PHYSICOCHEMICAL AND SENSORY CHARACTERIZATION OF CREAM CRAKER BISCUITS MADE WITH CHICKPEA FLOUR

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ABSTRACT

Chickpeas are a legume of the Fabaceae family, a source of proteins, lipids and carbohydrates, especially long-chain ones such as oligo and polysaccharides. Chickpea flour is considered nutritionally superior compared to refined wheat flour, showing itself to be an abundant source of protein. The use of mixed flours aims to partially replace wheat flour, aiming to improve the nutritional quality of food products and to meet the need of consumers for diversified products. The biscuits were made by mixing chickpea flour with wheat flour, in the proportions of 0%, 10%, 20%, 30% and 40% and other ingredients. Chickpea flour showed high levels of proteins, lipids and fibers, suggesting a high nutritional profile. The sensory analysis revealed that the color, aroma, and flavor attributes of the cookies were well evaluated, remaining within the hedonic preferences of "slightly liked" to "liked very much". Formulations with up to 40% added chickpea flour showed promising results in terms of texture and flavor, indicating a good receptivity on the part of consumers. The production of cream craker with chickpea flour can offer the food industry an opportunity to provide healthy and nutritious products.

Keywords: *Cicer arietinum L.* Mixed flour. Nutritional benefit. Salty biscuit. New products.

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INTRODUCTION

Chickpea (Cicer arietinum L.) is a legume of the Fabaceae family, originally from Asia Minor, from where it spread to several continents in antiquity. The grain ranks third in world grain production among the most important pulses (legumes with edible dry seeds) in the world, along with beans and peas (FAO, 2017). This grain is a source of proteins, lipids, and carbohydrates, especially long-chain ones such as oligo and polysaccharides, which metabolize more slowly in the body, having simple sugars such as glucose and sucrose in smaller proportions (Trindade, 2019).

Chickpeas have a great nutritional potential to be explored in order to minimize protein and mineral deficiencies in the population since in addition to the high protein content it is also a source of minerals such as P, Mg, Fe, K, Co and Mn) (Carneiro et al., 2017). The inclusion of legumes in the daily life of the population has beneficial physiological effects for the control and prevention of metabolic diseases such as diabetes mellitus, heart disease, and colon cancer (Kohajdová; Karovičová; Magala, 2011).

The approximate composition of chickpeas (g/100 g) can vary from 1.12 to 6.80 of lipids, 18.3 to 25.2 of proteins, 1.23 to 1.38 of soluble fiber, 14.1 to 23.2 of insoluble fiber, and 2.54 to 3.90 of total ash (Camargo et al., 2019).

Chickpea flour is considered nutritionally superior compared to refined wheat flour, showing itself to be an abundant source of protein of approximately (24.4% –25.4%) corresponding to twice that found in wheat flour (9.3% –14.3%) (Dandachy; Mawlawi; Obeid, 2019). Fernandes (2019), cited by Marques (2022), evaluating the characteristics of chickpea flour in his research, found that this flour has technological properties that demonstrate affinity with oil, water, and milk, which enables its use in formulations for various food products.

Studies show that the use of chickpea flour alone or associated with flours from other vegetable sources in the composition of bakery products is quite convenient (Arruda; Seville; Almeida, 2016). Mixed flours or flours composed of cereals, legumes and tubers have emerged on the market, in order to replace wheat flour in proportions for the production of baked goods without compromising the technological and sensory characteristics of the product (Cavallini et al., 2020) The intention of product enrichment is to improve the nutritional quality of food and human life, since the Brazilian population suffers from protein and mineral deficiencies.

It is also interesting the use of chickpea flour in the development of gluten-free food products, due to its functional properties of emulsification, foaming, gelling, high water and oil absorption capacity, and viscosity (Azeredo, 2022).

Thus, this work aimed to develop and characterize the physicochemical, nutritional and sensory properties of cream cracker cookies, made from chickpea flour, aiming at nutritional improvement and good sensory acceptance by the consuming public and diversifying eating habits.

THEORETICAL FRAMEWORK

Bakery products are foods that are widely consumed and known globally, and are considered a good source of nutrients and energy for the population (Cavallini et al., 2020). According to Lampignano et al. (2013) cited by Cavallini et al. (2020), the main ingredients used for the manufacture of bakery products are wheat flour, water, salt, and yeast. As essential components, wheat flour and water stand out, and the others can be added, such as: lipids, sugars, yeast, eggs, milk, flavorings and colorings, which will give the characteristics of the various types of product.

According to Oliveira, Pirozi and Borges (2008), the use of mixed flours aims to partially replace wheat flour, aiming to improve the nutritional quality of food products and to meet the need of consumers for diversified products. Until the 60s, the use of mixed flours had the objective of partially replacing wheat flour to reduce imports of this cereal (Arruda; Seville; Almeida, 2016).

Moraes and Teixeira (2021) reported that increased consumer awareness for a healthier dietary change encouraged the emergence of this new product niche, where even consumers who are not sensitive to gluten consider these foods to be of superior quality and healthier than those made of traditional wheat flour.

As stated by Azeredo (2022), the technique of replacing wheat flour constitutes a technological challenge in the production of bakery products, due to its rheological properties, since gluten plays a crucial role in the quality of the processing and the final product. These problems can be solved by using other types of combined flours, in order to adjust the specific characteristics in the desired formulation.

According to research by Cravo et al., (2023) chickpea flour is a potential ingredient for use in the development of a wide variety of gluten-free food products, due to its functional properties of emulsification, foaming, gelling, high water and oil absorption capacity, and viscosity.

Jacomelli (2021) in a research of biscuits with percentages of wheat flour and chickpea flour found satisfactory results for percentages of up to 30% of chickpea flour because they increased the nutritional parameters, without many differences from the standard sample. Cravo and Maradini Filho (2022) in a research with muffins made with different percentages of wheat flour and chickpea flour found an increase in protein and lipid values and a decrease in carbohydrates among the formulations with a higher percentage of chickpea flour, providing better nutritional quality and, in relation to sensory analysis, the results showed that the use of chickpea flour in the preparation of muffins is viable, for providing satisfactory sensory scores for most of the formulations tested.

According to studies carried out by other researchers, it is noted that the application of chickpea flour is increasingly present in the preparation of food products, presenting satisfactory results in replacing traditional flours, providing a wider range of bakery products for the diet of celiac people and for the vegan market that seeks a healthy diet through products of vegetable origin (Kanai, 2021).

In addition, it is crucial to examine the influence of different concentrations of this flour on the composition of bakery products, aiming to achieve optimal nutritional, sensory, and technological characteristics. Thus, the production of cream cracker cookies with chickpea flour can offer the food industry an opportunity to provide healthy and nutritious products, responding to the growing demand for functional and alternative foods.

MATERIAL AND METHODS

This work was developed at the Laboratories of Food Technology (LPA), Food Chemistry, Unit Operations and Sensory Analysis, of the Department of Food Engineering (CCAE/UFES) and at the Laboratory of Nutrition and Dietetics of the Department of Pharmacy and Nutrition (CCENS/UFES). Chickpeas (Cicer arietinum L.), wheat flour and other ingredients (margarine, sugar, salt, yeast and milk) purchased in the local commerce of the city of Alegre-ES were used.

OBTAINING CHICKPEA FLOUR

The flour was obtained by grinding the grains using a knife mill with a 0.50 mm mesh sieve, to obtain a fine flour, which was properly stored in 500 g plastic bags, vacuum-sealed and stored at room temperature (25 ºC) away from light and humidity until its use.

PHYSICOCHEMICAL CHARACTERIZATION OF CHICKPEA FLOUR

The chemical characterization of chickpea flour was carried out for water, ash, protein, lipid, crude fiber and carbohydrate content. The water content was determined by gravimetry after drying the sample in an oven at 105 °C (IAL, 2005). The ashes were quantified by gravimetry after complete incineration of the sample in muffle furnace at 550 ºC (IAL, 2005). The lipid content was determined in an intermittent Soxhlet extractor, using petroleum ether as a solvent (IAL, 2005). The total nitrogen content was determined by the modified Kjeldahl method, using a nitrogen digester and distiller system and multiplication factor of 6.25 for protein quantification (IAL, 2005). Crude fiber was quantified according to method 044/IV (IAL, 2005), based on acid digestion of the sample. Carbohydrates were determined by the difference method (Souci; Fachman; Kraut, 2000).

The granulometry of chickpea flour was determined according to methodology No. 66-20 adapted from the American Association of Cereal Chemists, for 100 g of sample (AACC, 1995). A set of sieves with (30, 40, 50 and 60) meshes, equivalent to (0.595, 0.420, 0.297 and 0.250) mm, was subjected to vibrating action for a period of 10 minutes. Then, each fraction was weighed separately and the results expressed as a percentage of material retained in each sieve.

To determine the pH, a solution was prepared with 5 g of flour sample in 50 mL of distilled water, which was stirred for 10 minutes in a magnetic stirrer. Next, the pH of the supernatant liquid was directly read using a digital pH meter (IAL, 2005).

After pH determination, the same solution was used to determine titratable acidity, adding 2 to 4 drops of phenolphthalein solution and titrating with 0.1 M sodium hydroxide solution, until pink color (IAL, 2005).

Flour color was measured by the CIEL*a*b* system, in colorimeter (Konica – Minolta CM-5). The coordinates analyzed were: L* or luminosity (black-0/white-100), a* (green -/red +) and b* (blue -/yellow +) (HUNTERLAB, 2013).

FORMULATION OF CREAM CRAKER COOKIES

The cookies were made from the mixture of wheat flour with chickpea flour in the proportions of 0%, 10%, 20%, 30% and 40%, in addition to margarine, sugar, salt, yeast and milk, after preliminary tests to define the best formulation.

DETERMINATION OF THE CHEMICAL COMPOSITION OF CREAM CRAKER COOKIES

The determinations of water content (method 012/IV), lipids (method 032/IV) and ash (method 018/IV) were carried out in the ready-to-eat biscuits, according to the methodology proposed by the Adolfo Lutz Institute (IAL, 2005).

ANALYSIS OF THE COLOR OF CREAM CRACKER COOKIES

The color of the cream craker cookies was measured by the CIEL*a*b* system, in colorimeter (Konica – Minolta CM-5). The coordinates analyzed were: L* or luminosity (black-0/white-100), a* (green -/red +) and b* (blue -/yellow +) (HUNTERLAB, 2013). The overall color difference between the cream crakers of each of the formulations was also calculated, compared to the standard cream craker (100% wheat flour) by the parameter ΔE*, according to equation 1:

$$\Delta E* = \sqrt{(\Delta a *^2 + \Delta b *^2 + \Delta L *^2)} \quad (1)$$

ANALYSIS OF THE INSTRUMENTAL TEXTURE OF CREAM CRACKER COOKIES

The instrumental texture properties of the cream crakers were evaluated using the Brookfield® Texture Analyzer (Model CT3), according to the methodology used by Mareti, Grossmann and Benassi (2010). Each sample of cream craker was arranged horizontally on a platform and cut in half with an HDP/BSK knife-type probe, blade set with knife, with pre-test, test and post-test speeds of 5.0 mm/s, trigger force of 0.20 N and 5.0 mm distance, recording the breaking or breaking force (hardness). Three determinations were made for each formulation of cream craker, in randomly selected samples. The samples were analyzed at room temperature (25 ºC) and the texture parameters determined were: hardness, fracturingability, elasticity, adhesiveness and chewiness. Data collection was performed with the aid of the Texture Pro CT V 1.4 Build 17 software.

DETERMINATION OF APPARENT AND SPECIFIC VOLUME OF CREAM CRACKER COOKIES

The apparent volume, in cm3, was determined by the method of displacement of millet seeds after cooling the roasted cream craker (El-Dash; Camargo; Diaz, 1982). The specific volume was calculated by dividing the apparent volume found for the cream craker (cm3) by its mass (g) (El-Dash; Camargo; Diaz, 1982).

PHYSICAL ANALYSIS OF SPREADING THE CREAM CRACKER COOKIES

The spread test was performed according to the AACC 10-50-05 methodology, a modified "Cookie Spread Test", in which six randomly selected cream craker cookies were stacked and aligned to remove the means of thickness (E) and length (C), and then the scattering factor (C/E) WAS CALCULATED (AACC, 1995).

SENSORY EVALUATION OF CREAM CRAKER COOKIES

The sensory analysis of the cream craker was performed through the acceptance test, according to Reis and Minim (2010). Each sample was tested by a group of 100 untrained evaluators, who wrote down on a card the impression that the product, as a whole, caused them. For this test, a 9-point hedonic scale was used (9 = extremely liked, 5 = indifferent, 1 = extremely disliked). The numerical values obtained were statistically analyzed. Cream craker samples coded with three-digit numbers were served randomly and monodicly in individual booths in the Food Sensory Analysis Laboratory and accompanied by mineral water at room temperature to clean the palate between evaluations.

In the sensory acceptance analysis form applied to the evaluators, the purchase intention test (IAL, 2005 – nº 167/IV) was also presented, in which the evaluators evaluated whether they would "certainly buy the product" (5), "possibly buy the product" (4), "perhaps buy or perhaps not buy" (3), "possibly not buy the product" (2) and "certainly would not buy the product" (1).

This research was approved, according to Opinion No. 6.194.213, by the Ethics Committee of the Alegre-ES Campus, of the Federal University of Espírito Santo, regarding ethical care for consumption by human beings. The evaluators adhered to the sensory analysis by signing the Informed Consent Form.

EXPERIMENTAL DESIGN AND STATISTICAL ANALYSIS OF DATA

To determine the physicochemical characteristics of chickpea flour, the results were analyzed by means of descriptive statistics, obtaining the mean and standard deviation for each analysis in triplicate.

To compare the effect of the different levels of chickpea flour in relation to the physical and physicochemical characteristics of the cream craker biscuits, the experiment was conducted in a completely randomized design, with five levels of chickpea flour concentration (0%, 10%, 20%, 30% and 40%) and three replications, totaling 15 experimental units. The means of the results of the analyses were statistically analyzed by means of Analysis of Variance (ANOVA) and comparison of means, adopting a significance level of 5% of probability.

The analyses of sensory acceptance and purchase intention of the cream crakers were carried out using a randomized block design with 100 evaluators, and the data obtained were analyzed through Analysis of Variance and test of means, adopting a significance level of 5% probability (Reis; Minim, 2010). Statistical analyses were performed with the aid of the GENES program (Cruz, 2006).

RESULTS AND DISCUSSION

PHYSICOCHEMICAL ANALYSIS OF CHICKPEA FLOUR

Table 1 shows that chickpea flour had a percentage of 89% of particles with granulometry between 0.600 and 0.300 mm in diameter, which can be considered a coarse flour, but did not compromise the stages of biscuit preparation.

Table 1 - Granulometry of chickpea flour:

	Opening the sieve				
	0.600 mm	0.425 mm	0.300 mm	0.250 mm	< 0.250 mm
%	58,90	16,24	14,23	6,86	0,87

Source: Production by the authors themselves (2024).

According to MAPA's Normative Instruction No. 08 of June 3, 2005, 95% of wheat flour must pass through a 0.250 mm particle size sieve (Brasil, 2005). However, ANVISA's RDC No. 711, of July 1, 2022, does not determine any specific particle size for flours in general (Brasil, 2022).

The results obtained in relation to the physicochemical composition of chickpea flour are presented in Table 2.

Table 2 - Proximate composition and physicochemical characteristics of chickpea flour

Parameters	Mean ± standard deviation*	
	boo**	Bs**
Water content (g/100)	11.62 ± 0.04	--------
Proteins (g/100)	22.89 ± 0.06	25.90 ± 0.07
Lipids (g/100)	10.15 ± 0.71	11.49 ± 0.80
Ashes (g/100)	3.04 ± 0.03	3.44 ± 0.03
Fibers (g/100)	35.16 ± 3.56	39.79 ± 4.02
Carbohydrates (g/100)	17.14 ± 4.37	19.38 ± 3.92
ph***	6.43 ± 0.01	
Acidity (mL NaOH/100g)	8.25 ± 0.67	
L*	87.16 ± 0.17	
the*	2.01 ± 0.13	
b*	20.14 ± 0.37	

*Average of three repetitions; **bu = wet base; bs = dry basis; pH = dimensionless.
Source: Production by the authors themselves (2024).

Based on the legislation in force in Brazil for flours, cereal starch and bran, RDC No. 711/2022 (Brazil, 2022), the maximum moisture content allowed for flours is 15%. The chickpea flour analyzed had an average water content of 11.62%, being within the specific legislation.

The average protein content of chickpea flour was 25.90 g/100 g on a dry basis. Fernandes et al. (2022) analyzed the proximal composition of chickpea flour and obtained a protein content of 15.74 g/100 g (bs), a value lower than that found in this study. In another study, Kanai (2021), obtained a protein content of 18.99 g/100 g (bs), a value also below this study.

The mean lipid value found was 11.49 g/100 g (bs), which is higher than that found by Kanai (2021), of 5.34 g/100 g (bs) and Fernandes et al. (2022) of 1.90 g/100 g (bs).

The average ash found in chickpea flour was 3.44 g/100 g (bs). The mean ash found by Fernandes et al. (2022) was 2.66 g/100 g (bs), a value lower than that found in this study. On the other hand, Kanai (2021) obtained 3.30 g/100 g (bs), a value closer to the present study.

In this study, a value of 39.79 g/100 g of fiber (bs) was found, which is higher than that found by Fernandes et al. (2022), of 10.18 g/100 g (bs), and Kanai (2021) of 16.85 g/100 g (bs).

The mean pH value of chickpea flour was 6.43. Ladjal and Chibane (2015) obtained a pH value of 6.41 in their study, which is almost identical in both studies. The acidity found was 8.25. Ladjal and Chibane (2015) found an acidity value of 4.17, a value lower than that found in this work.

Regarding color, the flour in this study was subjected to instrumental color measurements, with mean luminosity values (L*) of 87.16, a* of 2.01 and b* 20.14, close to the values observed by Sofi et al. (2023), who obtained L* of 83.3 to 87.0, a* of 1.3 to 2.5 and b* of 13.7 to 18.6, indicating that it is a flour with a light hue and color tending to yellow (b*+) reddish (a*+).

ANALYSIS OF THE CHEMICAL COMPOSITION OF BISCUITS

Table 3 presents the results of the analyses of the chemical composition of the cream cracks of the different treatments.

Table 3 – Results of the moisture, ash and lipid analyses of the biscuits on a dry basis ($g.100\ g^{-1}$)

Treatments	Water Content (bu)	Lipids (bs)	Ashes (bs)
F0	9.75 c	9.44 c	3.47 b
F10	10.30 to	9.71 c	3.87 abs
F20	9.61 c	11.16 to	3.94 abs
F30	9.68 c	10.23 BC	4.11 AB
F40	9.95 b	11.08 abs	4.58 to

*Average of three repetitions; bu = wet base; bs = dry basis. F0=100% wheat flour; F10=10% chickpea flour; F20=20% chickpea flour; F30=30% chickpea flour; F40=40% chickpea flour.
Means followed by the same letter in the columns did not differ statistically from each other according to Tukey's test, at a significance level of 5% ($p > 0.05$).
Source: Production by the authors themselves (2024).

It was observed that there was a significant difference ($p \leq 0.05$) for the water content, except between the formulations F0, F20 and F30, ranging from 9.61% (F20) to

10.30% (F10). Compared to the study by Junior, Menezes and Nascimento (2021) with biscuits enriched with cassava starch, the results differed greatly, ranging from 2.11 to 2.35; compared to the work of Cravo and Maradini Filho (2024) they also differed, ranging from 4.72 to 5.87%. However, the values found in the present study still provide microbiological stability to the cookies.

For the lipid content, a significant difference was observed by Tukey's test ($p \leq 0.05$) between the formulations, except for the F0 and F10 treatments, ranging from 9.44% (F0) and 11.16% (F20). It was expected to obtain increasing values of the lipid content of the biscuits with the increase in the amount of chickpea flour in the formulations, since chickpea flour has a higher lipid content than wheat flour.

In relation to the ashes, there was also a significant difference ($p \leq 0.05$) only between the F0 and F40 treatments, ranging from 3.47% (F0) to 4.58% (F40).

ANALYSIS OF THE COLOR, TEXTURE AND SPREADING FACTOR OF THE BISCUITS

The results of the analysis of the parameters of color, texture, specific volume and scattering factor of the biscuits are presented in Table 4. It was observed that there was a significant difference ($p \leq 0.05$) between the mean values of the treatments only for the parameters of fracturtability and scattering factor of the biscuits.

Table 4 – Results of the analysis of the parameters of color, texture, specific volume and spreading factor of the biscuits.

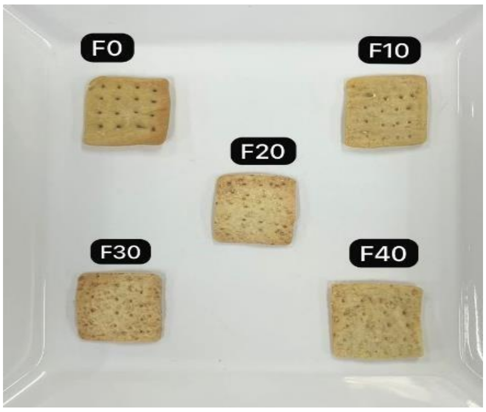
Treatments	L*	the*	b*	ΔE*	Hardness (N)	Fractureb. (N)	Spec Vol. (cm^3/g)	Factor Spread. C/E
F0	66.86a	8.61a	29.36 a	----	68.18a	63.32a	6.66a	8.17 cd
F10	67.18a	7.20A	28.63 a	4.16a	65.99a	44.40ab	6.84a	7.77d
F20	68.87a	7.18a	28.36 a	2.81a	78.08a	49.37ab	6.07a	8.90 b
F30	71.45a	6.81a	29.02 a	5.24a	43.10a	15.92 b	6.00A	8.82 bc
F40	68.50a	7.01a	28.86 a	3.32a	65.97a	60.40a	7.22a	9.88 to

Means followed by the same letter in the columns did not differ statistically from each other according to Tukey's test, at a significance level of 5% ($p > 0.05$).

Source: Production by the authors themselves (2024).

In this study, there was no significant difference ($p \leq 0.05$) between the means of the treatments for the color parameters L* (66.86 to 68.87), a* (6.81 to 8.61) and b* (28.36 to 29.36), indicating that all cookies had a slightly dark color, tending to a reddish yellow, as can be seen in Figure 1. The global color difference (ΔE*) quantifies how much a sample deviates from the standard sample in terms of color perception, that is, how noticeable this difference is to human eyes (Ramos; Gomide, 2007). According to the classification provided by Konica Minolta, a color difference (ΔE*) ranging from 3 to 6 is considered easily perceptible by consumers (Evangelista et al., 2011), which does not happen in the present study, as shown in Figure 1.

Figure 1 – Image of *cream crackers* made with different percentages of replacement of wheat flour by chickpea flour.



Source: Production by the authors themselves (2024).

It was observed that there was a significant difference ($p \leq 0.05$) between the mean values of the treatments for the fracturability parameter of the biscuits. The formulation with the addition of 30% chickpea flour (F30) differed statistically from the standard formulations (F0) and with the addition of 40% chickpea flour (F40), showing that the biscuits of the F30 formulation were more fragile (crunchy) when compared to the biscuits of the F0 and F40 formulations, but did not differ in relation to the F10 and F20 formulations. However, the formulation (F40) did not differ from the standard formulation (F0) and, therefore, we can infer that the addition of up to 40% chickpea flour did not significantly alter the texture properties of the biscuits. In the work by Cravo and Maradini Filho (2024) with cookie-type cookies, unlike this study, fracturing did not differ statistically, but Jacomelli (2021) observed significant differences only from the addition of 45% chickpea flour to the cookies, so up to 30% there was no statistical difference, thus defining that up to this percentage the cookies were less fragile than with 45% and 60%.

Regarding the spreading factor of the biscuits, it was found that the treatments F0 (control) and F10 presented the lowest values, while the treatment F40 presented the highest value, indicating that from the addition of 20% of chickpea flour, the biscuits presented a higher spreading factor in relation to the biscuit made only with wheat flour, mainly due to the decrease in height in relation to length. This behavior indicates that chickpea flour may have interfered in the rheological behavior of the dough, causing it to suffer greater extensibility and less elasticity during processing, due to the decrease in gluten content and, consequently, the decrease in the strength of wheat flour (Assis et al., 2009). It can be considered that the addition of chickpea flour reduces the viscoelastic network formed by gluten, due to the absence of this protein in this legume. Spreading is an important factor for the purchase of this product, as it influences its appearance, the main attribute observed by consumers. In addition, spreading control is decisive in industrial processing, as it determines whether the product will fit inside its packaging. Biscuits with too high or too low expansion factor cause problems in the industry, resulting in products with too small size or too high weight (Ferreira et al., 2009). In the study by Kanai (2021) there was no statistical difference between the treatments for the spreading factor, as well as in the work by Jacomelli (2021), but in the study by Cravo and Maradini Filho (2024) there was a statistical difference, as well as in the present study.

SENSORY ANALYSIS OF BISCUIT SAMPLES

Table 5 shows the mean scores of the sensory evaluation of the cookies regarding the attributes color, aroma, flavor, texture and overall impression, as well as purchase intention. It was observed that there was a significant difference ($p \leq 0.05$) between the mean values for the sensory attributes aroma, flavor, texture and overall impression and also for the purchase intention. Only the color attribute did not present a statistical difference between the treatments, being between the hedonic terms "moderately liked" and "liked a lot".

Table 5 – Mean scores of sensory acceptance and purchase intention of the samples of biscuits made with chickpea flour

Treatments	Colour	Aroma	Flavor	Texture	Global Impression	Purchase intent
F0	7.2 to	6.4 bc	6.0 b	5.2 b	5.9 b	2.8 b
F10	7.2 to	6.3 c	5.4 c	4.6 b	5.4 b	2.5 b
F20	7.2 to	6.7 ABC	6.5 AB	6.5 to	6.4 to	3.2 to
F30	7.5 to	6.9 to	6.7 to	6.2 A	6.6 to	3.2 to
F40	7.4 to	6.8 abs	6.5 AB	6.6 to	6.5 to	3.4 to

Means followed by the same letter in the columns did not differ statistically from each other according to Tukey's test, at a significance level of 5% ($p > 0.05$).

Source: Production by the authors themselves (2024).

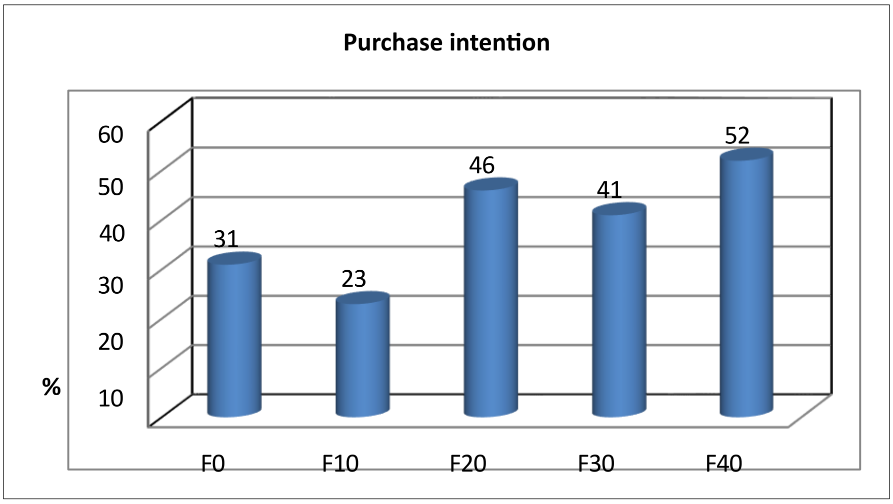
As we can see for the aroma parameter, only treatments F10 and F30 differed statistically ($p < 0.05$), and treatment F10 received the lowest sensory score. Regarding the flavor attribute, there was a significant difference only between the F0, F10 and F30 treatments, with the formulations F20, F30 and F40 as the most accepted, being located between the hedonic terms "I liked it slightly" and "I liked it moderately". Regarding texture, overall impression and purchase intention, the F0 and F10 treatments differed significantly from the F20, F30 and F40 treatments, with higher scores for the treatments with the highest chickpea flour content.

Cravo and Maradini Filho (2024) conducted a research on cookies prepared with different proportions of whole wheat flour and chickpea flour. The sensory analysis indicated that it is feasible to use chickpea flour in the preparation of cookies up to 40% of the addition of chickpea flour because it provides satisfactory sensory scores and good purchase intention for most of the formulations tested. Cravo et al., (2023) worked on the elaboration of muffins with different formulations of wheat flour and chickpea flour, concluding, from the results of the sensory analysis, that it is possible to use chickpea flour in the elaboration of muffins, as no significant differences ($p>0.05$) were found between the treatments F0 (control) to F40 (40% addition of chickpea flour) in the color attributes, aroma, taste and overall impression. The results were between the hedonic categories "I liked it slightly" and "I liked it a lot".

The purchase intention test evaluates the consumer's willingness to purchase a product, using the attributes "would buy" or "would not buy". A structured 5-point scale was used for this evaluation, in which consumers rated their intentions as: "would certainly buy the product" (5), "possibly buy the product" (4), "maybe buy or maybe not buy the product" (3), "possibly would not buy the product" (2) and "certainly would not buy the product" (1).

Regarding purchase intention, it can be observed in Table 5, as well as in Figure 2, that the formulations F20, F30 and F40 obtained the highest scores, being classified as maybe would buy or maybe would not buy the product, while F0 and F10, formulations with the lowest levels of chickpea flour, obtained lower scores classified as possibly would not buy the product.

Figure 2 – Purchase intention chart (class: would certainly buy/possibly buy) for the five formulations of cookies elaborated



Source: Production by the authors themselves (2024).

Therefore, it was observed that the F0 and F10 treatments, standard formulation and with 10% chickpea flour instead of wheat flour, were the least sensorially accepted by the evaluators and showed the lowest percentages of consumers who would certainly/possibly buy the product.

CONCLUSION

The analysis of chickpea flour revealed that this legume has high levels of protein, lipids and fiber, suggesting a good nutritional profile. In addition, color tests indicated that the flour has a light hue, with a tendency toward yellow. Therefore, chickpea flour is an excellent option for the development of food products, meeting the growing demand for functional and healthy foods. This reinforces the importance of research and development of new ingredients that can offer nutritional benefits.

In relation to the biscuits, it was found that the lipid content was higher for the formulations F20, F30 and F40, with a higher amount of chickpea flour as expected, due to the higher amount of lipids present in this flour. The water content of the biscuits was within the established standards for microbiological stability.

The sensory analysis revealed that the color, aroma, and flavor attributes of the cookies were well evaluated, remaining within the hedonic preferences of "slightly liked" to "liked very much". Therefore, chickpea flour can be considered a viable alternative for the development of bakery products with nutritional appeal and differential in the market, evidencing the feasibility of using this flour in the preparation of biscuits, partially replacing wheat flour without compromising the sensory acceptance and technological characteristics of the products. Formulations with up to 40% added chickpea flour showed promising results in terms of texture and flavor, indicating a good receptivity on the part of consumers.

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