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Egg replacement by chickpea aquafaba in sponge cake: physical properties and sensory analysis

Substituição de ovos por aquafaba de grão-de-bico em bolo de método espumoso: propriedades físicas e análise sensorial

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ABSTRACT

Objective
To study the effect of chickpea aquafaba as an egg replacer on the physical properties of sponge cakes.

Methods
The traditional sponge cake recipe was adapted to replace eggs with chickpea aquafaba. The analyses were conducted in two stages: initially, the control and test formulations were evaluated for physical properties (consistency, mass, height, volume, specific volume, density, and moisture of the cakes). Acceptance was studied using a seven-point structured hedonic scale (n=50) and the acceptability index was calculated. The t-test and Wilcoxon test were applied to compare means, with a significance level set at 5%.

Results
The control formulation showed statistically higher values for the evaluated physical parameters, except for specific volume, as well as a higher mean score in the sensory analysis. The acceptability index demonstrated acceptance of both formulations, with results of 84.57% for the control formulation and 78.28% for the test formulation.

Conclusion
Even though it is not possible to completely replace eggs with chickpea aquafaba, the test sponge cake presented physical parameters similar to those of the control formulation, with satisfactory results in terms of sensory quality, thereby demonstrating the potential of chickpea aquafaba.

Keywords: *Cicer arietinum*. Egg. Egg hypersensitivity. Legumes. Sponge cake. Vegetarianism.

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RESUMO

Objetivo

Estudar o efeito da aquafaba de grão-de-bico como substituta de ovos nas propriedades físicas de bolo de método espumoso.

Métodos

A receita tradicional de bolo de método espumoso foi adaptada para a substituição de ovos por aquafaba de grão-de-bico. As análises ocorreram em duas etapas: inicialmente, as formulações controle e teste foram avaliadas quanto às propriedades físicas (consistência da massa crua, massa, altura, volume, volume específico, densidade e umidade dos bolos). Na sequência, as formulações foram submetidas à análise sensorial para o teste de aceitação com o uso de uma escala hedônica estruturada de sete pontos (n=50) e calculou-se o índice de aceitabilidade. A comparação entre médias foi feita por meio do t-test e Wilcoxon, aceitando-se 5% de significância.

Resultados

A formulação controle apresentou valores estatisticamente maiores para os parâmetros físicos avaliados, exceto para volume específico; assim como maior média na análise sensorial. O índice de aceitabilidade demonstrou aceitação de ambas as formulações, com resultado de 84,57% para a formulação controle e 78,28% para a formulação teste.

Conclusão

Embora não seja possível substituir completamente os ovos pela aquafaba de grão-de-bico, o bolo de método espumoso testado apresentou parâmetros físicos semelhantes à formulação controle, com resultados satisfatórios em termos de qualidade sensorial, demonstrando o potencial da aquafaba de grão-de-bico.

Palavras-chave: Cicer arietinum. *Ovo. Alergia a ovo. Leguminosas. Pão-de-ló. Vegetarianismo.*

INTRODUCTION

Due to environmental or health concerns, the number of individuals who prefer, or need, to eliminate the consumption of ingredients of animal origin has grown. The search for healthy and safe food is stimulating the development of products for people with allergies and intolerances, but also for vegetarians and vegans. In this context, finding substitutes for foods of animal origin meets a growing demand [1,2].

Many preparations, such as cakes, breads and desserts, are formulated with eggs, which provide sensory characteristics such as color, softness and texture [3]. Highly soluble proteins, with the capacity to form foam, are responsible for various culinary applications, as well as lecithin and fat, which provide interesting culinary effects, such as emulsification, thickening and softness [4].

Other ingredients have been used as egg substitutes in the preparation of cakes, such as legumes, hydrocolloids, emulsifiers, chia seeds, linseed and some fruits, such as apples and bananas. These foods can contribute to desirable characteristics in cooking, such as structure formation, volume, moisture, texture and gas retention [5]. However, making cakes using a foaming method with these ingredients proves to be an obstacle, as they cannot satisfactorily simulate the aeration power provided by eggs.

However, this property is present in culinary preparations using chickpea aquafaba (*Cicer arietinum L.*, CA). From the Latin *aqua* (water) and *faba* (*Fabaceae* - legume family), aquafaba is the slightly viscous liquid resulting from the cooking water of legumes such as peas, beans, chickpeas, lentils and soybeans, or the liquid from canning them [6-10]. The first author to report a study on aquafaba as an egg white substitute was Jöel Roessel, in 2014. Subsequently, it became a popular ingredient in the vegan community for replacing eggs and milk, since it has the ability to foam, emulsify, bind and thicken [3,8].

The study of CA gained prominence in 2018, with publications on its chemical characterization [6,11], culinary applications [8,12-14] and studies highlighting the sustainability associated with the use of this ingredient [15]. Recent studies have explored the use of aquafaba in culinary preparations as an egg substitute in cake [5,16-18], meringue [19,20], mayonnaise [21-23] and mousse recipes [24]. Other studies have investigated the effects of processing methods [25], such as the use of ultrasound [6,10], drying [26] and freeze-drying [27], the assessment of nutritional composition [28], foaming [2,29] and emulsifying properties [30], the characterization of the aromatic profile of aquafaba subjected to fermentation [31] and the contribution of polysaccharides to foaming and emulsifying properties [32]. Furthermore, literature highlights that chickpeas have become a reference in the preparation of aquafaba because they have shown greater potential for simulating the technological characteristics of eggs in preparations [1].

However, few studies have evaluated the use of CA produced from the cooking of chickpeas in the preparation of cakes prepared using the foaming method. This ingredient is not only an alternative to meet the demands of people with dietary restrictions or who are concerned about environmental issues, but it also represents an advantage as a food by-product given the multifunctionality of aquafaba and the reduction of waste. The aim of this work was to study the effect of replacing eggs with CA on the physical properties of cakes prepared using the foaming method and to analyze the acceptability of the formulations through sensory analysis.

METHODS

Production of Chickpea Aquafaba

The Chickpea Aquafaba (CA) was produced by cooking three brands of dried chickpeas, obtained from the local market in Santos (São Paulo, Brazil), according to the procedures described by Medeiros and Rodrigues [33]. The use of different brands aimed to reduce potential variations inherent to grain characteristics, thereby ensuring greater standardization of the formulation. Initially, grains from each brand (~ 250 g) were washed in running water and soaked in filtered water (500 mL) for 6 hours at room temperature (grain:water ratio ~ 1:2, w/v). The water was discarded and the grains were cooked under pressure with filtered water (875 mL) (grain:water ratio ~ 1:3.5, w/v) for 20 minutes, on a gas stove (Fischer, Brazil). After cooking, the grains were stored with the cooking water at 4°C for 18 hours, and then drained; the CA produced by cooking the three brands was combined (~ 998 g) and used to prepare the cakes, without any additional concentration step.

The formulation for preparing aquafaba followed a previously published protocol, which contains data on chemical composition and pH, among other information [34].

Control formulation

For the preparation of the traditional recipe, herein referred to as the Control Formulation (CF) of the Foaming Method Cake (FMC – sponge cake), the Brazilian sponge cake batter formulation described by Costa et al. was adapted [35]. The CF was prepared with chicken eggs (150 g), refined sugar (225 g), filtered water (150 g), refined wheat flour (165 g) and baking powder (7 g). To optimize the culinary process, the adaptation of the formulation was in relation to the preparation method, with the beating of the whole eggs.

Test formulation

To define the best amount of aquafaba for the egg-free cake, six formulations were tested using CA as a substitute for chicken eggs, with concentrations ranging from 50% to 165% in relation to the weight of the eggs, as described in Table 1. The substitution levels were defined empirically, using a progressive range to evaluate the effects of increasing CA on batter aeration and cake structure. The other ingredients were kept in the same quantities as those used in the CF. Sunflower oil (13 g) was added to the Test Formulation (TF), to simulate the amount of lipids present in the eggs in the CF.

Table 1 – Amount of chickpea aquafaba used as an egg substitute in the egg-free Test Formulations.

Test formulation	Amount of aquafaba (g)	Percentage in relation to the weight of the eggs (%)	Percentage in relation to wheat flour (%)
TF 1	75	50	123.75
TF 2	85.5	57	141.07
TF 3	123.7	82	204.10
TF 4	165	110	272.25
TF 5	206.2	137	340.23
TF 6	247.5	165	408.37

Preparation of FMC samples – CF and TF

To obtain the formulations of FMC, chicken eggs (CF) or CA (TF) were beaten using a hand mixer (Bellagio Neve; 220V; 340W; Britania) at high speed (speed 4) for 15 minutes, until an aerated and consistent mixture was formed. Then, refined sugar was gradually added to both formulations and sunflower oil was added to the TF (with the mixer at speed 3). Using a wire whisk, the filtered water was incorporated into the mixture together with the refined wheat flour and baking powder. Each batter was placed in an English cake tin (30 cm x 10.3 cm x 8.9 cm) greased with sunflower oil and floured with wheat flour. The batters were baked at 160 °C for 32 minutes in a preheated oven (multiple cooking; Prática Technicook System combination oven). The samples were cooled at room temperature for 1 hour before analysis.

Photographic record

The image of the CF cake and all the TF cakes was recorded. The image of the CF and the TF that best simulated their appearance was also recorded, but in two ways: from above and from three slices obtained at equidistant points, positioned against a 1 cm graph paper scale.

Analysis of the physical properties of the cakes

The analysis of the physical properties of the cakes was carried out using three independent units of each formulation – CF and TF that best simulated their appearance. For the moisture analysis of the formulations, three new independent cakes were produced, maintaining the same preparation conditions.

The analysis of the physical properties of the cakes is described below, and was carried out in triplicate. To define the results, the mean and standard deviation were calculated.

Consistency of the raw batters of the formulations

The consistency of the batters was estimated using the linear spreading method, as described below: after formulation, a 100 g sample of the batters was kept in the refrigerator for 5 minutes. After this time, a diagram of concentric circles was used to estimate the spread of the samples, which were placed entirely within a plastic ring. The measurement of four equidistant points was used to estimate the average spreading 1 minute after removal from the ring [36].

Mass, height, volume, specific volume, density and moisture of cakes

The mass (g) of the cakes was determined after complete baking and resting for one hour in an open environment on a gridded surface. The volume (cm^3) was determined by the displacement method – leveled millet seeds were placed in a first container up to its edge; in a second equal container, each cake was positioned and covered by the seeds from the first container up to its edge; the remaining seeds were measured using a graduated cylinder [37]. The division of the volume, estimated in cm^3, by the weight measured in g, was used to calculate the specific volume (cm^3/g). The average height of the cakes was estimated to the nearest millimeter using a ruler, by taking measurements at four equidistant points. The density of the raw batters was calculated by dividing the mass (g) by the volume (cm^3).

The moisture content of the samples was determined according to method 920.39 of the Association of Official Analytical Chemists [38]. In triplicate, 10 g of cake cut into small pieces were distributed in porcelain capsules, dehydrated overnight in an oven (microprocessor drying oven – Q317M43, Quimis) at 105 °C, cooled in a desiccator to room temperature and weighed on an analytical balance to determine moisture by difference.

Sensory analysis

The sensory analysis was approved by the university's Research Ethics Committee (REC) (approval No.: 53573321.1.0000.5505), and was conducted with untrained volunteers, adults of both sexes, members of the academic community, recruited by means of invitations on *campus* bulletin boards. All panelists were informed about the research procedures and agreed to participate by signing a Free and Informed Consent Form (FICF). The exclusion criteria were having any restrictions, allergies or intolerances to any of the components in the formulations, not being a member of the academic community and/or not agreeing to the FICF.

Thus, the sensory analysis of the CF and TF that best simulated their appearance was conducted focusing on overall acceptability through an affective test using a seven-point structured hedonic scale, in which point 7 corresponded to "I liked it very much" and point 1 to "I disliked it very much". For this purpose, portions of the formulations weighing between 26 and 31 g were coded with three random digits and offered with a glass of water and the sensory analysis form to the panelists, who were previously informed about how to proceed with the analysis. The analysis was performed by 50 panelists, a number higher than the minimum required for the analysis of a product by affective tests [39], in a laboratory with individual and appropriate cabins, in a space with climate control and air flow.

With the hedonic scale values assigned by the panelists, the acceptability index (AI) was calculated according to the following equation [40]:

$$AI\ (\%) = A / B \times 100$$

where:

A: the average grade obtained.

B: the maximum grade awarded.

Samples with an AI above 70% were considered accepted [41].

Perception of the panelists

The panelists were invited to provide qualitative feedback on their perception of the formulations. Thus, it was possible to identify the perception of the panelists regarding the sensory characteristics from the spontaneous records made on the sensory analysis sheets. An initial reading was conducted, followed by the extraction of keywords to establish five categories: typical texture, pleasant taste, sweetness, adequate moisture and overall appearance; followed by a second stage with data exploration. These categories were created in such a way as to be mutually exclusive [42] and the third stage consisted of analyzing the results, which considered how many times each category was evoked per sample.

Statistical analysis

Statistical analysis was carried out using R Core Team software. To compare the groups (CF and TF) and estimate the difference between the physical properties of the preparations and the mean scores from the sensory analysis, the t-test and Wilcoxon test were used, respectively. The significance level adopted was set at 5%.

RESULTS

Definition of the test formulation

The six TF had chicken eggs replaced by CA in different proportions (ranging from 50% to 165% in relation to egg weight). Thus, with the formulations prepared, it was possible to observe that the greater the amount of CA used in the formulations, the more uncharacteristic the cakes became, reducing their resemblance to a foaming method cake, with modifications to the crumb structure and shape. As can be seen in Figure 1 (a), the sample that presented an appearance closest to the CF was the TF with 50% CA, which was subsequently chosen to be analyzed according to the proposed physical properties and was included in the sensory analysis.

Photographic record

The photographic record of the cakes from above (Figure 1b) and three slices obtained at equidistant points (Figure 1c), positioned against a 1 cm graph paper scale, made it possible to analyze the difference in crust color and height, between the cake formulations. The coloring of the CF was more intense, as well as having a greater height compared to the TF.

Physical properties

The results of the physical properties of the CF and the TF are shown in Table 2. According to the parameters evaluated (raw batter consistency, baked batter, height, specific volume and

moisture), the CF showed higher values for all the analyses, except for specific volume. It can be seen that there was a statistically significant difference between the formulations, except for the volume of the cakes (p>0.05).

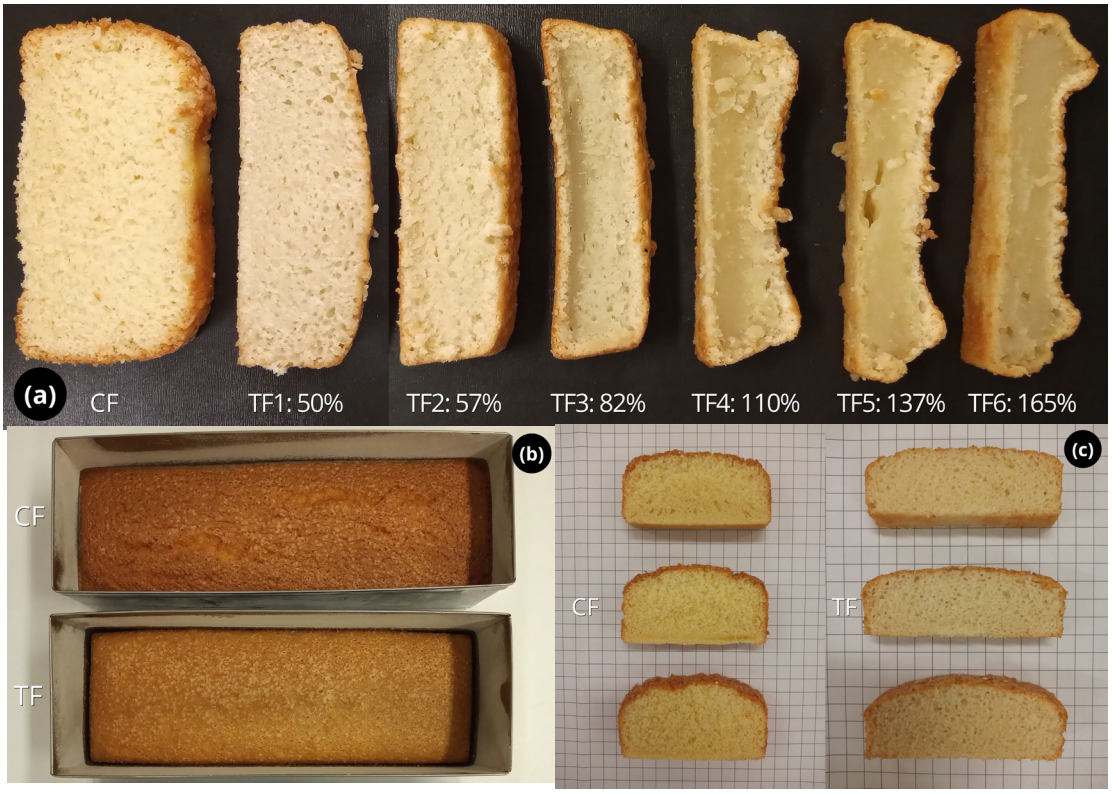


Figure 1 – (a) Control Formulation (CF) and Test Formulations (TF) made with increasing levels of chickpea aquafaba. (b) Top view of the cake with the Control Formulation (CF) and the Test Formulation (TF) that best simulated its appearance (TF1-50%). (c) View of three slices at equidistant points of the CF and TF cakes.

Table 2 – Physical properties of the Control Formulation and the Test Formulation that best simulated its appearance (n=3).

Analysis	CF		TF		p-value*
	M	SD	M	SD	
Raw batter consistency (cm)	10.02	0.13	7.94	0.04	0.001
Raw batter (g)	657.33	3.06	592.67	3.21	<0.001
Baked batter (g)	585.67	1.53	522.33	3.51	<0.001
Cake height (cm)	4.84	0.49	3.56	0.23	0.030
Cake volume (cm^3)	1.247	30.55	1200	10	0.107
Specific cake volume (cm^3/g)	2.13	0.06	2.30	0.03	0.018
Cake density (g/cm^3)	1.38	0.05	1.01	0.04	0.001
Moisture (%)	39.93	0.42	37.07	0.28	0.001

Note: *t-test. CF: Control Formulation; M: Mean, SD: Standard Deviation; TF: Test Formulation.

Sensory analysis

The panelists who took part in the sensory analysis (n=50) were aged between 18 and 54, with an average of 22.4 years, and 88% (n=44) were female. The overall acceptability index for the

CF was 84.57%, with an average score of 5.92 (0.99), and for the TF it was 78.28%, with an average score of 5.48 (1.22). Despite the statistically significant difference (p=0.019) between the average scores, the results of the acceptability index show that both formulations can be considered accepted (AI > 70%) [41]. These results are presented in detail in Table 3.

Table 3 – Mean and standard deviation of the scores attributed and overall acceptability index for the Control Formulation and Test Formulation, using the seven-point structured hedonic scale (n=50).

Sensory analysis	CF		TF		p-value*
	M	SD	M	SD	
Grades awarded	5.92	0.99	5.48	1.22	0.019
Acceptability index (%)	84.57		78.28		

Note: *Wilcoxon test. CF: Control Formulation; M: Mean, SD: Standard Deviation; TF: Test Formulation.

Perception of the panelists

The most frequent observations regarding the CF were: "fluffier/more aerated", "softer" and "lighter cake" (n=16), "very tasty" (or "tasty") (n=4), "very sweet/sweeter" and "more beautiful" (n=4). And as for the TF: "lighter and softer cake" (n=2), "more delicious" (or "tastier") (n=7), "sweeter" (or "extremely sweet") (n=11), "more moist" (or "wetter") (n=7) and "denser/heavier" (n=6). Table 4 shows the perception of the panelists in more detail.

Table 4 – Control Formulation and Test Formulation categories according to the perception of the panelists and how many times the perceptions (or observations) were mentioned (n).

	Categories				
Formulation	Typical texture	Pleasant taste	Sweetness	Adequate moisture	Overall appearance
CF	Fluffier/more aerated (n=10) Less dense and compact (n=4) softer (n=5) More pleasant texture (n=1) lighter (n=1) Better baked (n=2)	Very tasty (n=3) Tasty (n=1)	Very sweet/sweeter (n=3)		More beautiful (n=1)
TF	Lighter (n=1) Softer (n=1) Denser/heavier (n=6)	Tastier (n=4) More delicious (n=3) Preferred by me (n=3)	Sweeter (n=10) Extremely sweet (n=1)	More moist (n=4) Wetter (n=3)	

Note: CF: Control Formulation; TF: Test Formulation.

DISCUSSION

The study of culinary alternatives to replace eggs is motivated by different appeals, such as catering to individuals with allergies [5] or vegans [3], among other reasons. A study that evaluated the characteristics of a foaming method cake with egg white and aquafaba from canned chickpeas found that the cake with aquafaba had lower values for all the physicochemical parameters analyzed (moisture, height, volume and pH), but concluded that aquafaba has the potential to replace eggs [3]. With the results of our study, it is also possible to state that the test formulation showed significantly lower values for the parameters analyzed in a foaming method cake, except for specific

volume; thus, the limitations to the formulation caused by the absence of eggs in this culinary recipe are evident, which can be explained by the composition of these ingredients associated with the characteristics expected for the preparation.

This preparation is based on foamed/aerated batters in which whole or separated eggs are beaten, becoming the primary mechanical leavening method of the batter, along with sugar and wheat flour. Some formulations include liquid, fat and baking powder as a leavening agent [4]. The presence of albumin in egg whites is a determining factor in the ability of the foam to form and remain stable, demonstrating the importance of the proteins present in eggs, which help with the characteristic sensory aspects of the foaming method cakes [43].

The proteins found in chickpeas are globulins (56.0%), glutelins (18.1%), albumins (12.0%), prolamins (2.8%) and residual proteins. In smaller proportions, saponins are also present (1 to 3.7%) [44]. The proteins in legumes, including chickpeas, differ from egg white proteins due to their lower albumin content, which results in lower gelling capacity and higher protein solubility. In this context, the protein content together with the saponins (4.5 to 12mg/g in CA), which have been used in the industry as surfactants and foaming agents – as well as their ability to act as emulsifiers and foam stabilizers, is responsible for the foaming capacity of CA [4,9,43,45]. However, the properties of CA are due not only to proteins but also to carbohydrates (starch, oligosaccharides, cellulose, hemicellulose and lignin), polysaccharide-protein complexes and phenolic compounds [1,8,11,46,47]. The amount of water (whether in lower quantities or in excess) used for cooking influences the foaming capacity, since excessive water allows the chickpea starch granules to break the foam membranes. A high lipid content could also influence the foaming capacity of CA; unsaturated fatty acids reduce the volume and stability of the foam [1]. This could explain the noticeable differences between the formulations (control and test). However, the potential of CA is evident in the proposed formulation considering its similar appearance to the control formulation and the acceptability index of the test formulation.

Through the preparation of the cakes, it was observed that 75 g of CA was the best amount for the development of a foaming method cake – based on the appearance closest to the CF. This corresponds to half the weight of the chicken eggs (150 g) used in the CF under the conditions of this experiment. This finding is in agreement with the discussion by Aslan and Ertas [48], who analyzed egg replacement with homemade CA in traditional cake formulations. Their study demonstrated that replacing eggs with up to 50% CA was ideal, as it resulted in an acceptable volume index, firmness, and uniformity.

During the cake production stage, the TF underwent three adaptations in terms of the amount of refined sugar, with the aim of optimizing it. However, there was a noticeable loss of the organoleptic properties expected of a foaming method cake, especially in terms of texture and crumb formation. Sugar retains moisture in the cake due to its hygroscopic properties; however, its reduction may compromise the structure, interfere with starch gelatinization, and result in a preparation with poorer texture and volume [4,49,50].

Another important aspect is that lecithin, present in egg yolk along with other components, aids in emulsification and provides lubrication due to its fat content, contributing to the creaminess and softness of the preparations [4]. Fat also has the function of attracting air to the batter, and when removed it can alter its flavor and final texture [4]. Therefore, sunflower oil was added to the TF batter taking into account the amount of lipids present in 150 g of chicken eggs (about three units), and an attempt to remove it in one of the test formulations resulted in a cake with a less moist appearance.

In the literature, there are still few studies analyzing the use of CA in cake formulations. In addition to the work by Aslan and Ertas [48] with traditional cakes, Mustafa et al. (2018) [3] also studied the effect of aquafaba from ten brands of canned chickpeas in sponge cakes, concluding that aquafaba is a good candidate for egg replacement in cakes or other baked goods, and that further studies are planned to investigate the use of additives that can improve cake texture. Nguyen et al. [51] also applied CA from home-cooked chickpeas in a foaming method cake. In one sample, they added citric acid – to adjust the pH – and salt, which showed similarity foaming properties similar to those of egg white. In a second sample, they added xanthan gum, which improved foam formation, texture and the size of the air bubbles. However, unlike the studies conducted by the aforementioned authors, this research aimed to evaluate the differences between the formulations through analyses by replacing chicken eggs with CA, without the addition of other ingredients or food additives.

Grossi et al. [52], who evaluated emulsions based on CA as a fat substitute in pound cakes, concluded that the emulsions maintained the functional characteristics of the cake, as the product was accepted by the panelists (with an overall score of approximately 7.8 on the radar chart). Sensory analysis was also a fundamental part of this research and demonstrated an AI > 70% for the TF with CA. Similarly, the sensory analysis of a study investigating the potential of aquafaba in egg- and gluten-free cakes [53] showed that CA can be a promising and potent ingredient due to its multifunctionality, and that the percentage of satisfaction among consumers ranged from 60% to 80%.

Although the sensory analysis provided relevant information, this study was not designed to generate a detailed sensory profile of specific attributes, which represents a limitation. Future studies may incorporate this stage of analysis to provide a more comprehensive understanding of the impact of CA on cake quality. However, recent studies addressing the technological functionality of aquafaba in different culinary preparations, such as mayonnaise [54-56], Turkish cookies [57], muffin [58], and meringue [59], highlight the relevance of sensory analysis, particularly in the characterization of specific sensory attributes.

The CA formulation in this study was analyzed for physicochemical characterization, following a previously published protocol that includes data on its chemical composition, pH, total phenolic compounds, and foaming capacity [34]. The literature already describes the physicochemical characterization of CA and aquafaba from other legumes [2,10,11,27,29], as well as derived culinary preparations [60-62] and reviews on extraction, processing, and factors influencing the functional performance of aquafaba [63]. In addition, one study demonstrated that the mineral profile of aquafaba and the levels of potentially toxic elements vary according to the packaging and the origin of the chickpeas [64].

To the best of our knowledge, however, no studies have evaluated the artisanal production of CA as an egg substitute in foaming method cakes, which is of interest as it encourages culinary practices and reduces dependence on industrial ingredient processing. Additionally, the use of aquafaba adds value to this byproduct, which is typically discarded, by incorporating it into culinary preparations, thereby contributing to the full utilization of food resources. Thus, the use of aquafaba supports sustainability by reducing the environmental burden. Furthermore, its use gains even greater relevance by enabling the preparation of inclusive culinary products for individuals concerned with environmental factors, health improvement, better dietary choices, and potential economic considerations [1].

CONCLUSION

The analyses of the physical properties allow us to conclude that the TF, with the use of 50% CA in relation to the weight of eggs, is a good plant-based substitute in the formulation of foaming method cakes, as it yielded satisfactory appearance and physical parameters, as well as a good acceptability index indicated by the sensory analysis. Thus, CA demonstrated potential as an ingredient to replace eggs in the preparation of foaming method cakes and, possibly, in the preparation of other food products, reinforcing the need for further studies to expand the knowledge and application of this ingredient. The use of CA, the cooking water of the legume that would otherwise be discarded, encourages the full utilization of food and the reduction of waste, since it can be incorporated into a new culinary recipe, making it inclusive for those who cannot or do not want to consume foods of animal origin such as eggs.

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