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Acceptance and purchase intention of chia-enriched vegan brownies (*Salvia hispanica* L.)

Aceitação e intenção de compras de brownies veganos adicionados de chia (*Salvia hispanica* L.)

Abstract

Introduction: Chia (*Salvia hispanica* L.) and its by-products have technological properties and health benefits. **Objective:** To develop and evaluate the sensory acceptance and microbiological quality of vegan brownies with added chia (*Salvia hispanica* L.). **Method:** This experimental study developed two types of vegan brownies. In both, chia seed mucilage replaced eggs, and in one formulation, wheat flour was also partially replaced with 8% (BS8%) defatted chia flour. The samples underwent acceptance testing, with the assessment of acceptance rates and purchase intention for each formulation. Microbiological analyses were conducted before sensory evaluation. **Results:** Microbiological analyses confirmed that the samples were safe for consumption. Among the 100 participants, 75% identified as omnivores and 25% as vegetarians, with 55% being female. Both BS8% and BCV brownies showed good acceptance (>76%) across different groups. BS8% had higher acceptance for flavor, color, aroma, and overall impression ($p < 0.05$), compared to BCV. Purchase intention was higher ($p > 0.05$) for BS8% when a vegan label and ingredient list were present. **Conclusion:** The use of defatted chia flour in vegan brownies is feasible and has sustainability appeal due to the use of a by-product. The presence of a label and ingredient list on the packaging plays a crucial role in consumer acceptance, supporting greater commercialization.

Keywords: Sensory analysis. *Salvia hispanica*. Confectionery foods.

Resumo

Introdução: A chia (*Salvia hispanica* L.) e seus co-produtos apresentam propriedades tecnológicas e benefícios para a saúde. **Objetivo:** Desenvolver e avaliar a aceitação sensorial e qualidade microbiológica de brownies veganos com adição de chia (*Salvia hispanica* L.). **Método:** Trata-se de um estudo experimental em que foram desenvolvidos dois tipos de brownies veganos. Em ambos, a mucilagem de semente de chia substituiu o ovo e, em uma delas, substituiu-se, ainda, a farinha de trigo por 8% (BS8%) de farinha desengordurada de chia. As amostras foram avaliadas por meio de teste de aceitação, analisando-se o percentual de aceitação e a intenção de compras de cada formulação. Análises microbiológicas foram realizadas antes da análise sensorial. **Resultado:** As análises microbiológicas indicaram que as amostras estavam seguras para o consumo; 75% dos provadores se autodeclararam onívoros e 25%, vegetarianos, 55% eram do sexo feminino ($n = 100$). Os brownies BS8% e BCV apresentaram boa aceitação (>76%) nos diferentes grupos. O BS8% apresentou melhor aceitação em relação a sabor, cor, aroma e impressão global ($p < 0,05$) comparado ao BCV. Houve maior ($p > 0,05$) intenção de compra para o BS8% na presença do selo vegano e da lista de ingredientes. **Conclusão:** A utilização da farinha desengordurada de chia em brownies veganos é viável, e possui apelo de

sustentabilidade pelo uso de um co-produto. O selo e a lista de ingredientes na embalagem possuem importante papel na aceitação, visando maior comercialização.

Palavras-chave: Análise sensorial. *Salvia hispânica*. Alimentos de confeitaria.



INTRODUCTION

Chia (*Salvia hispanica* L.) is an annual herbaceous plant that contains minerals such as magnesium (335 mg/100 g), phosphorus (860 mg/100 g), calcium 631 (mg/100 g), potassium (407 mg/100 g) and sodium (16 mg/100 g), carotenoids (54 µg/100 g) and vitamins B1 (0.62 g/100 g), B2 (0.17 g/100 g) and B3 (8.83 g/100 g).¹ The seeds are also characterized by the presence of bioactive compounds with high antioxidant capacity, mainly rosmarinic acid (653.98 to 926.7 µg/100g), caffeic acid (3.0 to 128.66 µg/100g), gallic acid (11.05 to 42.56 µg/100g), ferulic acid (35.87 µg/100g) and p-coumaric acid (25.96 µg/100g).^{2,3}

The high content of polyunsaturated fatty acids (32.33 g/100 g),³ particularly from the omega-3 group (63.79%),⁴ in chia seeds promotes cardiovascular health⁵ and prevents neurological diseases.^{1,6,7} This property is of particular interest to the food industry, as it enables the development of foods with beneficial functional properties for health.⁸

Due to the fatty acids contained in chia seeds, chia oil is extracted and marketed on an industrial scale, while the defatted part is generally thrown away. However, due to its high content of phenolic compounds (5.00 mg GAE/g)³ and dietary fiber (56.46 g/100 g), defatted chia flour has been studied and incorporated into various foods^{9,10} to enhance nutritional value, improve functional properties and reduce waste.¹¹ These compounds confer a high antioxidant activity, which helps to extend the shelf life of foods, for example by delaying lipid oxidation in meat products.^{3,8}

The technological and functional properties of defatted flour are similar to those of the seeds and can be used in food products in an integrated form or even in the form of an extract.¹² In addition, defatted chia flour has proven to be a good product for use in bakery products, such as brownies, offering similar sensory properties to those of traditional brownies. This makes the product appealing to individuals who choose or require dietary restrictions, such as vegetarians.¹²

Due to their excellent ability to form a gel in contact with water, chia seeds mucilage are used in products that require water binding and viscosity, such as emulsions, yogurts and bakery products,^{13,14} to improve rheological properties and stability.^{15,16} Chia seed mucilage can be used as an egg substitute in vegetarian and/or vegan products, as it acts as a thickening agent, gelling agent, chelating agent and fat substitute,^{17,18} and also reduces the calorie content of the product. In bakery products, chia seed mucilage can replace eggs or gluten in bakery products such as cookies, promoting dough cohesion and reducing the need for animal ingredients.^{8,19} In dairy products, chia seed mucilage can serve as a stabilizer in plant-based yogurts or puddings, giving them a more pleasant texture and preventing phase separation.¹⁴

Thus, the use of chia seed mucilage together with defatted chia flour in foods can be a good alternative to develop products with functional properties that contain fiber, omega-3 fatty acids and phenolic compounds. In addition, these ingredients are very versatile and align with demands for vegan, clean-label and functional foods that meet the needs of health-conscious consumers and/or those following a specific diet.^{8,19-21}

In the United States, the plant-based food market amounted to seven million dollars and grew twice as fast as the animal-based foods market in 2020,²² despite being a country with a relatively low proportion of vegans and vegetarians.²³ This suggests that vegan products are not only consumed by vegans and vegetarians, but that they have also gained popularity among omnivores.²⁴ For this reason, the use of a "vegan seal" or the claim that the product contains no ingredients of animal origin has been used as an effective communication tool on labels.²⁴

In Brazil, the “Selo Vegano” (vegan seal) was created in 2013 by the Sociedade Vegetariana Brasileira (SVB) (Brazilian Vegetarian Society), a private and non-profit civil society.²⁵ Despite the existence and use of this seal,²⁵ there is no official seal that is regulated or approved by the Agência Nacional de Vigilância Sanitária do Brasil - ANVISA (Brazilian National Health Superintendency).²⁶ This is because there is currently no resolution or law for vegetarian and vegan products in the country, which is against the rights and principles provided for in the Código de Defesa do Consumidor Brasileiro (Brazilian Consumer Protection Law) in relation to the right to information.²⁷ Thus, it is at the discretion of entities such as the SVB to determine the criteria and analysis of the products to be covered by the vegan seal.²⁵ In addition, other seals and certificates from other societies and associations exist, such as that of the Associação Brasileira de Veganismo (Brazilian Association of Veganism),²⁸ which have their own criteria and are authorized in Brazil. This demonstrates a lack of standardization and can cause confusion among consumers. Therefore, the objective of the present work was to develop and evaluate the sensory acceptance and microbiological quality of vegan brownies with the addition of chia (*Salvia hispanica* L.)

OBJECTIVE

To develop and analyze the sensory and microbiological properties of vegan brownies enriched with defatted chia flour (*Salvia hispanica* L.).

METHOD

Brownies ingredients and formulations

The chia seeds and defatted chia flour were donated by Produzza Foods (Foz do Iguaçu, PR, Brazil). The ingredients (chocolate bar - 50% cocoa, refined wheat flour, cocoa powder, salt, refined sugar, baking powder, soybean oil, vanilla essence and white vinegar) for the development of the brownie recipes were purchased from a local supermarket, using the same brand and batch of each product for the formulations (Limeira, SP, Brazil). Vegan products were purchased that did not contain any ingredients of animal origin listed in the ingredients.

Two vegan brownies were made, a control vegan version (BCV) and one with partial replacement of refined wheat flour with 8% defatted chia flour (BS8%). Both brownies were formulated with chia seed mucilage as an egg substitute.

The chia seed mucilage used to replace the egg was prepared in a glass container by adding a 1:40 (w/v) ratio of seeds to distilled water. The mixture was kept in a glass bottle with a lid for 24 hours at $13\pm1^{\circ}\text{C}$, and then added at a rate of 30g/100g of dough at room temperature ($24\pm1^{\circ}\text{C}$) without control during preparation.

Defatted chia flour, which serves as a partial substitute for refined wheat flour, was added after preliminary trials to determine the best ratio. To this end, volunteers who were not involved in the project were asked to evaluate the texture and flavor of brownies prepared with different concentrations of defatted chia flour (data not shown). The concentration of 8g/100g (w/w) was found to be the most promising, as it demonstrated adequate dough growth and expansion, with little or no change in flavor and texture, when compared to the control vegan brownie (BCV).

The brownies were developed according to the method described by Moreira et al.¹² with adaptations such as the use of liquid mucilage and defatted dried chia flour (powder) instead of dehydrated mucilage and defatted chia flour extract (Moreira et al.¹²) with the aim of reducing costs, increasing the usability of the by-



product and domestic reproduction. Table 1 describes the ingredients, and the respective amounts used in each recipe.

Table 1. Ingredients used in the formulation of vegan brownie samples and with the addition of defatted chia flour (*Salvia hispanica* L.). Limeira-SP, 2023.

Ingredients	BCV*	BS8%**
Refined sugar (g)	140	140
Refined wheat flour (g)	100	92
Water (mL)	45	45
Chocolate Bar – 50% cocoa (g)	35	35
Chia Seed Mucilage (g) [#]	30	30
Soybean Oil (mL)	24	24
Cocoa powder (g)	9	9
Vanilla Essence (g)	3	3
White vinegar (mL)	2	2
Defatted chia flour (g)	-	8
Baking powder (g)	0.95	0.95
Salt (g)	0.47	0.47

Source: by the authors, based on the study by Moreira et al. (2022). *BCV: control vegan brownie; **BS8% vegan brownie with the addition of 8% defatted chia flour; #chia seed mucilage: seeds and distilled water in a ratio of 1:40 (w/v), stored at 13±1°C for 24 hours before use.

The brownies were prepared with a mixture of ingredients in the following order: chocolate bar (50% cocoa) melted in a water bath, soybean oil, chia mucilage, refined sugar, refined wheat flour, defatted chia flour (for BS8%), cocoa powder, vanilla essence, baking powder and vinegar. After mixing and homogenizing the ingredients by hand, the dough was filled into aluminum molds (measuring 30 cm long x 44 cm wide x 56 cm) deep and baked in an electric oven at 200 °C for 20 minutes. All formulations were developed in the Laboratório de Técnica Dietética da FCA – UNICAMP (Limeira, SP) (Laboratory of Dietetic Technique of the FCA).

Microbiological analyzes

The microbiological analysis of the products was carried out to guarantee the quality of the samples before the sensory analysis, according to Guideline (Instrução Normativa) n° 60,²⁹ using the following tests: *Escherichia coli* count, the presumptive *B. cereus* count and molds and yeasts count, for the identification of pathogenic and spoilage microorganisms. All analyzes were performed at the Laboratório de Higiene e Análise de Alimentos da FCA – UNICAMP, Limeira, SP (Laboratory of Hygiene and Food Analysis of the FCA), following the methods described by Silva et al.³⁰ Prior to the analyzes, 10 g of each brownie sample was homogenized with 90 ml of 0.1% peptone water (10-1 dilution), from which serial dilutions were performed – 1 ml of the 10⁻¹ dilution into a tube containing 9 ml of milk broth, creating a 10⁻² dilution. Then 1 ml of the 10⁻² dilution into a tube containing 9 ml of lactated broth, resulting in a 10⁻³ dilution. The results were interpreted based on Guideline (Instrução Normativa) n° 161 from 2022, which specifies the lists of standards for ready-to-eat foods offered to consumers.³¹

Sensory analysis

The sensory analysis was performed with 100 untrained tasters of both sexes over the age of 18, who had neither a food intolerance nor an allergy to any of the ingredients in the recipe. Before testing began, tasters completed a simple

questionnaire with information on their age, gender and dietary habits to determine whether they were vegan/vegetarian or omnivorous. The analyzes were carried out in August 2023 in the sensory booths of the Laboratório de Técnica Dietética da FCA – UNICAMP (Limeira, SP) (Dietary Technology Laboratory). Recruitment was achieved through posters, e-mail lists and WhatsApp groups of students of FCA-UNICAMP, Limeira, SP. The volunteer tasters signed the informed consent form (ICF) approved by the Comitê de Ética da UNICAMP (# 4.799.737) (Ethics Committee of UNICAMP) before performing the sensory analysis. Brownie samples were analyzed in the same session (day and time). The BCV and BS8% samples were cut into squares of 2 cm x 2 cm x 3 cm (height) in a homogeneous format and arranged separately in ceramic containers coded with three random digits. The brownies were provided to the tasters in a monadic manner. Each taster was given a glass of mineral water to cleanse the palate. The acceptance test was conducted using a rating sheet with a 9-point hedonic scale ranging from 9 - "very good" to 1 - "very bad" to analyze the color, flavor, texture, smell, and overall impression of each sample (BCV and BS8%).³² On the same sheet, the tasters also filled in the purchase intention on a five-point scale with the values 1 = "I would definitely not buy" and 5 = "I would definitely buy" for both samples (BCVcontrol and BS8%). The results were expressed as mean and standard deviation for each attribute assessed. The acceptability index (AI) was calculated according to the equation $AI (\%) = \text{Score} \times 100 / 9$, where the score is the average value assigned by the tasters for each sensory attribute and is expressed as the mean (%) of these values, which is considered ideal when results above 70% are achieved.

Following the acceptability analysis, the tasters conducted the purchase intention test to analyze the influence of the ingredient list and the vegan seal on the packaging according to SVB.²⁵ Each taster received two clear plastic packages, each containing 40 g of the BS8% brownie. One of the packages contained the SVB vegan seal and an ingredient list label on the outside. The other pack contained neither an ingredients list nor a vegan seal on the outside. The tasters received the two packs at the same time, along with a form on which they were asked to indicate their purchase intention for each of the samples. The purchase intention was rated on a five-point scale with the values 1 = "I would definitely not buy" and 5 = "I would definitely buy". The implementation of this phase was inspired by the work of Zanetta et al.³³

Statistical analysis

The results of the sensory analysis were analyzed with the T-test using the statistical software, Graph Pad Prism 9. The unpaired T-test was used to compare the groups (omnivores vs. vegetarians) and to analyze acceptance and purchase intention. Statistical significance was defined as a p-value < 0.05.

RESULTS

The BCV and BS8% samples were found to be safe for consumption,³¹ according to the interpretation of the parameters for the results of the analysis of *E. coli*, *Bacillus cereus* and molds and yeasts (Table 2).³¹

Table 2. Microbiological analysis results, showing the mold and yeast count, and counts of *E. coli* and *B. cereus* (log UFC/g) for samples of BCV and BS8% brownie. Limeira, SP, 2023.

Samples	Molds and yeasts (UFC/g)	<i>E. coli</i> (UFC/g)	<i>B. cereus</i> (UFC/g)
<i>Brownie</i> BCV	8.0x10 ³	<10x10 ¹	<10x10 ¹
<i>Brownie</i> BS8%	1.2x10 ⁴	<10x10 ¹	<10x10 ¹

BCV: control vegan *brownie*; BS8%: *Vegan brownie* with the addition of 8% defatted chia flour. Dilutions of 10⁻¹, 10⁻², 10⁻³ were performed in duplicate for both samples.

Of the tasters (n=100), 75% described themselves as omnivores and 25% as vegetarians, 55% were female and 45% were male. The average age of the tasters was 23 ± 6.08 years.

The acceptability index of the samples (BCV and BS8%) ranged between 77.7% and 84.4% (Table 3), indicating a good acceptability of the two types of brownies by the tasters (omnivores, vegans and vegetarians). The BS8% sample presented better acceptance ($p < 0.05$) than the BCV sample by the omnivore tasters for the attributes of flavor, color, aroma and overall impression. In addition to the greater sensory acceptance among omnivores, the BS8% sample also demonstrated higher purchase intention. When evaluated by vegetarians/vegans, the BS8% brownie did not differ from the BCV in terms of the sensorial attributes ($p > 0.05$). Given that the results showed average attributes of above 6.0 (Table 3) and an acceptability index of over 76%, it can be generally concluded that the samples were well accepted.

Table 3. Results of the analysis of the acceptance and purchase intention of vegan brownies (BCV and BS8%), according to the type of diet of the tasters (omnivores vs. vegans and/or vegetarians), Limeira, SP, Brazil. Values expressed as means (\pm SD) for acceptability analysis and as percentages (%) for acceptability and purchase intention (n=100 tasters). Limeira, SP, 2023.

	Omnivores		Vegetarianssand/orvegans	
	Brownies			
Attributes	BCV	BS8%	BCV	BS8%
Appearance	7.40 (1.49) ^a	7.55 (1.46) ^a	7.68 (1.03) ^a	7.68 (0.85) ^a
Color	8.05 (1.06) ^b	8.04 (1.07) ^a	8.28 (0.84) ^a	8.12 (0.88) ^a
Aroma	6.68 (1.83) ^b	7.20 (1.36) ^a	7.58 (1.32) ^a	7.54 (1.06) ^a
Flavor	6.36 (2.08) ^b	7.01 (1.48) ^a	7.40 (1.23) ^a	7.00 (1.04) ^a
Texture	6.67 (1.64) ^a	7.00 (1.52) ^a	7.24 (1.30) ^a	7.00 (1.52) ^a
Global Printing	6.81 (1.59) ^b	7.29 (1.12) ^a	7.44 (1.08) ^a	7.16 (0.99) ^a
Acceptability Index (%)	77.72	81.65	84.48	82.41
Purchase intention	3.08 (1.25) ^b	3.53 (0.95) ^a	3.88 (1.05) ^a	3.64 (1.11) ^a
Would certainly buy (%)	12	17	36	16
Would probably buy (%)	31	31	28	56
I have doubts whether I would buy (%)	25	43	24	12
I would probably not buy (%)	17	7	12	8
Would definitely not buy (%)	15	3	0	8

BCV: control vegan *brownie*; BS8%: vegan *brownie* with the addition of 8% defatted chia flour. Equal letters in the same line indicate that there is no significant difference between the means by the T test ($p < 0.05$), comparing the results of each sample among the same group of tasters (omnivores; vegans and/or vegetarians)

Of the vegetarians/vegans, 56% stated that they "would probably buy" the BS8% brownie, while 43% of omnivores stated that they "have doubts about whether I would buy" the BS8% brownie" (Table 3).

Regarding the results of the purchase intention analyzes, a higher average purchase intention ($p < 0.05$) was observed when the brownie had a vegan seal and ingredient list on the package, both among omnivores (3.97 ± 0.93) and vegetarians/vegans (4.52 ± 0.65) (Table 4). Of the omnivores, 41% said they "would probably buy" the brownie in the pack with the seal and ingredients list, while 27% said they "would probably not buy" the brownie in the pack without the seal and ingredients list. For vegetarians/vegans, these results were 32% and 24%, respectively. When analyzing the comments, it was found that the vegan seal and the ingredients list

were the parameters that most influenced the purchase decision, as they give the product more credibility and make it more attractive and professional, while the ingredients list was decisive for the purchase decision of vegetarians/vegans. According to the comments, the lack of a seal and ingredient list reduces credibility and increases mistrust.

Table 4. Results of the analysis of the purchase intention of the BS8% brownie, depending on the packaging (with vegan seal and ingredients list vs. without vegan seal), among the same group of tasters (omnivores; vegans and/or vegetarians), Limeira, SP, Brazil. Values expressed as means (\pm SD) for the purchase intention results and as percentages for the other results (n=100 tasters). Limeira, SP, 2023.

	Omnivores		Vegetarians and/or vegans	
	With seal and list of ingredients	No seal	With seal and list of ingredients	No seal
Purchase intention	3.97 (0.93) ^a	2.85 (1.09) ^b	4.52 (0.65) ^a	2.96 (1.06) ^b
Would certainly buy (%)	32	8	60	8
Would probably buy (%)	41	16	32	20
I have doubts whether I would buy (%)	20	37	8	40
I would probably not buy (%)	5	27	0	24
Would definitely not buy (%)	1	12	0	8

Equal letters in the same row for purchase intention mean that there is no significant difference between the mean values of the T-test ($p < 0.05$), when comparing the results for each package in the same group of tasters (omnivores; vegans and/or vegetarians)

DISCUSSION

For the sensory analysis of the brownies, the result of the acceptability index was greater than 76%, indicating that all participants rated the BCV and BS8% brownies favorably in terms of the properties analyzed.³⁴

According to a study by Justo et al,³⁵ the use of 5% chia seeds, 5% flaxseed and 10% soy in whole grain bread increased nutritional value and resulted in good acceptance by tasters, suggesting that this concentration would be ideal. Borneo, Aguirre & León³⁶ investigated the use of chia mucilage in a cake formulation to improve nutritional value and concluded that the use of up to 25% mucilage in the cake did not alter the sensory properties. Haros & Puig³⁷ developed a bread in which wheat flour was replaced with 5% chia seeds and 5% whole-grain chia flour, and concluded that chia seeds, or their flour, can be used as an ingredient in the production of bakery products. The authors concluded that the proportion of chia seeds and their mucilage should not exceed 25%, in order to maintain the functional and sensory properties of this product.³⁷

Additionally, regarding the addition of chia and/or derived products or by-products, studies have shown that the incorporation of different concentrations of defatted chia cake in whole wheat-based bread enhances sensory acceptability and nutritional quality. This improvement is due to the increase in antioxidant content, higher moisture content and reduced harshness.³⁸ The use of chia flour in cookies increases the total polyphenol content and, consequently, the antioxidant activity of the product, also resulting in better acceptability. In this study, the authors also observed an improvement in the in vitro digestibility of cookies with the addition of chia cake, suggesting a prebiotic effect.¹¹ When chia flour was used in muffins, the results

were also positive, compared to the control product.³⁶ The acceptability of the vegan brownies with the addition of 8% defatted chia flour in this study thus confirms that bakery products are a viable use for chia seed oil derived from industrial waste.³⁸

The results of the sensory analysis suggest that the development of a vegan brownie containing chia seed mucilage, instead of egg, as an emulsifier and gelling agent is feasible and provides benefits from an economic and health perspective, especially when refined wheat flour is replaced by 8% defatted chia flour. As reported by Moreira et al,¹² the phenolic composition of chia seeds and defatted flour enables the production of products with a high content of bioactive compounds, such as ferulic acid (1.91 ± 0.006 mg/100 g) and rosmarinic acid (3.79 ± 0.03 mg/100 g). The authors found that brownies prepared with 2, 4 and 6% defatted chia flour extract contained 70%, 89% and 92% ferulic acid and 60%, 75% and 91% rosmarinic acid, respectively, added to the recipe. Although not investigated in the present study, it may be suggested that the phenolic compound profile of chia may improve the product's shelf life by acting as an antioxidant.³⁹ As such, future studies should investigate other physicochemical and antioxidant properties of products containing defatted chia flour and chia mucilage seeds, such as brownies or similar products.

It is worth noting that one motivator for the consumption of chia and/or defatted chia flour by vegetarians and vegans is the culinary aspect. Chia not only enriches salads and fruit smoothies, but also replaces eggs in various recipes, such as cakes, mousses, meringues and mayonnaise, as the mucilage can provide the necessary binding in some recipes.^{13,14,16-18} Compared to flaxseed, which is commonly used by vegans and vegetarians, chia has the advantage of being easier to preserve and consume and has a more neutral flavor.⁴⁰

Regarding purchase intention, the results of this study, which indicate a higher purchase intention for the packaging with the vegan seal and with a list of ingredients, confirm the findings of Bialkova, Sasse & Fenko.⁴¹ According to the authors, the evaluation and choice of the product can be modulated according to the effectiveness of the message displayed on the front of the packaging, which also depends on the consumer's motivation for health and the perception of the healthiness of the products. Extrinsic characteristics related to acceptability refer to the physical characteristics of the product, such as brand, packaging, product information, origin, advertising and price, which can create expectations that influence consumption behavior and intention.^{33,42,43}

Recently, Stremmel et al.²⁴ conducted a study that aimed to further investigate the various consequences of labeling practices with specific labels for consumers who follow a certain diet, such as vegans and vegetarians.²⁴ The authors mentioned that labeling products as vegan can be considered beneficial, especially as it provides important additional information that often cannot be derived from the ingredient list.

According to Stremmel et al.,²⁴ labeling with specific seals has no undesirable side effects on people's consumption intentions, especially if consumers already have an expectation of the vegan product. Nonetheless, the authors recommended that food manufacturers use labels with specific seals to provide easily accessible and highly relevant information for this specific segment of consumers. Such actions provide transparency and indicate whether products comply with current regulations.²⁴ It is important to note that vegan products are no longer consumed only by vegans and vegetarians, but have gained popularity among the omnivorous population in general,⁴⁴ given the call to reduce the reduced consumption of animal products and the health appeal that these foods evoke.

It is worth noting that, while these are not limitations, the present study could have investigated other dimensions, such as a larger number of tasters, training of tasters and inclusion of the ingredient list in both packages, to compare the influence of the vegan seal alone. Finally, it would be of interest to evaluate aspects

such as shelf life, the stability of phenolic compounds or sensory changes over time and to present comparative data on the nutritional profile of brownies with and without added chia flour.

CONCLUSION

The incorporation of chia seed mucilage and defatted chia flour (8%) enabled the development of vegan brownies without changing the sensory properties of the product, compared to a control vegan brownie. The possibility of using defatted chia flour increases sustainability and functionality and can be used in various culinary preparations and in the development of vegan foods. The presence of the vegan seal as well as the list of ingredients on the packaging are efficient communication strategies and prove to be an important factor for achieving better acceptance.

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REFERENCES

1. Hrnčič MK, Ivanovski M, Cör D, Knez Ž. Chia Seeds (*Salvia Hispanica* L.): An overview-phytochemical profile, isolation methods, and application. *Molecules*. 2020;25(1). <https://doi.org/10.1590/1981-6723.1814>
2. Oliveira-Alves SC, Vendramini-Costa DB, Betim Cazarin CB, Maróstica Júnior MR, Borges Ferreira JP, Silva AB, et al. Characterization of phenolic compounds in chia (*Salvia hispanica* L.) seeds, fiber flour and oil. *Food Chem [Internet]*. 1º de outubro de 2017 [citado 10 de setembro de 2019];232(1):295-305. <https://doi.org/10.1016/j.foodchem.2017.04.002>
3. Fernández-López J, Lucas-González R, Viuda-Martos M, Sayas-Barberá E, Pérez-Alvarez JA. Chia Oil Extraction Coproduct as a Potential New Ingredient for the Food Industry: Chemical, Physicochemical, Techno-Functional and Antioxidant Properties. *Plant Foods for Human Nutrition*. 2018;73(2):130-6. <https://doi.org/10.1007/s11130-018-0670-5>
4. Ciftci ON, Przybylski R, Rudzińska M. Lipid components of flax, perilla, and chia seeds. *European Journal of Lipid Science and Technology*. 1º de julho de 2012 [citado 4 de fevereiro de 2025];114(7):794-800. <https://doi.org/10.1002/ejlt.201100207>
5. Capitani MI, Nolasco SM, Tomás MC. Stability of oil-in-water (O/W) emulsions with chia (*Salvia hispanica* L.) mucilage. *Food Hydrocoll*. Dec 1· 2016;61:537-46. <https://doi.org/10.1016/j.foodhyd.2016.06.008>
6. Coelho MS, Salas-Mellado M de las M. Review: Chemical composition, functional properties and technological applications of chia (*Salvia hispanica* L) seeds in foods. *Brazilian Journal of Food Technology*. 2014;17(4):259-68. <https://doi.org/10.1590/1981-6723.1814>
7. Melo Bruna Guedes de, Fernandes Sibeles Santos, Razo Alejandra Dominguez. Chia seeds as functional ingredient of healthy muffins. *Journal of Food Measurement and Characterization*. 2022. <https://doi.org/10.1007/s11694-022-01503-1>



8. Ferreira DM, Nunes MA, Santo LE, Machado S, Costa ASG, Álvarez-Ortí M, et al. Characterization of Chia Seeds, Cold-Pressed Oil, and Defatted Cake: An Ancient Grain for Modern Food Production. *Molecules*. 1º de janeiro de 2023;28(2). <https://doi.org/10.3390/molecules28020723>
9. Mesías M, Holgado F, Márquez-Ruiz G, Morales FJ. Risk/benefit considerations of a new formulation of wheat-based biscuit supplemented with different amounts of chia flour. *LWT - Food Science and Technology*. 1º de novembro de 2016;73:528-35. <https://doi.org/10.1016/j.lwt.2016.06.056>
10. Verdú S, Vásquez F, Ivorra E, Sánchez AJ, Barat JM, Grau R. Physicochemical effects of chia (*Salvia hispanica*) seed flour on each wheat bread-making process phase and product storage. *J Cereal Sci [Internet]*. 2015;65:67-73. <http://dx.doi.org/10.1016/j.jcs.2015.05.011>
11. Mas Agustín Lucini, Brigante Federico Iván, Salvucci Emiliano, et al. Defatted chia flour as functional ingredient in sweet cookies. How do Processing, simulated gastrointestinal digestion and colonic fermentation affect its antioxidant properties? *Food Chem*. 30 de junho de 2020;316. <https://doi.org/10.1016/j.foodchem.2020.126279>
12. Moreira MR, Sanches VL, Strieder MM, Rostagno MA, Capitani CD. Vegan *brownie* enriched with phenolic compounds obtained from a chia (*Salvia hispanica* L.) coproduct: Nutritional, technological, and functional characteristics and sensory acceptance. *Int J Gastron Food Sci*. 1º de dezembro de 2023;34. <https://doi.org/10.1016/j.ijgfs.2023.100835>
13. Segura-Campos MR, Salazar-Vega IM, Chel-Guerrero LA, Betancur-Ancona DA. Biological potential of chia (*Salvia hispanica* L.) protein hydrolysates and their incorporation into functional foods. *LWT - Food Science and Technology*. 1º de março de 2013;50(2):723-31. <https://doi.org/10.1016/j.lwt.2012.07.017>
14. Ribes S, Peña N, Fuentes A, Talens P, Barat JM. Chia (*Salvia hispanica* L.) seed mucilage as a fat replacer in yogurts: Effect on their nutritional, technological, and sensory properties. *J Dairy Sci*. 1º de março de 2021;104(3):2822-33. <https://doi.org/10.3168/jds.2020-19240>
15. Kim SY, Hyeonbin O, Lee P, Kim YS. The quality characteristics, antioxidant activity, and sensory evaluation of reduced-fat yogurt and nonfat yogurt supplemented with basil seed gum as a fat substitute. *J Dairy Sci [Internet]*. 1º de fevereiro de 2020 [citado 4 de fevereiro de 2025];103(2):1324-36. <http://doi.org/10.3168/jds.2019-17117>
16. Darwish AMG, Khalifa RE, El Sohaimy SA. Functional Properties of Chia Seed Mucilage Supplemented In Low Fat Yoghurt. *Alexandria Science Exchange Journal [Internet]*. 30 de setembro de 2018 [citado 11 de setembro de 2019];39(3):450-9. <https://doi.org/10.21608/asejaiqsae.2018.13882>
17. Gutiérrez-Luna K, Ansorena D, Astiasarán I. Flax and hempseed oil functional ingredient stabilized by inulin and chia mucilage as a butter replacer in muffin formulations. *J Food Sci [Internet]*. 1º de outubro de 2020 [citado 4 de fevereiro de 2025];85(10):3072-80. <https://doi.org/10.1111/1750-3841.15407>
18. Capitani MI, Spotorno V, Nolasco SM, Tomás MC. Physicochemical and functional characterization of by-products from chia (*Salvia hispanica* L.) seeds of Argentina. *LWT - Food Science and Technology*. janeiro de 2012;45(1):94-102. <https://doi.org/10.1016/j.lwt.2011.07.012>
19. Martínez E, García-Martínez R, Álvarez-Ortí M, Rabadán A, Pardo-Giménez A, Pardo JE. Elaboration of gluten-free cookies with defatted seed flours: Effects on technological, nutritional, and consumer aspects. *Foods*. 2021;10(6). <https://doi.org/10.3390/foods10061213>

20. Fernández-López J, Lucas-González R, Viuda-Martos M, Sayas-Barberá E, Navarro C, Haros CM, et al. Chia (*Salvia hispanica* L.) products as ingredients for reformulating frankfurters: Effects on quality properties and shelf-life. *Meat Science*. 2019;156(February):139-45. <https://doi.org/10.1016/j.meatsci.2019.05.028>
21. Pintado T, Ruiz-Capillas C, Jiménez-Colmenero F, Herrero AM. Impact of Culinary Procedures on Nutritional and Technological Properties of Reduced-Fat Longanizas Formulated with Chia (*Salvia hispanica* L.) or Oat (*Avena sativa* L.) Emulsion Gel. *Foods*. 1º de dezembro de 2020;9(12). <https://doi.org/10.3390/foods9121847>
22. Tendências Globais de Consumo [Internet]. Euromonitor International | Strategic Market Research, Data & Analysis; 05 Dez. 2020 [Acesso 2 Mar 2023]. Disponível em: <https://www.euromonitor.com>
23. IBOPE: Pesquisa de Opinião Pública sobre Vegetarianismo [Internet]. Instituto Brasileiro de Opinião Pública e Estatística; [Acesso 29 Jun 2023]. Disponível em: https://www.svb.org.br/images/Documentos/JOB_0416_VEGETARIANISMO.pdf
24. Stremmel G, Elshiewy O, Boztug Y, Carneiro-Otto F. Vegan labeling for what is already vegan: Product perceptions and consumption intentions. *Appetite*. 1º de agosto de 2022;175:106048. <https://doi.org/10.1016/j.appet.2022.106048>
25. Sociedade Vegetariana Brasileira [Internet]. 12 Mar 2013 [Acesso 20 Mar 2020]. Disponível em: <https://svb.org.br/selovegano/>.
26. Brasil. Legislação de propaganda. Agência Nacional de Vigilância Sanitária. Diário Oficial da União, 21 set. 2020. [Acesso 29 Mai 2023]. Disponível em: <https://www.gov.br/anvisa/pt-br/assuntos/fiscalizacao-e-monitoramento/propaganda/legislacao/legislacao#:~:text=Resolu%C3%A7%C3%A3o%20%2D%20RDC%20n%C2%BA%2018%2> (Citado em 14 Out. 2020).
27. Brasil. Lei nº. 8078, de 11 de setembro de 1990. Código de Defesa do Consumidor. Diário Oficial da União 12 set 1990; 128 (176 supl):1.
28. Associação Brasileira de Veganismo. Associação Brasileira de Veganismo [Internet]. 20 Jul 2017 [Acesso 20 Mar 2023]. Disponível em: <https://veganismo.org.br/>
29. Brasil M da S. Instrução normativa nº 60, de 23 de dezembro de 2019 [Internet]. Agência Nacional de Vigilância Sanitária [ANVISA]. 2019. p. 16. [Acesso 20 Mar 2023]. Disponível em: <https://www.in.gov.br/en/web/dou/-/instrucao-normativa-n-60-de-23-de-dezembro-de-2019-235332356>.
30. Silva BP da Anunciação PC, Matyelka JC da S, Della Lucia CM, Martino HSD, Pinheiro-Sant'Ana HM. Chemical composition of Brazilian chia seeds grown in different places. *Food Chem*. 2017; 221:1709-16. <https://doi.org/10.1016/j.foodchem.2016.10.115>
31. Brasil. Instrução Normativa n. 161, de 1 de jul. 2022. Agência Nacional de Vigilância Sanitária - ANVISA. Diário Oficial da União, 6 jul. 2022.
32. Associação Brasileira de Normas Técnicas (ABNT). Métodos de análise sensorial dos alimentos e bebidas – Classificação - ABNT NBR 12994, 1993.
33. Zanetta LDA, Umebara MTC, Costa JP, Takeda DK, Da Cunha DT. Hedonic, emotional and willingness-to-pay response to beers of a different type in Brazil. *British Food Journal*. 4 de janeiro de 2021;123(1):8-107. <https://doi.org/10.1108/BFJ-02-2020-0137>
34. Dutcosky Silvia Deboni. Análise sensorial de alimentos. 5th ed. Curitiba: PUCPRESS; 2019. 540 p. ISBN: 978-8554945473.

35. Justo Mayela Bautista, Alfaro Alejandra Denisse Castro, Aguilar Ernesto Camarena, Wrobel Katarzyna, Wrobel Kazimierz, Guzmán Guadalupe Alanís, et al. Desarrollo de pan integral con soya, chía, linaza y ácido fólico como alimento funcional para la mujer. Vol. 57, Organo Oficial de la Sociedad Latinoamericana de Nutrición. 2007.
36. Borneo R, Aguirre A, León AE. Chia (*Salvia hispanica* L) Gel Can Be Used as Egg or Oil Replacer in Cake Formulations. J Am Diet Assoc [Internet]. 1º de junho de 2010 [citado 11 de setembro de 2019];110(6):946-9. <https://doi.org/10.1016/j.jada.2010.03.011>
37. Puig El, Haros Claudia Monika. La chia na Europa: O novo ingrediente em produtos de panaderia. Alimentaria. 2011 Jan 15;(420):73-77.
38. Sayed-Ahmad B, Talou T, Straumite E, Sabovics M, Kruma Z, Saad Z, et al. Evaluation of nutritional and technological attributes of whole wheat-based bread fortified with chia flour. Foods. 1º de setembro de 2018;7(9). <https://doi.org/10.3390/foods7090135>
39. Lucini Mas A, Brigante FI, Salvucci E, Pigni NB, Martinez ML, Ribotta P, et al. Defatted chia flour as functional ingredient in sweet cookies. How do Processing, simulated gastrointestinal digestion and colonic fermentation affect its antioxidant properties? Food Chem. 30 de junho de 2020;316. <https://doi.org/10.1016/j.foodchem.2020.126279>
40. Hargreaves SM, Zandonadi RP. Flaxseed and Chia Seed Gel on Characteristics of Gluten-Free Cake. Journal of Culinary Science and Technology. 2018;16(4):378-88. <https://doi.org/10.1080/15428052.2017.1394951>.
41. Bialkova S, Sasse L, Fenko A. The role of nutrition labels and advertising claims in altering consumers' evaluation and choice. Appetite. 1º de janeiro de 2016;96:38-46. <https://doi.org/10.1016/j.appet.2015.08.030>
42. Chaya C, Pacoud J, Ng M, Fenton A, Hort J. Measuring the Emotional Response to Beer and the Relative Impact of Sensory and Packaging Cues. Journal of the American Society of Brewing Chemists [Internet]. 2015 [citado 4 de fevereiro de 2025];73(1):49-60. <https://doi.org/10.1094/ASBCJ-2015-0114-01>.
43. Ruddock HK, Field M, Jones A, Hardman CA. State and trait influences on attentional bias to food-cues: The role of hunger, expectancy, and self-perceived food addiction. Appetite. 1º de dezembro de 2018;131:139-47. <https://doi.org/10.1016/j.appet.2018.08.038>.
44. NIQ [Internet]; 13 dez 2017. The F word: Flexitarian is not a curse to the meat industry; [Acesso 15 Mai 2024]. Disponível em: <https://nielseniq.com/global/en/insights/analysis/2019/the-f-word-flexitarian-is-not-a-curse-to-the-meat-industry/>

Contributors

Altemari GC, Capitani CD and Moreira MR were involved in the conception of the work; Altemari GC and Moreira MR were involved in the development and methodology; Altemari GC, Capitani CD and Moreira MR were involved in the analysis and interpretation of the data; Capitani CD, Altemari GC, Moreira MR and Rostagno MA were involved in the review and approval of the final version.

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