

Full Length Research Paper

Sensory analysis of extruded corn-based breakfast cereals with whole peach palm fruit (*Bactris gasipaes*, kunth) powder

Ivone Lima Santos¹, Caroline Joy Steel², Jaime Paiva Lopes Aguiar³, Marcio Schmiele², José Carlos de Sales Ferreira¹ and Francisca das Chagas do Amaral Souza^{3*}

¹Postgraduate Programme in Food Science, Federal University of Amazonas (Universidade Federal do Amazonas, UFAM), Manaus, Amazonas, Brazil.

²Department of Food Technology, School of Food Engineering, University of Campinas (UNICAMP), Cidade Universitaria Zeferino Vaz, CEP 13083-862, Campinas, Sao Paulo, Brazil.

³Brazilian National Institute for Research in the Amazon, Coordination Society of Environment and Health (CSAS) and Laboratory of Physical Chemistry of Food (LFQA) Av André Araújo 2936, 69067-375, Manaus, AM, Brazil.

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This research work aimed to study the sensory characteristics of corn-based breakfast cereal with whole peach palm fruit (*Bactris gasipaes*, Kunth) powder. Sensory analysis was performed after approval of the local ethics committee (26884014.9.0000.5020) and written consent of the panelists. The samples were offered to 70 untrained panelists in disposable bowls codified with three random digits. The panelists reported how much they liked the product in terms of taste and crispness, their purchase intention, preference, and attitude or intention to consume. The scores given to the product with 25% whole peach palm fruit powder were significantly higher than the scores given to the other two study products, making it commercially viable.

Key words: Peach palm fruit powder, sensory analysis, breakfast cereal.

INTRODUCTION

In the last few years, consumers have shown higher desire for processed products that promote a balanced diet, aggregating nutritional value and bioactive compounds. Bioactive compounds are important to human health and nutrition, especially to prevent diseases, and it has been the focus of much research (Kay et al., 2009; He and Giusti, 2010).

Extruded foods are popular because they are ready-to-eat, crispy, and colorful, and have pleasant shapes (Hirth et al., 2014). However, they are often considered junk food (unhealthy) because of their composition, mainly of carbohydrates (Bolanho et al., 2015).

The extrusion process allows the development of numerous tastes, shapes, colours, and sizes, making

*Corresponding author. E-mail: francisca.souza@inpa.gov.br. Tel: 55929925921025, 559236431964.

extruded foods attractive to all kinds of consumers (Takeuchi et al., 2005). The addition of fruit powders in snacks and breakfast cereals may improve their nutritional quality and attractiveness. Fruit powders and extracts contain high levels of bioactive components, such as phenolic compounds and carotenoids, among others, making them a source of antioxidants and increasing the organoleptic quality of the products (Camire et al., 2007; Brennan et al., 2011; Potter et al., 2013).

The combination of tastiness and high nutritional value resulted in numerous snacks and processed cereals that are very successful, providing they contain natural ingredients with nuts and fruits (Payne, 2000). Although these products have been available for some decades, they meet the new dietary trends because of their high-energy and high-protein contents, nutritiousness, practicality, and wholesomeness (Souza, and Menezes, 2006).

Peach palm fruit (*Bactris gasipaes*, Kunth) is a fruit native to the Amazon region. Its powder, including all its residues to increase fiber content, can be added to extruded breakfast cereals to increase their nutritional quality and consumption of the fruit, which is usually eaten cooked in the region.

Clement and Mora Urpí (1987) reported that peach palm fruit powder is very similar to cornmeal and can often replace cornmeal, increasing the nutritional quality of a preparation. The fruit is very high in beta-carotene, a highly bioavailable functional component (Rodrigues-Amaya, 1993; Cozzolino and Cominetti, 2013).

Many studies have reported the beneficial effects of certain dietary components to human health. Such components have become known as functional ingredients, and the foods that contain them, functional foods (Hasler, 1998). Functional foods are defined as foods that not only fulfill their basic nutritional functions, but also benefit the body by improving health and reducing the risk of diseases (Berté et al., 2011). Hence, these foods are being sought by consumers who wish to improve their quality of life through diet. Many functional foods originated by combining pharmacology with food technology (Coelho and Wosiacki, 2010).

β -carotene is the predominant pigment in the human macula, and its increased intake has been associated with a lower incidence of eye diseases, such as age-related macular degeneration (AMD), cataracts, and retinitis pigmentosa (Fullmer and Shao, 2001; Ozawa et al., 2012). Recently, frequent and high dietary lutein intake has also been suggested as a means of preventing mild cognitive impairment and Alzheimer's disease in older people (Johnson, 2012; Kiko et al., 2012).

The interest in ingredients rich in dietary fiber (DF) has increased, and the importance of this food component has led to the development of a large market for fiber-rich products and ingredients (Pszczola, 2008). The intake of

foods with high DF content has been related to several physiological and metabolic effects: increase of the fecal bulk, provision of a favorable environment for beneficial intestinal microbiota multiplication, and prevention and control of obesity, atherosclerosis, coronary heart diseases, colorectal cancer, and diabetes (Vergara-Valencia et al., 2007).

The determination of the polysaccharide composition of DF (pectin, cellulose, and hemicellulose) is important to understand their physiological function, structure and organization in food products, allowing its planned use in functional foods (Waldron et al., 2003).

Extrusion cooking has been used by the food industry for many years. Ready-to-eat, grain-based food products, such as snacks, breakfast cereals, and pasta, and products with textured soy protein can be extruded (Suknark et al., 2001; Lin and Hsieh, 2002). Breakfast cereals are the precursors of a wide variety of extruded foods that today occupy numerous supermarket shelves (Sardagna et al., 2002)

Sensory analysis investigates people's responses to sensations caused by physiological reactions. Individuals respond to certain stimuli and the interpretation of such responses generates the intrinsic properties of a product. This requires individuals to interact directly with products. The stimulus is measured by physical and chemical processes, and the sensations, by psychological effects. The sensations provoked by a product vary in intensity, extension, duration, quality, and pleasantness (IAL, 2008).

Sensory analysis focuses on the sensory characteristics of a product and determines which product is preferred by a target population. Affective testing, also called consumer testing, can be classified into two categories: Acceptability and preference. The first aims to assess how much consumers like or dislike a given product, and the second, to assess consumer preference between two or more products (Damásio and Silva, 1996; Silva, 1997).

Consumer testing is mainly used for assessing the quality of a product, optimizing a product and/or process, and developing new products. The hedonic scale measures product appeal and consumer preference (Macfie and Thomson, 1994).

Two ready-to-eat corn-based breakfast cereals were developed with different percentages of peach palm fruit powder. The present study investigated the sensory characteristics of the breakfast cereals with whole peach palm fruit (*Bactris gasipaes*, Kunth) powder.

MATERIALS AND METHODS

Processing of breakfast cereals

The development of extruded corn-based breakfast cereals with whole peach palm fruit powder relied on a central composite design with full factorial of 2^2 , resulting in 12 runs that defined the optimized formulation points. The optimization provided optimal

PANELIST N° _____ Date: ____/____/____. Name: _____		
1. You are receiving 03 labeled samples of an extruded breakfast cereal with or without peach palm fruit powder. Please try them and rate your general impression of the product using the scale below:		
(9) like extremely		
(8) like very much		
(7) like moderately	_____ ()	Comments
(6) like slightly		
(5) neither liked nor disliked	_____ ()	
(4) dislike slightly		
(3) dislike moderately	_____ ()	
(2) dislike very much		
(1) dislike extremely		
2. Now using the same scale above, try the samples again and rate their taste.		
_____ ()		Comments
_____ ()		
_____ ()		
3. Again, using the same scale above, try the samples again and rate their crispness.		
_____ ()		Comments
_____ ()		
_____ ()		
4. Using the scale below, tell us what you would do if you saw any of the samples for sale. If I found this product for sale, I:		
5. Definitely would buy		
4. Probably would buy	_____ ()	Comments
3. Might buy	_____ ()	
2. Probably would not buy	_____ ()	
1. Definitely would not buy		

Form 1. Sensory analysis of a corn-based breakfast cereal with peach palm fruit powder using.

PANELIST N° _____ Date: ____/____/____. Name: _____	
Paired preference test	
You are receiving three labeled samples. Please tell us which one you prefer.	
_____	Comments:

Form 2. Sensory analysis of a corn-based breakfast cereal with peach palm fruit powder using a paired preference test.

processing points, which consisted of substituting 25 and 50% (maximum possible) of the cornmeal by peach palm fruit powder. The control cereal did not contain peach palm fruit powder.

The mixture was processed by the double-screw extruder 20DN-GNF 1014/2 (BRABENDER, Germany) with a circular matrix of 2.8 mm and fixed temperature (70-100-130-150°C). Only moisture and peach palm fruit powder content varied.

The breakfast cereals were then sprayed with glucose syrup, dried in an incubator, and packaged in sterile plastic bags.

Sensory analysis

Sensory analysis was performed at the laboratory of the National Institute for Amazon Research (Instituto Nacional de Pesquisa da Amazônia) – INPA. The laboratory has the right conditions for the procedure, such as proper lighting, individual booths, and absence of distractions, such as odours or noises that may influence the panelists' wellbeing and the study results. The researchers instructed the panelists verbally. The sensory analysis stage of the study was approved by the local Research Ethics Committee under protocol number 26884014.9.0000.5020. The study complied with all the regulations established by the National Council of Health/Brazilian Ministry of Health (Brasil, 1997).

The study recruited 70 male and female panelists aged 18 to 60 years. The samples were served in white, disposable bowls labeled with three random digits.

A hedonic scale investigated consumer acceptability of the breakfast cereal, an attitude or a purchase intention scale investigated purchase intention, and a paired preference test investigated consumer preference, as instructed by Instituto Adolfo Lutz (IAL, 2008).

Hedonic scales allow panelists to express their general impression of a product or its attributes. The study used 5-point, 7-point, and 9-point scales.

The panelists used 9-point scales ranging from "like extremely" to "dislike extremely" to report their general impression of a product and how much they liked or disliked its taste and crispness. Five-point scales ranging from "definitely would buy" to "definitely would not buy" investigated purchase intention (Form 1). The data were analyzed by analysis of variance (ANOVA), and the means of each pair of samples were compared by the Tukey test. The graphs were constructed by the software STATISTICA version 5.5 (STATSOFT, USA).

In the paired preference test (Form 2), the panelists received the three samples and chose their favorite.

The attitude or intention scales (Form 3) allow the panelists to express their desire to consume or purchase a product. The

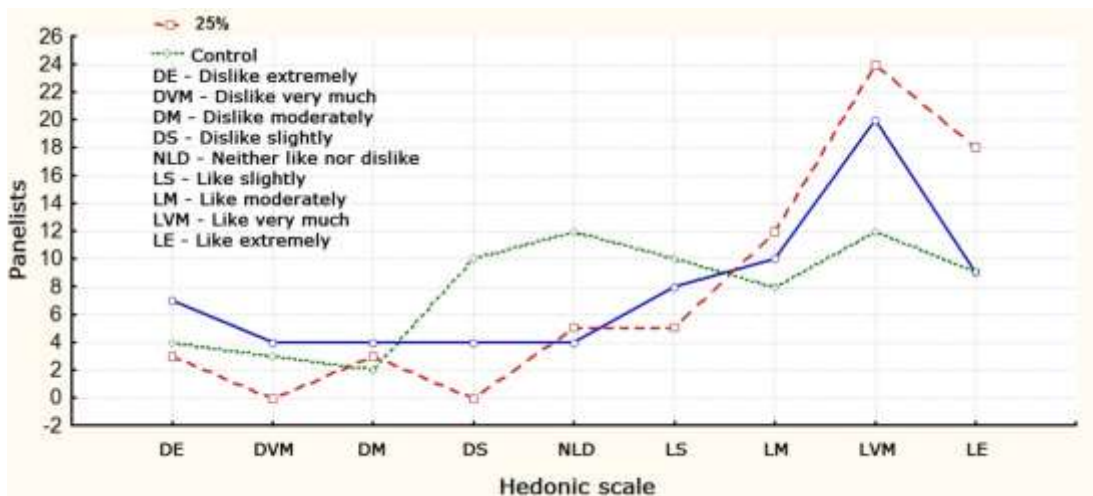
PANELIST N° _____ Date: ___/___/_____. Name: _____

Consumer testing of intention to consume

You are receiving three labeled samples. Please tell us your intention to consume them using the scale below.

(7) Always consume		
(6) Very frequently consume	_____ ()	Comments
(5) Frequently consume		
(4) Sometimes consume	_____ ()	
(3) Rarely consume		
(2) Very rarely consume	_____ ()	
(1) Never consume		

Form 3. Sensory analysis of a corn-based breakfast cereal with peach palm fruit powder using an intention-to-consume scale.



Graph 1. Distribution of product acceptability.

study used a 7-point scale. The options ranged from “definitely would buy” to “definitely would not buy,” with “might buy” in the middle.

RESULTS AND DISCUSSION

The flours processed from peach palm by-products have high level of non-starch polysaccharides, and consequently, they are important as a source of dietary fiber for inclusion in other foods, such as breakfast cereals or bakery products (Bolanho et al., 2015).

Graphs 1 to 3 show how the panelists’ rated their general impression, taste, and crispness of three corn-based breakfast cereals, two with added peach palm fruit powder, using a 9-point hedonic scale.

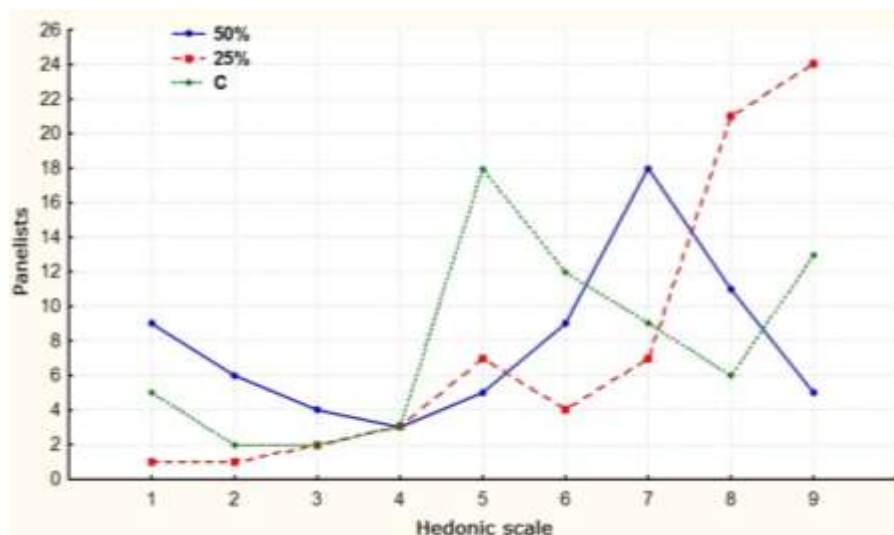
Graph 1 shows that the panelists preferred the sample with 25% peach palm fruit powder, considered the optimal point by the technological analyses. The intervals 8 (like very much) and 9 (like extremely) have the highest

frequencies. The sample with 50% peach palm fruit powder was also well accepted, not differing statistically from the sample with 25% peach palm fruit powder.

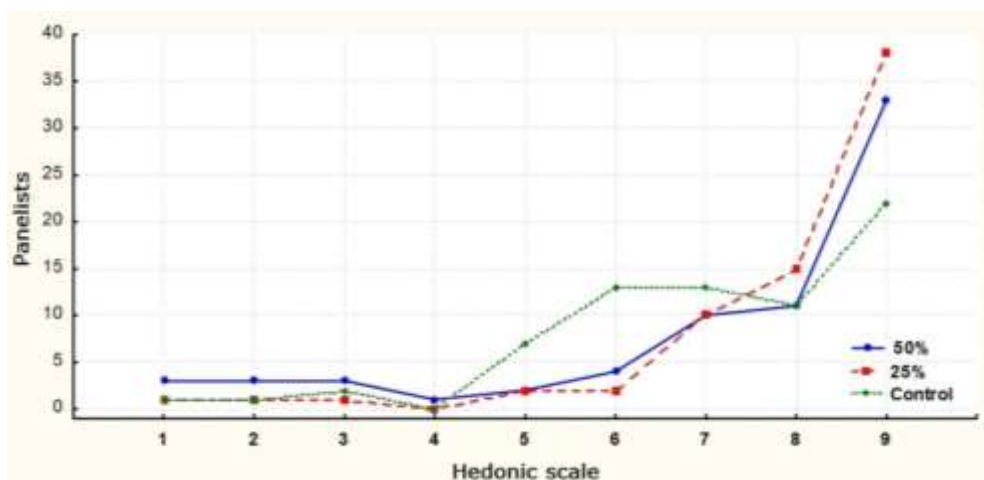
Graph 2 shows that the panelists preferred the taste of the sample with 25% peach palm fruit powder. Again the intervals 8 (like very much) and 9 (like extremely) have the highest frequencies. However, the taste of the sample with 50% peach palm fruit powder was not as appreciated as its general impression, with interval 7 (like moderately) having the highest frequency.

The general impression and taste of the control sample received the lowest scores, with interval 5 (neither like nor dislike) having the highest frequency. According to Food Insight (Food Insight, 2011), taste is the main attribute consumers take into account when purchasing a product.

The crispness of the sample with 25% peach palm fruit powder was also the panelists’ favourite. However, since intervals 1 (dislike extremely) to 5 (neither like nor dislike) of all samples had very low frequencies, the crispness of



Graph 2. Distribution of taste.



Graph 3. Distribution of crispness.

all samples can be considered satisfactory.

According to Hough et al. (2001), when consumers do not like the texture or crispness of a product, they reject the product, regardless of how much they like other attributes. Even great taste cannot save a soggy product. Most baked or extruded products with low moisture content, such as breakfast cereals, snacks, cookies, and wafers, are crispy. If the moisture content of these products increases due to water absorption from the atmosphere or from different nearby products during transportation, their crispness decreases, making them soggy (Roudaut et al., 1998).

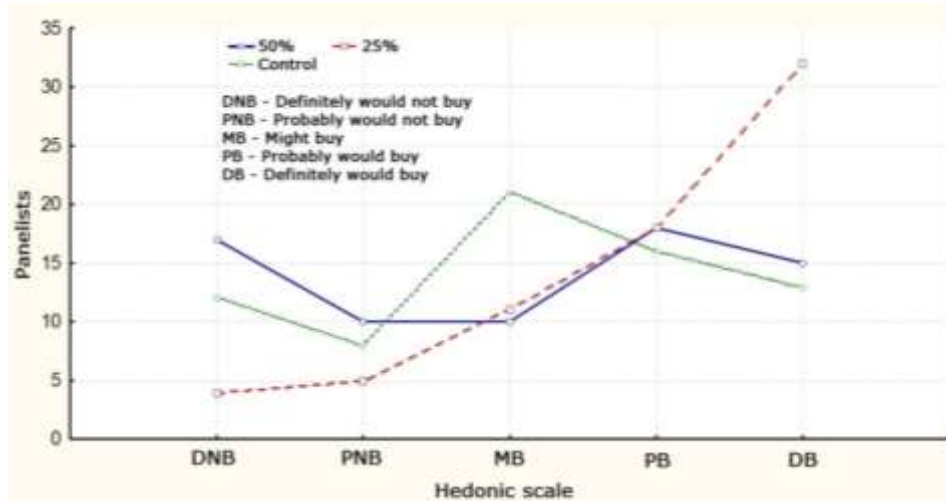
The low acceptability of the control sample is probably due to the higher cornmeal content, which increases expansion. Highly expanded products are more aerated, which decreases their hardness. The sample with 50% whole peach palm fruit powder had the highest fiber

content, making it the hardest sample because fiber increases hardness (Gularte et al., 2012). The sample with 25% whole peach palm fruit powder had intermediate fiber content, thus, intermediate hardness and higher crispness.

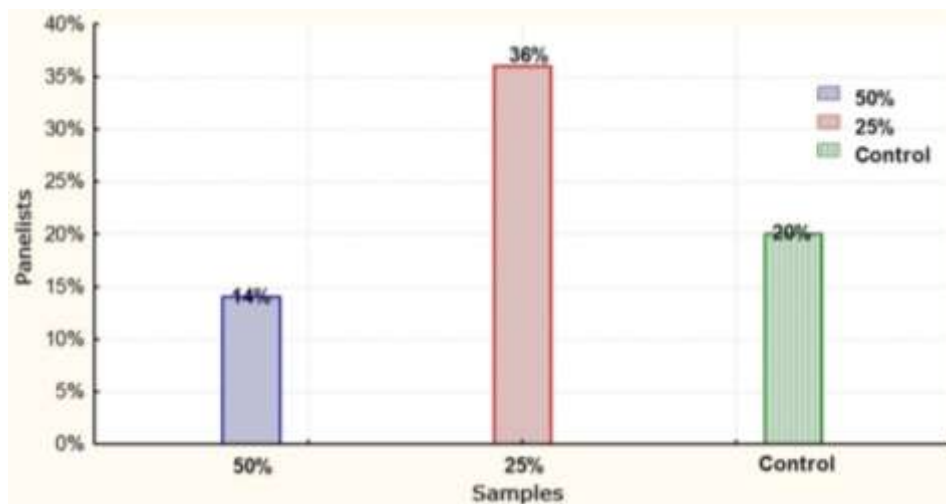
Avoiding the loss of crispness is of great interest to the food industry because crispness is associated with freshness and quality, and consumers reject soggy products (Souza and Menezes, 2006).

Graph 4 shows that the sample with 25% peach palm fruit powder had the highest purchase intention, with interval 5 (definitely would buy) having the highest frequency. This result confirms the other results that indicated the superiority of this sample: best general impression, taste, and crispness.

The control sample had the lowest purchase intention, with interval 3 (might buy) having the highest frequency,



Graph 4. Distribution of purchase intention.



Graph 5. Distribution of consumer preference.

similar to its crispness (neither like nor dislike).

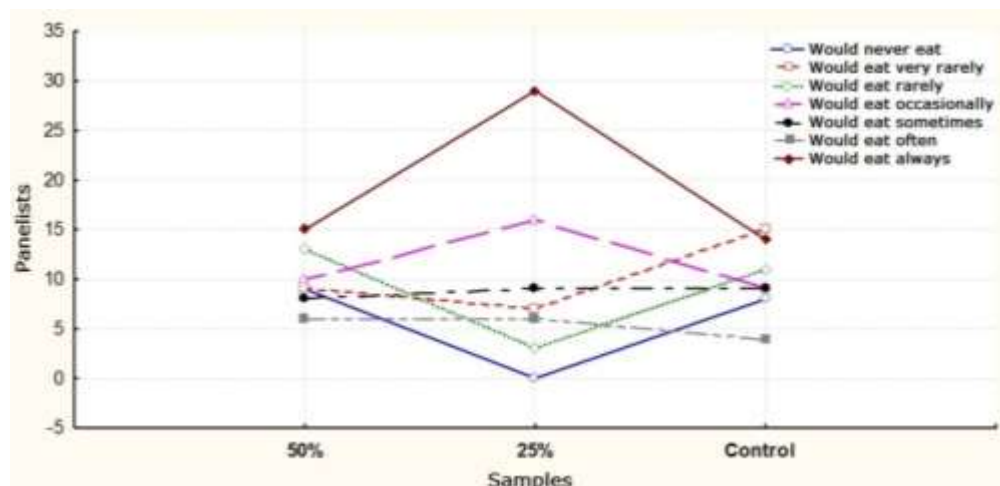
Graph 5 shows consumer preference using the paired preference test. Again the sample with 25% peach palm fruit powder was the favorite, with significantly higher consumer preference. Graph 6 shows that the sample with 25% peach palm fruit powder also had the highest intention to consume since interval 7 (would always eat) obtained the highest frequency.

The control sample had the lowest intention to consume, with interval 2 (would very rarely eat) having the highest frequency. According to Lucia (2008), aroma and taste are very important characteristics that affect the sensory properties of food products with special ingredients. Fiber-rich by-products may be incorporated into food products as inexpensive, non-caloric bulking agents for partial replacement of flour, fat, or sugar, as

enhancers of water and oil retention and to improve emulsion or oxidative stability (Elleuch et al., 2011). Furthermore, the market of functional foods is increasing, and there are few types of flours commercially available that can be added to food products to increase their fiber content at low cost. Thus, the flours produced have a promising market, especially for being very light in color, which facilitate their incorporation into food products.

Conclusion

Sensory analysis using hedonic scales showed that extruded corn-based breakfast cereal with 25% whole peach palm fruit powder had higher acceptability, taste, crispness, purchase intention, consumer preference, and



Graph 6. Distribution of intention to consume.

intention to consume than the corn-based control sample. Partial substitution of by peach palm fruit (*Bactris gasipaes*, Kunth) powder is a good option for the development of new extruded breakfast cereals, since such product has good sensory characteristics and acceptability higher than 50%, indicating its market potential.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests

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