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DEVELOPMENT OF CEREAL BARS BASED ON PASSION FRUIT PEEL FLOUR

DESENVOLVIMENTO DE BARRA DE CEREAL A BASE DE FARINHA DE CASCA DE MARACUJÁ

DESARROLLO DE BARRITAS DE CEREALES A BASE DE HARINA DE CÁSCARA DE MARACUYÁ

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ABSTRACT

Brazil produces tons of solid organic waste daily, resulting from the food industry, which compromise the ecosystem, since they are highly polluting materials. A large part of this waste is generated by juice extracting industries, which, when processing fruits, discard husks, albedos, seeds, shavings and vesicles. Passion fruit suffers a lot of loss during processing, as only 30% of the entire weight of the fruit is used, which is the pulp used to extract the juice. In recent years, the search for the use of these residues in the development of products with greater added value, such as flour with a high fiber content, has been the subject of research. The present work had as objective the physical, chemical and microbiological evaluation of the cereal bar formulated with passion fruit peel flour. The cereal bar was subjected to microbiological and physical chemical analysis, showing absence of Staphylococcus aureus, Salmonella and Coliforms. The pH, moisture, water activity, titratable acidity, ash and brix degree were analyzed. At the end of the analysis, it was concluded that the use of passion fruit peel in the production of the cereal bar proved to be viable.

RESUMO

O Brasil produz, diariamente, toneladas de resíduos sólidos orgânicos resultantes da indústria de alimentos, que comprometem o ecossistema, uma vez que são materiais altamente poluentes. Boa parte desses resíduos é gerada pelas indústrias extratoras de sucos, que ao processarem as frutas, descartam cascas, albedos, sementes, aparas e vesículas. O maracujá sofre muita perda durante o processamento, pois somente 30% de todo o peso do fruto é aproveitado, que é a polpa utilizada para a extração do suco. Nos últimos anos, é tema de pesquisa a busca do uso desses resíduos no desenvolvimento de produtos de maior valor agregado como, por exemplo, farinhas com alto teor de fibras. O presente trabalho teve como objetivo a avaliação físico-química e microbiológica da barra de cereal formulada a base de farinha de casca de maracujá. A barra de cereal foi submetida a análises microbiológicas e físico-químicas, apresentando ausência de Staphylococcus aureus, Salmonella e coliformes. Analisou-se o pH, umidade, atividade de água, acidez titulável, cinzas e sólidos solúveis. Ao final das análises concluiu-se que o uso da casca de maracujá na produção da barra de cereal provou-se viável para produção de produtos inovadores e sustentáveis.

RESUMEN

Brasil produce, diariamente, toneladas de residuos sólidos orgánicos provenientes de la industria alimentaria, que comprometen el ecosistema, ya que son materiales altamente contaminantes. Buena parte de estos residuos son generados por las industrias extractoras de jugos, las cuales al procesar los frutos descartan cáscaras, albedos, semillas, recortes y vesículas. El maracuyá sufre muchas pérdidas durante el procesamiento, ya que solo se utiliza el 30% del peso total de la fruta, que es la pulpa utilizada para extraer el jugo. En los últimos años, la investigación se ha centrado en el aprovechamiento de estos residuos en el desarrollo de productos de mayor valor añadido, como las harinas con alto contenido en fibra. El objetivo de este trabajo fue la evaluación físico-química y microbiológica de la barra de cereal formulada con harina de cáscara de maracuyá. La barra de cereal fue sometida a análisis microbiológicos y físico-químicos, demostrando la ausencia de Staphylococcusaureus, Salmonella y Coliformes. Se analizó el pH, humedad, actividad de agua, acidez titulable, cenizas y sólidos solubles. Al final del análisis se concluyó que el uso de la cáscara de maracuyá en la elaboración de la barra de cereal resultó ser viable.

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INTRODUCTION

Brazil stands out as the world's largest producer of passion fruit, producing nearly 683,993 tons in 2021, with emphasis on the Northeast region, with a production of 476,006 tons of fruit, representing 69.6% of the national production (IBGE, 2021).

However, passion fruits are often lost during the process, as only 30% of the entire weight of the fruit is harvested, which is the pulp used to extract the fruit (ITAL, 1994). Fruit waste can be reused as an alternative source of nutrients or used as an ingredient in the production of various types of food products (Santos, 2011).

The large production of fruits in Brazil reflects the high production of solid organic waste from the food industries, where compromise the ecosystem is compromised, since only highly polluting materials are used. A large part of this waste is generated by waste extraction industries, which process fruits, discard peels, albedos, seeds, shavings and vesicles. On the other hand, this material has great economic potential as a source of dietary fiber, preparation of medicines, production of jewelry and decorative objects, among others (Pelizer et al., 2007).

Passion fruit can be consumed in an industrialized way or in nature, having excellent acceptance among consumers and representing a small percentage of the exported crops (IBGE, 2021). The passion fruit peel contains important constituents, such as crude protein (13.4%), ethereal extract (0.21%), mineral matter (9.7%), non-fibrous carbohydrates (11.8%), neutral detergent fiber (64.9%), acid detergent fiber (45.3%), cellulose (28.4%), hemicellulose (19.5%) and lignin (16.9%) (Pazdiora et al., 2021; Lira et al., 2018).

The coronavirus pandemic disease 2019 (Covid-19) completely altered routine and activities around the world. However,if in the health and care there was generally a sudden change, the need to feed was not altered. In this sense, availability of healthy and nutritious food, both in quantity and quality, has become even more fundamental in all countries (Anuário Brasileiro de Fruticultura, 2021).

Various studies regarding the use of passion fruit and its waste are being carried out: alternative use of passion fruit peel for the production of a farinaceous product (Santos et al., 2018), flour production and cereal bars (Souza, 2014), yogurt preparation (Toledo, 2013) and physical-chemical characterization of seeds for oil production and cake use (Samico, 2010).

Cereal bars are intended as a compacted food product composed of cereals, dried fruits, seeds, sugar and other ingredients. At the beginning of their commercialization, the cereal bars were characterized by crunchiness, but due to pressure from the consumer market, they became solid, sweet or salted, with or without frosting, and fibers and oilseeds were added to the mixture, turning them into a functional food product (Silva, 2018).

As Brazil is the largest producer of passion fruit on a global level, the fruit processing industries generate a high amount of waste, including hulls, seeds, shavings, bags, membranes and

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vesicles. According to Fortaleza et al. (2005), these wastes present high levels of constituents that are essential to human nutrition, with beneficial effects in maintaining health and preventing diseases, such as: fibers, vitamins, minerals, phenolic composts and flavonoids.

The objective of this work is to formulate and evaluate the physical-chemical and microbiological evaluation of the cereal bar made with passion fruit peel.

METHODOLOGY

For the preparation of flour, residues of passion fruit husks (*Passiflora edulis)* were used, in accordance with the procedure described by Ferreira et al. (2013). The flour was then dried again for 1 h at 90°C, aiming for microbiological control.

Table 1 shows the cereal bar formulation, where 50% dry ingredients and 50% agglutination syrup are used. The dry ingredients are weighed and mixed to obtain a homogeneous mass. Next, the syrup was prepared in a bowl on a hot plate at 100°C, mixing the following ingredients: sugar, glucose, vegetable fat, water and cream of tartar. The two fractions were mixed to form the mass, which was distributed in a metallic form on the molded bars. The dough was chilled at 9°C, for 20 minutes, and then cut longitudinally and transversely with a standard size of 10x3x1 cm, with an average weight of 25 g. The bars are packaged in flexible laminated packaging and assembled at room temperature (25°C) at the time of analysis.

Table 1. Formulation used in the preparation of the cereal bar.

Ingredients Syrup	F1 (50:50) %
Sugar	24,7
Glucose	15
Vegetable fat	4
Water	6
Cream of Tartar	0,3
Dry Ingredients	
rice flake	15
Oat bran	15
NUT (chestnuts, banana raisins and raisins)	5 cast., 5 bp, e 5 up.
Passion fruit flour	5

Source: Authors.

For physical-chemical analyses, the cereal bar was crushed in a mortar with a pistil. The following tests were performed: humidity, zinc, theory of solute solids (°Brix), pH, titrated acidity, water activity (a_w) and vitamin C, based on the methodologies of the Adolfo Lutz Institute (2008).

For the microbiological analyses were determined*: Salmonella; total* and thermotolerant coliforms, counting of mold and yeast; standard counting of aerobic mesophilic bacteria; and counting of *Staphylococcus aureus,* following the methodology described by APHA (2001).

The measurement was carried out based on the weight loss of the material in the oven at 105°C at constant weight. The content of zincs was obtained by calcining the samples in a muffle furnace at 550°C to obtain clear zincs. The pH was measured after calibration with

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solutions also by inserting the electrode directly into the samples crushed and homogenized in distilled water. Water activity was measured in Aqualab equipment at 25°C. All the analyzes described above were carried out in triplicate.

To evaluate the statistics of the cereal bar, the mean and standard deviation were calculated in the Excel 2023 program.

The project was submitted to the ethics and research committee under CAAE number 14022319.6.0000.5087.

RESULTS AND DISCUSSION

Table 2 shows the results of the physical-chemical analyses of the cereal bar.

Table 2. Mean values and standard deviation of physical and chemical characteristics.

Parameters evaluated	Mean ± Standard deviation
pH	4,77 ± 0,239
Water activity (a_w)	0,48 ± 0,003
Humidity (%)	22,38 ± 1,826
Soluble solids (°Brix)	2,36 ± 0,205
Ashes (%)	0,99 ± 0,204
Vitamin C (mg/100g)	367 ± 1,28
Titratable Acidity (%)	0,58 ± 0,053

Source: Authors.

The cereal bar presents a water activity (a_W) with an average of 0.48. The value found ensures microbiological stability, according to Scott (1957), where food products with $a_W < 0.6$ are microbiologically stable. In a study carried out by Vieira et al. (2019), when preparing a cereal bar with dried pineapple and cashew residues, it was determined a $a_{w\ of}$ 0.61, being above the average value determined not in this study.

Silva et al. (2009), when evaluating cereal bars added with industrial waste from yellow passionfruit, found values of a_w similar to the ones of the present study in their formulations A (without residue or standard) and D (30% substitution) that are 0. 55 and 0.58, respectively.

The humidity values (22.38%) are related to the majority of the ingredients used in the formulation being dry. Similar values to the ones in the present study were reported by other authors in studies with cereal bars. Silva et al. (2021) developed different cereal bar formulations using passion fruit albedo flour and determined a humidity that varied from 8.26% to 13.15%. Dias et al. (2020), in their studies with a cereal bar made with yam flour, found a humidity value of 20.73%, which is close to the value found in this study. Costa et al. (2016) found in their work on the elaboration of cereal bars using passion fruit hulls a moisture content of 18.34%.

The pH value found was 4.77, which ensures that the cereal bar has microbiological stability. Resosemito et al. (2020), analyzing the use of passion fruit peel in gel preparation, found a pH of 4.0. On the other hand, Nascimento et al. (2017) determined to the green banana flour the hydrogen potential (pH) of 5.71.

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It is observed that the the cereal bar pH value verified in this study is beneficial to the final product, favoring the increase in the shelf life of this product, once, according to Borges et al. (2009), acid pH has an inhibitory effect on the development of microorganisms.

The quantity of soluble solids found in the cereal bar formulated with passion fruit husk flour was 2.36. Similar values were found in the studies of Soares et al. (2015), in which they present soluble solid values of 3.2, 3.1 and 3.5 for cajá-manga (Spondias cytherea), araticum (Annona crassiflora Mart. - Annonaceae) and murici (Byrsonima crassifolia L., Malpighiaceae) cereal bars, respectively.

The amount of vitamin C found in the cereal bar was 367mg/100g. MORETTI et al. (2006), in their studies on the storage and analyzing the stability of vitamin C in cereal bars in various packaging, found values from 178 mg/100g to 298.78mg/100g. On the other hand, Medina et al. (2014) found values of 400mg/100g.

For the zinc values, an average of 0.99% was found. The determination of zinc provides an indication of the richness of mineral elements in the sample, being constituted mainly of large quantities of K, Na, Ca and Mg and small quantities of Al, Fe, Cu, Mn and Zn (Silva, 2002). Fonseca et al. (2011) observed a zinc quantity of 1.17% in a cereal bar with pineapple husk gel, this quantity being close to the one found in this study. Aleixo, Ceruti and Carlesso (2021) when developing a salty cereal bar made from earthen saffron, determined a zinc value of around 4.88%. Czaikoski et al. (2016) determined a zinc value of 1.94% in the cereal bar with the addition of soy flour.

Since minerals represent only 4-6% of the total body mass, they are of utmost importance in the basic functions of the organism and, therefore, must be present in satisfactory quantities in the diet (Caballero et al. 2003).

The acidity found in this study was 0.58%. Santos et al. (2015) found titrated acidity of banana flour of 0.61%, which is higher than the value obtained in this work. Acidity is an important parameter in assessing the state of conservation of a food product because acidification plays a role in inhibiting microbial growth (Fennema , 2010) (Table 3).

Table 3. Results of microbiological analyses.

Essay	Results
Staphylococcus aureus	Absence
Mesophilic aerobic bacteria	(<10 UFC/g)
Salmonella	Absence
Coliforms	Absence
Molds and Yeasts	(<10 UFC/g)

Source: Authors.

It was not identified the presence of coliforms at 45°C, which is in accordance with resolution RDC n° 12 of the Brazilian Ministry of Health (Brazil, 2001), which states that the permitted size is of $5x10^{2}$. For mesophilic aerobic bacteria it was less than 10 CFU/g, as well as for mold and yeast.I It was not identified the presence of *Salmonella*, what is in accordance with the

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legislation. *Staphylococcus aureus* is not presente, what is in accordance with the resolution CNNPA n° 12, of 1978 (Brazil, 1978).

The effectiveness of the process is observed once the analyses are within the standards, indicating that the cereal bar was processed under satisfactory hygienic and sanitary conditions, guaranteeing the safety of the product.

CONSIDERAÇÕES FINAIS

The use of passion fruit peel in the production of the cereal bar should be carried out. The product in its final form presents a low water activity, and it ensures a microbiological stability, in addition to the pH, which is very close compared to other authors with similar works. In relation to microbiological analyses, *Staphylococcus aureus*, *Salmonella and* coliforms are absent, what is in accordance with the legislation of the Brazilian Ministry of Health. Mesophilic aerobic bacteria and mold and yeast present values below 10 CFU/g, being an acceptable parameter.

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