

**CONTENT OF NUTRIENTS COMPONENT AND FATTY ACIDS IN CHIA SEEDS
(*SALVIA HISPANICA* L.) CULTIVATED IN ECUADOR**

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ABSTRACT**Objective:** The aim of this work was to determine the fatty acids content in chia seeds oil (*Salvia hispanica* L.) sample cultivated in Ecuador.**Methods:** Chia oil was obtained from chia seeds using the cold pressing method. Methyl esters fatty acids (FAME) analysis was carried out using the gas chromatography (GC) method with a mass selective detector (MSD) and using the database Library NIST14.L to identify the compounds present in the oil of chia seed.**Results:** Methyl esters fatty acids were identified from chia (*Salvia hispanica* L.) seeds using the GC-mass spectrometer (GS-MS) analytical method. The total protein, lipid, and fiber content of chia seeds of plants cultivated in Ecuador was of 19.78, 16.06, and 27.88%, respectively, of the total content on fresh weight. Fatty acids were analyzed as methyl esters on a capillary column DB-WAX 122-7062 with a good separation of palmitic acid, stearic acid, oleic acid, elaidic acid, linoleic acid, arachidic acid, and linolenic acid. The structure of FAME was determined using the GS-MS. Chia oil high content of linolenic acid (omega 3) with a value of 54.08% the total content of fatty acids in chia oil. Omega 6 content was of 18.69% and omega 9 content was of 10.24% the total content of fatty acids in chia oil.**Conclusions:** Chia oil has a good content of fatty acids omega 3, 6, and 9. The higher value was of omega 3 with 54.08%. Omega 3 is recommended to the prevention of risk cardiovascular.**Keywords:** Chia, *Salvia hispanica* L., Fatty acids, Lipids.© 2018 The Authors. Published by Innovare Academic Sciences Pvt Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>) DOI: <http://dx.doi.org/10.22159/ajpcr.2018.v11i2.17096>**INTRODUCTION**

Chia (*Salvia hispanica* L.) is a tropical and subtropical climates herbaceous plant belongs to the family *Labiatae*, originated from Mexico and northern and Guatemala. Food seeds have been important for human nutrition since 1500 BC [1,2]. Conventionally, chia seeds have been used as a food, in a wide range of traditional medicines, primary cosmetics, and a part of religious rituals in pre-Columbian civilizations [3]. Conventionally, chia seeds were used by Aztecs and Mayas people in the preparation of folk medicines, food, and canvases. Chia seeds are composition 22–24 g/100 g of protein, 26–41 g/100 g of carbohydrates, 18–30 g/100 g of dietary fiber, 4–6 g/100 g of ash, and 32–39 g/100 g oil contents, also have important content of vitamins, minerals, and antioxidants [4]. The quality of edible vegetal oils is important for their acceptance as food or medicinal supplements because the fatty acids composition is a primary factor in its formulation. Chia seeds have a lower content of saturated fatty acids (palmitic and stearic acids), adequate concentration of linoleic acid omega 6 (18–20 %), and higher content of alpha-linolenic acid omega 3 (55–60%) makes chia oil as a preferred and appealing choice for healthy food and cosmetic applications [5,6].

MATERIALS AND METHODS**Oil extraction**

Chia is cultivated in the central region of Ecuador. Chia oil sample was obtained from sambo seeds using the cold pressed method. Oil was then stored at 4.0±2°C. Oil extraction was conducted using a Soxhlet apparatus for approximately 5 h with hexane as solvent, with a solid-to-solvent ratio of 1/7 m/v. After the extraction process, the flask contents were filtered, and the liquid fraction containing the lipid extract and solvent was poured into a 250-mL flask of a rotary film evaporator to

remove the solvent. The obtained oil was collected, evaporated under nitrogen, weighed, and stored in sealed amber glass vials at –20°C until analysis [7].

Fatty acids analysis by gas chromatography-mass selective detector (GC-MSD)

The fatty acid composition of oil extracted from chia seeds was analyzed by injecting fatty acid methyl esters (FAME) [8] into an Agilent Technologies 7980A system GC (Agilent, Santa Clara, CA) equipped with a MSD 5977A GC/MSD, an auto-sampler 7693, column (60 m×250 µm×0.25 µm, Agilent 122-7062). The oven temperature was programmed as follows: From 80°C; ramp 1: To 100°C at 20°C/min during 1 min; ramp 2: At 200°C at 25°C/min during 10 min; and ramp 3: At 250°C at 2°C/min. The injector and detector temperatures were set at 250°C. Helium was used as carrier gas at a linear flow velocity of 1.4 mL/min.

RESULTS**Proximate analysis**

The results of proximate analysis of chia seeds (*S. hispanica* L.) are shown in Table 1. The chia seeds from Ecuador content 19.78% of protein, the content of fat of chia seed were of 16.06%. The content of fiber was of 27.88% and content of carbohydrates was high with a value of 31.46%. In Fig. 1 shows chia seeds from Ecuador. These seeds are of small size with 2 mm approximately and with dark spots. All seeds present similar color and sizes.

GC analysis

The GC chromatogram of FAME from chia oil present five majoritarian peaks that were separated with a column Agilent DB-WAX 122-7062.

These peaks were identified with the help of a spectrum of database NILTS14. L. The quantification of fatty acids was obtained using the peak area ratio. Fig. 2 shows seven majoritarian peaks with an excellent separation and definition, these peaks were identified such C16:0 with a retention time of 19.283 min, C18:0 with a retention time of 25.929 min, C18:1 with a retention time of 26.750 min, C18:1 trans with a retention time of 27.101, C18:2 with a retention time of 28.557 min, C18:3 with a retention time of 31.036 min, and finally was possible identified other peak C20:0 with a retention time of 34.022 min.

Concentration of FAME

The concentration of FAME from chia oil was measured using the peak area ratio. Table 2 summarizes C16: With $8.545 \pm 0.212\%$ of fatty acid total content, C18:0 With $3.375 \pm 0.0071\%$ of fatty acid total content, C18:1 with $10.240 \pm 0.0141\%$ of fatty acid total content, C18:1 trans with $0.815 \pm 0.0071\%$ of fatty acid total content, C18:2 with $18.69 \pm 0.0283\%$

Table 1: Proximate analysis of chia seeds

Analysis	Content (%)
Ash	4.82 ± 0.025
Moisture	5.71 ± 0.032
Fat	16.06 ± 0.038
Protein	19.78 ± 0.015
Fiber	27.88 ± 0.021
Carbohydrates	31.46 ± 0.062

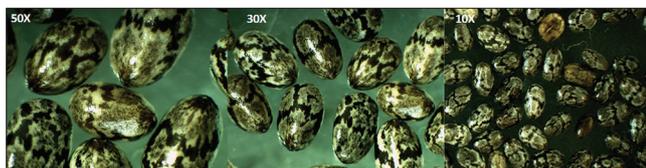


Fig. 1: Photographic of chia seeds from Ecuador at different augment

of fatty acid total content, and C18:3 with $54.08 \pm 0.0141\%$ of fatty acid total content of chia oil, and finally C20:0 with $5.065 \pm 0.0212\%$ of fatty acid total content. Chia seeds present high content of polyunsaturated fatty acids (PUFA) C18:3 acids with $54.08 \pm 0.0141\%$ of fatty acid total content.

The mass spectrum of FAMEs obtained from chia oil is shown in Fig. 2. The identity and structures of these fatty acids were confirmed by the GC-MS method. Palmitic acid (C16:0) was identified using the mass spectrum with ions of mass/charge (m/z) between 57 and 270 m/z. In the previous range, the ions 74 and 87 m/z were the most abundant in the mass spectrum (Fig. 3a). Stearic acid (C18:0) (Fig. 3b), oleic acid (C18:1) (Fig. 3c), linoleic acid (C18:2), and linolenic acid (C18:3) (Fig. 3b-e).

DISCUSSION

In this study, content of protein of chia seeds from Ecuador presents a value of 19.78%. Ullah *et al.*, 2015 [9] reported protein content ranged 15–25% form chia seeds, our value is between this limit [9]. The protein content of chia seed grown in different habitats ranged from 18.8% to 21.5%, the variation in protein content was probably be due to agronomic, climatic, and soil conditions [10]. Content of fat of chia seed was of 16.06%. Ixtaina *et al.*, 2008 reported 30–33% of fat in chia seeds, us value is less than value. In Argentina, it reported different values of content of oil from chia with value of 32.2–36.8 compared with 35.6–38.6% [11]. The difference of content oil could be connected to the difference in climatic conditions, agronomic practices, fertilization regimes, irrigation practices, etc.[12]. The higher values of tocopherols can have a positive impact on the storage stability of chia oil. Content of fiber was of 27.88%. Protein, lipids, and fiber are biocompounds have good acceptance in the consumers. European accepted that chia can be such as functional food. Chia seeds are considerate safe without harmful effects for health for this reason can be in baked goods, nutritional supplements, cereal bars, cookies, bread, snacks, etc. Actually, chia seeds are used such component of several food in Mexico, Argentina, Chile, Ecuador, Canada, US, and Japan to different purposes. The US dietary guidelines recommend consuming chia seeds

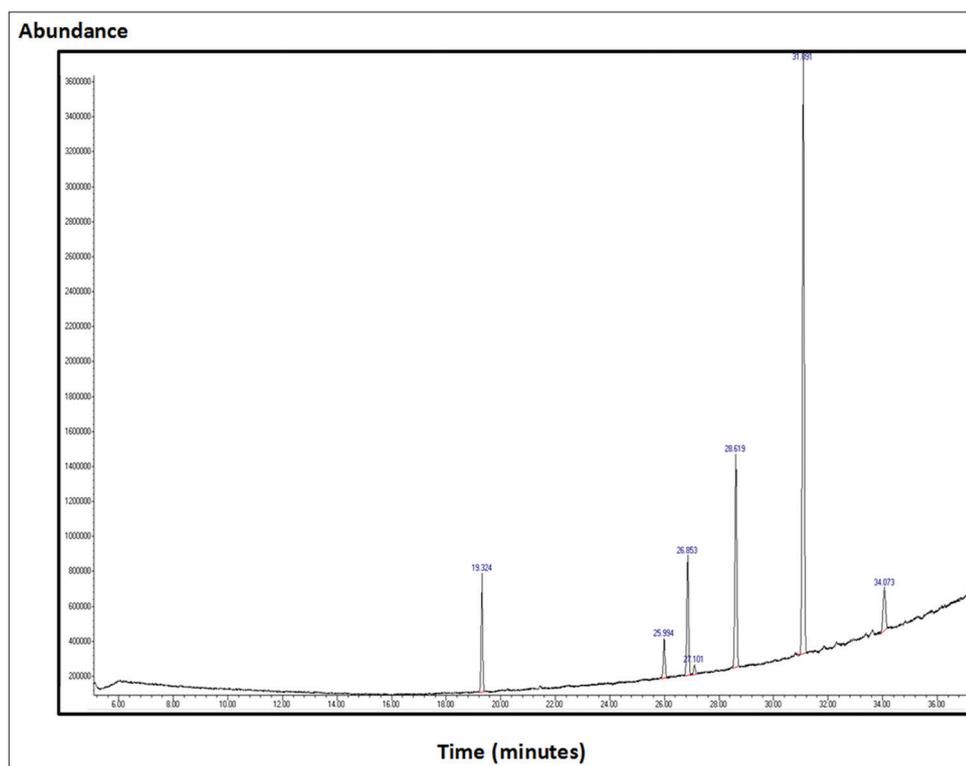
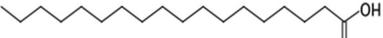
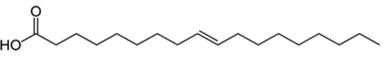
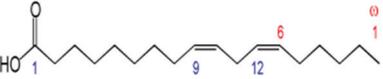
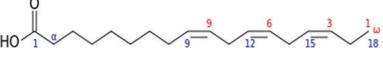


Fig. 2: Gas chromatography-mass spectrometer analysis of methyl esters fatty acids present in chia oil sample from Ecuador

Table 2: Total lipid and fatty acids composition of chia oil sample from Ecuador by GC/MS analysis and their content

Retention time (min)	FAMES	Structural formula/chemical name	Numbers of Carbons	Percentage peak area
19.283	Palmitic acid	Hexadecanoic acid 	C16:0	8.545±0.0212
25.929	Stearic acid	Octadecanoic acid 	C18:0	3.375±0.0071
26.750	Oleic acid	Cis-9-octadecenoic acid 	C18:1	10.240±0.0141
27.101	Elaidic acid	trans-9-octadecenoic acid 	C18:1 trans	0.815±0.0071
28.557	Linoleic acid	(9Z,12Z)-9,12-Octadecadienoic acid 	C18:2	18.69±0.0283
31.036	Linolenic acid	(9Z,12Z,15Z)-octadeca-9,12,15-trienoic acid 	C18:3	54.08±0.0141
34.022	Arachidic acid	Eicosanoic acid 	C20:0	5.065±0.0212

GC/MS: Gas chromatography/mass spectrometer, FAMES: Methyl esters fatty acids

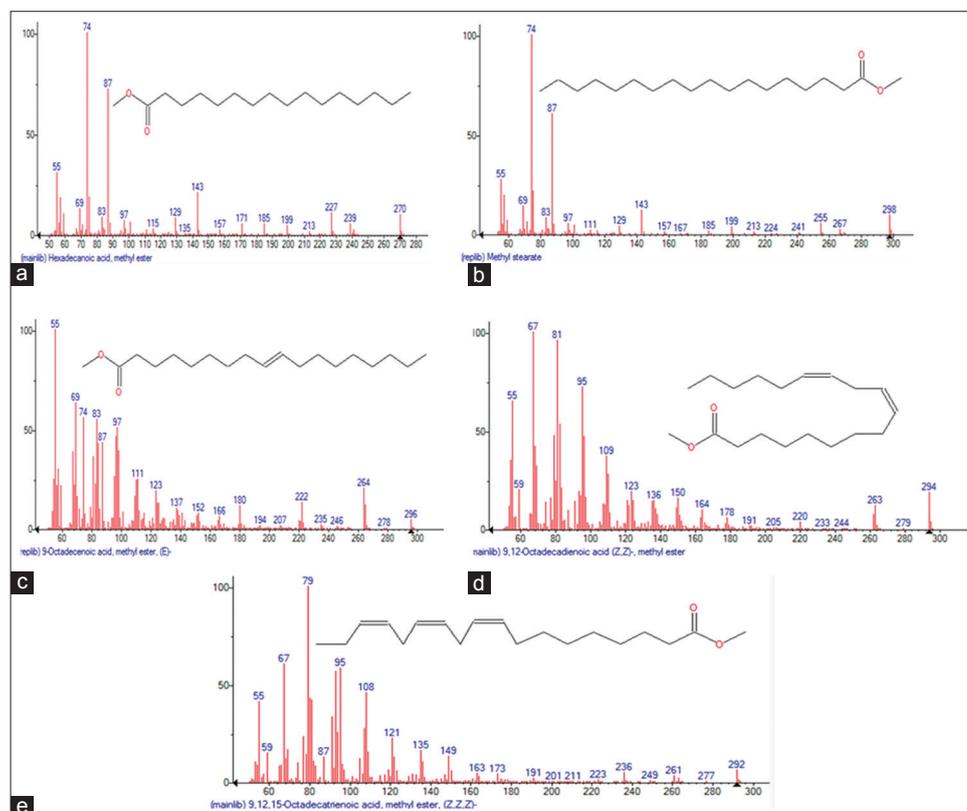


Fig. 3: (a-e) Mass spectrum of methyl esters fatty acids from chia oil

for healthy as a primary source of good food, chia sprouts are used in salads, chia seed is used in beverages and cereal-based foods, and chia seeds can be consumed in raw form [13]. American Heart Association also directs the consumers to shift from saturated fats to unsaturated

oils [14]. Foods with lower contents of saturated fatty acids are the order of day and in recent year's significant increase in the demand of such products have been observed. The great deal of shifting from saturated fats to unsaturated sources of oils is greatly attributed to the large

number of incidences of cardiovascular diseases, hypertension, obesity, diabetes, and other health-related disorders [15]. The situation has led to the increased consumption of functional foods containing higher content of PUFA. Ali *et al.*, 2012 reported content of PUFA of chia seed with value of 64% to ω 3 and a value of 19% to ω 6. Ixtaina *et al.*, 2011 reported high content of PUFA from chia seeds with a value of 19.1% to ω 6 and a value of 64.7% to ω 3. Alvarez-Chávez *et al.*, 2008 reported high content of PUFA from chia seeds with a value of 19.9% to ω 6 and a value of 63.4% to ω 3. Coates and Ayerza, 1998 reported high content of PUFA from chia seeds with a value of 7.63% to ω 6 and a value of 63.20% to ω 3 [16]. Ayerza, 1995 reported a content of 17.65% of ω 6 and a value of 64.08% to ω 3. Us relation of ω 3/ ω 6 was of 18.64/54.08% chia seeds present high content of omega 3 [17]. Vegetable oils are utilized for many food and industrial activities. In nature, there is a great variety of vegetable oils sources, however in the world, consumption of vegetal oil is mostly by palm, soybean, rapeseed, and sunflower oils with 38.1, 35.7, 17.8, and 18.2 million tons consumed per year, respectively [18]. In recent year, there is interest in the development of new plant species as a source of dietary or specialty oils with good composition of monounsaturated and PUFA. Omega 3 is an important fatty acid of long-chain-PUFA (ω 3 LC-PUFA) [19]. These fatty acids are increase being used in the prevention and treatment of several cardiovascular risk factors. ω 3 and ω 6 PUFA families are considered essential fatty acids, as the human body is itself unable to synthesize them. Cardiovascular disease is the leading cause of mortality in many economically developed countries, and its incidence is increasing at a rapid rate in emerging economies [20-22]. Diet and lifestyle issues are very associated with a myriad of cardiovascular disease risk factors including abnormal plasma lipids, hypertension, insulin resistance, diabetes, and obesity, suggesting that diet-based approaches may be of benefit.

CONCLUSION

Chia plant is a good source of vegetal oil with good composition of monounsaturated and PUFA. Chia oil has high content of linolenic acid ω 3 with a value of 54.08%. Omega 3 is recommending to prevent risks cardiovascular. Chia oil is also content good proportion of omega 6 and 9 with the value of 18.69 and 10.24%, respectively. Chia oil is a good biocompound that can be used to include in the food industry to different uses.

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AUTHOR CONTRIBUTIONS

Carrillo W, Cardenas M, Carpio C, and Morales D conceived and designed the experiments. Silva M and Alvarez M performed the gas chromatography analyses. Carrillo W wrote the paper.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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