Original Article
Food Science and Technology

ISSN 0101-2061 (Print)
ISSN 1678-457X (Online)

DOI: https://doi.org/10.5327/fst.91422

Development of "bisnaguinha" bread fibre source

Juliane dos Santos COUTINHO[1], Iris Laura Lima da SILVA[1], Elenice Souza dos Reis GOES[2], Thaise Mariá TOBAL[1*]

Abstract

Fibre-source "bisnaguinha" breads were developed using the addition of sweet passion fruit peel flour. The developed formulations were evaluated for physical properties, chemical composition and sensory acceptability. The flour obtained was characterised in terms of dietary fibre content and used as a partial substitute for wheat flour, in the proportions of 11.5%, 17.3% and 23%. The flour of sweet passion fruit peel presented high content of dietary fibre and its addition in the formulations of breads resulted in an increase in the content of ash, lipids and fibres, and all "bisnaguinha" breads with added fruit peel flour were considered a source of fibres. The addition of peel flour did not affect the hardness, chewability and shear force of the bread. Regarding sensory acceptability, all samples had good acceptance, and the proportion of 11.5% was closer to the standard bread, which obtained the highest scores. It is concluded, therefore, that it is feasible to use this flour in the preparation of breads, adding nutritional value to the products, and with good physical and sensorial characteristics.

Keywords: peel flour; fruit residues; sweet passion fruit; *Passiflora alata curtis*; bread products.

Practical Application: Use of flour from sweet passion fruit peel in the production of fibre source breads.

1 Introduction

World fruit production has been growing in recent years and by the year 2020 Brazil produced between 44.3 and 44.5 million tons of fresh fruit, and average production is expected to reach 40 million tons annually (Food and Agricultural Organization of the United Nations, 2019), This fruit production generates a large volume of commonly discarded fruit residues, including passion fruit.

The passion fruit, comprising around 500 different species, is most often not fully used, since its discarded weight corresponds to 62% in terms of peel and 38% corresponding to pulp and seeds (Ramli et al., 2020). Among the various species, sweet passion fruit (*Passiflora alata curtis*), known as 'spoon passion fruit', has high acceptance by consumers, mainly for unprocessed consumption, for presenting reduced acidity when compared to sour passion fruit (Borges et al., 2020). Its pulp is usually ingested with the seeds and has a characteristic flavour and pleasant aroma.

In addition to the pulp, which is more commonly consumed, the peel of this fruit can be used in the manufacture of cookies, and for the production of flours (Sampaio et al., 2022). It can be used for therapeutic purposes, due to its functional benefits, as well as being used in various preparations in order to increase the content of dietary fibre in the final product (Damasceno et al., 2018). Moreover, this fruit is commonly wild harvested in the Brazilian cerrado and has great potential to be used as a functional food, as it contains a significant amount of carotenoids, alkaloids, flavonoids, in addition to vitamins and minerals, thus presenting some important properties beneficial to human health, such as antioxidant, anti-inflammatory, anxiolytic, antidiabetic, cardioprotective, haematoprotective and antimicrobial (Brandão et al., 2020).

The passion fruit peel is composed of flavedo and albedo, corresponding to the yellow/orange and white parts, respectively, and both have around 2 to 3% pectin, in addition to other nutritional components mentioned above, and can be used to enrich dough, due to their various benefits and the easy incorporation of their by-products as is the case of peel flour (Muñoz-almagro et al., 2021).

Passion fruit peel flour can contribute to a healthy diet due to the presence of soluble and insoluble dietary fibre, and can be increased in food formulations, as is the case of bakery products (Cunha et al., 2020). It is identified as a functional food due to scientific evidence of its health benefits, including reducing cholesterol, controlling blood glucose and assisting in intestinal transit (Faveri et al., 2020).

The breads, in their different characteristic forms, such as "bisnaguinha" bread, are intended for the general public, and especially children, which is noticeable in the lively and colourful packaging to attract the attention of children and parents, as a nutritional marketing technique (Tavares et al., 2017). As bakery products are widely consumed and commonly do not have significant dietary fibre contents, there is a need to add ingredients that can increase the content of this nutrient, such as fruit peel flours (Damasceno et al., 2018). Thus, the objective of this work was to evaluate the chemical composition and sensory acceptability of formulations of "bisnaguinha" bread, with the addition of different percentages of flour from sweet passion fruit peel in partial replacement of wheat flour.

Received 12 Sept., 2022
Accepted 08 Mar., 2023
[1] *Faculty of Health Sciences, Universidade Federal da Grande Dourados – UFGD, Dourados, MS, Brasil*
[2] *Faculty of Agricultural Sciences, Universidade Federal da Grande Dourados – UFGD, Dourados, MS, Brasil*
*Corresponding author: thaisetobal@ufgd.edu.br

2 Materials and methods

2.1 Production of sweet passion fruit peel flour

The sweet passion *fruit (Passiflora alata curtis)* and other ingredients were acquired from local shops in the city of Dourados, located in the south-central region of the state of Mato Grosso do Sul (MS) (Latitude: 22º13`18.54" South; Longitude: 54º48`23.09" West). To obtain fresh passion fruit peel flour (PF), the fruits were previously selected, washed and, after separation of the pulp, the peel was immersed in water for 24 hours, with water exchange every hour, in order to reduce the compounds, present in the peel responsible for the bitterness. They were then cut into small pieces, distributed in trays lined with parchment paper and placed in a drying oven at 60 °C for 24 hours. After milling using a domestic blender of the brand Philips-Walita, the cut peel was sieved using 28 mm mesh sieves to obtain the flour (Figure 1), which was then stored in polyethylene bags at room temperature and under light (Sampaio et al., 2022).

2.2 Dietary fibre analysis

The flour obtained was characterised in terms of dietary fibre content by the gravimetric enzymatic method, including the use of the same 3 enzymes, α-amylase, protease, and amyloglucosidase (AOAC Method 985.29) (Association of Official Analytical Chemists, 2005).

2.3 Preparation of "bisnaguinha" bread

For the production of the standard formulation of "bisnaguinha" bread (0%), first 150 mL of whole milk was heated, to which was added 16.6 g of organic yeast, 100 g of granulated sugar, 25 mL of soybean oil and 12.5 g of refined salt, and mixed to achieve complete homogenisation. Subsequently, 5 hen's eggs and 650 g of wheat flour were added gradually, kneading the dough for at least 10 minutes until it no longer stuck to the hands, and was then left to rest for 40 minutes. After this period, the dough was stretched with the aid of a manual cylinder for pasta of the brand Malta and cut into strips, to shape the individual "bisnaguinhas", which were then placed on a baking sheet with soybean oil and wheat flour for the fermentation process for 3 to 4 hours. Then, the oven was pre-heated for 10 minutes at a temperature of 180°C and the loaves placed to bake at the same temperature for 30 minutes.

Figure 1. Flour from sweet passion fruit peel.

For the formulations of "bisnaguinha" bread with the addition of passion fruit peel flour, the preparation method was similar and the same ingredients and quantities as in the standard formulation were used, except in the amount of wheat flour, due to the addition of sweet passion fruit peel flour as a partial substitute in the proportions of 11.5%, 17.3% and 23%. Several tests were completed in order to find an inclusion of sweet passion fruit peel flour that guaranteed a "bisnaguinha" bread with a good sensory acceptability. After baking the breads, they were cooled at room temperature and stored for physical analysis and sensory tests that were carried out on the same day that the respective formulations of bread were prepared. Samples of all formulations were also frozen for subsequent chemical analysis.

2.4 Physical properties of the breads

The formulations were weighed before and after cooking, and the breads from the same oven were randomly sampled in triplicate and used to determine the parameters of yield, diameter, thickness and expansion factor (ratio before and after baking), according to the procedures described in the macro method 10-50 d of the AACC (American Association of Cereal Chemists, 1995). The weight was obtained on a semi-analytical scale and the thermal factors determined by the difference between the weight of the breads before and after cooking and the yield determined by thermal factor multiplied by 100. Diameter and thickness were determined using a calliper (Profield, China). The expansion factor was determined by the ratio between the width and thickness values of the breads. Colour was determined using a chromameter CR-400 colorimetric device (Konica Minolta, Japan), and the results were expressed in L*, a* and b*.

The texture profile of the breads was analysed one day after its manufacture, in a texturometer model TA. XT plus (Stable Micro Systems Texture Analyser, United Kingdom), equipped with cylindrical probe compression, 36 mm in diameter, and with computer-coupled interface and data obtained through the Program T.A. Settings: TPA 1. The parameters determined were texture firmness (N), elasticity, cohesion and chewability.

2.5 Chemical composition of breads

The moisture was determined by drying in an oven at 105 °C; the proteins were determined using the Kjeldhal method, using a conversion factor of 6.25; the lipids by hot extraction of the Soxhlet type; the ash by incineration in a muffle furnace at 550 °C; the dietary fibre by the enzymatic gravimetric method 985.29; and the carbohydrates obtained by difference (Association of Official Analytical Chemists, 2005).

2.6 Sensory analysis

Testing of the sensory acceptability of the developed breads was performed in the sensory analysis laboratory, in individual booths, under white light, with 40 tasters including employees, professors and students of the University, who voluntarily agreed to participate in the research after signing the Free and Informed Consent form, previously approved by the Ethics Committee on Research with Human Beings of the Federal University of Grande Dourados (protocol no. 1.005.028). The formulations were identified with three-digit numbers and presented randomly (Dutcosky, 2013).

For the acceptance analysis, a structured hedonic 9-point scale was used, anchored with the descriptions "I greatly disliked it" and "I liked it very much", evaluating the attributes colour, aroma, texture, flavour and overall impression. The purchase intention was evaluated using a 5-point scale containing the choices "Certainly buy; possibly buy; maybe buy/maybe not buy; possibly would not buy; and certainly would not buy" (Meilgaard et al., 1999).

2.7 Data analysis

The results obtained were represented in mean and standard deviation being analysed by Variance Analysis (ANOVA) and the means compared by the Tukey test ($p \leq 0.05$), using the Origin 6.0 program.

3 Results and discussion

3.1 Chemical composition of flour

Sweet PF (Figure 1) presented high dietary fibre content (69.42 g/100 g), and can be consumed daily to contribute to the recommended daily intake of this nutrient (25 g and 38 g/day for healthy adult women and men, respectively) (Institute of Medicine, 2005). Other studies have quantified the dietary fibre content in the flour of the flavedo peel and sweet passion fruit albedo, having found 63.59% and 79.37% fibre (Sampaio et al., 2022), respectively, and of sweet PF and albedo flour having 64.12% (55.95% of insoluble fibre and 8.18% of soluble fibre) and 42.97% (35.27% of insoluble fibre and 7.70% of soluble fibre), respectively (Dourisboure & Ortega, 2017).

In addition, the fiber content of sweet PF is higher than that of other fruit peels such as tahiti lime peel (67.70%) (Correia et al., 2022) and mango peel flours (59.44%) (Noor Aziah & Min, 2011).

3.2 Physical properties of breads

The colour of bread is one of the most important indicators of its quality (Olojede et al., 2020). The crust and colour of the crumb desirable for bread should be golden brown and creamy white, respectively (Phattanakulkaewmorie et al., 2011). In the colorimetry of the crust of "bisnaguinha" breads (Table 1), it was observed that the inclusion of 11.5% of passion fruit peel flour provided breads with higher luminosity (L*), lower intensity of red (a*) and higher intensity of yellow (b*) in relation to the other formulations ($p \leq 0.05$), contributing to the brown hue. The colour of the crust in bakery products is directly influenced by caramelisation and Maillard reactions, since large changes occur in the coloration during cooking (Reis et al., 2020). Passion fruit peel flour contains more fibres and fewer carbohydrates and proteins than wheat flour, and the substitution of wheat flour with passion fruit peel flour may limit the Maillard reaction (Conti-Silva & Roncari, 2015), resulting in breads with a less intense colour, as observed in this study for "bisnaguinhas" with 11.5% passion fruit peel flour (Figure 2).

In the colour of the bread crumb (Table 1), it was found that with increasing levels of inclusion of passion fruit flour,

Table 1. Colour (n = 9), texture profile (n = 6) and preparation characteristics (n = 3) of the "bisnaguinha" breads (mean ± standard deviation).

Features	Inclusion levels of passion fruit peel flour*			
	0%	11.5%	17.3%	23%
Crust colour				
L*	52.56 ± 3.28^{a}	66.00 ± 1.55^{b}	51.63 ± 2.27^{a}	50.88 ± 1.09^{a}
a*	15.48 ± 1.42^{a}	9.82 ± 1.28^{c}	13.85 ± 0.68^{b}	14.48 ± 0.62^{ab}
b*	18.02 ± 3.93^{a}	29.91 ± 0.95^{b}	20.66 ± 2.31^{a}	19.51 ± 1.51^{a}
Crumb colour				
L*	81.59 ± 0.96^{a}	73.92 ± 1.22^{b}	67.28 ± 1.79^{c}	66.78 ± 2.42^{c}
a*	0.80 ± 0.11^{a}	3.82 ± 0.39^{b}	5.57 ± 0.73^{c}	5.65 ± 0.45^{c}
b*	20.81 ± 0.38^{a}	23.69 ± 1.00^{b}	23.42 ± 0.80^{b}	22.90 ± 1.23^{b}
Texture profile				
Hardness (gf)	5.17 ± 3.15^{a}	5.98 ± 2.36^{a}	4.55 ± 2.14^{a}	5.80 ± 2.67^{a}
Cohesiveness	0.61 ± 0.03^{a}	0.56 ± 0.04^{a}	0.59 ± 0.02^{a}	0.59 ± 0.05^{a}
Elasticity	0.85 ± 0.01^{a}	0.77 ± 0.08^{ab}	0.73 ± 0.04^{b}	0.73 ± 0.11^{ab}
Chewability	2.68 ± 1.63^{a}	2.57 ± 1.06^{a}	1.94 ± 0.84^{a}	2.63 ± 1.39^{a}
Shear force	6.29 ± 2.06^{a}	4.60 ± 3.34^{a}	8.91 ± 1.12^{a}	8.82 ± 1.87^{a}
Expansion index	1.13 ± 0.09^{ab}	1.23 ± 0.03^{b}	1.15 ± 0.01^{a}	1.15 ± 0.10^{ab}
Preparation yield (%)	90^{a}	90^{a}	90^{a}	90^{a}
Thermal factor	0.9^{a}	0.9^{a}	0.9^{a}	0.9^{a}

*Percentages of replacement of wheat flour with sweet passion fruit peel flour. Different letters on the same line indicate significant difference by Tukey test ($p \leq 0.05$).

Figure 2. Percentages of replacement of wheat flour by flour from sweet passion fruit peel of 0%, 11.5%, 17.3% and 23%, from left to right, respectively.

Figure 3. Percentages of replacement of wheat flour with sweet passion fruit peel flour of 0%, 11.5%, 17.3% and 23%, from left to right, respectively.

there was a decrease in luminosity (L*), and an increase in the intensity of red (a*) and yellow (b*). Similarly, in another study, breads with the addition of 15% of flour from the orange passion fruit peel presented breads with lower luminosity, redder and more yellow in relation to breads without added passion fruit peel flour (Reis et al., 2020). It is known that the colour of the bread crumb is influenced by the wheat flour, and the smaller the particle size, the lighter the kernel will be (Popov-Raljić et al., 2009). Thus, with the substitution of wheat flour with passion fruit peel flour, it was expected that the breads would become darker with higher levels of passion fruit peel flour, depending on the colour of this flour (Figure 3).

In the analysis of the texture profile (Table 1), the hardness and cohesivity parameters were not affected by the different treatments ($p \leq 0.05$), but the elasticity was lower in the breads with 17.3% inclusion ($p \leq 0.05$). The shear force was also not altered ($p \leq 0.05$) by the inclusion of passion fruit peel flour.

Hardness is defined as the force that teeth exert on a food; while cohesiveness is considered as the success of a food in resisting a second deformation in relation to its resistance to the first deformation (Carocho et al., 2020). Increasing the fibre in the formulation of breads usually leads to a firmer bread crumb (Wang et al., 2002), because the substitution of wheat flour with a flour rich in fibre breaks the starch-gluten matrix, restricting the retention of gas in the gluten network, affecting the specific volume of bread and the hardness of the bread crumb (Rosell & Santos, 2010). Nevertheless, in the "bisnaguinhas", hardness and cohesiveness were not affected by the inclusion of passion fruit flour, indicating that this flour, despite having increased the fibre content, did not significantly impact the firmness of the breads.

Another dimension of texture is elasticity, defined as the rate at which a deformed food reverts to its un-deformed state after the removal of the deforming force (Faber et al., 2017). In this study, the "bisnaguinhas" with 17.3% of passion fruit peel flour presented lower average elasticity in relation to the control breads. The addition of fibre to bakery products can cause a reduction in proteins and consequently gluten, a process that affects the absorption of water in the dough and inhibits the formation of the gluten network (Conti-Silva & Roncari, 2015), and this may explain the lower elasticity of breads with the addition of passion fruit peel flour.

Chewability is the product of hardness, cohesiveness and elasticity, and is generally defined as the energy needed to chew food, although it is dimensional (Chandra & Shamasundar, 2015). The hardest bread is the most chewable, which means that it requires more energy to be consumed, which is widely expected due to the greater strength needed to chew a hard substance (Carocho et al., 2020). Thus, as no changes were observed in the hardness of the breads, it was also expected that there would be no significant effect on the chewability, and consequently, also on the shear force. Typically, the lower the shear force, the greater the softness of a product (Gomathi & Parameshwari, 2022). The expansion index, yield and thermal factors did not differ between treatments, with the exception of the expansion index, which for the 11.5% formulation was higher than for the others.

3.3 Chemical composition of breads

The addition of sweet PF led to a significant reduction in moisture content in the formulations, and the lipid, ash and fibre content increased significantly in the formulations with added peel flour (Table 2).

According to Souza et al. (2021), breads with reduced moisture content are less likely to develop pathogenic microorganisms and have an extended shelf life, having also found moisture reduction in gluten-free "bisnaguinha" breads made with yams and flour mixes (brown rice, almonds, sweet sprinkles and potato starch). The amount of proteins in all formulations is similar to the values found in "bisnaguinha" breads with added eggplant peel flour (7.66 g/100 g) (Teixeira et al., 2018).

The increase in lipid content in breads with sweet PF was similar to that found in the study conducted by Meneses et al. (2020), which prepared breads with different proportions of soybean flour and finally obtained an increase in lipid concentration. The presence of fatty acids beneficial to health, contained in the flavedo of sweet passion fruit and consequently of the flour used can be beneficial (Dourisboure & Ortega, 2017). The increase in ash content proportional to the increase in the amount of sweet PF was similar to that found in other studies that developed products using fruit peel flour, such as for "bisnaguinha" breads with eggplant peel flour (Teixeira et al., 2018) and in breads using flour from sour passion fruit *albejaand jabuticaba* peel (Constantino & Lopes, 2019), which can be explained by the high concentration of minerals in fruit peel.

The proportional increase in dietary fibre with the addition of peel flour is due to the fact that sweet PF has a high fibre content. Damasceno et al. (2018), developed breads partially replacing wheat flour with passion fruit peel flour (MF) in the proportions of 5%, 10% and 15%, and obtained a significant increase of this component proportional to the increase in the content of added MF. It is important to highlight that dietary fibre sources in foods and preparations help to delay glucose absorption, especially after large meals and in addition, contribute to an adequate and healthy diet (Kuiavski et al., 2020).

According to Normative Instruction No. 75 of October 8, 2020 (Brasil, 2020), which addresses the technical requirements for the declaration of nutritional labelling of packaged foods, all formulations with added sweet PF can be considered a source of dietary fibre. It is noteworthy that a large part of the population does not have an adequate intake of dietary fibre and that breads rich in fibre could contribute significantly to the achievement of the recommended intake, since they are foods widely consumed by the population.

3.4 Sensory analysis

Regarding the results of sensory acceptability (Table 3), all formulations were well accepted.

For all the characteristics evaluated, the minimum score corresponded to the description "I liked slightly" (score 6.2) and the maximum to "I really liked" (score 8.4), indicating that all samples were well accepted in relation to all attributes evaluated. The standard formulation had greater sensory acceptance, followed by the formulation of 11.5%, which did not differ from each other in terms of aroma. The formulation of 11.5% obtained greater acceptance in relation to the other additions of peel flour in terms of colour, texture and overall impression, indicating that the use of peel flour up to 11.5% decreases the impact on sensory acceptability.

The reduction in the score for the characteristics colour and texture proportional to the increase in peel flour of the peel added to the formulations, corroborates the physical changes shown in the colour analysis and in the decrease in elasticity (Table 1). According to Teixeira et al. (2018), the high dietary fibre content in breads results in reduced volume, darker bread crumb colour, firmness, modified taste, water absorption of the ingredients and consequently a decrease in the fermentation process.

Table 2. Chemical composition of "bisnaguinha" bread with sweet passion fruit peel flour.

Parameter	Inclusion levels of passion fruit peel flour*			
	0%	11.50%	17.30%	23%
Moisture	18.05 ± 0.67[ab]	18.59 ± 0.52[a]	17.44 ± 0.34[b]	15.66 ± 0.42[c]
Proteins	7.76 ± 0.38[a]	6.87 ± 0.34[b]	8.16 ± 0.30[a]	7.87 ± 0.43[a]
Lipids	4.11 ± 0.14[a]	5.77 ± 0.20[b]	5.62 ± 0.17[b]	5.74 ± 0.05[b]
Carbohydrates	68.25 ± 1.20[a]	67.01 ± 0.99[a]	65.42 ± 0.07[b]	68.50 ± 0.50[a]
Ashes	1.84 ± 0.10[ab]	1.75 ± 0.13[b]	3.37 ± 0.03[c]	2.23 ± 0.25[a]
Food fibre	1.97 ± 0.04 [a]	5.51 ± 0.22[b]	7.67 ± 0.40[c]	9.27 ± 0.37[d]

*Percentages of replacement of wheat flour by flour from sweet passion fruit peel. Different letters in the same line indicate a significant difference between the samples by the Tukey test ($p \leq 0.05$).

Table 3. Sensory acceptability of "bisnaguinha" bread with sweet passion fruit peel flour.

Features	Inclusion levels of passion fruit peel flour*			
	0%	11.5%	17.3%	23%
Colour	8.3 ± 1.1[a]	7.6 ± 1.4[b]	6.6 ± 2.1[c]	6.8 ± 1.5[c]
Aroma	7.6 ± 1.5[a]	7.1 ± 1.4[ab]	6.8 ± 2.0[b]	6.5 ± 1.8[b]
Texture	8.4 ± 0.8[a]	7.6 ± 1.3[b]	6.2 ± 2.2[c]	6.2 ± 1.9[c]
Flavour	8.1 ± 1.4[a]	7.3 ± 1.7[b]	6.9 ± 2.0[b]	6.7 ± 1.9[b]
Overall impression	8.3 ± 1.1[a]	7.5 ± 1.4[b]	6.8 ± 1.7[c]	6.8 ± 1.6[c]

*Percentages of replacement of wheat flour with sweet passion fruit peel flour. Different letters in the same column indicate a significant difference between the samples by the Tukey test ($p \leq 0.05$).

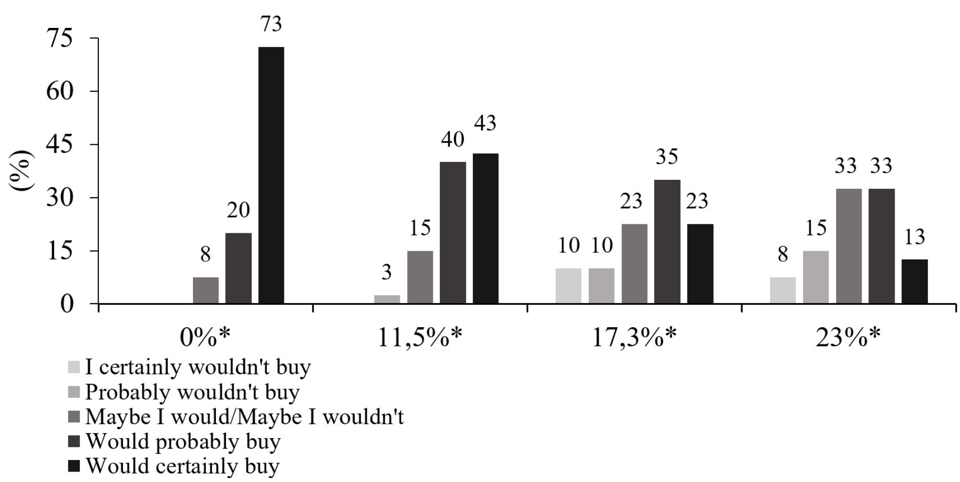

Figure 4. Intention to buy the "bisnaguinhas" breads. *Percentages of replacement of wheat flour with sweet passion fruit peel flour.

Regarding flavour and overall impression, the results were similar to those of Lima et al. (2021), in which the formulation of standard gluten-free bread had better acceptance regarding flavour, compared to the formulation with addition of tangerine peel flour, and Santos et al. (2018), in which the formulation of the control bread and the lowest addition of mixed seed flour and papaya peel obtained better acceptance for overall impression, when compared with the formulations with a higher amount of mixed flour. The standard formulation is a common food within the daily diet of the majority of the Brazilian population and probably the tasters.

As for the intention to buy the "bisnaguinhas" (Figure 4), for the formulations 0% and 11.5% most tasters would probably or certainly buy.

Colour is one of the factors that influences the decision to purchase a food and/or preparation, since when it comes to breads these should have golden brown crust and creamy white crumb (Phattanakulkaewmorie et al., 2011). Thus, it was found that the standard formulations and 11.5% presented better acceptance regarding colour and other attributes, and consequently greater purchase intention.

Much research has targeted the use of fruit peel in the development of products, since they have an interesting nutritional composition, with significant amounts of fibres, minerals and bioactive compounds (Brandão et al., 2020; Cunha et al., 2020; Damasceno et al., 2018). The breads developed in the present study presented sensory acceptability equal to or greater than that found in other studies with the addition of fruit peel flours in breads, including gluten-free breads prepared with tangerine peel flour (Lima et al., 2021) and breads with mixed seed flour and papaya peel (Santos et al., 2018), as well as the sweet PF in cookies (Sampaio et al., 2022), confirming that sweet PF can be used in bakery products.

4 Conclusion

The flour of the sweet passion fruit peel was found to have a high content of dietary fibres, and your addition contributed to an increased nutritional value of breads, and can be considered a source of fibre. The use of peel flour up to 11.5% obtained greater acceptance in relation to the other additions of peel flour in terms of colour, texture and overall impression, and greater purchase intention. Therefore, its use in bakery products may contribute to increasing the nutritional value of the diet, contributing to human health.

Acknowledgments

The authors thank the Federal University of Grande Dourados for financial support.

References

American Association of Cereal Chemists – AACC. (1995). *Approved Methods of the American Association of Cereal Chemists*. St. Paul: AACC.

Association of Official Analytical Chemists – AOAC. (2005). *Official Methods of Analysis of AOAC International* (18th ed.). Gaithersberg: AOAC International.

Borges, R. M., Alencar, E. R., Costa, A. M., & Junqueira, N. T. V. (2020). Physicochemical aspects of genotypes of Passiflora alata Curtis. *Brazilian Journal of Food Technology*, 23, 1-10. http://dx.doi.org/10.1590/1981-6723.18819.

Brandão, T. M., Vieira, M. A., Elias, H. H. S., Schiassi, M. C. E. V., Santos, H. V., & Pereira, P. A. P. (2020). Effect of time and temperature on the physical characteristics of dietetic functional mixed cerrado fruit preserves. Research. *Social Development*, 9(10), 1-22. http://dx.doi.org/10.33448/rsd-v9i10.9267.

Brasil, Ministério da Saúde. Agência Nacional de Vigilância Sanitária – ANVISA. (2020). Estabelece os requisitos técnicos para declaração da rotulagem nutricional nos alimentos embalados (Instrução Normativa - IN nº 75, de 08 de outubro de 2020). *Diário Oficial da República Federativa do Brasil*.

Carocho, M., Morales, P., Ciudad-Mulero, M., Fernández-Ruiz, V., Ferreira, E., Heleno, S., Rodrigues, P., Barros, L., & Ferreira, I. C. F. R. (2020). Comparison of different bread types: Chemical and physical parameters. *Food Chemistry*, 310, 1-8. http://dx.doi.org/10.1016/j.foodchem.2019.125954. PMid:31841942.

Chandra, M. V., & Shamasundar, B. A. (2015). Texture profile analysis and functional properties of gelatin from the skin of three species of fresh water fish. *International Journal of Food Properties*, 18(3), 572-584. http://dx.doi.org/10.1080/10942912.2013.845787.

Constantino, J. S. F., & Lopes, J. D. (2019). Desenvolvimento de pão de forma contendo farinha mista de maracujá e jabuticaba. In N. A. Cardoso, R. R. Rocha, & M. V. Laurindo (Eds.), *As ciências biológicas e da saúde na contemporaneidade* (2. ed., pp. 127-142). Ponta Grossa: Atena Editora.

Conti-Silva, A. C., & Roncari, R. F. (2015). Sensory features and physical-chemical characterization of Brazilian honey bread with passion fruit peel flour. *Nutrition & Food Science*, 45(4), 595-605. http://dx.doi.org/10.1108/NFS-03-2015-0023.

Correia, L. D. B., Sampaio, R. F., Lima, V. C., & Tobal, T. M. (2022). Tahiti lime peel flour as an alternative for increasing fiber content in new food products. *Multitemas*, 27(65), 73-86. http://dx.doi.org/10.20435/multi.v27i65.3375.

Cunha, J. A., Rolim, P. M., & Silva, C. D. (2020). From seed to flour: sowing sustainability in the use of cantaloupe melon residue (Cucumis melo L. Var. Reticulatus). *PLoS One*, 15(1), e0219229. http://dx.doi.org/10.1371/journal.pone.0219229. PMid:31895921.

Damasceno, C. S. B., Silva, D. N., Damasceno, E. R., Oliveira, L. F., Porto, K. R. A., & Candil, R. F. M. (2018). Efeito da adição de farinha da casca de maracujá (Passiflora edulis) na aceitabilidade de pão. *Visão Acadêmica*, 19(3), 46-60. http://dx.doi.org/10.5380/acd.v19i3.62298.

Dourisboure, L. N., & Ortega, N. F. (2017). *Composição química e avaliação do teor de carotenoides da farinha de maracujá doce (Passiflora alata Curtis)* (Trabalho de Conclusão de Curso). Universidade Federal da Grande Dourados, Dourados.

Dutcosky, S. D. (2013). *Análise sensorial de alimentos* (4. ed.). Paraná: Champagnat.

Faber, T. J., Jaishankar, A., & McKinley, G. H. (2017). Describing the firmness, springiness and rubberiness of food gels using fractional calculus. Part I: Theoretical framework. *Food Hydrocolloids*, 62, 311-324. http://dx.doi.org/10.1016/j.foodhyd.2016.05.041.

Faveri, A., Faveri, R., Broering, M. F., Bousfield, I. T., Goss, M. J., Muller, S. P., Pereira, R. O., Silva, A. M. O., Machado, I. D., Quintão, N. L. M., & Santin, J. R. (2020). Effects of passion fruit peel flour (Passiflora edulis f. flavicarpa O. Deg.) in cafeteria dietinduced metabolic disorders. *Journal of Ethnopharmacology*, 250, 112482. http://dx.doi.org/10.1016/j.jep.2019.112482. PMid:31866512.

Food and Agricultural Organization of the United Nations – FAO. (2019). T*he stage of food and agriculture – Moving forward on food loss and waste reduction*. Rome: FAO.

Gomathi, G. K., & Parameshwari, S. (2022). Evaluation of buckwheat flour addition on the sensory, nutritional and materialistic properties analysis of Indian flat bread. *Materials Today: Proceedings*, 66, 988-995. http://dx.doi.org/10.1016/j.matpr.2022.04.778.

Institute of Medicine. (2005). Dietary reference intakes for energy, carbohydrate, fiber, fat,fatty acids, cholesterol, protein, and amino acids. Washington, D.C.: National Academy Press.

Kuiavski, M. P., Bezerra, J. R. M. V., Teixeira, A. M., & Rigo, M. (2020). Preparation of breads with the addition of malt bagasse flour. *Brazilian Journal of Development*, 6(7), 53208-53221. http://dx.doi.org/10.34117/bjdv6n7-823.

Lima, K. N., Oliveira, M. L., & Ferreira, M. C. M. (2021). Sensory analysis and nutritional value of gluten-free bread with tangerine shell flour (Citrus reticulata). *Food Science and Technology (Campinas)*, 16, 1-12. http://dx.doi.org/10.54372/sb.2021.v16.2922.

Meilgaard, M., Civille, G. V., & Carr, B. T. (1999). *Sensory evaluation tecniques* (3rd ed.). New Work: CRC Press.

Meneses, I. S. B., Feitosa, B. R., Dias, L. S. C., Tulini, F. L., Souza, V. B., & Martins, M. V. (2020). Chemical-physical and sensory analysis of breads enriched with different proportions of soybean flour (Glycine max). *Brazilian Journal of Development*, 6(11), 87049-87060. http://dx.doi.org/10.34117/bjdv6n11-216.

Muñoz-almagro, N., Montilla, A., & Villamiel, M. (2021). Role of pectin in the current trends towards low-glycaemic food consumption. *Food Research International*, 140, 109851. http://dx.doi.org/10.1016/j.foodres.2020.109851. PMid:33648169.

Noor Aziah, A. A., & Min, L. (2011). Nutritional and sensory quality evaluation of sponge cake prepared by incorporation of high dietary fiber containing mango (Mangifera indica var. Chokanan) pulp and peel flours. *International Journal of Food Sciences and Nutrition*, 62(6), 559-567. http://dx.doi.org/10.3109/09637486.2011.562883. PMid:21534889.

Olojede, A. O., Sanni, A. I., & Banwo, K. (2020). Effect of legume addition on the physiochemical and sensorial attributes of sorghum-based sourdough bread. *Lebensmittel-Wissenschaft + Technologie*, 118, 108769. http://dx.doi.org/10.1016/j.lwt.2019.108769.

Phattanakulkaewmorie, N., Paseephol, T., & Moongngarm, A. (2011). Chemical compositions and physico-chemical properties of malted sorghum flour and characteristics of gluten free bread. *World Academy of Science, Engineering and Technology*, 5(9), 532-538. http://dx.doi.org/10.5281/zenodo.1080728.

Popov-Raljić, J. V., Mastilović, J. S., Laličić-Petronijević, J. G., & Popov, V. S. (2009). Investigations of bread production with postponed staling applying instrumental measurements of bread crumb color. *Sensors (Basel)*, 9(11), 8613-8623. http://dx.doi.org/10.3390/s91108613. PMid:22291527.

Ramli, M. N. A., Manap, A. W. N., Bhuyar, P., & Azelee, W. I. N. (2020). Passion fruit (Passiflora edulis) peel powder extract and its application towards antibacterial and antioxidant activity on the preserved meat products. *Springer Nature Switzerland*, 1(10), 1748. http://dx.doi.org/10.1007/s42452-020-03550-z.

Reis, L. C. R., Facco, E. M. P., Salvador, M., Flôres, S. H., & Rios, A. O. (2020). Characterization of orange passion fruit peel flour and its use as an ingredient in bakery products. *Journal of Culinary Science & Technology*, 18(3), 214-230. http://dx.doi.org/10.1080/15428052.2018.1564103.

Rosell, C. M., & Santos, E. (2010). Impact of fibers on physical characteristics of fresh and staled bake off bread. *Journal of Food Engineering*, 98(2), 273-281. http://dx.doi.org/10.1016/j.jfoodeng.2010.01.008.

Sampaio, R. F., Lima, V. C., Bungart, G. A. M., Correia, L. D. B., & Tobal, T. M. (2022). Flour of winged-stem passion fruit peel: nutrition composition, incorporation in cookies and sensory acceptability. *Brazilian Archives of Biology and Technology*, 65, e22200776. https://doi.org/10.1590/1678-4324-2022200776.

Santos, C. M., Rocha, D. A., Madeira, R. A. V., Queiroz, E. R., Mendonça, M. M., Pereira, J., & Abreu, C. M. P. (2018). Preparation, characterization and sensory analysis of whole bread enriched with papaya byproducts flour. *Brazilian Journal of Food Technology*, 21, 1-9. http://dx.doi.org/10.1590/1981-6723.12017.

Souza, M. R., Martins, A. L. S., Souza, H. L. S., Oliveira, C. F., Mallet, A. C. T., & Nascimento, K. O. (2021). Development of gluten-free and egg-free bisnaguinha bread, made with yam and a mix of flours: a proposal for school feeding of children with food allergies. *Research, Social Development*, 10(13), 1-15. http://dx.doi.org/10.33448/rsd-v10i13.21364.

Tavares, J. S., Mendes, M. C., Passos, S. R., Lourenço, A. A., Pederzoli, B. A., Soares, C. G., & Botellho, F. T. (2017). Nutritional composition of bread and comparison with the legislation of nutritional labeling. *Vigilância Sanitária em Debate: Sociedade, Ciência & Tecnologia*, 5(1), 45-51.

Teixeira, F., Lima, K. A., Silva, V. C., Franco, B. C., Santos, E. F., & Novello, D. (2018). Eggplant peel flour in bread: physico-chemical and sensorial analysis among children. *Revista Ciencias de la Salud*, 11(2), 128-134. http://dx.doi.org/10.15448/1983-652X.2018.2.00000.

Wang, J., Rosell, C. M., & de Barber, C. B. (2002). Effect of the addition of different fibres on wheat dough performance and bread quality. *Food Chemistry*, 79(2), 221-226. http://dx.doi.org/10.1016/S0308-8146(02)00135-8.