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Sensory acceptance of carrot bread

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Abstract

Bread is a product obtained by cooking, under technologically appropriate conditions, a dough, fermented or not, prepared with wheat flour and other ingredients. Carrot (*Daucus carota*) is a plant of the *Umbelliferae* family, characterized as one of the most important olive crops, due to its great consumption worldwide. The present work aimed to produce and evaluate the sensory acceptance of bread made from carrots. Sensory analysis was performed using affective methods. For this purpose, 4 formulations were prepared and consisted of (A) 30% raw carrots and 70% wheat flour, (B) 30% carrot puree and 70% wheat flour, (C) 40% raw carrots and 60% wheat flour and (D) 40% carrot puree and 60% wheat flour. The acceptability index was evaluated in terms of appearance, color, texture, odor, flavor, aftertaste and aroma on a 9-point hedonic scale at the extremes "very much disliked and extremely liked", for 50 untrained tasters. The results showed that formulation C with 40% raw carrot puree and 40% wheat flour, 10% yeast, 3% salt and 7% water, showed greater acceptability. In view of this, it is concluded that formulations B and C were accepted and are recommended to be used as a partial replacement of wheat flour.

Keywords: Bread; Carrots (*Daucus carota*); Food formulations; Sensory analysis

1 Introduction

Carrot (*Daucus carota*) is considered a functional food, because in addition to composing the list of vegetables rich in nutrients in the basic diet, its consumption benefits one or more functions of the organism and, in this way, contributes to the state of health and well-being. Being, and can mitigate the risks of diseases, when consumed in regular amounts and intensity [19].

The inclusion of vegetables in the diet brings many benefits, it is known that this category of food is rich in vitamins, fibers and minerals, and 25% of these nutrients bring a series of benefits, among which, the improvement in the digestive process, prevention of cardiovascular diseases, and the fight against neoplasms, citing as an example the carrot, which has antioxidant activity, and provitamin A [23].

Carrot is, Gonçalves [13], a plant of great importance in food, participating in the supply of calories, vitamins and minerals in the diet, being a widely spread food due to its ease of cultivation, rusticity and wide adaptation. In financial terms, according to FAO [8], it is one of the main vegetables grown in the world and has great economic importance. Production in 2015 was approximately 37.1 million tons, with China being the largest producer of carrots in the world, followed by Uzbekistan.

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The production of carrot-based bread is an important alternative for the valorization of the culture, as it is a low-cost process and, as a differentiated product, it will be able to meet a growing market of natural products and for special purposes [1]. According to Francisco *et al.* [11], wheat is the only cereal from which flours with full capacity to form cohesive, consistent, elastic and extensible doughs can be extracted. The wheat grain basically consists of pericarp (7.8 to 8.6%), endosperm (87 to 89%) and germ (2.8 to 3.5%).

According to Normative Instruction 8/2005, established by brazilian Ministry of Agriculture, Livestock and Food Supply (MAPA), wheat flours are made from wheat grains of the genus *Triticum aestivum* L. or other species of the genus *Triticum*. They are classified into types 1, 2 and 3 when according to the values established by the legislation for the tolerance limits of wheat flour, in relation to ash content, moisture, granulometry, proteins and fatty acidity [2].

Bread is defined as the product obtained by cooking, under technologically appropriate conditions, a dough, fermented or not, prepared with wheat flour and or other flours that naturally contain gluten-forming proteins or added to them and water, which may contain other Ingredients. Bread can be classified according to ingredients and/or manufacturing process and/or format [3].

The present study aimed to produce and evaluate the sensory acceptance of carrot-based bread. Seeking to minimize post-harvest losses that are found throughout its production chain, from planting to conservation, due to lack of use of appropriate technologies. As a contribution, the production of carrot-based bread was carried out as an alternative for diversifying food and mitigating the waste of these products, and to evaluate the organoleptic characteristics with the preference of the target audience.

2 Material and methods

2.1 Study area

The study was carried out in the laboratory of the Higher Polytechnic Institute of Gaza, located in the district of Chókwè in the south of the province of Gaza, in the middle course of the Limpopo River, with the Limpopo River as its northern limit, which separates it from the districts of Massingir, Mabalane and Guijá, to the south the district of Bilene and the Mazimuchope river by the district of Bilene, Chibuto and Xai-Xai, to the east it borders the districts of Bilene and Chibuto and to the west the districts of Magude and Massingir [16].

2.2 Acquisition of material

The samples of carrots of the Nantes-strong-top variety were acquired with previous selection (orange color, firm consistency and without cracks), from local producers in the district of Chókwè, and wheat brand *Fazpão*, salt from the filling brand, yeast from the Anchor brand - instant yeast and packed in polyethylene bags, they were taken to the agro-processing and hygiene and food quality laboratory of the Higher Polytechnic Institute of Gaza, for bread production and evaluation of the acceptability index.

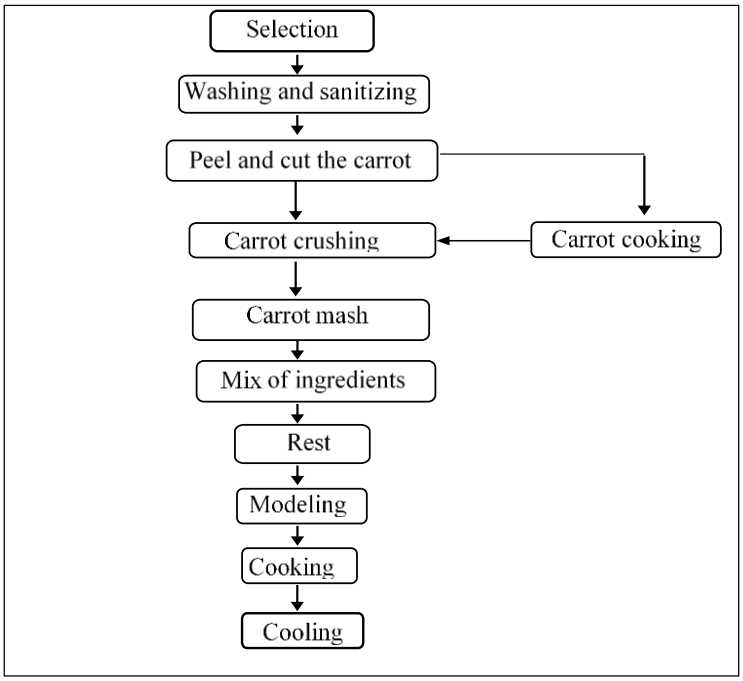
2.3 Bread production

Table 1 Bread formulations made from carrots

Ingredients (%)	**Formulations**			
	A	**B**	**C**	**D**
Flour	50	50	40	40
Carrot puree	0	30	0	40
Raw carrot	30	0	40	0
Salt	3	3	3	3
Water	7	7	7	7
Yeast (*Saccharnomyces cerevisae*)	10	10	10	10

Subtitle: A - 30% raw carrot puree and 50% wheat flour, 10% yeast, 3% salt and 7% water, **B** - 30% boiled carrot puree and 50% wheat flour, 10% yeast,3 % salt and 7% water, **C-** 40% raw carrot puree and 40% wheat flour, 10% yeast, 3% salt and 7% water, and **D**- 40% boiled carrot puree and 40 % raw carrot puree and 40% wheat flour, 10% yeast, 3% salt and 7% water. **Source**: Authors.

The production of bread (figure 1) consisted of crushing 3kg of carrots with the aid of a vegetable crusher (Hobart model VCB/HCB-61) to obtain a puree, 100g of carrots were cooked with the addition of 150ml of distilled water at 100°C for 30 minutes after which they were cooled and homogenized. For this purpose, 4 carrot-based bread formulations were prepared according to table 1.



Source: Author

Figure 1 Carrot-based bread production flowchart

2.3.1 Selection

Carrots were selected based on their organoleptic characteristics in terms of hardness, color, odor and size, free from physical damage, rot and/or injuries, to avoid obtaining an unpleasant-tasting puree and consequent bad end product. Quality.

2.3.2 Washing and sanitizing

Washing and sanitizing consisted of 3 steps, being (i) first wash, (ii) sanitization and (iii) second wash. The carrots were subjected to the first wash with running water to remove dirt. Then, sanitization was carried out by submerging the carrots in a solution of chlorinated water, in the proportion of 5L of water to 100mL of sodium hypochlorite for 15 minutes, after which they were rinsed in running water.

2.3.3 Peel and cut

The carrot peel was manually removed with the aid of a stainless steel knife and any defects that reached the pulp or the injury suffered were eliminated. The cut was made into cubes of approximately 5 cm.

2.3.4 Carrot mash

The carrots were mechanically mashed using a vegetable crusher (Hobart model VCB/HCB-61) until obtaining a very uniform consistency and mass.

2.3.5 Weighing the ingredients and mixing

Weighing was performed using a scale (ADAM) accurate to 0.001g. Mixing was carried out using a Hobart mixer for 30 minutes. The process took place in two phases: (i) mixing wheat flour, salt and carrot puree, brand yeast (ANCHOR-instant yeast) and (ii) adding water, homogenizing for another 25 minutes using a mixer, brand Hobart. The ingredients were placed in stainless steel bowls.

2.3.6 Rest

The dough was placed in a completely closed polystyrene container and left to ferment for 20 minutes at room temperature. The objective of this stage was to allow the dough to grow and also to complement the development of gluten, which took place through the action of the yeast that transforms the sugar into carbon dioxide and alcohol.

2.3.7 Modeling

This operation was performed manually by dividing the dough into portions of approximately 100g and modulated in a circular shape, which helped to improve the texture and structure of the bread cell, as well as the shape of the desired bread.

2.3.8 Supply

It consisted of placing the modulated mass on a metal tray in an electric oven (Samsung) at a temperature of 200ºC for 45 minutes. This stage aimed to inactivate enzymes and yeast, allowing the formation of the crust, and the development of aroma and flavor.

2.4 Sensory analysis

50 untrained tasters were selected at the Higher Polytechnic Institute of Gaza of both sexes, aged between 18 and 34 years, using the 9-point hedonic scale at the extremes "I disliked it very much and I liked it very much". 5g portions of each formulation were served to evaluate the attributes: appearance, color, texture, odor, flavor, residual flavor and aroma. The product was considered accepted in terms of sensory characteristics when its AI was, according to Teixeira [27], equal to or greater than 70%. The calculation of the acceptability index (AI) was performed from equation 1.

$$IA(\%) = \frac{A*100}{B} \quad \text{.....(1)}$$

Where:

- It represented the average score obtained for the product;
- Maximum rating given to the product.

2.5 Statistical analysis

The analysis of variance was performed according to the procedures of the Minitab program version 2018, using the General Linear Model (GLM), considering a significance level of 5%, and the means of the results were compared using the Tukey test.

3 Results and discussion

Table 2 shows the results of the evaluation of sensory acceptance of bread made from carrots.

Table 2 Results of sensory analysis of carrot bread

	Attributes							
Formulations	**Appearance**	**Color**	**Texture**	**Odor**	**Flavor**	**aftertaste**	**Aroma**	**Overall rating**
A	6.10±1.93[a]	6.02±2.21[a]	5.97±1.87[a]	6.06±1.93[a]	6.62±1.67[a]	6.22±1.72[a]	6.47±1.81[a]	7.08±1.50[a]
B	6.39±2.01[a]	6.79±1.89[a]	6.12±1.79[a]	6.48±1.34[a]	6.68±1.71[a]	6.39±1.74[a]	7.10±1.49[a]	7.06±1.38[a]
C	6.22±2.10[a]	6.56±1.84[a]	6.52±1.63[a]	6.56±1.77[a]	6.77±1.90[a]	6.56±1.93[a]	6.79±1.73[a]	6.86±1.94[a]
D	6.54±2.03[a]	6.64±1.92[a]	6.39±1.86[a]	6.45±1.97[a]	6.56±1.83[a]	6.06±1.92[a]	6.58±2.11[a]	6.68±1.95[a]

Means ± standard deviation followed by the same letter in the same column do not have significant differences between them. Caption: A - 30% raw carrot puree and 50% wheat flour, 10% yeast, 3% salt and 7% water, B - 30% boiled carrot puree and 50% wheat flour, 10% yeast .3% salt and 7% water, C- 40% raw carrot puree and 40% wheat flour, 10% yeast, 3% salt and 7% water, and D- 40% cooked carrot puree and 40% raw carrot puree and 40% wheat flour, 10% yeast, 3% salt and 7% water.Source: Authors

3.1 Sensory analysis

Although formulations (C) and (D), made with 40% carrot puree, showed an intense orange color, probably due to the high content of beta-carotene and accepted by the panelists, they did not show significant differences when compared to breads of formulations A and B. made with 30% carrot puree at 5% significance.

Evaluating breads made with partial replacement of wheat flour by carrot pulp and changes in the crumb, Mello [18] also found an intense orange color due to the high content of beta-carotene and 74.9% were well accepted by the consumer.

The flavor aspect showed significant differences between the formulations, which is probably related to the concentration of carrots and also to the treatments that both treatments were submitted (cooking the carrots and crushing them in their raw state).

The results showed that the samples with 30 and 40% of carrots did not differ from each other, but the highest averages were presented by the second formulation.30% Mashed Carrots and 50% wheat flour, in line with the results of Santos *et al*. [25] when they studied the physicochemical and sensory quality of homemade carrot bread. Comparing with Chaves [4] in his study of the development of new products based on carrots and beets, I find results similar to those where he had an average of 80% acceptance with regard to flavor.

The aroma, color and flavor did not cause, between the formulations, statistical differences at the level of 5% of significance, this fact can be justified taking into account the percentage added in each formation A and B of the carrot and also by the treatments that both were submitted.

Figueirinhas [9], in his study on the elaboration of breads with partial replacement of wheat flour by carrot pulp and evaluation of the sensorial acceptance of the bread, reports that the addition of carrot pulp in standard bread with 60% and 40% obtained the higher averages, 7.56 and 7.50, respectively, while for the standard sample the grade was 7.37. The high averages can be explained by the fact that the aroma compounds of carotenoids belonging to the class of noroisoprenoids, such as b-ionone, a-ionone, dihydroactinidiolide, damascenol and b-cyclocitral, are some of the volatile compounds with high aromatic potential, such as points out José [15].

In the texture attribute, the formulations also showed no significant difference, with 6.52 being the best average and found in formulation C. A similar result was found by Nunes et al. [21], studying the sensory quality of carrot-based bread, when they found a score of 8 for the texture of carrot flour bread

According to studies by Esteller *et al.* [7], the factors that interfere in the increase of hardness in breads had different results to those found in this present study, where it obtained results superior to those of the study where this can be caused by the evaporation of water after the cooking, starch retrogradation and protein denaturation. Also compared to Ripari and Seravalli [24] in their study of the quality of bread crumbs made from carrots, they had good acceptance (put the average they obtained here) regarding the texture of the bread, which is in line with the study.

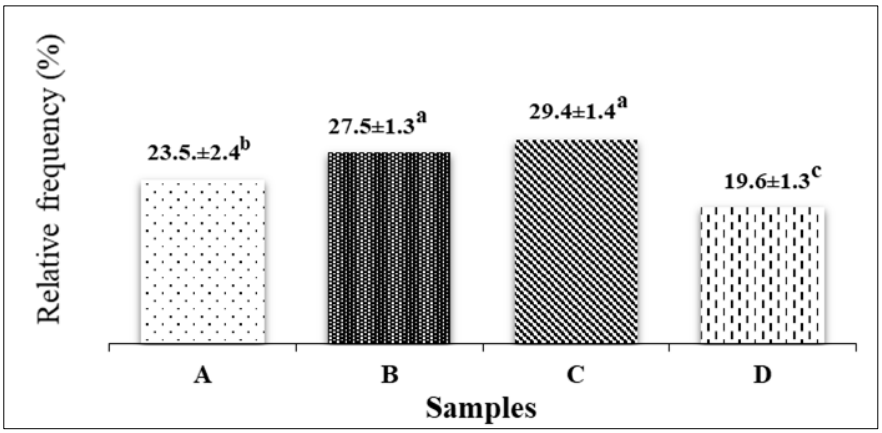
In the present research and regarding the aftertaste, no significant differences were found between formulations A and B made with 30% raw carrots and carrot puree, this may be related to the amount of puree that did not differ between the two formulations. Joana *et al.* [14] in their study on the influence of color and odor in determining the taste and acceptance of the product, found 76% acceptance, similar results to this study.

As for the odor, formulations A and B did not differ significantly. This was possibly due to the ability of volatile substances present in carrots to be released when subjected to a temperature of 100°C, causing non-differentiation. Dhingra and Jood [6], in their work on carrot bread, noticed that wheat breads supplemented with 15% of carrot puree reached a good degree of 8 sensory acceptance points in the odor attribute.

Oluwalana *et al.* [22], in their studies on sensory acceptance of bread with flour substitution, found that the best proportion 8 points was 15% carrot flour and 85% wheat flour, with no significant difference for all parameters studied and the same was notable in the present work on wheat flour and carrot puree breads.

3.2 Buy intention

The information regarding the purchase intention of carrot bread is shown in Figure 2. Formulation B and C do not present a significant difference ($p > 0.05$) between them, but formulation C differed statistically in terms of significance ($p < 0.05$) of formulations A, B, D, and the option “none of the samples would buy”.



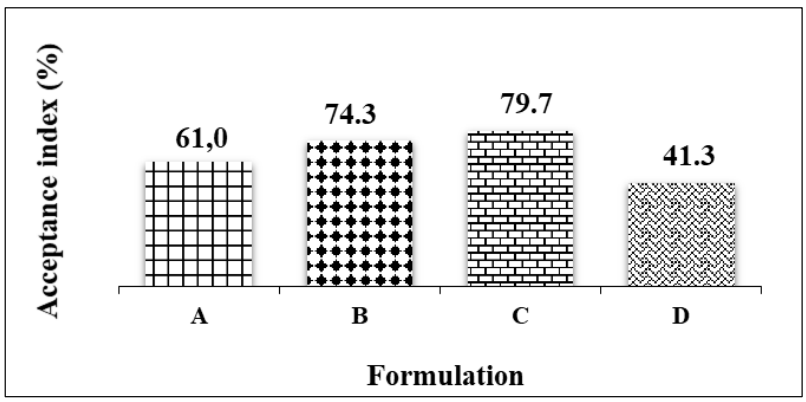
Means ± standard deviation of the graphs followed by the same letter do not have significant differences between them. **Caption: A** - 30% raw carrot puree and 50% wheat flour, 10% yeast, 3% salt and 7% water, **B** - 30% boiled carrot puree and 50% wheat flour, 10% yeast .3% salt and 7% water, **C-** 40% raw carrot puree and 40% wheat flour, 10% yeast, 3% salt and 7% water, and **D**- 40% cooked carrot puree and 40% raw carrot puree and 40% wheat flour, 10% yeast, 3% salt and 7% water.**Source:** Authors

Figure 2 Carrot bread purchase intent level

In the purchase intention test carried out, formulations B and C showed no significant difference between them, but formulations A and D differ statistically, with a higher purchase intention of 29.4% of formulation C. This low purchase rate may be related to with the addition of the carrot which consumers might not be used to. Frank [12] in his study found that the purchase intention for the formulations of 40% of carrot puree substituted in 50% of wheat flour and 50% of rice flour, only 2% of consumers would not buy the bread, being that 30% of consumers would buy this bread with 40% carrot puree and 50% wheat flour, if it were on sale.

The results obtained by Sousa [26] in his study on cake made with a partial replacement of carrots showed that in the purchase intention of the two samples, the judges would certainly/probably buy, and the samples did not differ from each other in terms of significance level. 5%. Also, in line with the study by Maurício *et al.* [17] in their study on carrot cake with and without gluten: formulation development and product acceptance, obtained greater acceptance than the work in question, this higher purchase percentage of 45%, may be linked to the use of mashed potatoes. carrot that provided better sensory characteristics. José [15] in his study of bread made with beetroot and carrots, it is possible to verify, through the data obtained from sensory analysis,

3.3 Acceptance Index



Caption: A - 30% raw carrot puree and 50% wheat flour, 10% yeast, 3% salt and 7% water, B - 30% boiled carrot puree and 50% wheat flour, 10% yeast .3% salt and 7% water, C- 40% raw carrot puree and 40% wheat flour, 10% yeast, 3% salt and 7% water, and D- 40% cooked carrot puree and 40% raw carrot puree and 40% wheat flour, 10% yeast, 3% salt and 7% water. Source: Authors

Figure 3 Carrot-based bread acceptability index

The acceptance rate of the carrot-based bread samples is represented in figure 3, where bread C stood out with high values and D with the lowest. The higher acceptance rate of C and then B must be related to the contribution of the ingredients, considered potential in altering the sensory characteristics of foods due to the substances that compose them.

Only formulations C and D presented sufficient evidence to be accepted, assuming that Noronha [20] establishes that products whose acceptance rate is greater than 70% are accepted in the market. Similar situations were verified by Fleet *et al.* [10] who obtained higher values of 84.4, 86.7 and 77.8% in formulations of their study on the use of carrots in the elaboration of bakery products. Mello and Basso also developed a bread using carrots for teenagers at a school. The results expressed a total acceptability index of 80%, the highest index being associated with texture (85%) and the lowest for appearance (75%), results that are similar to the present research. Damiani *et al.,* [5] in studies that aimed to assess the acceptance of preparations with full use of food.

4 Conclusion

The production of bread based on carrot puree in formulations with the inclusion of 40% of carrot puree, 10% of yeast, 3% of salt and 7% of water, in partial substitution of wheat flour (40%) showed greater acceptance. The breads obtained by partial replacement of wheat flour by carrot puree were relatively well accepted, especially the C formation with a level of 79.7% of acceptance by the tasters. And regarding the purchase intention, it was found that most of the tasted ones tend to buy the base of the formulation C that presented 8 acceptance points.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

This work was carried out with the consent, contribution and approval of its authors. There are no conflicts of interest.

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