

# Nutritional composition and sensory analysis of bread rolls added *Pereskia aculeata*

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## Abstract

The plant *Pereskia aculeata*, known popularly as ora-pro-nobis, has high levels of protein, fiber, minerals and vitamins. In order to offer a product with higher nutritional quality and good consumer acceptance, this study aimed to analyze the nutritional value, preference and purchase intent for bread rolls made with mixed flour, composed of wheat and *Pereskia aculeata*. For the production of *Pereskia aculeata* flour, the plant was dried and ground, its chemical composition was assessed and bread rolls were subsequently prepared. Rolls were produced with two concentrations of *P. aculeata* flour, 5 and 10%. The two samples of rolls underwent sensory analysis by untrained judges that used the simple paired comparison test and the attitude scale. Rolls with the lowest addition of *Pereskia aculeata* (5%) had 72% preference among the judges. For purchase intent, most panelists said that they “would buy” bread with 5% “if affordable”, and “would buy” bread with 10%, both with a score higher than 4, which can be considered a product well suited for commercialization. As for nutritional value, the greater the amount of *Pereskia aculeata*, the lower the amount of carbohydrate and calories, and the greater the amount of proteins, lipids and fiber. It follows that the *Pereskia aculeata* flour may be added to bread rolls, thus making them a product with improved nutritional value and good acceptability.

**Key words:** Bread. Nutritional Value. Food Composition.

## Introduction

*Pereskia aculeata* Miller is a plant that belongs to the family *Cactaceae*; it is found in various parts of the world. In Brazil, it is known as ora-pro-nobis and is distributed between the states of Rio Grande do Sul and Bahia.<sup>1</sup> It is a perennial plant with climbing features, but it can grow in the absence of screening, with lanceolate succulent leaves. The flowers are small and white, and the fruits are small yellow berries. In the stem, there are spines (false thorns), which grow in clusters in older branches.<sup>2</sup>

Ora-pro-nobis has juicy and edible leaves, and it can be used on various food preparations such as flours, salads, stews, bread, pastries and pasta.<sup>3</sup> Besides food, the plant can be used for ornamentation and grown by beekeepers for honey production purposes, as its flowers are pollen- and nectar-rich.<sup>2</sup>

Studies have shown that ora-pro-nobis has high protein content, ranging between 22.93 and 28.4 g 100g<sup>-1</sup>.<sup>1,2,4</sup> The assessment of amino acid content showed that this plant has tryptophan as the most abundant amino acid, and lysine and methionine as limiting amino acids. It also has high levels of total dietary fiber (39.1 g 100g<sup>-1</sup>), antioxidants, minerals, especially iron, calcium, magnesium, manganese and zinc, and vitamins A, C and folic acid.<sup>1</sup>

It is known that fiber intake is associated with the prevention of certain diseases such as heart and intestinal diseases, and cancer.<sup>5</sup> Conversely, there is prevalence of inadequate food intake (percentage of people who ingest a nutrient at levels below the daily needs or above the recommended limit), excess intake of saturated fat and sugar (82 g 100g<sup>-1</sup> and 61 g 100g<sup>-1</sup>, respectively) and lack of fibers (68 g 100g<sup>-1</sup> of population).<sup>6</sup>

Bread rolls are one of the major calorie sources of the Brazilian diet, because it is a food product widely accepted by all age groups and quite affordable to the population.<sup>7</sup> Bread is popular because of its taste, price and availability in thousands of bakeries and supermarkets, and the baking and confectionery industry is one of the largest economic segments in Brazil. Sales rose by **13.7% in 2010** and revenue was **R\$ 56.3 billion** in the same period, according to the Brazilian Bakery and Confectionery Association.<sup>8</sup>

Wheat flour is the key ingredient in the baking industry, given its technological properties for breadmaking, but its proteins are considered to have low nutritional quality, due to the low amount of essential amino acids and fiber.<sup>9,10</sup> Thus, the use of mixed flours is aimed at partial substitution of wheat flour in order to improve the nutritional quality of food products and to meet the need of consumers for diversified products.<sup>11</sup>

Bread quality is determined by factors that can be assessed by physical-chemical, microbiological and sensory analyses.<sup>5</sup> There are effective analytical/instrumental methods to detect the emergence of problems during processing and storage of food, but often they are unable to measure perceived changes that affect the acceptance of the product. Therefore, sensory tests should be included as food quality assurance, because they are an integrated multi-dimensional type of measurement and offer significant advantages; for example, they determine product acceptance by consumers because organs of the human senses are used as measurement “instruments”.<sup>12</sup>

In order to provide a product with higher nutritional quality, good consumer acceptance and affordable cost to the majority of the population, this study aimed to evaluate the nutritional value, preference and purchase intent for bread rolls made with mixed flour, composed of wheat and *Pereskia aculeata* at concentrations of 5 and 10%.

## Material and Methods

### Collection, preparation of raw materials and making of the *Pereskia aculeata* flour

The plant *Pereskia aculeata* Miller was obtained through a partnership signed with the Brazilian Agricultural Research Corporation (Embrapa Clima Temperado). After collecting 1.628 kg of leaves, plants were taken to the Nutritional Science Laboratory, Nutrition School, Federal University of Pelotas, where they were washed in running water and subsequently dried in a forced air circulating oven (Nova Ética, model 402/Dno) for a period of 72 hours at 30 ° C. Thereafter, the leaves were milled (FRITSCH pulverisette 14 mill) through a 0.5 mesh,<sup>13</sup> and the flour was stored in sealed glass vials at room temperature until use.

### Nutritional value of dried Ora-pro-nobis flour and bread dough

The chemical composition of *Pereskia aculeata* flour was determined by the difference method for crude protein, moisture, ether extract, fiber, ash and carbohydrates, according to methods outlined by the *Association of Official Analytical Chemists*.<sup>14</sup> To calculate energy value, Atwater coefficients were used, with conversion factors of 4 Kcal g<sup>-1</sup> for proteins and carbohydrates and 9 Kcal g<sup>-1</sup> for lipids.<sup>15</sup>

The nutritional value of bread rolls was calculated based on the chemical composition of the ora-pro-nobis flour determined at the laboratory, together with the nutrient values of other ingredients that have been compiled by the Brazilian Table of Food Composition.<sup>16</sup>

## Preparation of the rolls with flour mixed with wheat and *Pereskia aculeata*

A Britania bread maker (Multi Pane Panificadora) was used to prepare the rolls. The *Pereskia aculeata* flour was used at two concentrations, 5 and 10%, as described in Table 1. The method of preparation was selected as indicated in the user's guide of the breadmaker for traditional breadrolls, and followed the rules of hygiene set by the Resolution RDC n° 216, of the National Health Surveillance Agency.<sup>13</sup> Total fermentation time was 1 hour and 30 minutes, and kneading time, 25 minutes. The rolls were produced to weigh about 900 g, and were stored in plastic containers until the time of analysis.

**Table 1.** Formulations used to prepare bread with flour mixed with wheat and *Pereskia aculeata*. Pelotas-RS, 2012.

Ingredients*	Samples	
	5 %	10 %
Wheat flour	67.5	63.9
<i>Pereskia aculeata</i> flour	3.6	7.1
Water	31.1	31.1
Powdered milk	6.7	6.7
Biological Yeast	1.1	1.1
Salt	0.8	0.8
Margerine	2.5	2.5
Sugar	3.3	3.3

\*Percentage of ingredients compared with total weight of bread ingredients.

## Sensory study of bread rolls made with mixed flour (wheat and *Pereskia aculeata*)

The two samples of rolls (at concentrations of 5 and 10% *Pereskia aculeata* flour) underwent sensory analysis by means of the simple paired comparison test, also known as "preference test", and the attitude scale, known as "purchase intent" test.<sup>17</sup> The study was conducted with 53 judges, including students, staff and faculty of the Federal University of Pelotas, Pelotas, both males and females, aged between 18 and 50 years. The inclusion criterion was to eat bread on a regular basis. The samples were served in individual booths at the Sensory Analysis Laboratory, Chemical, Pharmaceutical and Food Sciences Center, Federal University of Pelotas.

The judges received about 15 g of each bread sample at room temperature and an answer sheet with sociodemographic questions, questions about bread consumption, the simple paired comparison test and the attitude scale. The bread rolls were served in a disposable dish coded with three-digit random numbers. The judges were asked to taste the two food products and identify which one they preferred. Then, they were expected to indicate their intention to purchase the preferred product if it were available in the market, through a 7-point purchase intent scale (Figure 1).

<b>PREFERENCE TEST AND ATTITUDE SCALE</b>	
Name: _____	
Sex: <input type="checkbox"/> Female <input type="checkbox"/> Male	Date: _____
Age range: <input type="checkbox"/> up to 18 years of age	<input type="checkbox"/> between 18 and 25 years of age
<input type="checkbox"/> between 25 and 50 years of age	<input type="checkbox"/> above 50 years of age
Schooling: <input type="checkbox"/> Elementary School <input type="checkbox"/> High School <input type="checkbox"/> Undergraduate Degree	
<input type="checkbox"/> Undergraduate Degree - unfinished <input type="checkbox"/> Graduate Degree	
Please answer:	
Type of bread eaten most often: _____ Favorite type of bread: _____	
1- Which statement best describes how much you like or dislike bread? <input type="checkbox"/> Like it extremely <input type="checkbox"/> Like it very much <input type="checkbox"/> Like it moderately <input type="checkbox"/> Like it slightly <input type="checkbox"/> Dislike it	2- Which statement best describes how often you eat bread? <input type="checkbox"/> Eat it very much (3 times a week or more) <input type="checkbox"/> Eat it moderately (once a week) <input type="checkbox"/> Do not eat it much (less than three times a month) <input type="checkbox"/> Hardly ever eat it (less than once a month) <input type="checkbox"/> Never eat it
We are conducting a survey on the preference for this product. Please taste the samples and indicate your preference.	
I prefer sample _____	
The product you tasted and indicated as <u>preferred</u> were available on the market, mark on the scale below the level of certainty of whether or not you would buy the product	
7- I would buy it very often	
6- I would buy it often	
5- I would buy it	
4- I would buy it if affordable	
3- I would not buy it	

**Figure 1.** Answer sheet used in the preference and purchase intent tests.

## Ethical considerations

This study was submitted to the Ethics Committee of the School of Medicine, Federal University of Pelotas and approved (Official Letter 01/12) for ethical and methodological issues in accordance with Resolution 196/96 of the National Health Council.<sup>18</sup>

## Statistical analysis

The mean, frequency and standard deviation of the results were calculated. The analyses were performed with the statistical package STATA 9.1<sup>®</sup>,<sup>19</sup> using the t-test to compare means, ANOVA for analysis of variance and the chi-square test for association between categorical variables, considering differences as significant at  $p \leq 0.05$

## Results and Discussion

### Proximate composition of *Pereskia aculeata* flour and bread rolls with different concentrations of the flour

Table 2 shows the results for moisture, ash, lipids, proteins, carbohydrates and fiber content in the *Pereskia aculeata* flour.

**Table 2.** Proximate composition of *Pereskia aculeata* flour. Pelotas-RS, 2012.

Component	Mean $\pm$ standard deviation
Humidity (g 100 g <sup>-1</sup> )	7.67 $\pm$ 0.06
Proteins (g 100 g <sup>-1</sup> )	17.00 $\pm$ 0.19
Lipids (g 100 g <sup>-1</sup> )	2.44 $\pm$ 0.16
Dietary fiber (g 100 g <sup>-1</sup> )	8.66 $\pm$ 0.31
Ashes (g 100 g <sup>-1</sup> )	18.78 $\pm$ 1.70
Carbohydrates (g 100 g <sup>-1</sup> )	45.45 $\pm$ 0.18
Energy value (Kcal 100g <sup>-1</sup> )	271.76 $\pm$ 2.92

The results of the chemical analysis of *Pereskia aculeata* flour showed protein content of 17.0 g 100g<sup>-1</sup>, unlike other studies, such as those by Takeiti et al.,<sup>1</sup> who found 28.4 g 100g<sup>-1</sup>, and Rocha et al.,<sup>3</sup> who found 22.9 g 100g<sup>-1</sup> protein. This may have been caused by climatic variations, planting, fertilization and soil liming, among other reasons.<sup>20</sup> Fiber content of *Pereskia aculeata* flour was 8.7 g 100g<sup>-1</sup>, below the values found in the literature, i.e., 9.8 and 12.6 g 100g<sup>-1</sup>, respectively, by Takeiti et al.<sup>1</sup> and Rocha et al.<sup>3</sup>

Table 3 shows the nutritional composition of the bread rolls with and without the addition of *Pereskia aculeata*. When 5 and 10% concentrations of *Pereskia aculeata* flour were added to bread, fiber content increased by 13% and 27%, respectively, compared to bread without addition of the plant. It is known that low fiber intake by the population is associated with the occurrence of constipation and weight gain.<sup>21</sup> According to the Ministry of Health, the reference daily intake (RDA) of fiber is 25g/day; therefore, the daily consumption of 100g of bread containing 5 and 10% of *Pereskia aculeata* corresponds to approximately 7.4 and 8.3% of the RDA, respectively.<sup>22</sup>

The study by Esteller<sup>23</sup> states that dietary fiber is widely used in the baking industry, in the formulation of low-calorie foods. However, Thebaudin et al.<sup>24</sup> have warned that high-fiber ingredients can only be used in food products with good sensory properties.

**Table 3.** Proximate composition of bread rolls with and without the addition of *Pereskia aculeata* flour\*. Pelotas-RS, 2012.

	0%	5%	10%
Total Energy Value (kcal 100g <sup>-1</sup> )	316.88	313.70	310.25
Protein (g 100 g <sup>-1</sup> )	8.67	8.93	9.17
Carbohydrates (g 100 g <sup>-1</sup> )	59.31	58.24	57.13
Lipids (g 100 g <sup>-1</sup> )	4.48	4.52	4.56
Dietary fiber(g 100 g <sup>-1</sup> )	1.64	1.86	2.08

\*Calculation according to the TACO table (2011).

The greater the amount of *Pereskia aculeata* flour added to the bread rolls, the lesser the amount of carbohydrate and calories, and the greater the amount of lipids and proteins. The amount of protein in the rolls with addition of 5 and 10% concentrations were respectively 3 and 6%, as the plant in the form of flour has about 75% more protein than wheat flour.<sup>16</sup>

Ora-pro-nobis was used in the preparation of some foods, such as pasta and bread, to increase nutritional value through a food product of plant origin.<sup>3,25</sup> Rocha et al.,<sup>3</sup> in their study with noodles prepared with 2% ora-pro-nobis, found higher levels of protein and fibers, as occurred in the present study.

## Profile of judges and sensory analysis

Fifty-three untrained judges, with 79% of females, participated in the test. Because the sensory analysis was conducted at a university, most respondents were aged between 18 and 25 years (63%), and 71 % of them had not completed their degree yet.

As for type of bread consumed most often, 53% of respondents reported eating bread rolls; 24%, wholewheat bread, and 16%, loaves. Rolls are Brazilians' favorite type of bread,<sup>8</sup> but because the population in this study is young, it should be noted that wholewheat bread is the second most consumed type. This is indicative of the increased consumption of high-fiber foods by people with higher levels of schooling. The same has occurred when the judges reported that they prefer bread rolls (44%), followed by wholewheat bread (22%); therefore, consumption of bread is apparently not tied only to the dissemination of its benefits, but also to sensory matters. There were significant differences between preference for bread type and sex of judges ( $p < 0.05$ ); women are the greatest consumers of rolls and wholewheat bread.

Most consumers reported that they "like it extremely" (49%), followed by "like it moderately" (25%) and "like it very much" (23%), while the frequency of consumption was 87% for "eat it very often - 3 times a week or more", and nobody answered "do not eat it much", "hardly ever eat it" and "never eat it".

Whereas consumers reported that they like bread and eat it frequently, and a portion of the population prefers and eats wholewheat bread, it can be seen that consumers can properly assess bread types with different sensory aspects, whose color is similar to that of wholewheat bread (Figure 2).



**Figure 2.** Pictures of mixed flour bread slices at the two different concentrations of 5 (a) and 10% (b)

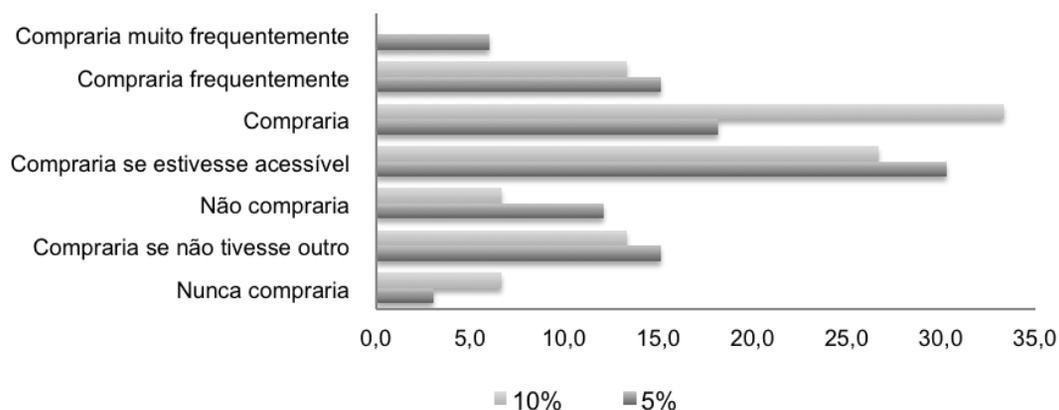
The results of sensory analysis showed that the different concentrations of *Pereskia aculeata* flour were significantly different between the samples ( $p < 0.05$ ), and the sample with the lower concentration of *Pereskia aculeata* was the most widely accepted (72% of judges). The reason for their preference could be the texture and taste provided by the fiber to the piece of bread with greater amount of *P. aculeata*.

However, this was not found in studies using other ingredients as a source of fiber such as flaxseed meal and amaranth flour. In a study conducted with the addition of flaxseed meal to bread, the proportion of 10% was found to be technically feasible, since the product ended up with good flavor and overall acceptability by consumers.<sup>5</sup> In another study, in which higher amount of amaranth was used, 26% in the formulations of bread and 30% in cookies, there were good acceptability and marketing scores among the judges, even though amaranth as a source of fiber and bread and cookies had amounts above 3-4g fiber 100g-1.<sup>26</sup>

However, Giuntini et al.<sup>27</sup> pointed out that high-fiber food products are not always well accepted by consumers due to changes to texture and flavor. Thus, another factor that may have occurred is the breakdown of the gluten protein network, causing weakness and loss of elasticity of the flour, due to the addition of *Pereskia aculeata*, as the gluten proteins are affected by fibers which facilitate the breakdown of the gluten network matrix.<sup>28</sup>

Furthermore, the bread in the present study had higher concentrations of *Pereskia aculeata* and showed slightly greenish color, which might have interfered in its acceptability. The same color was found in the dough of noodles prepared with *P. aculeata* at different concentrations, because of pigments present in the plant and involved in photosynthesis.<sup>3</sup>

When asked about the purchase intent for bread with added *Pereskia aculeata*, 30.3% said they would buy it if available, followed by 18.2% who said they would buy bread with 5% addition of the plant. By contrast, 33.3% of the participants responded that they would buy bread with 10% added, followed by 26.2% who would buy it if available (Figure 3). Moreover, the means for acceptance of the bread were similar, 4.1 and 4.2% for bread with 5 and 10%, respectively. These means have exceeded the score of 4 on the 7-point hedonic scale of purchase intent; thus, the product can be considered as well-accepted for sale in the market.



**Figure 3.** Purchase intent of the judges for bread with 5 and 10% addition of *Pereskia aculeata* flour.

In studies where food products were prepared from alternative or unconventional food, there were differences in acceptability among consumers. In the study of Martinevski et al.,<sup>25</sup> bread with Malabar spinach showed an overall acceptability score of 6.17 while bread with ora-pro-nobis had score 7. In the study by Ziglio et al.,<sup>29</sup> in which bread was prepared in the proportions 0-15% corn cob flour, bread with 5% achieved the highest acceptance, with an average score equal to 7, similar to the result in the present study .

Another study that showed better scores for preparations with smaller amounts of alternative ingredients was the one by Souza et al.,<sup>30</sup> in salty pastries made with vegetable stems and husks with proportions below and above 50% of these ingredients. And in the study by Rocha et al.,<sup>3</sup> carried out with addition of dehydrated *Pereskia aculeata* in noodles, there was 92% acceptability of pasta with the addition of 2.0% of the plant. This shows that small concentrations added in food preparations are better accepted by consumers.

The reasons why consumers give better scores to products developed with lower levels of alternative foods or foods fortified with husks and stems may be due to the presence of fiber, which increases food texture and requires more chewing when consumed, as well as gives different or darker colors to traditional food, such as bread in the present study, which was greenish.<sup>3,31,32</sup> However, foods with lower proportion of alternative foods do not always meet nutritional requirements, especially for fiber,<sup>3,29</sup> and it was necessary to carry out further work to increase the amount of these ingredients without interfering in consumer acceptance, in order to provide nutritional and sensory quality.<sup>33</sup>

There was a significant difference between preference for bread types and purchase intent for bread with *Pereskia aculeata* ( $p < 0.05$ ), which shows that consumers of wholewheat bread have greater intention to purchase bread with *Pereskia aculeata*. This finding shows that the habit of consuming foods with higher fiber content can help in better acceptance of alternative or enriched products.

## Conclusion

Bread made with mixed flour, consisting of wheat and 10% *Pereskia aculeata* flour, had better nutritional value because of the increase in fiber and protein content. However, bread with 5% of added *P. aculeata* had greater preference, although the means for purchase intention were similar in the two bread types and indicative of products with good marketing potential.

Further research is needed in order to develop other products containing added *Pereskia aculeata* with significant increase in nutritional value, and better technological quality and consumer acceptance.

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