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Chemical composition and fatty acid profile of some wild populations of *Salvia leriifolia* Benht.

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Abstract
In this study, chemical composition, fatty acid (FA) profile and oil characteristics of seeds of *Salvia leriifolia* Benht collected from different regions of Iran. All samples were rich in oil (24-28.5% dry weight basis), protein (24.5-28.5%) and crude fiber (13.1-16.6%). The mean values for Ca, P, K, Mg, Fe, Mn, Cu, Na and Zn were found at the levels of 3866, 2970, 3141, 2584, 57, 18.5, 9.0, 10 and 18.5 mg/kg, respectively. Iodine value varied from 83 to 107 which indicated level of unsaturation extracted oils. Saponification number, acid value, peroxide value and refractive index varied from 177 to 198, 0.70 to 1.36, 0.80 to 1.01 and 1.448 to 1.460 respectively. Fatty acids (FA) analysis revealed that oleic acid from 39.6% to 44.9% and linoleic acids from 41.1% to 44.4 were the main unsaturated FA. Palmitic acid (11.3-13.5%) is also the main saturated FA and alpha linolenic acid was found at trace levels (lower than 2%). The results showed that the seeds of all six *S. leriifolia* can be a good source of edible oil.

Key words: *Salvia leriifolia* Bethe; Oil; Protein; FA profile; Minerals

Introduction
Salvia L is one of the largest genera of the family Lamiaceae. There are more than 900 species in this genus (Standley and Williams, 1973), which are widespread all over the world. However, the Mediterranean, Central Asia, America and South Africa are the main centers of the diversity of the genus (Foster and Tyler, 2004). The application of many *Salvia* species in curing diseases such as colds, bronchitis, tuberculosis, hemorrhage, and menstrual disorders (Foster and Tyler, 2004; Steinegger and Hansel, 1988) has a long history.
The seeds of several species of Lamiaceae family have been reported to be composed of highly unsaturated oils with some unusual fatty acids. In different studies, palmitic acid, oleic acid, linoleic acid (LA) or alpha linolenic acid (ALA) have been reported as the main fatty acid(s) (FA) of the seed oil in different *Salvia* species (Smith *et al*., 1969). FA profile of some sage species such as Chia (*Salvia hispanica*) (Ayerza, 2010) and 12 species of sage native to Turkey has been previously studied and the main fatty acids were similar to other members of the plant family Lamiaceae (Azcan *et al*., 2004).
Fifty-eight species of the genus *Salvia* (Lamiaceae) are found in Iran, of which 17 are endemic (Rechinger, 1982). *Salvia leriifolia* Benth., a perennial herbaceous, This plant which mainly grows in Khorasan and Semnan provinces (Rechinger, 1982) and commonly used for traditionally medicinal purposes and as nut by local people in east Iran. Recently, a review of the pharmacological and toxicological effects of *S. leriifola* has been reported by Hosseinzadeh *et al*. (2009).
Despite the many studies carried out on the proximate composition and FA profile of different *Salvia* species (Ayerza, 2010; Azcan *et al*., 2004; Ayerza and Coates, 2009; Bagci *et al*, 2004) there is lack of data on chemical composition of *S. leriifola*in the literature. So, the aims of this study was to determine the proximate composition of the seeds, fatty acid profile and some chemical properties of oil in

S. leriifolia seed for the first time. This will help us to identify its nutritional potentials and whether this seeds can be introduced to the edible oil industry. Regarding the distribution of *S. leriifola* in Iran, the results of the current study will be important from economic and technological points of view.

Materials and Methods

Sample collection and chemicals

S. leriifolia seeds were collected from six regions in Iran (Tabel 1). A voucher specimen was deposited to the Herbarium of the Faculty of Agriculture and Natural Resources, University of Tehran (Karaj-Iran). The seeds were transferred to the laboratory in polypropylene bags and kept at room temperature. Then, the seeds were cleaned in an air screen cleaner to remove all exterior materials such as dust, stones. Immature and broken seeds were also discarded. All samples were stored at refrigerated conditions (4 ˚C) until used in the experiments. The solvents and chemicals used in this study were of analytical grade and were purchased from Merck Chemical Company (Darmstadt, Germany).

Table 1- grow Locations *S. Lerifoliia* investigated in this study (2010)

Location	Code Samples	Elevation (m)	Longitude	Latitude	Average temperatures(°C)*	Average rainfall(mm)*
Ghaen	GH	1397	33 45 46 N	59 17 37 E	16.15	124.78
Mashhad	MA	1058	36 33 97 N	59 22 27 E	17.55	15.45
Bajestan	BA	1295	34 30 04 N	58 13 27 E	23.53	62.46
Ferdows	FE	1275	34 03 25 N	58 09 56 E	17	112.22
Shahrud	SH	1080	36 29 47 N	55 40 37 E	17	135.33
Rivand	RV	1051	36 16 65 N	57 18 81 E	19.53	160

*Average temperature and rainfall are related to the sample years

Proximate compositions

Proximate analysis of moisture, total fat, ash, crud fiber and protein were carried out in duplicate according to AOAC Official Methods (1995). Moisture content was determined by heating 2.0 g of each sample in an oven maintained at 105 °C for 24 h. Total fat content was obtained by the Soxhlet extraction method described by Zhang *et al*. (2009) using n-hexane. The ash content was determined by incineration at 600±15 ºC. Crude fiber was obtained by digesting 2.0 g of sample with H_2SO_4 and NaOH and incinerating the residue in a muffle furnace maintained at 550 °C for 5h. Protein content was determinated by measuring Nitrogen content through the micro Kjeldahl method (Kjeltec 1030 Autoanalyzer, Foss Tecator AB, Hogans, Sweden) with a convert factor of 5.75 (1995). Carbohydrate content was evaluated by subtracting total percentages of other components (moisture + protein + fat + ash) from 100.

Mineral composition

The minerals, Iron (Fe), Copper (Cu), Manganese (Mn), Calcium (Ca), Magnesium (Mg) and zinc (Zn) were determined by using an atomic absorption spectrophotometer, as described by Agte *et al*. (1995) with a slight modification. Absolutely, 1 g sample was dry-ashed in a muffle furnace at 550 ºC for 5 h until a white residue with constant weight was obtained. After adding 20.0 ml of 2.5% (V/V) HCI, the ash was heated in a steam bath to reduce the volume to about 7.0 ml. Then, the solution was transferred to a 50 ml volumetric flask and diluted to final volume with deionized water. The mineral contents were determined on an atomic absorption spectrophotometer (Perkin-Elmer, Model 2380, USA). Sodium (Na) and potassium (K) were determined similar to the method of Chapman & pratt, (1962) using flame photometry (with voltage 230/115 V and power 13 VA, by Jenway Limited, Dunmow Essex, UK). Phosphorus (P) content was

determined by the phosphomolybdate method (International AOAC 1990).

Oil extraction for the chemical analysis

Five g of ground seed was transferred into a glass flask containing hexane as solvent which was shaken for 6 hours at room temperature. This process was repeated three times using fresh solvent each time in order to extract most of the oil from the seeds. The mixture was filtered and then solvent was evaporated by vacuum Rotary Evaporator at 40ºC. The pure oils were kept at refrigerated condition in sealed glass.

Physicochemical indices of the extracted oil

The AOAC methods were used for determining iodine value (IV) (method 920.158) and saponification value (SV) (method 920.160) (International AOAC, 2005). Acid value (AV) was determined by method Cd 3d-63 of Official Methods of Analysis (AOCS, 1993). Peroxide value (PV) was evaluated based on the standard method of International Dairy Federation (IDF, 1974), similar to the method previously described by Moayedi *et al*. (2011). Refractive index (RI) was measured using a refractometer (model Abbe, Bellingham-Stanley Ltd., London, UK) in the ambient temperature (25ºC±2).

FA composition

The fatty acid methyl ester (FAME) was prepared using the methanolic sodium hydroxide and boron trifloride (BF3) for esterifying the FAs as previously reported by Moayedi *et al*. (2011) Then, FAME was analyzed for its FA composition on a gas chromatograph (GC) (Unicam model 4600, UK), equipped with a flame-ionization detector (FID), and a BPX70 capillary column (0.25 mm ID × 30 m long × 0.22 µm film thickness). The oven temperature was programmed as follow: 160 °C for 6.0 min ramp at 20 °C/min to 180°C, hold for 10 min, ramp at 20 °C/min to 210 °C, for a total run time of 40 min. The temperature of Injector and detector was set at 250°C. Helium was used as the carrier gas and the split ratio was 40:1. The FAs were identified by comparing their retention times with those of standard FAs previously injected to the GC under the same conditions.

Statistical analysis

All experiments were performed in duplicate. Comparison among the means were carried out by using Duncan's (1955) multiple range tests; significance was accepted at 5% level ($P \leq 0.05$) Statistical Analysis System (SAS) release 9.1 (SAS Institute, Inc., Cary, NC). Additinally correlation and regresion analyses were undertaken to develop the relationships between average temperature of growth locations and protein and oil contents.

Results

Proximate compositions

Seed chemical compositions of six populations of *S. leriifolia are* shown in Table 2. Considering the Table 2, significant differences were observed among the seeds in relation to their oil, protein, crude fiber, carbohydrate, ash and moisture contents ($P<0.05$). Oil content varied from 24% in BA to 28.5% in GH population (for abbreviation see table 2).

The protein contents varied from 24.5% (GH) to 28.5% (BA). Protein Values for MA, FE, SH and RV were not statistically different ($p<0.05$).

The seeds of studied *S.leriifoliaare* populations were also rich in crude fiber. The highest and lowest level of crud fiber were for MA (16.6%) and SH (12.2%), respectively. Fiber percentages were evaluated 13.1 for GH, 15.5 for BA, 14 for FE and 15 for RV. Very important valuable physiological roles have been attributed to dietary and crude fiber in human intestinal system. Thus, consuming the seeds of *S.leriifoliaare* may be useful for intestine health. The Carbohydrate contents of samples ranged from 19.6 % to 25.5 %, following also the order SH>FE>GH>RI> BA>MA.

Minerals

The values of minerals quantified in this study are shown in Table 3. Some samples showed significant different in relation to their mineral contents. The highest amount of Ca was found in FE (4400 mg/Kg) and the least in GH (3500 mg/Kg). The levels of Ca in MA, RV, BA and SH were 4000, 4000, 3700 and 3600 mg/kg, respectively. Significant differences were also observed in the levels of K in different samples studied here. FE had higher amount of K (4500 mg/Kg) than RV (1750 mg/Kg) and SH (1900 mg/Kg) as much as two times. GH, MA and BA contained K at the levels of 3700, 3300 and 3600 mg/Kg, respectively.

Table 2- Chemical characteristics of *S. lerifoliia* seed investigated in this study (2010)

Component	Genotype					
	GH	MA	BA	FE	SH	RV
Oil*	28.5^{a}±0.71**	27.5^{ab}±0.85	24^{b}±0.99	25.5^{ab}±0.28	27.5^{ab}±0.57	25^{ab}±1.27
protein	24.5^{b}±0.28	26^{ab}±1.41	28.5^{a}±0.71	26^{ab}±1.13	27.5^{ab}±0.57	27.5^{ab}±0.42
Crude fiber	13.1^{ab}±0.1	16.6^{a}±.14	15.5^{ab}±0.85	14^{ab}±0.85	12.2^{b}±0.3	15^{ab}±0.45
Carbohydrate	24^{abc}±1.41	19.6^{d}±0.78	21.7^{cd}±0.99	25.4^{ab}±0.39	25.5^{a}±0.14	22.1^{bcd}±0.22
Ash	3.5^{a}±0.42	4.8^{a}±0.42	4.5^{a}±0.14	3.7^{a}±0.14	3.2^{a}±0.22	4.5^{a}±0.35
Moisture	6.4^{a}±0.57	5.6^{a}±0.42	5.3^{a}±0.42	5.5^{a}±0.57	4.5^{a}±1.06	5.9^{a}±0.57

All values given are means of duplicate determinations.
*Based on dry weight
** Standard deviation

The amounts of Mg in GH, MA, BA, FE, SH and RV were 2500,2500,02900 and 2700 mg/kg, respectively. The essential element, P was evaluated at the levels of 2800, 2860, 3450, 2300, 2560 and 2800 per kg of GH, MA, BA, FE, SH and RV, respectively. Fe ranged from 33.9 mg/kg (RV) to 82.4 mg/kg (GH). Among the minerals evaluated here, Cu was found at the least quantity. The highest and lowest Cu contents were found for FE (10.3) and RV (6.1), respectively. According to National Research Council (NRC), human daily requirement for Cu is 1.5-3.0 mg (Hans *et al*., 2003). Other micro-elements including Mn, Na and Zn were also in the ranges of 16.2-21.5 mg/kg, 7.01-13.5mg/kg and 10.4-27.5mg/kg, respectively. BA, MA and FE had the highest concentrations of Mn, Na and Zn, respectively.

Table 3- Chemical characteristics of *S. lerifoliia* seed investigated in this study (mg/100g) (2010)

Mineral	Genotype						
	GH	MA	BA	FE	SH	RV	Mean
Ca*	350^{c}±42**	400^{b}±56	370^{c}±70	440^{a}±28	360^{c}±71	400^{b}±35	386±41
P	280^{bc}±42	386^{a}±84	345^{ab}±70	230^{c}±56	256^{c}±113	280^{bc}±42	297±21
K	370^{b}±1.41	330^{c}±0.83	370^{b} ±1.4	450^{a} ±1.4	190^{d} ±0.4	$1750.^{d}$ ±0.1	314±0.6
Mg	250^{ab}±42	150.7^{b}±70	340^{a} ±49	250^{ab} ±42	290^{ab} ±84	270^{ab} ±70	258.4±35
Fe	82.4^{b}±5.6	60^{ab}±7.0	67.6^{a} ±3.4	50^{b} ±7.0	47.7^{b} ±2.8	33.9^{c} ±4.2	57±0.1
Mn	16.2^{b}±0.5	16.8^{b}±0.8	21.5^{a} ±0.7	20.8^{a} ±1.1	19.7^{a} ±0.4	16.6^{b} ±0.8	18.5±0.3
Cu	9.05^{a}±0.77	9.7^{a}±0.9	9^{a} ±0.7	10.3^{a} ±0.4	9.8^{a} ±0.3	6.1^{b} ±0.1	9±0.02
Na	10.22^{c}±0.31	13.5^{a}±0.71	12.13^{b} ±0.2	7.01^{e} ±0.72	9.45^{cd} ±.07	8.8^{d} ±0.14	10±0.01
Zn	10.4^{d}±0.5	11.45^{d}±0.7	26.35^{a} ±1.2	27.5^{a} ±1.4	16.45^{c} ±1.3	19.8^{b} ±1.1	18.5±1.0

Each value is the mean±standard deviation of duplicate determinations.
* Calcium, Phosphorus, Potassium, Magnesium, Iron, Manganese, Cupper, Sodium, Zinc
** Standard deviation

Table 4- some physicochemical characteristics of oils from *S. lerifoliia* seed investigated in this study (2010)

Sample		SN*	AV*	PV*	RI*
GH	95^{b}±0.17	181^{b}±0.15	0.7^{b}±0.03	0.8^{d}±0.04	1.448^{b}±0.000
MA	107^{a}±0.03	184^{ab}±0.22	1.28^{a}±0.07	0.9^{c}±0.05	1.461^{a}±0.000
BA	84^{c}±0.17	198^{a}±0.16	0.93^{b}±0.06	0.92^{b}±0.04	1.443^{b}±0.000
FE	97^{b}±1.26	177^{b}±0.21	0.6^{b}±0.09	0.9^{c}±0.02	1.456^{b}±0.000
SH	83^{c}±0.26	189^{ab}±0.19	0.73^{b}±0.03	1.01^{a}±0.08	1.456^{b}±0.000
RI	107^{a}±.94	182^{b}±0.13	1.36^{a}±0.02	0.92^{b}±0.03	1.460^{a}±0.000

*IV iodine value (g I2 per 100 g of oil), SN saponification number (mg KOH per g of oil), AV acid value (mg KOH per g of oil), PV peroxide value (mequiv O2 per kg of oil) and RI refractive index (at room temperature)

Fatty acid profile

The results of FA profile of oils from different populations of *S. leriifolia* tested in this study are provided in Table 5. All samples were highly unsaturated as USFA comprised at least 85% of total FA. All six samples studied here contained approximately equal ratios of oleic and linoleic acids. The percentages of oleic acid of GH, MA, BA, FE, SH and RV were of 41.9, 41.1, 39.6, 44.9, 39.9 and 41.1, respectively and those of Linoleic were of 42.6, 42.4, 43.3, 44.4, 43.4 and 41.1, respectively. The concentrations of ALA ranged from 1-2% in all samples.

Physicochemical characteristics of seed oil

IV, SN, AV, PV and RI of extracted oils are shown in Table 4. PV and AV are valuable parameters for oil quality. PV (mequiv O_2 per Kg of oil) of GH, MA, BA, FE, SH and RV were estimated at 0.80, 0.90, 0.92, 0.90, 1.01 and 0.92, respectively. Also, the estimated AV (mg KOH per g of oil) of GH, MA, BA, FE, SH and RV were 0.68, 1.28, 0.93, 0.60, 0.73 and 1.36, respectively. AV reflects the amounts FFA formed by lipase activity and hydrolysis of triacylglycerol (Moodley *et al*., 2007). IV (g I_2 per 100 g oil) which is a measure of the unsaturation level of oil ranged from 83 (for SH) to 107 (for MA). IV of GH, BA, FE and RV were 95, 84, 97 and 106, respectively. These IV values indicated that the oil extracted from different populations of *S. lerrifolia* were highly unsaturated and therefore susceptible to oxidative degration. SN (mg KOH per g oil) of oil extracted from GH, MA, BA, FE, SH and RV were evaluated at the levels of 182, 185, 198, 177, 190 and 182, respectively. SN is the indication of average molecular weight of FA in an oil sample. Significant differences were also observed among RI values. RI of the extracted oils varied from 1.448 (in GH) to 1.461 (in MA). The differences in PV, IV, and SN could be related to the slight diversity of FA profile of seeds collected from different locations.

Table 5- Fatty acid compositions (%, w/w) of the oils extracted fro *S. leriifolia* seed investigated in this study (2010)

Sample	Palmitic	Stearic	Oleic	Linoleic	Linolenic	SFA*	USFA*	MUFA/PUFA*
GH	11.3^{a}±1.0	2.63^{b}±0.1	$41.9^{ab\pm}$1.1	42.6^{a}±0.2	1.61^{a}±0.3	13.86±0.1	86.13±0.1	0.95^{ab}±0.1
MA	12.1^{a}±0.1	2.59^{b}±0.1	$41.1^{ab\pm}$0.1	42.4^{a}±0.1	1.75^{a}±0.1	14.66±0.2	85.35±0.1	0.93^{b}±0.1
BA	12.0^{a}±0.1	3.38^{a}±0.1	39.6^{b}±0.1	43.3^{a}±0.5	1.74^{a}±0.0	15.34±0.1	84.65±0.1	0.88^{c}±0.00
FE	11.5^{a}±0.1	2.87^{b}±0.2	44.9^{a}±3.8	44.4^{a}±1.6	1.93^{a}±0.1	14.37±0.3	85.63±1.5	0.97^{a}±0.00
SH	11.5^{a}±0.2	2.85^{b}±0.2	39.9^{b}±0.2	43.4^{a}±0.5	1.64^{a}±0.1	14.14±.1	85.88±0.1	0.87^{c}±0.1
RV	13.5^{a}±2.2	2.62^{b}±0.2	41.1^{ab}±1.0	41.1^{a}±1.3	1.7^{a}±0.1	16.05±0.2	83.94±2.1	0.96^{ab}±0.00

*SFA saturated fatty acid, USFA unsaturated fatty acid, MUFA monounsaturated fatty acid, PUFA polyunsaturated fatty acid

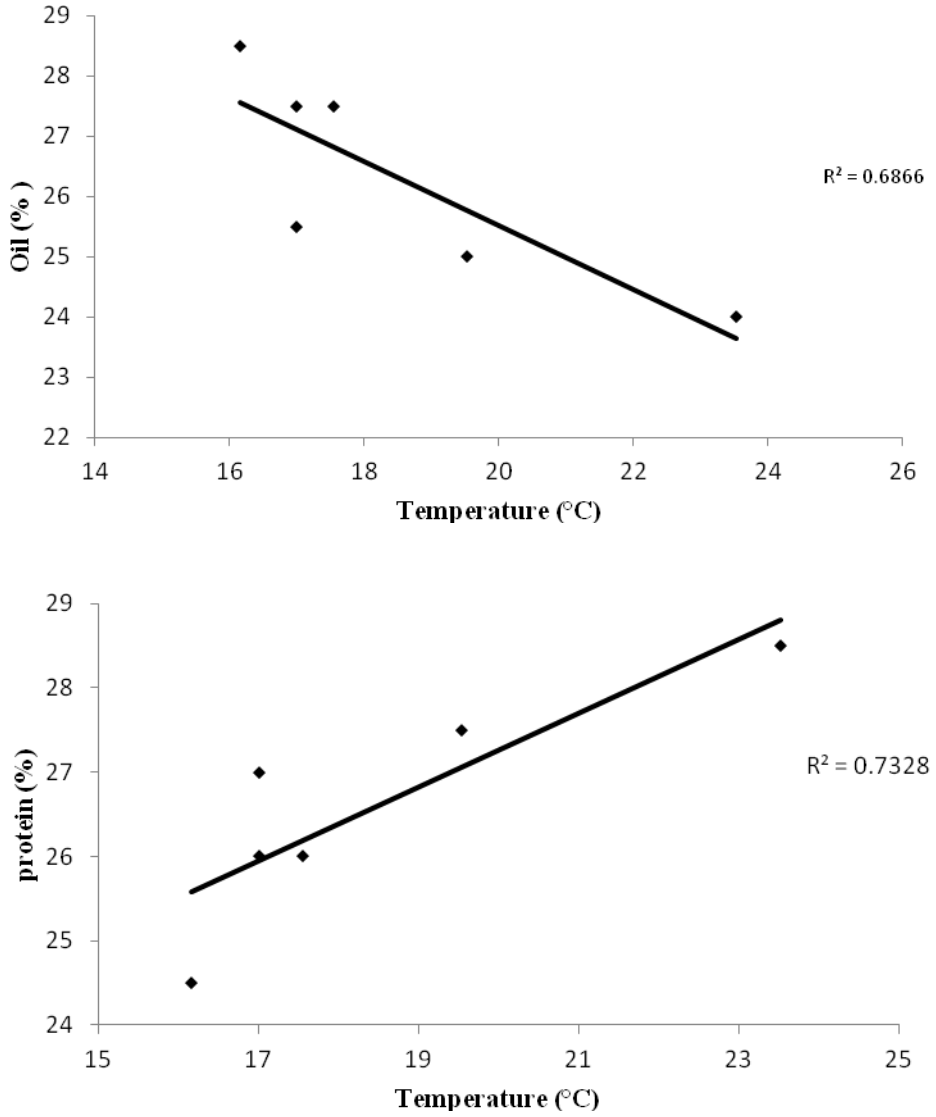

Fig. 1- relationship between Temperature and oil content (a), protein content (b).

Discussion

Proximate compositions

The levels of oil reported for other salvia species such as S. albimaculata (3.2%), S. candidisima (5.6%), S. cedronella (3%), S. cryptantha (4.7%), S. forskahlei L(2.7%), S. fruticosa (11%), S. halophila (20.8%), S. hypargeia (2%), S. sclarea (4%), S. tomentosa Miller(4.6%), S. tchihatcheffii (3.9%) and S. virgata (20.9%) are considerably lower than those obtained for S. leriifoliaare in this study (Azcan et al., 2004). Ayerza showed that there was negative correlation between growing temperature and oil content of chia seeds Ayerza and Coates, 2009. As seen in Figure 1, our results agree well with that statement (R^2= 0.68, P>0.042). Therefore, the diversity observed in oil contents of different populations tested in this study may be related to differences in climate conditions of growing places. Protein levels obtained here for tested *S. leriifolia* populations were found to be more than those of other *salvia* species native to Iran (Nejad habibvash and Rajamand, 2007). Regression coefficient represented in Figure 1 (R^2=0.73, P>0.030) showed that protein content was positively influenced by growing temperature (Fig 1 and Table 2). Such result is consistent with that of Ayerza (2010).

Minerals

Bresson *et al*. (2009) have reported Ca contents of two chia populations at 557 and 770 mg/100g which are higher than those obtained in the current study for *S. leriifolia* seeds.

There is no data on Ca and other minerals of *S. leriifolia* in the literature for comparison. The values of K obtained for *S. leriifolia* samples in the current study were found to be lower than those of chia seeds (667 and 660 mg/100g) (Bresson *et al*., 2009) and sage (*Salvia sclarea* L.) (Szentmihalyi *et al*., 2009). Magnesium plays key role in the function of many enzymatic activities corresponding to energy metabolism and nucleic acid synthesis (Hans*et al*., 2002). Mg was found at considerable amounts in all samples. Iron (Fe) is an essential micro-element that contributes in hemoglobin synthesis. Of all micro-elements measured here, Fe was found at the highest levels in all samples. The mean value of Fe of all samples evaluated here are higher than that of sage (43.5 mg/kg) (Szentmihalyi *et al*., 2009) and comparable with that of Chia reported by Bresson *et al*. (2009).

Fatty acid profile

Also, the percentages of palmitic acid, as the predominant SFA, were in the range 11.3 to 13.5 which were not statistically different. No significant differences were found in the concentrations of linolenic, linoleic and palmitic acids in relation to different growth locations. However, the levels of oleic acid varied among different samples. Oleic acid content in FE was found to be statistically higher than those in BA and SH. It has been suggested that quality and quantity of oil can be influenced by temperature, light, soil type and diet (Ayerza, 1995). Ayerza showed that chia genotypes grown in a place with lower elevation and Entisod type soil had significantly lower linolenic and higher linoleic than did other genotypes grown in a place with higher elevation and Canbisol type soil. He also showed that growth place had much more effects on oil contents and FA profile than did genotypes (Ayerza, 2010). Although Catoes and Ayerza showed that chia seeds collected from locations with higher elevation and subsequently higher rainfall had significantly higher amount of linoleic and lower amount of linolenic acid (Coates and Ayerza, 1998), such relationship between environmental factors and FA profile were not observed among different *S.leriifolia* populations studied here.

The MUFA / PUFA (monounsaturated fatty acid/ polyunsaturated fatty acid) rate is important from the oil stability point of view. The oxidation ratio for oleic acid (a MUFA), linoleic acid (a PUFA) and linolenic acid (a PUFA) is 1:10:20 (Zacheo *et al*., 2003). FA profile of tested seeds showed that the least MUFA/PUFA ratio was in BA (0.88) and SH (0.87). There for, the oils from BA and SH are expected to be more susceptible to oxidative deterioration than those from GH, MA, FE and RV. MUFA/PUFA ratio of different *S. leriifolia* populations studied here are higher than those of some common vegetable oils such as sunflower, safflower and soybean oil but lower than those of Canola and Olive oil (Foster *et al*., 2009).

There is no data about FA profile of *S. leriifolia*in the literature, but comparing to those of other *Salvia* species studied by other researchers, FA profile of *S. leriifolia* populations investigated here were completely different. Ayerza (2010) reported the ALA as the main FA in the seeds of different Chia genotypes and populations (Ayerza, 2010). Bagci *et al*. (2004) studied FA profile of several *Salvia* species (*S. bracteata, S. euphratica* var. euphratica, *S. aucherii*var. canascens, *S. cryptantha, S. staminea, S. limbata, S. virgata, S. hypargeia, S. halophylla, S. syriaca and S. cilicica*) and observed highly significant differences between their FA profile (Bagci *et al*., 2004). Kilic *et al*. (2004) observed that LA was the main FA in the seeds of S. bracteata and S. aethiopis. While, the seed oil of *S. candidissima* ssp. *candidissima* contained almost equal levels of ALA, LA, palmitic acid and oleic acid (Kilic *et al*., 2005). Compared with FA profile of vegetable oil, the FA profile of *S. leriifolia* studied here is somewhat similar to that of sesame oil (Gunstone, 2002). There for, the oils from *S. leriifolia* seem to be suitable for being used in food purposes such as salad, salad dressing and mayonnaise. While, Similar to flaxseed oil, Chia oil is comprised of elevated amounts of ALA, which may make the chia oil be unsuitable for food purposes.

SFA have shown to be harmful for the cardiovascular system. Total SFA of all samples investigated in the current study were found to be lower than 17% of total FA. This percentage is comparable to those of soybean, corn, olive, and sesame oil but lower than those of peanut, coconut and palm oil (Foster *et al*., 2009). Also, oleic acid-rich oils have shown

to reduce low density cholesterol (LDL) and total cholesterol in consumer blood. As a result, regarding to FA profile and FA classes, *S. leriifolia* seed oil can be served as a health-promoting vegetable oil.

Regardless the slight differences in chemical properties, all *S. lerrifolia* populations studied here were found to be a good source of vegetable oil, protein and minerals. From FA profile point of view, all samples showed considerable differences from other *Salvia* species mentioned in the litterateur and were rich in essential omega 6 (linoleic acid) and omega 9 FAs. In conclusion, in addition to healthy oil they have, their oil-free residue can be served as nutrient food and feed. However, more studies are needed to investigate potentially nutritional aspects of *S. lerrifolia* populations.

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