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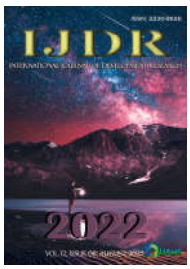

RESEARCH ARTICLE OPEN ACCESS

DEVELOPMENT OF A CEREAL BAR CONTAINING THE PLANT *Pereskiaacuelata* MILLER

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ABSTRACT

The *Pereskiaacuelata* plant has high nutritional value in its leaves, being rich in proteins, vitamins and minerals. The present work had as objetive develop a cereal bar containing the *Pereskiaacuelata* plant. The leaves of *P. aculeata* were dried and crushed in a knife mill and then the powder obtained from the plant was used in the preparation of the cereal bar, along with oat bran, rice flakes, sucrose syrup and honey. To evaluate the quality control of the product, tests were carried out for of humidity, pH, acidity, verification of the protein content and microbiological analysis were carried out. The developed product was subjected to sensory analysis, with a group of 30 untrained tasters, chosen at random. In the moisture test, pH, acidity and microbiological tests, the results were within the established limits. In the test to evaluate the protein content, the value obtained was 13.34%, which was considered satisfactory. As for the sensory analysis, the research showed diverse opinions, ranging from very much liked to very much disliked. In this way, the cereal bar developed presented adequate quality, mainly due to the high protein content, and may be beneficial to health, being a functional food alternative.

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INTRODUCTION

Modernity envolving the lifestyle of the human being can directly affect the well-being of the individual by altering health, which can lead to morbidity or mortality. The global effects, where the industrialization of food can directly affect health, leads to dietary changes, with inadequate diets, in addition to increase in sedentary lifestyle, leading to chronic diseases such as: cardiovascular diseases, hypertension, increase in liver diseases (Souto, 2020). The functional foods, according to Resolution RDC nº. 18 (Brasil, 1999), to be considered functional, they must obtain the claim of functional property, which is the one that exerts metabolic effects, physiological effects or contains beneficial effects on human health. According to this Resolution, it suggests or implies the existence of relationship between the food or ingrediente with a disease or health-related condition. A more comprehensive definition of functional food would be that any natural or human-prepared food, containing one or more substances classified as nutrients or non-nutrientes, capable of acting on human metabolism and physiology, promoting beneficial health effects (cell growth, development and differentiation crescimento, effects on physiological functions) and also delaying pathological processes that the lead to chronic and/or a degenerative diseases (gastrointestinal and cardiovascular system, etc), thus improving the quality and life expectancy of people (Torres, 2009; Henrique *et al*., 2018). The eating habits are defined by physiological and health factors. It is noticed that individuals who incorporate functional foods into their diet generally have healthier lifestyle habits: they practice physical activities, have an adequate weight, have a greater preference for organic and/or natural foods, and are generally people who do not smoke (Goetzke *et al*., 2014; Azambuja *et al*., 2020). Among the components of foods with physiological functions, we can mention polysaccharides, such as dietary fiber, the biological acids of the omega-unsaturated family (eicosapentaenoic acid - EPA and docosahexnoic acid - DHA), polyols, some acids, vitamins, essential minerals, proteins, and peptides. Non-nutrients include oligosaccharides, flavonoids, soy isoflavones, carotenoids, tomato, lycopene, phytosterols, lactic acid bacteria, organosulfur compounds,

phenolic compounds, limonoids, and indole substances (Leoro, 2007, Brasil, 2002). Kraus (2015) confirms that interviews in that study demonstrated greater self-care when they consume functional foods, making conscious choice for disease prevention, generating na increase in quality of life. When the nutritional property is extended to a certain product considered healthy, it usually receives greater acceptance (Annunziata andVecchio, 2013; Lähteenmäki, 2013; Kraus, 2015). Roman *et al*. (2017), investigated the importance of the perception of natural products developed in new food processing technologies. It was found that the tendency of consumers who appreciate functional foods is always to seek options for more natural foods, without preservatives, coloring, or chemical additives, being then, an attribute related to functional food, has an influence on the perception and acceptance of consumers in question. Brazil was the first country in Latin America to have legislation regarding the quality claims for the functional properties of products (Henrique *et al*., 2018). Thus, the cereals bars can be considered as functional foods, as long as have adequate concentrations of substances in their composition for this purpose (Torres, 2009). Such produts were introduced as a healthy alternative, when consumers were more insterested in health and well-being.

Cereal bars are a trend in the food sector because they are associated with healthy foods, they emerged in the food market because they are a practical way to eat, with a nutritional quality that provides protection from diseases that lead to anemia, cancer (Arévalo-Pinedo *et al*., 2013; Silva Filho *et al*, 2022). The main aspects highlighted for a elaboration of this product include the choice of cereal, the selection of appropriate carbohydrate, the enrichment with various nutrients and its stability in processing (Freitas and Moretti, 2006). A plant that has shown promise in phytotherapeutic field is the species *Pereskiaacuelata*, popularly known as ora-pro-nobis, shrub vine, belonging to the Cactaceae family (Moraes *et al*., 2019, Duarte and Hayashi, 2005). The plant is composed of stem, leaf, flower and fruits that can be used in food as it is rich in nutritional compounds (Carnevalli *et al*., 2022). The *Pereskiaacuelata* plant has a high content of essential amino acids, above what is necessary for human consumption recommended by the Food and Agriculture Organization (FAO). The plant is rich in essentials proteins, minerals like iron, which makes it very useful in malnutrition combating in humans, in addiction the compounds found such as betacyanin, flavonols, betain, isobetain, and phyllocactin, Vitamin C, Vitamin A, calcium (Sierakowski *et al*., 1987; Vicente *et al*., 2020; Francelin *et al*., 2021). The *P. acuelata* has great nutritional value, therefore having a great potential in the food and pharmaceutical industry, in addition to presenting bioactive compounds, such as phenolic compounds, which present antioxidant action (Carnevalli *et al*., 2022). Its leaves are popularly used as an emollient and consumed as a food source, with no reports of toxicity (Duarte and Hayashi, 2005). Considering the recommended daily intake of minerals and vitamins for adults, the leaves of ora-pro-nobis meet to need for minerals for calcium, magnesium, zinc and iron, and like that Vitamin C (Silveira *et al*., 2020). Considering the chemical composition of the *P. acuelata*, mainly because it contains a high protein content, iron in addition to antioxidant compounds, the use of this plant in the development of a cereal bar justified, since its beneficial properties can help human health. In this way, in the present work aimed to develop a cereal bar containg the *P. acuelata* plant, as well as the evaluation of the quality of the elaborated product.

MATERIALS AND METHODS

Processing of Pereskia aculeata*:* The leaves of *Pereskia aculeate* were collected in the medicinal plant Garden of the State University of Maringá (UEM), in the city of Maringá-PR, in the morning, on a day without rain. The indentified exsiccate is deposited at the HUEM, with the register LMG 1.12. Then, the plant underwent a process of sorting and drying at room temperature. After drying, the material was ground in a knife mill and store in a plastic bottle and kept at room temperature of 25ºC.

Development of cereal bar: The powered plant was used in the development of cereals bars, which was composed of a misture of dry ingredientes and biding ingredientes, being prepared two formulations (formulation A and formulation B), in the pharmacotechnical laboratory (Unicesumar). Formulation A presented the following raw materials: oat bran (35 g), rice flakes (15 g), sucrose syrup (25 g), and honey (25 g). Formulation B, presented the same raw materials, in addition to *P.acuelata*power (10 g), sucrose syrup (25 g), and honey (25 g). First, the dry ingredientes and the binders were homogenized separately. The binders were concentrated at temperature approximatly 80ºC, and then the dry ingredientes were added.The modeling of the bars was carried out using a typical cereal bar mold, and the cooling was done at 5ºC for 20 minutes. The cereal bars were removed from the mold and placed in aluminum packaging.

Physicochemical analysis of cereal bar: The developed cereal bar was submitted to physical-chemical analysis, being carried out the tests of humidity, pH, acidity and protein content.The cereal bar was previously crushed. All analyzes were performed in triplicate. The moisture content was determined by the gravimetric method, based on the weight loss of the material submitted to heating in an oven at 105ºC until constant weight (Adolfo Lutz Institute, 2008).The pH was analyzed in a pH meter from weighing approximately 2 g of the sample, being diluted in 50 mL of distilled water under agitation. From the samples used for pH, the acidity was determined(Adolfo Lutz Institute, 2008). The protein content of the cereal bar was calculated by determining the percentage of total nitrogen in the sample, according to the Kjeldahl method, considering 6.25 as a conversion factor for the calculation of crude protein. The Kjeldahl method is based on three stages: digestion, distillation and titration of the sample. The amount of nitrogen present in the sample is determined by titrating the excess of the acid used in the distillation with sodium hydroxide (Adolfo Lutz Institute, 2008).

Microbiological analysis of cereal bar: Microbiological analysis was performed by total count of aerobic mesophilic microorganism on the surface, using the culture medium standard Agar for Counting (PCA). First, the sample was enriched with the first dilution, containing 25 g of the sample, placing it in an Erlenmeyer flask and adding 225 mL of petone saline water, the moisture being homogenized, and kept at 37ºC for 24 hours. Afterwards, the others solutions were made at 10^{-2} and 10^{-3} , transferring them to the culture medium, in the form of surface plating, remaining at 35ºC for 48 horas (Silva *et al*., 2017).

Sensory analysis of cereal bar: The affective acceptability test was applied for the sensory analysis of cereal bar, evaluating attributes such as appearance, flavor and texture, with a 9-point hedonic scale, according to the methodology cited by Hautrive *et al*. (2008), whose extremes anchor in the terms “1. I disliked it a lot” and “9. really enjoyed". The product purchase intent test was also applied through a closed question, whose extremes anchor in the terms “1. would certainly not buy” and “5. I would certainly buy it.”Sensory analysis and purchase intent test were performed with the approval of Unicesumar Research Ethics Committee with number 974042. All participants (30 untrained tasters) signed the Free Informed Consent form, following Resolution 196/96 of the CNS/MS.

Statistical analysis: Afterwards, the data were analyzed in order to verify the quality of the cereal bars developed. All of the experiments were performed in triplicate, and mean values were calculated using GraphPad Prism v. 5.0 software (GraphPad, San Diego, CA, USA).

RESULTS AND DISCUSSION

Development of cereal bar: The dry components used in the preparation of cereal bars were oat bran, and rice flakes. According Gutkoski *et al*. (2007) oats received great attention from doctors, nutritionists, consumers and regulatory bodies due to their nutritional characteristics, and mainly due to their content and quality of dietary fibers. On the other hand, rice flakes have fast-digesting carbohydrates, which may be responsible for the higher glycemic

index of cereal bars (Santos, 2010). The biding components used the preparation of cereal bars were sucrose syrup and honey. According to Freitas and Moretti (2006), sucrose syrup is considered an agglutination syrup, and the dry ingredients are mixed with the agglutination syrup, followed by forming and pressing, to obtain the format. Honey has binding properties, as well as being a grain preservative (Silva *et al*., 2006).

Physicochemical analysis of cereal bar: The moisture content test performed in formulation A showed 12%, in formulation B showed 13% moisture, which is accordance with the vale established by the Brazilian Pharmacopeia (Agência Nacional de VigilânciaSanitária, 2010), which is a maximum 14%. This is an important test, because when the moisture content is higher than allowed, degradation of chemical constituents can occur, in addition to allowing the development of fungi and bacteria (Simões *et al*., 2003). The pH test carried out for formulations A and B presented the same result, the pH being 6. As the acidity test, formulation A presented 1,91% and the formulation B presented 4,92%. The pH and acidity results are in accordance established by the Brazilian Pharmacopeia (Agência Nacional de VigilânciaSanitária, 2010), considering the cereal bar anslightly acidic food. In the test performed for acidity, formulation B showed a higher acidity, which may be due to the presence of vitamin C in the chemical composition of *Pereskiaaculeata*. Takeiti *et al*., (2009) report that this plant is a good source of minerals and vitamins such as vitamin C. Formulation A, which did not a *Pereskia aculeata,* had a protein content 8,89%. Formulation B, which contained *Pereskia aculeata*,had a higher content protein, which was 13,34%, considered satisfactory. In a study carried out by Freitas & Moretti (2006), the cereal bar developed had a content protein of 15,3%, obtaining a desirable content, since the products found in the Market present average values of 4,4% of protein, according the authors.

Microbiological analysis of cereal bar: The microbiological test for total count of mesophilic aerobic microorganism performed in formulation A presented 1.4 UFC/g, in formulation B presented 4.0 UFC/g. According Silva *et al*. (2017), the reference value established for cereals is up to 10 UFC\g, therefore formulations A and B are suitable.

Sensory analysis of cereal bar: The sensory analysis showed that highest percentage of judges (30%) evaluated the sample that did not contain the plant, on the hedonic scale with an average value of 9, that is, "I really liked it".The majority of the judges (33.3%) evaluated the sample that contained *Pereskiaaculeata*, with an average value of 7, which characterized it as "I liked it moderately". However, it should be noted the fact that 23.3% of the tasters classified the cereal bar containing the plant as, "I disliked it very much", showing that opinions regarding the cereal bar were discrepant. This fact can be explained by the characteristic flavor of the plant that pleased some judges and by the appearance, which due to the characteristics of the plant led the cereal bars to present a dark green color, which displeased some of the tasters.

CONCLUSION

The cereal bar developed in the present research containing the *P. aculeata* plant showed good stability at room temperature, in addition to adequate quality for the proposed standards, especially regarding the high protein content presented, which suggests helping in muscle mass, in addition to other benefits. In this way, the development of a cereal bar with the *P.aculeata* plant, which contains important nutrients for health, can be a functional food alternative.

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