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USING CHIA (*Salvia hispanica* L.) SEEDS FOR VEGAN APPETIZERS WITH FUNCTIONAL POTENTIAL

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Abstract

In recent years, we are witnessing a growing consumer demand for plant-based foods that are as unprocessed and free of synthetic additives as possible, providing the human body with as many bioactive compounds as possible to prevent various diseases. Chia (Salvia hispanica L.) seeds have gained increased attention from researchers and nutritionists, with numerous studies clearly highlighting their high functional potential, due to their rich composition especially in dietary fiber, polyphenols, ω-3, ω-6 and ω-9 fatty acids, proteins that provide all essential amino acids. The aim of this work was to obtain two varieties of vegan appetizer based on chia seeds: one using almond milk, green onion, carrots, lemon juice, flaxseed oil (CSA1), and the second one using soy milk, red onion, seaweed, baked capia peppers, lemon juice, olive oil (CSA2), and to characterize the obtained products in terms of vitamin C content, total polyphenols, carotenoids, antioxidant activity, proximate composition and sensory properties.

Key words: *antioxidant activity; carotenoids; chia seeds; polyphenols; vitamin C.*

INTRODUCTION

The importance of nutrition for human health has been known since ancient times, an example being the famous phrase attributed to Hippocrates: "Let thy food be thy medicine and medicine be thy food" (Salem & El Shahawy, 2020). Although the term "functional food" was first introduced in Japan in the 1980s to refer to foods that, in addition to being nutritious, contain ingredients that help certain body functions, there is currently no legal definition of it. But the basic idea from all the definitions that have been given so far is that functional foods are those containing biologically active substances or physiologically active nutrients and non-nutrients that confer proven health benefits (Kaur & Das, 2011; Chhikara & Panghal, 2022; Temple, 2022). Nowadays it is well known that many consumers aspire to a healthy and safety diet (Mitrea et al., 2003; Petcu et al., 2007). The expanding field of food science is characterized by a surge in research focused on novel natural ingredients, the development of innovative food products, and the strategic creation of niche markets, particularly within the functional food sector. Concurrently, consumer preferences are demonstrably evolving towards plant-based (vegan) products that exhibit both elevated nutritional profiles and functional attributes. (Sim et al., 2021; Valero-Cases et al., 2023). As a result of scientific progress and current trends in consumer culture, the global functional food market continues to grow, with a special focus on functional vegan products (Granato et al., 2020; Rana et al., 2025).

Salvia hispanica L., commonly known as chia, is a semi-annual herbaceous plant classified within the family *Lamiaceae* (formerly *Labiatae*), division *Spermatophyta* (Mohd et al., 2012). Chia is indigenous to a region encompassing parts of northern Mexico and Guatemala. The seeds of this plant constituted a significant resource for Aztec civilizations, serving diverse purposes including sustenance, medicinal applications, and the production of pigments (Cahill, 2003; Peláez et al., 2019). *Salvia hispanica* L. seed exhibits a substantial lipid content, comprising approximately 40% of its total weight. Notably, omega-3 fatty acids constitute nearly 60% of this lipid fraction. Dietary fiber (soluble and insoluble) represents over 30% of the seed's total weight, while proteins of high biological value account for approximately 19% of its composition (Ixtaina et al., 2011; Dinçoğlu & Yeşildemir, 2019). The documented health-promoting attributes of *Salvia hispanica* L. seeds are attributable to their complex chemical composition, notably their elevated concentrations of essential fatty acids, essential amino acids, polyphenols, vitamins, and bioelements (Motyka et al., 2023). A substantial body of recent scientific literature has characterized the chemical composition of *Salvia hispanica* L. seeds and corroborated their diverse biological activities, demonstrating beneficial effects on human physiology. These documented effects include anti-inflammatory, cardioprotective anticoagulant, hypotensive, hypoglycemic, antioxidant, hypolipemic, hepatoprotective, and immunostimulatory properties (Rahman et al., 2017; Rabail et al., 2021; Montes et al., 2018; Fonte-Faria et al., 2019). Currently, *Salvia hispanica* is recognized for its diverse health benefits and is increasingly incorporated into a wide range of culinary preparations. Chia seed functions effectively as a food additive, possessing multifaceted applications, including utilization as a thickening agent, gelling agent, chelating agent, foam enhancer, and emulsifier. A variety of food products, such as frozen foods, baked goods, beverages, confectionery, pasta, and sausages, can be fortified with chia seeds. Furthermore, chia oil can serve as a fat replacer in select formulations (Chaudhary et al., 2021).

This paper focused on the preparation and characterization of two novel vegan, ready-to-eat appetizers derived from chia seeds. Two distinct formulations were developed: the first (ChA1) incorporated almond milk, green onions, carrots, and flaxseed oil, while the second (ChA2) utilized soy milk, baked red capia peppers, seaweed flakes, and olive oil. The research further aimed to assess the nutritional and sensory properties of both chia-based appetizers, specifically focusing on ascorbic acid content, total polyphenol content, carotenoid levels, antioxidant activity, proximate composition, and sensory attributes.

MATERIALS AND METHODS

Vegan chia seeds appetizers preparation

Two distinct varieties of chia seed-based vegan appetizers were formulated utilizing raw and auxiliary materials sourced from the Romanian market, following the recipes detailed in Table 1.

Table 1. Recipes for vegan chia seed appetizers

Materials (%) \ Appetizer type	ChA1	ChA2
Chia seeds	14.0	14.0
Almond milk	56.0	-
Soy milk	-	56.0
Lemon juice	4.5	4.5
Carrots (fresh)	8.0	-
Baked red capia pepper (*Capsicum annuum*)	-	8.0
Green onion	7.0	-
Red onion	-	6.0
Nori (*Pyropia yezoensis*) seaweed flakes	-	1.0
Flaxseed oil	9.0	-
Extra virgin olive oil	-	9.0
Himalayan black salt	1.5	1.5

The preparation of vegan appetizers involves the following procedure: initially, pre-measured quantities of vegetable milk, chia seeds, and salt are combined in a mixing bowl. For the ChA2 variant, seaweed flakes are incorporated into this initial mixture. This blend is subsequently allowed to stand for approximately 30 minutes to induce the formation of a gelatinous texture. Concurrently, preparation of the remaining ingredients proceeds. Specifically, for the ChA1 appetizer, fresh carrots are finely grated, and green onions are finely chopped. For the ChA2 assortment, red onion and baked capia peppers are finely chopped. Upon achieving the desired gel consistency, the prepared ingredients for each respective appetizer (ChA1 or ChA2) are sequentially incorporated into the base mixture, accordingly to recipes (Figure 1). The resultant products are then transferred to chilled storage containers and maintained under refrigeration for consumption within a 48-hour period. The resultant products were subjected to sampling for subsequent physical-chemical and sensory analyses.

ChA1 ChA2

Figure 1. The two types of vegan chia-based ready-to-eat appetizers

Assessment of ascorbic acid content

Ascorbic acid content in both raw materials and finished products was determined using a modified iodometric method as described by Dumbrava et al. (2016).

Assessment of the total polyphenol content

The total polyphenol content (TPC) of both the chia-based vegan appetizers and the raw materials was determined using the Folin-Ciocalteu method. Ethanolic extracts (70%) were prepared from each sample. The analytical procedure followed the methodology outlined by Dumbrava et al. (2020), with results expressed as milligrams of gallic acid equivalents per gram of sample (mg GAE/g).

Assessment of carotenoids content

The determination of carotenoid compounds in finished products was performed using the following procedure: for each chia-based vegan appetizer assortment (ChA1 and ChA2), a 3.00 g sample was weighed and homogenized using a grinder with the addition of quartz sand and an extraction solvent mixture consisting of petroleum ether: acetone (6:3 v/v). The resulting homogenate was transferred to a centrifuge tube, filled with the extraction solvent mixture, and centrifuged at 3000 rpm for 5 minutes. The supernatant was collected after filtration into amber glass bottles. This extraction procedure was repeated with successive aliquots of the solvent mixture until the remaining material was colorless. The combined supernatants were then concentrated under vacuum at 45°C using a rotary evaporator to a final volume of approximately 50 ml. These primary carotenoid extracts were subsequently saponified by the addition of an equal volume of 15% (w/v) KOH ethanolic solution and incubated overnight at room temperature in darkness. Following saponification, the samples were transferred to separating funnels, and petroleum ether was added to re-extract the unsaponified carotenoids. The extracts were then washed with distilled water to ensure complete removal of soaps and alkali. Residual water in the ether extracts was removed using anhydrous sodium sulfate. The dehydrated extracts were concentrated under vacuum to a reduced volume and stored in amber glass bottles at -20°C until analysis.

Carotenoid concentration was determined spectrophotometrically using a JASCO V-670 UV-VIS spectrophotometer. Absorbance measurements were performed in petroleum ether at a wavelength of 450 nm (λ=450 nm) using a 1 cm cuvette, with petroleum ether serving as the blank. Carotenoid content was subsequently calculated using the formula (Rodriguez-Amaya & Kimura, 2004):

$$\mu\text{g carotenoids/g plant material} = \frac{A \cdot V \cdot 10^4}{A_{1cm}^{1\%} \cdot m}$$

where:

A represents the absorbance at the specified wavelength.

V - volume of the analyzed extract (mL).

$A^{1\%}_{1cm}$ - specific absorption coefficient of β-carotene in petroleum ether (2592).

m - mass of the sample (g)

Assessment of the antioxidant activity

The cupric ion reducing antioxidant capacity (CUPRAC) of both the finished products and raw materials was assessed. This analysis utilized the same 70% ethanolic extracts prepared for TPC determination. The analytical procedure followed the methodology described by Dumbrava et al. (2020).

Assessment of the antiradical activity

The antiradical activity of both the ChA1 and ChA2 appetizers, as well as the constituent raw materials, was assessed by evaluating the 2,2-

diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity (RSA). The methodology employed for this analysis was consistent with that previously reported (Poiana et al., 2022).

Assessment of the proximate composition and energy value

Proximate composition of the chia-based vegan appetizers ChA1 and ChA2, was determined according to established International Organization for Standardization (ISO) methods. Specifically, protein content was assessed following SR ISO 937:2007, total lipid content per SR ISO 1443:2008, mineral content per SR ISO 936:2009, sugar content per SR ISO 91-2007, and fiber content per ISO 13906:2007. Moisture content was determined following SR ISO 1442:2010 using a FOOS Fibertec 2010&M6 instrument (Sweden). Carbohydrate content was calculated by difference, subtracting the sum of protein, total fat, dietary fiber, minerals, and moisture content from 100%. The energy value of each finished product was subsequently calculated by summing the caloric contributions of carbohydrates, lipids, and proteins, using conversion factors of 9 kcal/g for lipids and 4 kcal/g for both carbohydrates and proteins.

Statistical analysis

Statistical analysis of data obtained from triplicate determinations of total polyphenol content (TPC), carotenoid content, antioxidant activity, antiradical activity, and proximate composition was performed using Microsoft Excel 2010 software.

Sensory evaluation

A sensory evaluation of the chia-based vegan appetizers was conducted in accordance with ISO 4121:2002. A panel of 20 evaluators (both male and female), ranging in age from 21 to 60 years, participated in the assessment. A 5-point hedonic scale (1-5) was utilized for rating the following attributes: appearance, odor, taste, texture and overall acceptability. Prior to participation, each evaluator provided written informed consent, in compliance with the ethical guidelines established by the European Union for research on food (Alfonsi et al., 2012). The evaluation was performed under standardized conditions, employing the same acceptability levels and score range interpretations as described by Dumbrava et al. (2020).

RESULTS AND DISCUSSIONS

Ascorbic acid content

The experimentally derived vitamin C concentrations for both the ingredients and the two chia-based vegan appetizer formulations are presented in Table 2.

Table 2. Ascorbic acid content in the ingredients and finished products

Sample	Vitamin C (mg/100 g)
Lemon juice	40.34±0.16
Carrots (fresh)	14.52±0.08
Baked red capia pepper	9.14±0.02
Green onion	26.48±0.06
Red onion	39.75±0.11
ChA1	5.02±0.04
ChA2	5.37±0.05

Of the constituent ingredients, lemon juice exhibited the highest ascorbic acid concentration (40.34±0.16 mg/100 g), followed by red onion (39.75±0.11 mg/100 g) and green onion (26.48±0.06 mg/100 g). The final product formulations demonstrated comparable ascorbic acid concentrations, with the ChA2 exhibiting a marginally elevated level (5.37±0.05 mg/100g). Nyoku et al. (2011) reported ascorbic acid concentrations in lemon juice ranging from 24.9 to 30.6 mg/100 g, with observed values decreasing at higher temperatures. In a separate study, Najwa and Azrina (2017) determined an ascorbic acid content of 43.96 mg/100 g, which marginally exceeded the concentration observed in the present work. The reported vitamin C content of red onions exhibits considerable variation in the literature, likely attributable to factors such as geographical origin, analytical methodology employed, and other potentially influential variables. Thus, Onyeoziri et al. (2016) found much higher values (229.098 mg/100 g) than in this study, and Jeong et al. (2006) reported lower values (28.34 mg/100 g).

Total polyphenols content

The total phenolic content (TPC) of the two chia-based vegan appetizer assortments and their constituent raw materials is presented in Table 3.

Table 3. TPC in the chia-based vegan appetizers and in their constituents raw maerials

Sample	TPC (mg gallic acid/g)
Chia seeds	1.56±0.11
Almond milk	0.38±0.02
Soy milk	2.04±0.10
Lemon juice	1.36±0.06
Carrots (fresh)	1.78±0.03
Baked red capia pepper	35.16±0.41
Green onion	1.62±0.05
Red onion	6.57±0.14
Nori seaweed flakes	24,62±0.44
ChA1	1.14±0.04
ChA2	5.12±0.18

Evaluation of ingredients for vegan chia-based appetizer formulation revealed that baked red capia peppers exhibited the highest TPC (35.16±0.41 mg GAE/g), followed by Nori seaweed flakes (24.62±0.44 mg GAE/g) and red onion (8.57±0.14 mg GAE/g). Almond milk presented the lowest total polyphenol concentration (0.38±0.02 mg GAE/g). Comparative analysis of the vegan chia-based appetizer formulations demonstrated a 4.49-fold greater TPC in ChA2 (5.12±0.18 mg GAE/g) relative to ChA1 (1.14±0.04 mg GAE/g).

Saphier et al. (2017) documented total polyphenol concentrations (TPC) in chia seeds ranging from 1.339 to 1.99 mg GAE/g, dependent on the water: ethanol ratio employed during extraction. The maximum TPC was observed utilizing a 50:50 water: ethanol ratio. The TPC value determined in the present study is concordant with this previously reported range. Suri et al. (2020) also found lower TPC, ranging from 0.88 to 0.94 mg GAE/g, for chia seeds from various origins. Çiftçi & Ceylan (2024) reported TPC ranging from 73.89±18 to 46.26±8.77 mg GAE/g for industrially canned red capia peppers, with the variation attributed to storage duration.

The TPC value obtained in the present study for industrially canned roasted red capia peppers is lower than the range reported by these authors. Regarding red onion, Lu et al. (2011) found TPC values lower than in the present work: 4.28±0.28 mg GAE/g, and Metrani et al. (2020) reported even lower values: 1.40 - 1.57 mg GAE/g.

Carotenoid compounds content

Table 4 presents the carotenoid content spectrophotometrically determined in the two varieties of vegan chia-based appetizers

Table 4. Carotenoids content in raw vegan appetizers

Sample	Carotenoids content (μg/g)
ChA1	10.14±0.12
ChA2	12.08±0.20

Within the vegan chia-based appetizer formulations developed in this study, ChA2 demonstrated a 19.13% greater carotenoid content (12.08±0.20 μg/g) than ChA1 (10.14±0.12 μg/g).

Antioxidant and antiradical activities

The antioxidant and antiradical activities of the individual ingredients and the vegan appetizers, ChA1 and ChA2, were assessed experimentally using the CUPRAC assay. The results obtained are presented in Table 5.

Table 5. Antioxidant and antiradical activities of the individual ingredients and the vegan appetizers

Sample	Antioxidant activity (mg Trolox/g)	RSA (%)
Chia seeds	38.37±0.28	96.46±0,38
Almond milk	5.14±0.08	45.68±0,14
Soy milk	3.35±0.02	40.21±0,11
Lemon juice	11.02±0.21	91,02±0,32
Carrots (fresh)	8.54±0.16	90.64±0,31
Baked red capia pepper	4.38±0.09	58.11±0,18
Green onion	5.61±0.06	88,14±0,21
Red onion	7.47±0.08	91.68±0,36
Nori seaweed flakes	16.73±0.21	94.98±0,31
ChA1	11.14±0.18	70.02±0.20
ChA2	12.47±0.23	73.46±0.24

A compositional analysis of the ingredients comprising ChA1 and ChA2 appetizers demonstrated that chia seeds exhibited the greatest antioxidant capacity (38.37±0.28 mg Trolox/g), followed by Nori algae flakes (16.73±0.21 mg Trolox/g) and lemon juice (11.02±0.21 mg Trolox/g), respectively. Regarding DPPH free radical scavenging activity, chia seeds demonstrated the highest value (96.46±0.38%), followed by Nori algae flakes (94.98±0.31%) and lemon juice (91.02±0.32%), respectively.

In the finished product form, both ChA1 and ChA2 exhibited significant and comparable antioxidant and antiradical activities. However, ChA2 demonstrated an 11.94% and 4.91% increase in antioxidant and antiradical activity, respectively (12.47±0.23 mg Trolox/g, 73.46±0.24%), relative to ChA1 (11.14±0.18 mg Trolox/g, 70.02±0.20%).

Concerning the ingredients employed in the present study, Manzoor et al. (2021) reported comparatively lower antioxidant activity and RSA values for almond milk, specifically 4.03 mg Trolox/g and 40.54±0.15%, respectively. The RSA value of 94.76% reported by Łaczkowski et al. (2018) for chia seeds is slightly lower than the value observed in the present study. Similarly, the antioxidant activity range of 49.38-57.90 mg Trolox/g reported by Tunçil & Çelik (2019) is somewhat higher than the value obtained in the current investigation. Park et al. (2019) reported antioxidant activity values for *Pyropia yezoensis* ranging from 9.53±0.47 to 19.45±0.07 mg Trolox/g; the present study's findings are consistent with this reported range.

Proximate composition and energy value of vegan chia-based appetizers

Table 6 presents the proximate composition and energy values determined for the vegan appetizers developed in this study.

A comparative analysis of the proximate composition of two vegan chia-based appetizer variants, ChA1 and ChA2, revealed significant differences in several macronutrient constituents. Specifically, ChA2 exhibited a 1.5-fold increase in protein content (4.20±0.05 g/100 g) relative to ChA1. In contrast, total lipid concentrations were observed to be equivalent across both varieties, registering at 14.00 g/100 g. Furthermore, ChA2 demonstrated a 21.95% elevation in total carbohydrate levels (10.00 g/100 g) compared to ChA1 (8.20 g/100 g). A substantial disparity was also noted in sugar content, with ChA2 exhibiting a 2.18-fold higher concentration (2.40±0.03 g/100 g) than ChA1 (1.10± 0.01 g/100 g). Conversely, the dietary fiber content remained relatively consistent between the two variants, with ChA1 registering 5.30±0.08 g/100 g and ChA2 5.40±0.10 g/100 g. ChA2 is also characterized by an energy value 7.53% higher (182.80 kcal/100 g) than ChA1 (170.00 kcal/100 g) (Figure 2).

Table 6. Proximate composition and energy value of vegan chia-based appetizers

Parameters	ChA1	ChA2
Proteins (g/100 g)	2.80±0.06	4.20±0.05
Lipids (g/100 g)	14.00±0.22	14.00±0,24
Saturated fatty acids (g/100 g)	1.30±0.03	1.80±0.02
Carbohydrates (g/100g)	8.20	10.00
Sugar (g/100 g)	1.10±0.01	2.40±0.03
Dietary fiber (g/100 g)	5.30±0.08	5.40±0.10
Moisture (g/100 g)	68.55±0.44	65.26±0.52
Mineral substances (g/100 g)	1.15±0.02	1.14±0.01
Energy value (kcal/100 g)	170.00	182.80

Sensory analysis

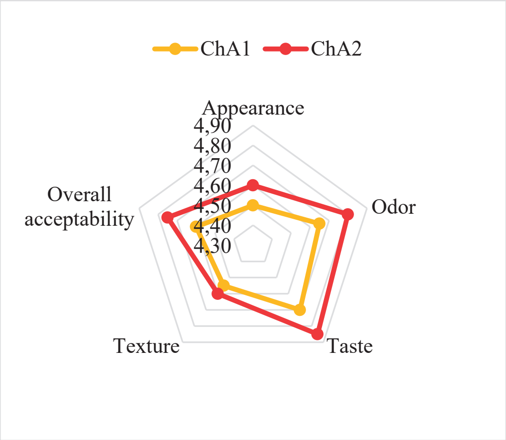

Figure 2. Global values of the sensory evaluation of breads using a 5-point hedonic scale

The developed vegan chia-based appetizer formulations exhibited a high degree of organoleptic acceptance, as indicated by sensory evaluation scores consistently exceeding 4.5 across all evaluated characteristics. ChA2 exhibited superior sensory performance compared to ChA1 across all attributes, notably achieving the highest mean score of 4.85 for taste. Panelists described the flavor profile of ChA2 as closely approximating that of traditional fish roe salad.

CONCLUSIONS

The contemporary food sector is witnessing a significant trend towards the innovation and development of vegan products possessing functional attributes, driven by escalating consumer demand for such dietary options.

This research presents the development and comprehensive characterization of two distinct vegan chia-based appetizer formulations, designated ChA1 and ChA2. ChA1 was formulated utilizing almond milk, carrots, flaxseed oil, and green onion, whereas ChA2 incorporated soy milk, Nori algae flakes, baked capia peppers, red onion, and extra virgin olive oil. Both formulations were characterized by elevated concentrations of ascorbic acid, total polyphenols, and carotenoid compounds, concomitantly exhibiting substantial antioxidant and antiradical activities, and were deemed highly acceptable based on sensory evaluation. Comparative analysis revealed that ChA2 demonstrated higher levels of ascorbic acid, total polyphenols, and carotenoids, as well as superior antioxidant and antiradical activities, increased protein content, and enhanced sensory attributes relative to ChA1. The developed chia-based appetizer formulations present a potential avenue for technological transfer to supermarket in-house laboratories and/or public food service establishments.

REFERENCES

Alfonsi, A., Coles, D., Hasle, C., Koppel, J., Ladikas, M., Schmucker von Koch, J., Schroeder, D., Sprumont, D., Verbeke, W., & Zaruk, D. (2012). *Guidance Note: Ethics and Food-Related Research*. European Commission Ethics Review Sector: Brussels, Belgium.

Cahill, J. P. (2003). Ethnobotany of chia, *Salvia hispanica* L. (*Lamiaceae*). *Economic botany*, *57*(4), 604-618.

Chaudhary, N., Dangi, P., Kumar, R., & Bishnoi, S. (2021). *Chia Seeds - A renewable source as a functional food*. In Handbook of Cereals, Pulses, Roots, and Tubers, 235-252. Boca Raton, USA: CRC Press Publishing House.

Chhikara, N., & Panghal, A. (2022). Overview of functional foods. *Functional Foods*, 1-20.

Çiftçi, S., & Ceylan, A. H. (2024). Effect of cooking conditions and storage on phenolic contents of bottled Capia red pepper. *International Food Research Journal*, *31*(2), 454-462.

Dinçoğlu, A. H., & Yeşildemir, Ö. (2019). A renewable source as a functional food: Chia seed. *Current nutrition & food science*, *15*(4), 327-337.

Dumbravă, D.G., Moldovan, C., Raba, D.N., Popa, V.M., & Drugă, M. (2016). Evaluation of antioxidant activity, polyphenols and vitamin C content of some exotic fruits. *Journal of Agroalimentary Processes and Technologies*, 22(1), 13-16

Dumbrava, D., Popescu, L. A., Soica, C. M., Nicolin, A., Cocan, I., Negrea, M., ... & Dehelean, C. (2020). Nutritional, Antioxidant, Antimicrobial, and Toxicological Profile of Two Innovative Types of Vegan, Sugar-Free Chocolate. *Foods*, *9*(12), 1844.

Fonte-Faria, T., Citelli, M., Atella, G. C., Raposo, H. F., Zago, L., de Souza, T., ... & Barja-Fidalgo, C. (2019). Chia oil supplementation changes body composition and activates insulin signaling cascade in skeletal muscle tissue of obese animals. *Nutrition*, *58*, 167-174.

Granato, D., Barba, F. J., Bursać Kovačević, D., Lorenzo, J. M., Cruz, A. G., & Putnik, P. (2020). Functional foods: Product development, technological trends, efficacy testing, and safety. *Annual review of food science and technology*, *11*(1), 93-118.

Ixtaina, V. Y., Martínez, M. L., Spotorno, V., Mateo, C. M., Maestri, D. M., Diehl, B. W., ... & Tomás, M. C. (2011). Characterization of chia seed oils obtained by pressing and solvent extraction. *Journal of Food Composition and Analysis*, *24*(2), 166-174.

Jeong, C. H., Kim, J. H., & Shim, K. H. (2006). Chemical components of yellow and red onion. *Journal of the Korean Society of Food Science and Nutrition*, *35*(6), 708-712.

Kaur, S., & Das, M. (2011). Functional foods: An overview. *Food Science and Biotechnology*, *20*, 861-875.

Laczkowski, M. S., Gonçalves, T. R., Gomes, S. T., Março, P. H., Valderrama, P., & Matsushita, M. (2018). Application of chemometric methods in the evaluation of antioxidants activity from degreased chia seeds extracts. *Lwt*, *95*, 303-307.

Lu, X., Wang, J., Al-Qadiri, H. M., Ross, C. F., Powers, J. R., Tang, J., & Rasco, B. A. (2011). Determination of total phenolic content and antioxidant capacity of onion (*Allium cepa*) and shallot (*Allium oschaninii*) using infrared spectroscopy. *Food Chemistry*, *129*(2), 637-644.

Manzoor, M. F., Siddique, R., Hussain, A., Ahmad, N., Rehman, A., Siddeeg, A., ... & Yahya, M. A. (2021). Thermosonication effect on bioactive compounds, enzymes activity, particle size, microbial load, and sensory properties of almond (*Prunus dulcis*) milk. *Ultrasonics Sonochemistry*, *78*, 105705.

Metrani, R., Singh, J., Acharya, P., K. Jayaprakasha, G., & S. Patil, B. (2020). Comparative metabolomics profiling of polyphenols, nutrients and antioxidant activities of two red onion (*Allium cepa* L.) cultivars. *Plants*, *9*(9), 1077.

Mitrea, S.I., Petcu, D.C., Savu, Gh. (2003). *Food safety through the application of the HACCP system*. Bucharest, RO: Bogdana Publishing House.

Mohd Ali, N., Yeap, S. K., Ho, W. Y., Beh, B. K., Tan, S. W., & Tan, S. G. (2012). The promising future of chia, *Salvia hispanica* L. *BioMed Research International*, *2012*(1), 171956.

Montes Chani, E. M., Pacheco, S. O., Martínez, G. A., Freitas, M. R., Ivona, J. G., Ivona, J. A., ... & Pacheco, F. J. (2018). Long-term dietary intake of chia seed is associated with increased bone mineral content and improved hepatic and intestinal morphology in sprague-dawley rats. *Nutrients*, *10*(7), 922.

Motyka, S., Skała, E., Ekiert, H., & Szopa, A. (2023). Health-promoting approaches of the use of chia seeds. *Journal of Functional Foods*, *103*, 105480.

Najwa, F. R., & Azrina, A. (2017). Comparison of vitamin C content in citrus fruits by titration and high performance liquid chromatography (HPLC) methods. *International Food Research Journal*, *24*(2), 726.

Njoku, P. C., Ayuk, A. A., & Okoye, C. V. (2011). Temperature effects on vitamin C content in citrus fruits. *Pakistan Journal of Nutrition*, *10*(12), 1168-1169.

Onyeoziri, U. P., Romanus, E. N., & Onyekachukwu, U. I. (2016). Assessment of antioxidant capacities and phenolic contents of Nigerian cultivars of onions (*Allium cepa* L.) and garlic (*Allium sativum* L.). *Pakistan Journal of Pharmaceutical Sciences*, *29*(4), 1183-1188.

Park, J. S., Jeong, Y. R., & Chun, B. S. (2019). Physiological activities and bioactive compound from laver (*Pyropia yezoensis*) hydrolysates by using subcritical water hydrolysis. *The Journal of Supercritical Fluids*, *148*, 130-136.

Peláez, P., Orona-Tamayo, D., Montes-Hernández, S., Valverde, M. E., Paredes-López, O., & Cibrián-Jaramillo, A. (2019). Comparative transcriptome analysis of cultivated and wild seeds of *Salvia hispanica* (chia). *Scientific Reports, 9*, DOI:10.1038/s41598-019-45895-5.

Petcu, C.D., Savu, C., Mitrănescu, E., & Chirilă, S., (2007). The implementation of the integrated quality and food safety management system in the food industry units. *Lucrări Ştiințifice Medicină Veterinară*, XL, 545-51.

Poiana, M. A., Moigradean, D., Dumbrava, D. G., Radulov, I., Raba, D. N., & Rivis, A. (2022). Exploring the potential of grape pomace extract to inhibit thermo-oxidative degradation of sunflower oil: From routine tests to atr-ftir spectroscopy. *Foods*, *11*(22), 3674.

Rabail, R., Khan, M. R., Mehwish, H. M., Rajoka, M. S. R., Lorenzo, J. M., Kieliszek, M., ... & Aadil, R. M. (2021). An overview of chia seed (*Salvia hispanica* L.) bioactive peptides' derivation and utilization as an emerging nutraceutical food. *Frontiers in Bioscience-Landmark*, *26*(9), 643-654. analysis of cultivated and wild seeds of *Salvia hispanica* (chia). *Scientific reports*, *9*(1), 9761.

Rahman, M. J., de Camargo, A. C., & Shahidi, F. (2017). Phenolic and polyphenolic profiles of chia seeds and their in vitro biological activities. *Journal of Functional Foods*, *35*, 622-634.

Rana, A., Taneja, N. K., Singh, A., Dhewa, T., Kumar, V., Kumar, A. & Oberoi, H. S. (2025). Synergistic fermentation of vitamin B2 (riboflavin) bio-enriched soy milk: optimization and techno-functional characterization of next generation functional vegan foods. *Discover Food*, *5*(1), 10.

Rodriguez-Amaya, D. B., & Kimura, M. (2004). *HarvestPlus handbook for carotenoid analysis. HarvestPlus Technical Monograph*. Whashington DC, USA: International Food Policy Research Institute and International Center for Tropical Agriculture.

Salem, A. A., & El Shahawy, N. A. (2020). Hippocrates's Advice and Nutritional Secrets. *Open Journal of Nutrition and Food Science*, *2*, 52-54.

Saphier, O., Silberstein, T., Kamer, H., Ben-Abu, Y., & Tavor, D. (2017). Chia seeds are richer in polyphenols compared to flax seeds. *Integrative Food, Nutrition and Metabolism*, *4*(3), 1-4.

Sim, S. Y. J., Srv, A., Chiang, J. H., & Henry, C. J. (2021). Plant proteins for future foods: A roadmap. *Foods*, *10*(8), 1967.

Suri, S., Passi, S. J., & Goyat, J. (2020). Chia Seed (*Salvia hispanica* L.) - A new age functional food. *International Journal of Advanced Technology in Engineering and Science, 4*(03), www.ijates.com.

Temple, N. J. (2022). A rational definition for functional foods: A perspective. *Frontiers in nutrition*, *9*, 957516.

Tunçil, Y. E., & Çelik, Ö. F. (2019). Total phenolic contents, antioxidant and antibacterial activities of chia seeds (*Salvia hispanica* L.) having different coat color. *Akademik Ziraat Dergisi*, *8*(1), 113-120.

Valero-Cases, E., Frutos, M. J., & Pérez-Llamas, F. (2023). Development of synbiotic vegan beverages: probiotic viability, sensory profile, consumers' acceptance and functional stability. *International Journal of Food Science and Technology*, *8*(5), 2325-2335.

***ISO 4121:2002. *Sensory analysis: Methodology: evaluation of food product by methods of using scales.* International Organization for Standardization: Geneva, Switzerland.