Research Article

Comprehensive Physicochemical and Fatty Acid Profile Characterization of Cold-Pressed Chia (*Salvia hispanica* L.) Oil from Western Morocco

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Abstract | This research reveals the first in-depth physicochemical and fatty acid profile characterization of cold-pressed chia (*Salvia hispanica* L.) oil from an experimental cultivation in Western Morocco. Oils were extracted from mechanical pressing and analyzed according to international AOCS standards and GC-MS methods. Moroccan chia oil showed exceptionally high levels of α-linolenic acid (65.6 ± 3.2%), substantial linoleic acid (18.7 ± 1.5%), with moderate palmitic (10.8 ± 0.2%) and stearic acids (5.6 ± 0.3%). Key physicochemical parameters included: saponification value (191.2 ± 4.5 mg KOH/g), acid value (1.05 ± 0.08 mg KOH/g), peroxide value (35.7 ± 2.1 meq O_2/kg), and refractive index (1.48389 ± 0.0005 at 20°C), suggesting that the oil meets reported ranges for cold-pressed chia oils, although the relatively high peroxide value is discussed as a limitation for oxidative stability. Statistical analysis demonstrated strong inter-lot reproducibility and significant correlations, especially between saponification value and α-linolenic acid per lot (r = 0.70). This evidence indicating that Moroccan chia oil may represent a promising omega-3 and omega-6 source, with potential relevance for dietary diversification in North Africa, while requiring further validation on stability and scalability.

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Introduction

Chia- or *Salvia hispanica* L.- is an herbaceous plant that originated in Central America, which has recently received acknowledgement globally for the unique nutritional and functional benefits it can confer to food from its seeds, and food associated with its seeds, and other edible parts of the plant (Khalid *et al*., 2023). Chia seeds are known for their high concentration of proteins, dietary fibre and phenolic compounds and the oil produced from its seed also contains one of the highest quantities of polyunsaturated omega-3 acids found in a plant (Ixtaina *et al*., 2011; Oteri *et al*., 2023). Due to these properties, and advances concerning food security, malnutrition, and sustainability issues associated with traditional oilseed crops, chia has also emerged as a viable option for diversification in farming systems. The nutritional benefits attributed to chia oils are mostly associated with their high content of alpha-linolenic acid (ALA, C18:3, omega-3), an endogenous compound, with recognized cardiovascular, neuroprotective and anti-inflammatory properties (Khalid *et al*., 2023). Additionally, the oxidative stability, emulsifying abilities, and antioxidant activity of chia oil have garnered interest in the food and nutraceutical industries (Oteri *et al*., 2023).

Chia production has been studied in Latin America, Australia, Asia, and more recently Europe, but North Africa remains unexplored in the literature for this crop (Lopez *et al*., 2022; FAO, 2023). No study has fully characterized the oil profile of chia grown in Morocco or examined the adaptability, or nutritional characteristics, under local growing conditions.

To date, and despite increased interest in this seed globally, no study has fully characterized the physical and nutritional factors of chia oil produced in Morocco or North Africa. The local applicability of cultivation and processing methodologies have not been evaluated, creating full justification for this study and providing further scientific content to the literature.

This research presents a comprehensive physicochemical and lipidomic analysis of cold-pressed chia oil sourced from experimental cultivation in Western Morocco, a novel regional crop, providing comparison benchmarks with the international context and highlighting the original agro-environmental context. The emphasis is on the fatty acids composition, technological quality indices, and correlations of interest for the food industry and for nutrition.

Materials and Methods

Seed material

A field trial was conducted in Mnasra, Kenitra Province (34.36°N, 6.55°W; ~12 m a.s.l.), Western Morocco, under Mediterranean climatic conditions (Köppen Csa), characterized by hot, dry summers and mild, wet winters in Western Morocco (Rossafi *et al*., 2025). The soil at the experimental site had a sandy texture (approximately 70–90% sand, 5–20% silt and 5–10% clay), was slightly alkaline, non-calcareous, with very low salinity and very low organic matter content, while being well supplied with mineral nitrogen, available phosphorus and exchangeable potassium (Rossafi *et al*., 2025). Soil preparation consisted of a disc harrow pass one week before sowing, followed by manual preparation with a simple hoe on the day of sowing. Plots of 3 × 1.5 m were sown by hand at 1–2 cm depth, with 50 cm between rows and 30 cm between plants, using certified *S. hispanica* L. seeds (FLORAGARDEN, Morocco) were sown of 3 kg/ha (approximately 150–200 seeds/m^2), as recommended for Lamiaceae species (Vârban *et al*., 2021). Sheep manure was applied at 20 t/ha within 30 days before sowing, distributed by hand and followed by irrigation. Irrigation was applied immediately after planting and then twice per week according to plant requirements and soil conditions. Weed control was performed manually about three weeks after sowing and throughout the vegetative cycle, and no herbicides or synthetic fertilizers were used, so that the crop was managed under organic-like conditions.

Oil extraction

Crude chia oil was obtained via cold pressing using a mechanical screw press. Each batch was extracted in triplicate, and the oils were filtered and stored at 4 °C in amber glass bottles under a nitrogen atmosphere to minimise oxidation. Each batch was defined as oil obtained from seeds harvested from the same plot and sowing date (Sowing between 14 and 28 May), processed together under identical pressing conditions. Chia seeds were cleaned before processing, and all batches were extracted in cold-press mode, with the press-head temperature kept below 40 °C and an average oil yield of approximately 33 % (w/w).

Physicochemical characterization

Standard AOCS Official Methods were employed for the determination of key oil quality indices:

- Saponification index, acidity (mg KOH/g fat), and peroxide value (meq O_2/kg) (cf. AOCS Ce 1h-05, Ixtaina *et al*., 2011; Khalid *et al*., 2023).
- Brix (%) was measured at 20°C using a digital refractometer as in Khalid *et al*. (2023).
- In this study, Brix was used as a complementary indicator of soluble co-extracted constituents,

which may reflect compositional differences among batches and have been reported as ancillary quality markers in chia oil.

Refractive index (20°C) was determined using an Abbe refractometer (RX-5000A-PLUS, ATAGO). All measurements were performed in triplicate, and results were expressed as the mean ± standard deviation.

Fatty acid profile analysis (GC-MS)
Fatty acid methyl esters (FAMEs) were prepared by standard base-catalyzed transesterification with methanolic potassium hydroxide. GC-MS analysis was conducted using an Agilent 7890A GC coupled to a 5975C MS detector (Agilent Technologies), with a DB-23 capillary column (30 m × 0.25 mm, 0.25 µm film). The oven temperature program was set as follows: initial at 100°C for 2 min, ramped to 240°C at 4°C/min, held for 15 min. Injector and detector temperatures were 250°C. Helium was used as the carrier gas at a constant flow rate of 1.0 ml/min. Identification and quantification of fatty acids were accomplished by comparison with authentic FAME standards and database spectra (NIST14).

Results were expressed as percentage of total fatty acids.

Statistical analysis
All data were analyzed with SPSS v23.0 (IBM Corp.). Values are presented as mean ± SD together with 95 % confidence intervals. One-way ANOVA and Tukey's post hoc test ($p < 0.05$) were used to compare batch differences, and effect sizes (Cohen's d) were calculated and are reported in the tables where appropriate. Pearson's correlation coefficients were used to explore associations among physicochemical indices and fatty acid profiles, without implying causal relationships.

Results and Discussion

Physico-chemical properties
Cold-pressed chia oil produced from Western Moroccan seeds exhibited premium physicochemical quality. The principal indices were as follows: saponification index (191.2 ± 4.5mg KOH/g), acidity (1.05 ± 0.08 mg KOH/g), peroxide value (35.7 ± 2.1 meq O_2/kg) is relatively high and should be interpreted as a potential limitation for oxidative stability rather than an indicator of exceptional freshness (Table 1), Brix at 20°C (77.38 ± 0.15%), and refractive index (1.48389± 0.0005 at 20°C). All these parameters fell within the ranges reported for cold-pressed chia oils in previous studies (Ixtaina *et al*., 2011; Oteri *et al*., 2023; FAO, 2023; Lopez *et al*., 2022; Melo *et al*., 2022; Montanari *et al*., 2023).

Fatty acid composition (GC-MS) and nutritional value
C-MS analysis revealed a dominant α-linolenic acid content (65.6 ± 3.2%), substantial linoleic acid (18.7 ± 1.5%), moderate palmitic (10.8 ± 0.2%), stearic (5.6 ± 0.3%), and oleic acids (5.2 ± 0.15%). These profiles closely matched premium chia oils from South America and Asia. (Table 2).

To place the fatty acid profile of Moroccan chia oil in a broader context, its main fatty acids were compared with literature values for several commonly consumed edible oils, including perilla, hemp, walnut, sesame, olive, argan and flaxseed oils (Table 4). This comparison highlights how chia differs from traditional Mediterranean oils and other ω-3-rich oils in terms of α-linolenic, linoleic, oleic and saturated

Table 1: *Physico-chemical parameters of moroccan chia oil*

Parameter	Value (Mean ± SD)	95% CI	Cohen's d	International range	References
Saponification index (mg KOH/g)	191.2 ± 4.5	[180.0, 202.4]	0.27	180–200	Ixtaina *et al*., 2011 ; Khalid *et al*., 2023; FAO (2023)
Acidity (mg KOH/g)	1.05 ± 0.08	[0.85, 1.25]	1.25	0.7–1.2	Ixtaina *et al*., 2011 ; Oteri *et al*., 2023
Peroxide value	35.7 ± 2.1	[30.5, 40.9]	0.86	30–45	Oteri *et al*., 2023; Melo *et al*., 2022; Montanari *et al*.,2023
Brix (%)	77.38 ± 0.15	[77.0, 77.8]	2.53	74–80	Khalid *et al*., 2023; Lopez *et al*., 2022; Melo *et al*., 2022
Refractive Index	1.48389 ± 0.0005	[1.4826, 1.4851]	7.78	1.475–1.485	Ixtaina *et al*., 2011; Khalid *et al*., 2023; FAO (2023)

Table 2: *Main fatty acids in moroccan chia oil (% of total)*

Fatty acid	Value (%)	95% CI	Cohen's d	International range	References
α-Linolenic (C18 :3)	65.6 ± 3.2	[57.7, 73.6]	1.59	54–67	Khalid *et al*., 2023; Oteri *et al*., 2023
Linoleic (C18 :2)	18.7 ± 1.5	[15.0, 22.4]	1.47	12–21	Ixtaina *et al*., 2011 ; Oteri *et al*., 2023
Palmitic (C16 :0)	10.8 ± 0.2	[10.3, 11.3]	6.50	7–12	Melo *et al*., 2022 ; Montanari *et al*., 2023
Stearic (C18 :0)	5.6 ± 0.3	[4.9, 6.3]	4.83	0.3–8	Ixtaina *et al*., 2011
Oleic (C18 :1)	5.2 ± 0.15	[4.8, 5.6]	12.00	6–8	Ishak *et al*., 2025 ; Montanari *et al*.,2023

fatty acid contents.

Correlation analysis

Pearson correlation analysis revealed strong positive associations between the saponification value and α-linolenic content (r = 0.70), palmitic acid (r = 0.98), and refractive index (r = 0.89) (Figure 3). These correlations suggest that simple physicochemical indices may serve as rapid proxies for compositional traits, but experimental studies would be required to confirm any causal relationships.

Table 3: *GC–MS Peak Assignment and Quantification of Fatty Acid Methyl Esters (FAMEs) in Cold-Pressed Chia (S. hispanica L.) Oil Moroccan*

Peak	Retention time (min)	Area norm (%)	Height	Major compound
1	13.02	1.19	1924	Methyl palmitate (C16:0)
2	17.94	10.56	3104	Methyl stearate (C18:0)
3	22.31	100.00	4153	Methyl linolenate (C18:3)
4	23.01	5.03	4324	Methyl linoleate (C18:2)
5	25.33	0.36	4889	Methyl oleate (C18:1)

This study presents a complete characterization of chia (*S. hispanica* L.) oil from field trials conducted in Western Morocco, highlighting its physicochemical quality and nutritional relevance in the context of existing chia oil studies.

Fatty acid composition (GC-MS) and nutritional value

Moroccan chia oil had a high α-linolenic acid level (65.6 ± 3.2 %) that regularly met or exceeded values reported for chia oils from Australia and Latin America (Timilsena *et al*., 2023; Ixtaina *et al*., 2011; Khalid *et al*., 2023; Oteri *et al*., 2023; FAO, 2023; Lopez *et al*., 2022; Melo *et al*., 2022; Montanari *et al*., 2023). In addition to α-linolenic acid, the oil showed notable proportions of linoleic (18.7 ± 1.5 %), palmitic (10.8 ± 0.2 %) and stearic (5.6 ± 0.3 %) acids, which are consistent with nutritionally favourable chia oil profiles. Overall, these results indicate that the geo-climatic conditions of Western Morocco can produce chia oil that matches, and in some cases exceeds, international benchmarks for nutritional quality, supporting previous observations on the importance of regional variability for defining chia oil composition (Ayerza and Coates *et al*., 2005). The very high α-linolenic acid content is particularly promising in light of the considerable evidence for its cardiovascular and anti-inflammatory benefits (Marineli *et al*., 2023). Relative to other ω-3 source oils such as flaxseed, perilla and camelina, Moroccan chia oil also displays a well-balanced ω-6:ω-3 ratio and a comparatively low saturated fat content (Saini *et al*., 2023), reinforcing its potential value for the development of functional foods and supplements.

As shown in Table 4, Moroccan chia oil contains markedly higher levels of α-linolenic acid (C18:3, ω-3) than traditional Moroccan olive and argan oils, which are typically dominated by oleic acid and contain only trace amounts of α-linolenic acid (Oubannin *et al*., 2024; Khallouki *et al*., 2022). Its α-linolenic content is also comparable to, or even higher than, that reported for flaxseed and perilla oils, two of the richest plant sources of ω-3 fatty acids (Lee *et al*., 2011; Al-Madhagy *et al*., 2023). By contrast, hemp and walnut oils generally contain intermediate levels of α-linolenic acid and are more strongly characterised by linoleic and oleic acids (Da Porto *et al*., 2012; Ciftci *et al*., 2023). At the same time, Moroccan chia oil presents lower saturated fatty acid levels than olive and argan oils, while maintaining intermediate linoleic acid (C18:2, ω-6) concentrations that fall within the range of nutritionally valued edible oils, including sesame, olive and argan oils (Baydar *et al*., 2012; Oubannin *et al*., 2024; Khallouki *et al*., 2022). Taken together, these comparisons suggest that, within the local and broader context of edible

Table 4: *Main fatty acid composition (%) of Moroccan chia oil compared with selected edible oils (literature values)*

Fatty acid	Chia (Morocco, this study)	Perilla oil	Hemp oil	Walnut oil	Sesame oil	Olive oil	Argan oil	Flaxseed oil
α-Linolenic (C18:3, ω-3)	65.6 ± 3.2	60–65	17–20	12	Traces	<1	<0.5	45–70
Linoleic (C18:2, ω-6)	18.7 ± 1.5	12–21	55–60	58	39–41	3.5–21	32–40	12–24
Oleic (C18:1)	5.2 ± 0.15	12–15	9–14	17	39–42	55–83	42–50	10–21
Palmitic (C16:0)	10.8 ± 0.2	4.5–8	6	~10	8–10	7.5–20	12–20	~7
Stearic (C18:0)	5.6 ± 0.3	~5	~2	~3	4–5	2–12	2–6	3–5

Values for olive, argan and flaxseed oils perilla, hemp, walnut and sesame oils are approximate ranges compiled from published fatty acid composition data [Oubannin A., et al. 2024; Khallouki F., et al. 2022; Al-Madhagy S.F., et al. 2023; Lee J.H., et al. 2011; Da Porto C., et al. 2012; Ciftci O.N., et al. 2023; Baydar H., et al. 2012]

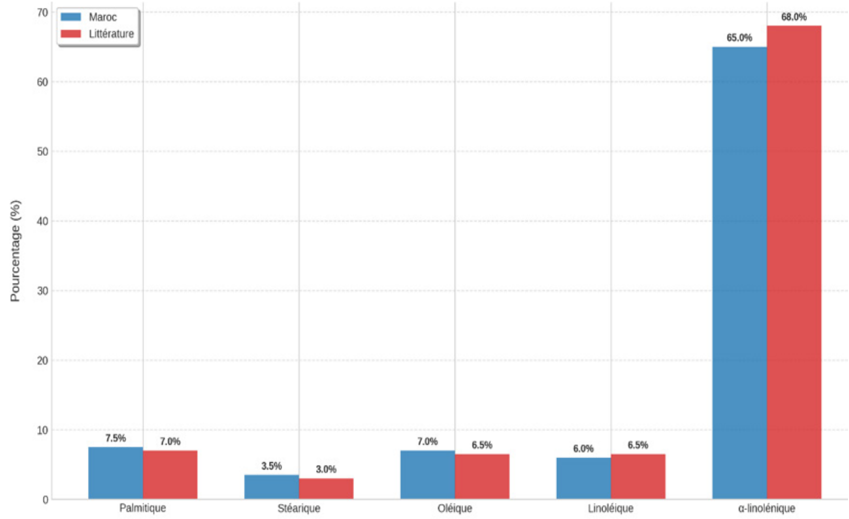

Figure 1: *Fatty Acid Composition of Moroccan Chia Oil vs. International Benchmark Grouped bar chart comparing the mean percentage of major fatty acids (palmitic, stearic, oleic, linoleic, α-linolenic) in chia oil from Western Morocco to reference values from recent studies (Ixtaina et al., 2011; Khalid et al., 2023). Moroccan oil shows a competitive omega-3 (α-linolenic) profile and slight variation in palmitic content.*

vegetable oils, chia oil represents a particularly dense source of plant-based ω-3 fatty acids that could complement the more oleic-rich profiles of olive, argan and sesame oils, as well as the mixed ω-3/ω-6 profiles of flaxseed, perilla, hemp and walnut oils in dietary applications.

Table 2 shows that α-linolenic acid represents almost two-thirds of total fatty acids, while linoleic, oleic and saturated fatty acids remain within ranges reported for nutritionally favourable chia oils. This combination of very high ω-3 content and relatively low saturated fat further reinforces the potential of Moroccan chia oil as a valuable ingredient for functional foods, provided that its oxidative stability is adequately controlled. Figure 1 illustrates that Moroccan chia oil closely matches or exceeds international benchmark chia oils in terms of α-linolenic acid, while maintaining comparable proportions of linoleic and saturated fatty acids, supporting the view that Western Moroccan conditions can produce chia oil of nutritional quality similar to that of established producing regions. As visualised in the correlation heatmap (Figure 3), strong positive correlations between saponification index, α-linolenic and palmitic acids, as well as between saponification and refractive index, suggest that these simple physicochemical indices may serve as rapid proxies for monitoring oil composition; however, these relationships are exploratory and should not be interpreted as evidence of causal mechanisms.

Physico-Chemical propertie

As summarised in Table 1, the main physicochemical parameters of Moroccan chia oil (saponification index, acidity, free fatty acids and refractive index) fall within the ranges reported for edible chia oils and other high-quality vegetable oils, indicating acceptable refining-free quality for nutritional use (Ixtaina *et al*., 2011; Oteri *et al*., 2023; Lopez *et al*., 2022; Melo *et al*., 2022; Montanari *et al*., 2023). The international ranges shown in Table 1 were compiled from physicochemical characterizations of chia seed oil reported by Segura-Campos *et al*. (2014), Imran *et al*. (2016) and Abad and Shahidi (2020), as well as from Codex Alimentarius standards for named vegetable oils (CXS 210-1999). Although the main physicochemical indices of Moroccan chia oil fell within these reported ranges, the peroxide value (35.7 ± 2.1 meq O_2/kg) was comparatively high: Codex standards for virgin and cold-pressed vegetable oils generally recommend peroxide limits around 10–15 meq O_2/kg, and most published chia oils show much lower values (≈1–18 meq O_2/kg), indicating that the present value is elevated relative to both regulatory guidance and literature data (Ixtaina *et al*., 2011; Bodoira *et al*., 2022; FAO/WHO, 2023). This likely reflects the intrinsic susceptibility of α-linolenic-rich oils to oxidation and/or pre-analytical factors such as seed storage conditions and the time elapsed between pressing and analysis. Consequently, the peroxide

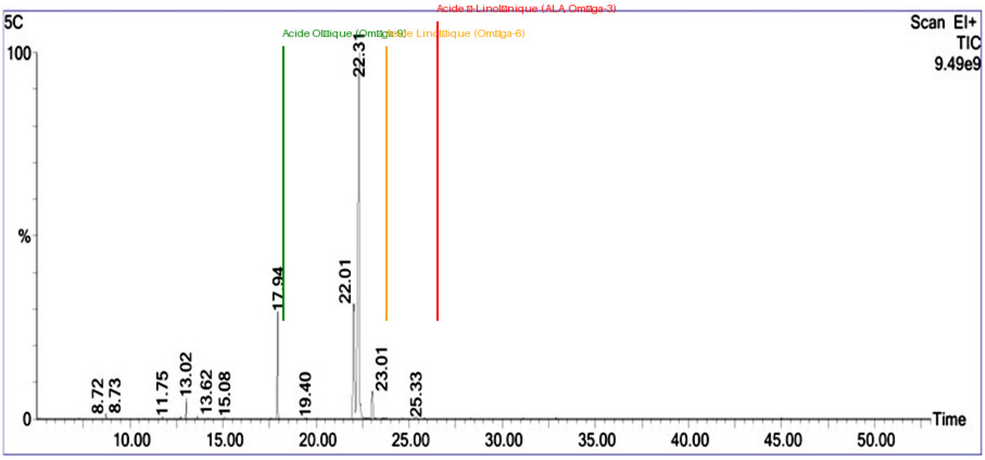

Figure 2: *Total Ion Chromatogram (TIC) of Fatty Acid Methyl Esters (FAMEs) Derived from Cold-Pressed Chia (S. hispanica L.) Oil by GC–MS Analysis.*

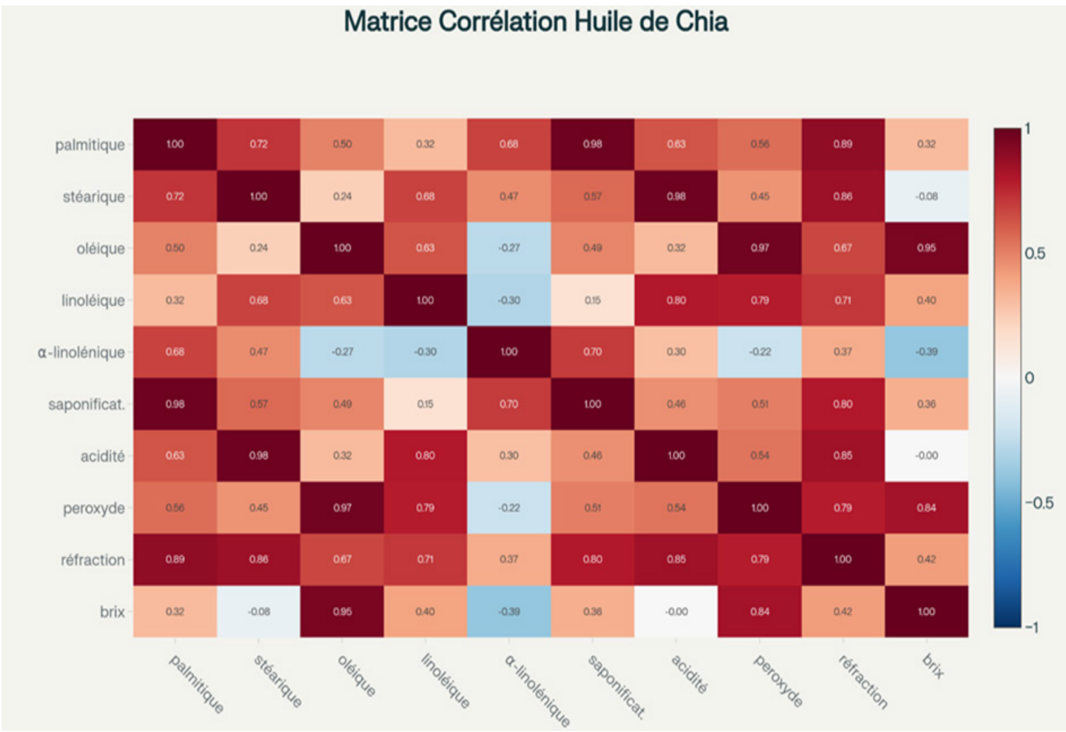

Figure 3: *Correlation Heatmap of Oil Quality Parameters Heatmap visualizing Pearson correlation coefficients between major physicochemical indices (saponification, acidity, peroxide, Brix, refractive index) and fatty acid percentages. Strong positive correlations are observed between saponification, α-linolenic, and palmitic acids, indicating integrated structural integrity.*

Each box indicates the Pearson correlation coefficient between two variables (main fatty acids, physicochemical indices).
Red: strong positive correlation (+1), blue: negative correlation (–1), white/grey: weak correlation.

value should be considered as a constraint for oxidative stability and shelf-life rather than an indicator of superior freshness, and future work should focus on optimising storage conditions, packaging and antioxidant protection for Moroccan chia oil. The Brix values observed in Moroccan chia oil were also within the range reported for cold-pressed chia oils and may reflect differences in co-extracted minor constituents among batches, although this parameter should be interpreted as a secondary quality descriptor (Khalid *et al*., 2023; Lopez *et al*., 2022; Melo *et al*., 2022)

Correlation analysis

Significantly, strong association between the saponification index and key fatty acids (α-linolenic r = 0.70; palmitic r = 0.98), and likewise the refractive index with saponification (r = 0.89), indicates the potential use of these variables as fast, quality, non-destructive proxies. (Timilsena *et al*., 2023; Oteri *et al*., 2023) confirm the technological merit of these indices for future industrial and research recommendation

These correlations should be interpreted as exploratory associations only and do not demonstrate any causal relationship between physicochemical indices and individual fatty acids; experimental studies would be required to confirm causality.

Variability, limitations, and future directions

Beyond its nutritional attributes, chia cultivation also has environmental implications that are relevant for semi-arid Mediterranean regions such as Western Morocco. Experimental observations and previous agronomic reports indicate that chia can complete its cycle under moderate water inputs and warm conditions, provided that sowing dates are adjusted to avoid extreme heat and terminal drought, which suggests a relatively efficient water use compared with some traditional oilseed crops (Silva *et al*., 2018; Khalifa *et al*., 2025). In addition, the crop can be grown on light, low-organic-matter soils with limited fertiliser inputs, and recent guidelines describe chia as a low-water-requiring crop that performs well even in marginal soils (ICAR, 2026). These features indicate that chia has the potential to be integrated as a low-to-medium-input rotation crop in Mediterranean farming systems, although comprehensive life-cycle and long-term field assessments will be required to fully validate its sustainability.

Batch-to-batch variability is likely driven by environmental, edaphic, and post-harvest profiles, as recently reported (Ishak *et al*., 2025). These organic fertilization and moderate irrigation practices should be considered when interpreting the observed oil yield and composition (Rossafi *et al*., 2025). This indicates a clear need for follow-up trials across several sites, with soil and climate monitoring, as well as close tracking of oil extraction. Longer-term assessments of storage stability, oxidation and/or retention of bioactivity will next be important for appropriate commercial implications and validating markets.

The majority of studies published have explored chia oil from Latin American, Asian, or imported seeds, and there is very little known about the cultivation of chia in Africa. By reporting trustworthy, reproducible data associated with cultivating chia in Morocco, this study fills an important gap providing evidence the crop could potentially be grown sustainably and used as an agronomic source of valorization on a local and international market.

The present study is limited by the use of a single production region and a relatively small number of batches, and by the absence of long-term storage or shelf-life experiments. In addition, only the fatty acid profile was quantified, whereas other bioactive lipid classes (e.g. tocopherols, sterols, phenolic compounds) were not assessed. Future research should therefore expand sampling across multiple agro-ecological zones in North Africa, include detailed characterization of minor lipid components, and evaluate oxidative stability under realistic storage conditions, alongside studies on the nutritional and health effects of chia oil consumption. Until such information on stability, sensory quality and consumer intake is available, any conclusions about large-scale commercialization or public health impact should be considered tentative.

Valorization and prospects

Given its favourable fatty acid profile and acceptable physicochemical indices, Moroccan chia oil may represent a promising ingredient for niche edible oil and functional food formulations. However, claims related to export potential, market positioning and public health impact remain preliminary and should be substantiated by additional data on oxidative stability, sensory acceptance, shelf-life and regulatory aspects.

Given the relatively high peroxide value observed, subsequent studies should include systematic storage and shelf-life trials under different conditions to determine how rapidly oxidation progresses and how it can be controlled in commercial settings.

Conclusions and Recommendations

This research presents the first systematic investigation into the physicochemical quality and fatty acid composition of chia oil produced in Western Morocco. The oils assessed in this study demonstrated a strong and reproducible quality profile, containing very high levels of α-linolenic acid, beneficial omega-6/omega-3 fatty acid ratios, as well as meeting international quality standards for edible oils. This research validated the technological integrity of the oils in order to assess inter-batch variation while flagging key correlations that showed robust indices for quality parameters useful for monitoring agricultural oil.

The findings indicate that the terroirs of Morocco can effectively produce chia oil with the nutritional quality comparable to chia oils reported from other producing regions. Consequently, this novel oilseed crop may contribute to agricultural diversification and to improving access to plant-based omega-3 sources in North Africa, pending further agronomic, technological and nutritional evidence.

Future work should seek to expand field production and improve agronomic practices, along with better understanding potential bioactive compounds, shelf-stability, etc. Overall, these activities should work towards positioning Moroccan chia oil as a valued crop both locally and internationally.

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Novelty Statement

This study reports reproducible benchmarks for quality indices and a high alpha-linolenic acid content with favorable ω6/ω3 balance.

Author's Contribution

Aicha Rossafi: Conducted research, data collection and write-up
Sana El moutaouakil: Designing
Soukaina Njili: interpretation of data
Siham Belkacemi: Conceptualization
Hassna Leknizi: Supervision
Safaa Rhaimi: Statistical analysis
Mohamed Rossafi: Analysis of data and arrangement of tabulated data
Mohammed Ouhssine: Helped in format setting and citations, validation of the manuscript

Generative AI and AI-assisted technology statement
The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

Conflict of interest
The authors have declared no conflict of interest.

References

Abad, A. and F. Shahidi. 2020. Compositional characteristics and oxidative stability of chia seed oil and its fractions. Food Chem., 326: 126966. https://doi.org/10.1186/s43014-020-00024-y

Al-Madhagy S.F. and A.A. Madhagy. 2023. A comprehensive review of the health benefits of flaxseed oil in relation to its chemical composition and comparison with other omega-3-rich oils. Frontiers in Nutri., 10: 1035315. doi: https://dx.doi.org/10.3389/fnut.2023.1035315.

AOCS. 2017. Official methods and recommended practices of the AOCS, 7th ed. American Oil Chemists' Society, Champaign, IL, USA.

Ayerza, R. and W. Coates. 2005. Composition of chia (*Salvia hispanica*) seed oil from five regions of Latin America. J. Americ. Oil Chemist. Soc., 82: 451–456.

Baydar H., *et al.* 2012. Comparison of oil content and fatty acids composition of sesame (*Sesamum indicum* L.) lines. Field Corps Res., 128: 1–6.

Bodoira, R.M., M.C. Penci, P.D. Ribotta and M.L. Martinez. 2022. Chia (*Salvia hispanica* L.) oil stability: influence of natural antioxidants and storage conditions. Int. J. Gastron. Food Sci., 27: 100447.

Ciftci, O.N., *et al.* 2023. Total lipid and fatty acid components of some Persian walnut (*Juglans regia* L.) cultivars. Scientia Hortic., 317: 112123.

Codex Alimentarius Commission. 1999. Standard for named vegetable oils (CXS 210-1999, Rev. up to 2019). FAO/WHO, Rome, Italy.

Da Porto, C., D. Decorti and A. Natolino. 2012. Fatty acid composition and oxidation stability of hemp (*Cannabis sativa* L.) seed oil. Indust. Crop. Prod., 36(1): 65–69. https://doi.org/10.1016/j.indcrop.2011.09.015

FAO and WHO 2023. Fat and fatty acid requirements and recommendations for infants and children. Rome: WHO.

FAO. (2023). Guidelines on healthy oil consumption. Rome: FAO.

Imran, M., F.M. Anjum, M. Nadeem, N. Ahmad, M.K.Khan and Z.Mushtaq.2016.Fractionation of chia oil for enrichment of omega-3 and 6 fatty acids and oxidative stability of fractions. J. Food Sci. Tech., 53(3): 1415–1423.

Indian Council of Agricultural Research (ICAR). 2026. Cultivation practices for chia (*Salvia hispanica* L.) in shallow black soils and drought-prone areas. ICAR Technical Bulletin, New Delhi, India.

Ishak, I., R. Ahmad and M. Zaidi. 2025. Effects of Extraction Methods on Quality and Stability of Chia Seed Oil. Pertanika J Tropical Agril. Sci., 48(1): 237–257. https://doi.org/10.47836/pjtas.48.1.13

Ixtaina, V. Y., S.M. Nolasco and M.C. Tomás. 2011. Physicochemical characterization and lipid composition of chia (*Salvia hispanica* L.) seeds from Argentina. J. Food Composit. Analy., 24(2): 166–174.

Khalid, W., U.U. Rahman, M. Ahmad and S. Hussain. 2023. Chia seeds (*Salvia hispanica* L.): A therapeutic weapon in metabolic syndrome. Food Sci. Nutri., 11(7): 4095–4108.

Khalifa, H.E. 2025. Productivity of chia crop in the sandy soils of East Delta, Egypt, under different irrigation levels. Middle East J. Agric. Res., (MJAS). 14(1): 1–15.

Khallouki, F., C. Younos, R. Soulimani, T. Oster and Z. Charrouf. 2022. Argan Oil: Chemical Composition, Extraction Process, and Quality Control. Front. Nutri., 9: 804587. doi: https://dx.doi.org/10.3389/fnut.2021.804587.

Lee, J.H., H.Y. Lee, S.H. Kim. 2011. Health effects of omega-3,6,9 fatty acids: *Perilla frutescens* is a good example of plant oils. J. Biomed. Sci., 18: 1–7. doi: https://doi.org/10.1186/1423-0127-18-1.

Lopez, C., J. Lecomte and C. Tesar. 2022. Oil bodies from chia (*Salvia hispanica* L.) and camelina (Camelina sativa L.) seeds for innovative food applications—microstructure, composition and physical stability. OCL - oilseeds and fats. Crop. Lipids., 29: 37.

Marineli, R.S., E.A. Moraes, S.A. Lenquiste, and M.R. Maróstica. 2023. Health effects of chia (*Salvia hispanica* L.) seed and oil with emphasis on cardiovascular disease and inflammation. Nutrien., 15: 1234.

Melo, D., S.C. Oliveira-Alves, A. Dávalos, A. Brandão and A.P. Massarioli. 2022. Characterization of chia seeds, cold-pressed oil, and defatted cake: An ancient grain for modern food production. Molecul., 27: 2002.

Montanari, R. *et al.* 2023. Fatty acid and amino acid profiling of chia seeds and physicochemical characterisation of chia seeds oil. Afr. J. Food Sci., 16: 225–234. https://doi.org/10.5897/AJFS2022.2227

Oteri, M., P. Mazzei, A. Piccolo and A. Spina. 2023. Chia (*Salvia hispanica* L.) oil extraction: study of processing parameters. Indust. Crop. Prod., 204: 117–123.

Oubannin , A., *et al.* 2024. Rheological behaviour, fatty acid composition and pigment content of Moroccan Picholine virgin olive oil during three harvest periods. Food Sci. Appl. Biotech., 7(1): 37–47. https://doi.org/10.30721/fsab2024.v7.i1.327

Rossafi, A.**,** S. Njili, M. Rossafi and M. Ouhssine. 2025. Optimizing sowing dates for enhanced growth and development of *Salvia hispanica* l. in western morocco during the spring season. Sar. J. Agric., 41(5): 149-157.DOI https://dx.doi.org/10.17582/journal.sja/2025/41.5.149.157

Saini, R.K., Y.S. Keum and S.H. Nile. 2023. Omega-3 rich plant oils: Fatty acid composition, health benefits and applications. Food Res. Intl., 170: 112999.

Segura, C. M.R., N. C. Solís, G. R. Rosado, L.C.Guerrero and D.A. Betancur. 2014. Physicochemical characterization of chia (*Salvia hispanica*) seed oil from Yucatán, México. Food Sci. Technol., 34(3): 485–492.

Silva, H., P. Silva, L. Guzmán, Y. Muñoz and M. Moya, *et al.* 2018. Effect of sowing date and water availability on growth of plants of chia (*Salvia hispanica* L.) established in Chile. PLOS ONE., 13(9): e0203116. doi: https://

dx.doi.org/10.1371/journal.pone.0203116.

Timilsena, Y.P., R. Adhikari, C.J. Barrow and B. Adhikari. 2023. Chia (*Salvia hispanica* L.) oil: Composition, extraction and applications in food systems. J. Food Composit. Analy., 114: 104803.

Vârban, R., I. Crișan, D. Vârban, C. Mureșan and A. Ghețe, *et al*. 2021. Cultivation potential of chia (*Salvia hispanica* L.) in the continental temperate conditions of Cluj County, Romania. Scientific Papers. Series A. Agron., 64(1): 441–448.