The panelists recorded the degree of taste or dislike in terms that best described their perception of the product (Rincón et al., 2016).

Statistical analysis

The trials were conducted in triplicate in order to ensure reliable analytical results using the GraphPad Prism 5 program. The results were expressed in mean ± EEM (standard error of the mean).

Results and discussion

In the results collected in Table 1, the proximal composition of the coconut mesocarp fibers can be observed.

Table 1. Results of the proximal composition of coconut mesocarp fibers
Tabla 1. Resultados de la composición proximal de las fibras de mesocarpio de coco

Moisture (%)	Protein (%)	Ash (%)	Fat (%)	Fiber (%)	Carbohydrates (%)
6.01±0.10	4.17±0.33	2.15±0.15	2.11±0.18	55.14±0.05	85.56±0.11

Source: own elaboration. Fuente: elaboración propia.

It was identified that the coconut mesocarp has a higher contribution of fiber (55.14±0.05%) and carbohydrates (85.56±0.11%).

The ash content (2.15±0.15%) mainly indicates the composition in minerals, authors such as Rincón et al., point out that coconut fiber is a rich source of potassium and chlorine, however, over time, if the fiber is exposed to the environment, the amount of these minerals are lost due to the leaching effect causing the elimination of soluble salts, therefore, the mineral content depends on the variety and place of cultivation of the fruit.

According to Rincón et al. (2016), the total carbohydrate content is mostly structural polysaccharides such as cellulose and hemicellulose, which confer supporting and flexible properties to fibers (Román and Valencia, 2006; Trujillo and Arias, 2013).

Table 2 presents the results of the proximal composition of cookies enriched with coconut fiber, which has a higher fiber intake (8.26±0.25%).

Table 2. Results of the proximal composition of cookies enriched with coconut fiber
Tabla 2. Resultados de la composición proximal de las galletas enriquecidas con fibra de coco

Parameters	**Results**
Moisture (%)	3.96±0.05
Protein (%)	6.30±0.45
Ash (%)	3.32±0.20
Fat (%)	1.40±0.42
Fiber (%)	8.26±0.25
Carbohydrates (%)	85.02±0.91
Sodium (mg)	205.03±0.42
Calcium (mg)	26.87±0.55
Iron (mg)	1.10±0.96
Magnesium (mg)	24.33±0.22
Zinc (mg)	0.61±0.15
Texture (N)	57.74±0.28
L*	49.51±0.49
a*	5.27±0.67
b*	20.70±0.43

Source: own elaboration. Fuente: elaboración propia.

In general, biscuits are products made basically with wheat, oat or rye flours, sugar and vegetable fat, whose minimum protein content should be five to eight percent (Rincón et al., 2016).

The protein values (6.30±0.45) of cookies enriched with coconut fiber meet this chemical specification. Román & Valencia reported a protein content of 8.1% for cookies made with cereal fibers, Granito et al. (2010) reported 10.1% protein in cookies made with 30% beans; Escobar et al. (2009) reported 10.7–13.3% protein in biscuits made with carob cotyledon flour; Ceron et al. reported a protein value between 9.6–12.6% for potato flour-based biscuits of the Parda Pastusa variety (*Solanum tuberosum* L.); Delgado-Vidal et al. indicated the protein values (8.8–13.9%) of biscuits enriched with skipjack meat; León et al. showed the protein value (5.25±0.22) of biscuits based on pelipita banana flour (*Musa abb*) and sweet potato (*Ipomea sweet* potatoes) at 70:30% respectively.

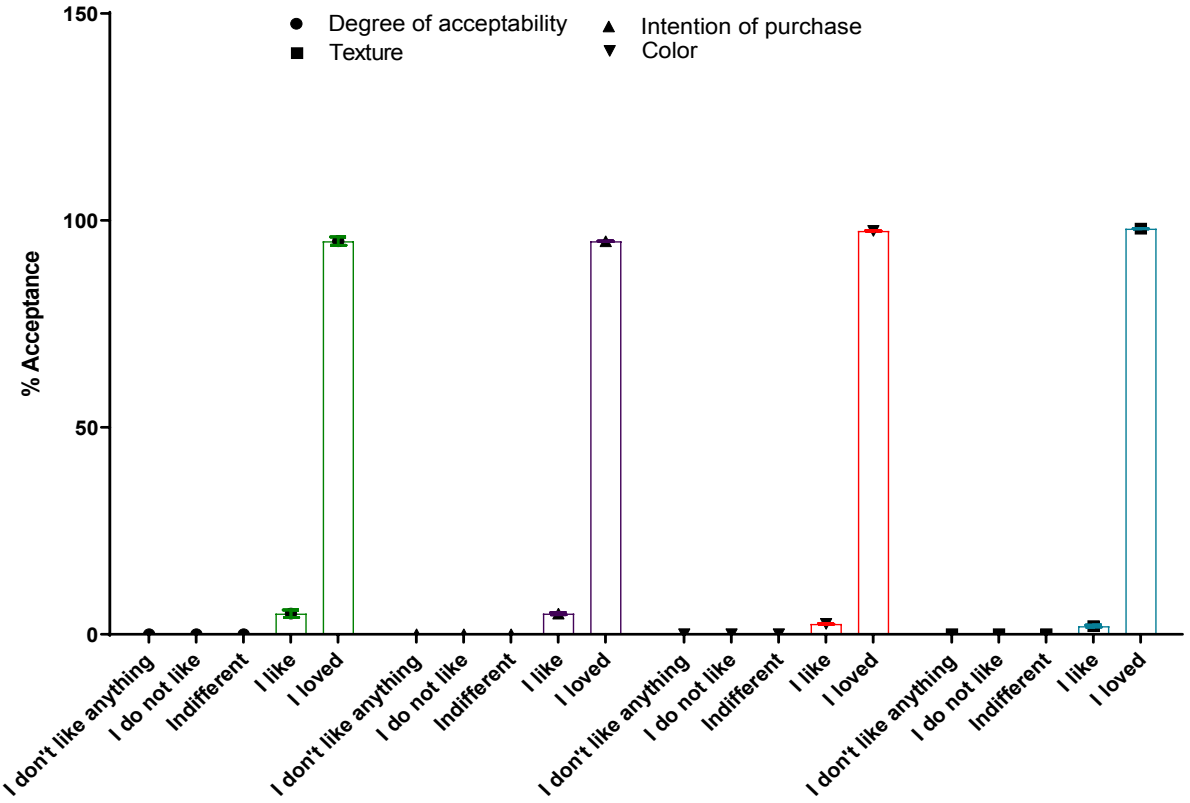
Fiber is a component present in coconut mesocarp, which is difficult to degradable due to its components such as cellulose and hemicellulose (Granados et al., 2014; Hernández et al., 2018).

The order of importance of the minerals present in the cookie was determined based on their relative concentrations, with sodium being the most abundant mineral, followed by calcium, magnesium, iron, and finally zinc. This ranking reflects the prevalence of each mineral in the product and provides insight into its potential contribution to daily intake. This order of importance offers a comprehensive understanding of the mineral distribution in the cookies and their possible nutritional impact.

The distinctive color of the formulations is related to the effect of temperature and baking time on the content of sugars, lipids, proteins, and starch. These components appear to have produced a characteristic coloration attributed to the Maillard reactions. In a product, the higher the amount of sugars present, including non-reducing sugars, the more intense the brown color on its surface will be (Granados et al., 2021).

It is evident in the results corresponding to the sensory analysis of the cookies, that there is a high percentage of acceptance of the sensory attributes of the formulation, identifying itself as a quality product that, in turn, has persistent flavors according to a cookie with fiber, crunchy and sweet (Figure 1).

Figure 1. Percentage of acceptance by the panelists
Figura 1. Porcentaje de aceptación por parte de los panelistas



Source: own elaboration. Fuente: elaboración propia.

This is evidenced by the values (8.26±0.25) of the cookies and by the sensory analysis where they were evaluated as a high-quality product.

Conclusions

In conclusion, the evaluated coconut mesocarp fiber has demonstrated a range of physicochemical and functional properties that make it suitable for various applications in the food industry. Its ability to enrich products like cookies with additional fiber without significantly compromising sensory quality, such as taste and texture, highlights its potential as a functional ingredient. Overall, coconut mesocarp fiber represents a promising option for enhancing the nutritional and functional profile of food products, offering benefits for both health and the quality of the final product.

Acknowledgments

The authors express their gratitude to the Fundación Universitaria Tecnológico Comfenalco for their support with the methodology focused on formative research (Classroom Project), to the Universidad de Cartagena, and to SENA for providing space, resources, and time for the researchers.

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