DEVELOPMENT OF FUNCTIONAL BREADS WITH AQUEOUS EXTRACT OBTAINED FROM THE BY-PRODUCT OF SUNFLOWER OIL PRODUCTION

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INTRODUCTION:

The increase in foods that are nutritionally rich in phenolic compounds, proteins, fibers and other nutrients has become a topic of great attention, and products that have constituents that promote health and protect against diseases that are frequent today are called functional foods (BOGGIA; ZUNIN; TURRINI, 2020). Among the foods that have these functional characteristics, there is the sunflower seed (nugget) used for the industrial extraction of the oil, which generates a by-product rich in proteins, micronutrients such as calcium, iron, vitamin A, vitamin E and vitamins of the B complex, as well as phenolic compounds. Regarding the phenolic composition, chlorogenic acid constitutes more than 70% of the total phenolic compounds present in sunflower nugget flour, followed by caffeic, gallic and ferulic acids (GAI et al., 2020). Thus, considering that such flour is generated during the sunflower oil extraction process, it would be more profitable for the industry to use this by-product for some purpose, in order to provide a means of disposal of the generated residue, in addition to adding nutritional value and functional to products already marketed (PRETO, 2014). It is worth mentioning that the presence of chlorogenic acid in culinary formulations is still seen as an obstacle due to the occurrence of oxidation reactions that cause the formation of greenish compounds (WILDERMUTH; YOUNG; WERE, 2016). However, this position has been revised due to the high potential for use in foods as a functional ingredient, and also as a natural antioxidant to replace synthetic preservatives (SHCHEKOLDINA; AIDER, 2012). As bread is a food consumed worldwide, the present project aimed to develop functional breads from the use of an aqueous extract rich in chlorogenic acid obtained from sunflower seed flour, in order to determine the stability of the compound phenolic acid to thermal processing, as well as verify the changes in the organoleptic characteristics of the final product.

METHODOLOGY:

For the preparation of the breads, the International AACC method (10-11.01) was used with some changes. The recipes were based on the ingredients wheat flour, sunflower nugget flour, salt, biological yeast and vegetable fat. First, initial tests were carried out with sunflower seed flour, which replaced wheat flour in different proportions. Regarding the aqueous extract rich in chlorogenic acid, this was obtained through a lyophilization

process and was added to water in the formulation of breads with extract, together with natural colorants (paprika, turmeric and annatto). After all the breads were prepared, the phenolic compounds were extracted, the chlorogenic acid was analyzed and the physical and rheological properties of the breads were analyzed (Figure 1).

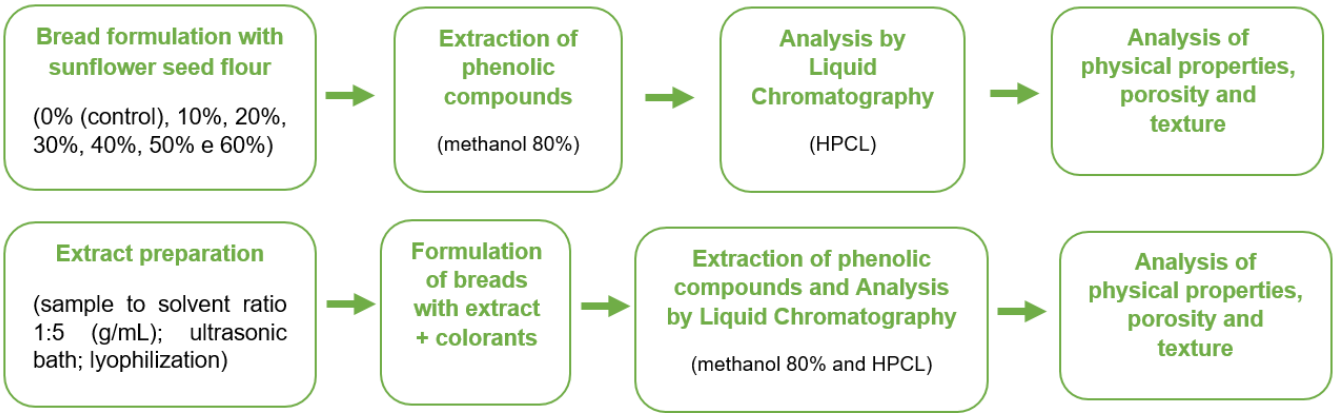

Figure 1. Scheme of materials and methods.

RESULTS AND DISCUSSION:

In the sunflower nugget flour used as raw material to obtain the extract, 40.43 mg/g of chlorogenic acid was found, a significant amount that is close to the value found in the scientific literature. In this sense, the development of a functional product through the addition of this flour proves to be very successful, since the addition of phenolic compounds in foods, in addition to improving the amount of antioxidants, also offers other benefits, such as antimicrobial properties and increased shelf life product (XU; WANG; LI, 2019).

To verify the stability of chlorogenic acid to thermal processing, firstly, the high performance liquid chromatography analysis of breads enriched with different concentrations of sunflower seed flour before and after cooking was performed. Thus, from the results, it was observed that the baked breads had a greater amount of chlorogenic acid compared to the raw ones. In this context, having proven the significant presence of this phenolic compound and its stability to cooking in breads enriched with sunflower nugget flour, the extract rich in chlorogenic acid was prepared from this raw material. The concentration of chlorogenic acid found in the obtained extract was 443.89 mg/g, a fact that had been one of the main difficulties encountered previously. In this way, this extract more concentrated in chlorogenic acid allowed to optimize the amount of this phenolic compound in the final product elaborated from the aqueous extract. In view of this, the breads made with the aqueous extract obtained from the flour showed a significant amount of chlorogenic acid (68.78 mg/g). In addition, this phenolic compound showed certain stability to thermal processing, since the amount found after cooking was greater than that found in raw dough (Figure 2) and much greater than that found in breads made from flour. In view of the comparison of the

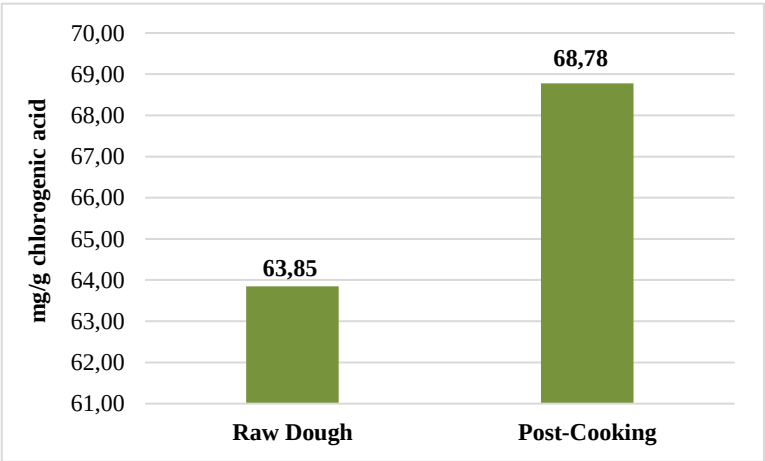

Figure 2 - Quantification of chlorogenic acid in breads enriched with aqueous extract rich in chlorogenic acid (mg/g) before and after cooking.

results found in breads enriched with sunflower nugget flour and breads enriched with the aqueous extract, it can be noted that the breads made from the addition of the aqueous extract showed 51.02 mg/g more of chlorogenic acid than breads with the highest percentage of flour (60%).

According to Xu, Wang and Li (2019), the presence of these compounds in bakery products can lead to several interactions of these compounds with other components of the dough, affecting its physicochemical and rheological properties. Based on the breads made from sunflower nugget flour, it was noted that as the nugget flour content increased, they acquired a darker color, less volume and a less aerated texture when compared to the control. Thus, the presence of chlorogenic acid in sunflower nugget flour, added to the reduction in the amount of wheat flour in these formulations, may be related to changes in the volume and texture of the breads. Regarding the breads made from the aqueous extract, they also showed a darker color due to the higher content of chlorogenic acid, but there was a smaller visual change in terms of volume and texture.

In order to corroborate these conclusions, Tables 1, 2 and 3 present the results obtained in the analysis of physical properties, porosity and texture of breads enriched with the extract rich in chlorogenic acid and with sunflower nugget flour. Regarding the specific volume (Table 1), as previously mentioned, it is observed that the volume of the breads decreased as the concentration of sunflower nugget flour increased. On the other hand, the breads enriched with the extract had a volume 0.30 cm³/g greater than the control bread. Similar results were found in Domingos (2014), who when applying green tea extract and yerba mate extract, which have chlorogenic acid in their phenolic composition, and introduced into wheat flour obtained specific volume values greater than the control (DOMINGOS, 2014). Regarding porosity (Table 2), the breads enriched with the extract showed a slightly different number and size of alveoli than the control, but even so, the difference was still minimal when compared to breads with higher concentrations of sunflower nugget flour. Furthermore, the relationship between the size and the number of alveoli of the breads with extract may have helped in the volume. Finally, Table 3 brings the results of the texture analysis of the breads, where the hardness refers to the force required to produce deformation, so a high hardness negatively influences the acceptance of the product (ESTELLER, 2007; PAZ, 2013). In the case of prepared breads, those enriched with the extract rich in chlorogenic acid had a hardness value very close to the control and lower than breads enriched with flour, which have increased hardness as the flour

		Control	Extract	10%	30%	60%
Physical properties	Loaf specific volume (cm³/g)	3,40	3,70	3,57	2,00	1,36
	Crumb moisture	42,97	43,87	44,97	39,33	43,31
	Crumb firmness	3,80	2,09	2,11	31,24	17,25

Table 1 - Results of the analysis of the physical properties of the prepared loaves of bread.

		Control	Extract	10%	30%	60%
Porosity	Nº of alveolus	50,75	64,50	23,63	79,33	93,50
	Alveolus size (mm²)	0,25	0,18	0,28	0,15	0,10
	Area (%)	39,09	39,07	42,30	35,50	28,17

Table 2 - Results of porosity analysis of prepared loaves of bread.

concentration increases (Table 3). The springiness and cohesiveness did not show great differences between breads with extract and those with nugget flour when compared to the control (Table 3). Regarding gumminess and chewiness, breads with extract showed more satisfactory results, while breads with nugget flour showed higher results.

		Control	Extract	10%	30%	60%
TPA	Hardness	168,50	162,95	148,03	692,83	2526,40
	Springiness	0,97	0,97	0,99	0,89	0,76
	Cohesiveness	0,67	0,69	0,68	0,58	0,47
	Gumminess	135,56	101,87	140,41	490,44	1262,12
	Chewiness	132,28	100,47	138,34	409,69	937,97

Table 3 - Results of texture analysis (TPA) of prepared loaves of bread.

Regarding the coloring of the breads, the tests carried out with natural colorants (paprika, annatto and turmeric) proved to be beneficial to mask the green color characteristic of the oxidation of chlorogenic acid in breads enriched with the aqueous extract. Furthermore, the addition of these colorants adds more value to the final product, both from a sensory and nutritional point of view, since such colorants have other health-beneficial compounds, such as flavonoids, phenolic acids, carotenoids, among others. In this context, although the food industry prefers neutral ingredients in terms of sensory attributes, this fact allows them to be used in a wider range of foods without impairing the quality and acceptance of the final product (WILDERMUTH; YOUNG; WERE, 2016).

CONCLUSIONS:

That said, based on the results obtained through this project, it can be concluded that the amount of chlorogenic acid found in breads enriched with the extract was good, even after cooking, noting a certain stability of the compound to thermal processing. Regarding the changes in the physical-chemical and sensory properties promoted by the presence of chlorogenic acid, the changes observed in breads made from the aqueous extract rich in chlorogenic acid were smaller when compared to the control and breads enriched with sunflower seed flour. Regarding the change in the color of the breads, which was the main change and one of the main obstacles of this product, the tests carried out with the natural colorants (annatto, paprika and turmeric) showed positive results. Thus, the use of an aqueous extract rich in chlorogenic acid obtained from the by-product of the production of sunflower oil together with natural colorants, adds value to the prepared breads, providing the consumer with a functional food with high potential for health benefits, in addition to providing a sustainable way of disposing of this by-product. However, further analysis is still needed to verify the acceptance of these products in the market.

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