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The nutritional composition of fennel (*Foeniculum vulgare*): Shoots, leaves, stems and inflorescences

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ABSTRACT

The chemical composition and the nutritional value of different parts of *Foeniculum vulgare* (fennel): shoots, leaves, stems and inflorescences, were determined. The evaluation of chemical composition included the determination of moisture, total fat, crude protein, ash, carbohydrates, and nutritional value. The composition in individual sugars was determined, being fructose and glucose the most abundant sugars. The analysis of fatty acid composition, allowed the quantification of twenty one fatty acids. Polyunsaturated fatty acids were the main group in all the fennel parts; linoleic acid predominated in shoots, stems and inflorescences, while α-linolenic acid predominated in leaves. The higher levels of ω-3 fatty acids found in leaves contributed to its lowest ratio of ω-6 to ω-3 fatty acids. Also, the lower levels of ω-3 fatty acids found in inflorescences contributed to its highest ratio of ω-6 to ω-3 fatty acids.

1. Introduction

Fennel (*Foeniculum vulgare* Mill.) is a hardy, perennial, umbelliferous (Apiaceae) herb generally considered native to the Mediterranean areas that has become widely naturalised elsewhere; actually it may be found growing feral in many parts of the world. Fennel is highly aromatic with a characteristic aniseed flavour. Ethnobotanical data currently available on wild useful plants in Portugal highlight the importance of fennel' culinary and medicinal uses (Camejo-Rodrigues, Ascensão, & Bone, & Vallès, 2003; Carvalho, 2005; Novais, Santos, Mendes, & Pinto-Gomes, 2004; Santayana et al., 2007; Veigas, 2007). Roots, young shoots, leaves, flowering stems, mature inflorescences and fully ripened and dried seeds are commonly used for homemade remedies, being useful in the treatment of several complaints, specifically those of the digestive system. Fennel is also highly recommended for diabetes, bronchitis and chronic coughs, for the treatment of kidney stones, and is considered to have diuretic, stomachic and galactogogue properties (Camejo-Rodrigues et al., 2003; Carvalho, 2005; Novais et al., 2004; Salgueiro, 2004).

Different fennel parts are widely used in many of the culinary traditions of the world and particularly in Portugal (Table 1). Shoots, tender leaves and stems are chewed and sucked due to its exquisite aniseed flavour. All these parts are also commonly used as vegetables. They are added raw to salads, stewed with beans and chickpeas, used to stuff fish for grilling, put in soups and in traditional fish and bread bouillons. Besides seasoning, fennel is used to preserve food: stems are sometimes one of the ingredients of the brines prepared for olives' cure; leafy stems are boiled in the water where figs are soaked before being dried. Flowering stems, sugar and honey macerating in brandy produce a highly valorised spirit. Herbal teas prepared with fresh tender or dried flowering stems are drunk chilled or hot, depending on the season (Carvalho, 2005; Santayana et al, 2007; Tardío, Pardo de Santayana, & Morales, 2006; Tardío, Pascual, & Morales, 2005; Veigas, 2007). The culinary use and therapeutic effects of fennel were so large that it has been exported from country to country for centuries (Oktay, Gülçin, & Küfrevioğlu, 2003).

Fennel culinary value might be related to its organoleptic properties such as aroma and flavour, and also to its richness in carbohydrates, including sugars (Cataldi, Margiotta, & Zambonin, 1998), minerals (Özcan & Akbulut, 2007; Özcan, Ünver, Uçar, & Arslan, 2008) and essential fatty acids (Vardavas, Majchrzak, Wagner, Elmadfa, & Kafatos, 2006). Carbohydrates are important as short-term energy-storage compounds and also as major structural compounds in plant cell walls. Sugars such as glucose and fructose occupy key roles in energy metabolism and supply carbon skeletons for the synthesis of other compounds (Zubay, 2006). Polyunsaturated fatty acids from omega-6 and omega-3 families have strong biological properties in low concentrations (Gibney, Vorster, & Kok, 2002) and are biosynthetic precursors of eicosanoids (i.e. prostaglandins), which are signalling molecules with complex control over many body systems, having effects on cardiovascular

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Table 1
Uses of fennel as food as reported in Portuguese ethnobotanical studies.

Portuguese Region	Local name	Plant part and edible uses
Trás-os-Montes (northeast)	Fiolho, fionho, erva-doce	Shoots, tender leaves and stems – snacks, salads, soups, stews, spices Flowering stems – beverages, spirits, spices Stems – brochettes, herbal teas Seeds – spices, flavour for cakes, biscuits, sweets and chestnuts
Arrábida and Açor (center)	Funcho, erva-doce	Seeds – flavour for cakes and pastries and for cooking chestnuts
Alentejo and Algarve (south)	Funcho, fiolho, funcho-doce, funcho-amargo	Shoots, tender leaves and stems – fried with eggs, omelettes, fish stuff, stewed with different kinds of beans and chickpeas, fish and bread bouillons, soups, sauces Tender leafy stems – grilled fish and fish dishes in general Seeds – spices, flavour for cakes, bread and biscuits, chestnuts Whole plant – olives brines, figs preserves and for aromatizing brandy

diseases, triglycerides levels, blood pressure and arthritis (Zubay, 2006). A deficient intake of essential fatty acids can be responsible for many problems such as dermatitis, immunosuppression and cardiac dysfunctions (Kaplan, 1996). In the present study it is reported the valuable nutritional composition of different parts of *F. vulgare* (fennel) – shoots, leaves, stems and inflorescences – particularly in sugars, monounsaturated, polyunsaturated and saturated fatty acids, total ω-3 and ω-6 fatty acids and ω-6 to ω-3 ratio. On the basis of the contents of moisture, proteins, fat, carbohydrates and ash, an estimation of their nutritional role was performed.

2. Materials and methods

2.1. Samples

Samples of shoots, leaves, stems and inflorescences were gathered in Bragança, Trás-os-Montes, north-eastern Portugal. The selected sites and gathering practices took into account local consumers gathering criteria for the use of fennel and the optimal growth stage. The plant material was collected in half shade sites at the edges of woods, in early spring (shoots), in June (leaves) and during and after the flowering period in July (stems and inflorescences). Shoots are the young stems that sprouted from the persistent and woody base in spring; leaves, fully expanded, were collected in the median nodes of the annual flowering stems; stems correspond to the herbaceous portion of the annual main stems; inflorescences are the fully developed compound umbels, with fertile flowers and immature seeds.

Morphological key characters from the Iberian Flora (Castroviejo, 2003) were used for plant identification. Voucher specimens were deposited in the Herbarium of the Escola Superior Agrária de Bragança, Portugal. The material was lyophilized (Ly-8-FM-ULE, Snijders, HOLLAND) and kept in the best conditions (−20 °C, ~30 days) for subsequent use.

2.2. Standards and reagents

Acetonitrile 99.9% pure of HPLC grade was purchased from Lab-Scan (Lisbon, Portugal). Methanol, diethyl ether, toluene and sulphuric acid were of analytical grade purity: The fatty acids methyl ester (FAME) reference standard mixture 37 (fatty acids C4 to C24; standard 47885-U) was from Supelco (Bellefonte, PA, USA) and purchased from Sigma (St. Louis, MO, USA), as well as other individual fatty acid isomers and the sugar standards. All the other chemicals were obtained from Sigma Chemical Co. (St. Louis, MO, USA). Water was treated in a Mili-Q water purification system (TGI Pure Water Systems, USA).

2.3. Determination of macronutrients

The samples were analysed for chemical composition (proteins, fat, carbohydrates and ash) using the AOAC (1995) procedures. The crude protein content ($N \times 6.25$) of the samples was estimated by the macro-Kjeldahl method; the crude fat was determined by extracting a known weight powdered sample with petroleum ether, using a Soxhlet apparatus; the ash content was determined by incineration at (600 ± 15) °C; reducing sugars were determined by DNS (dinitrosalicylic acid) method. Total carbohydrates were calculated by difference: Total carbohydrates = 100 − (moisture + proteins + fat + ash), where moisture, proteins, fat and ash, stand for their masses, respectively, expressed in units of 1 g. Total energy was calculated according to the following equation: Energy (Kcal) = 4 × (proteins + carbohydrates) + 9 × (fat), where proteins and carbohydrates stand for their masses, respectively, expressed in units of 1 g.

2.4. Determination of sugars by HPLC/RI

2.4.1. Preparation of standard solutions

Individual solutions (~10 mg/ml) of L-arabinose, D-fructose, L-fucose, D-galactose, D-glucose anhydrous, lactose 1-hydrate, maltose 1-hydrate, maltulose monohydrate, D-mannitol, D-mannose, D-melezitose, D-melibiose monohydrate, D-raffinose pentahydrate, L-rhamnose monohydrate, D-sucrose, D-trehalose, D-turanose and D-xylose were prepared in water and stored at −20 °C. A stock standard mixture with fructose, glucose and sucrose was prepared in water with the final concentration of 30 mg/ml. Melezitose was used as internal standard (IS), being prepared a stock solution (25 mg/ml in water) and kept at ~20 °C.

2.4.2. Extraction procedure

Dried sample powder (1.0 g) was spiked with the IS (5 mg/ml), and was extracted with 40 ml of 80% aqueous ethanol at 80 °C for 30 min. The resulting suspension was centrifuged at 15,000 *g* for 10 min. The supernatant was concentrated at 60 °C under reduced pressure and defatted three times with 10 ml of ethyl ether, successively. After concentration at 40 °C, the solid residues were dissolved in water to a final volume of 5 ml, filtered through a 0.22 μm disposable LC filter disk, transferred into an injection vial and analysed by HPLC.

2.4.3. HPLC analysis

The HPLC equipment consisted of an integrated system with a Smartline pump 1000, a Smartline manager 5000 degasser system, a Smartline 2300 RI detector (Knauer, Germany), and an AS-2057 auto-sampler (Jasco, Japan). Data were analysed using Clarity 2.4 Software (DataApex). The chromatographic separation

was achieved with an Eurospher 100-5 NH_2 column (4.6 mm × 250 mm, 5 mm, Knauer) operating at 35 °C (7971R Grace oven). The mobile phase used was acetonitrile/deionized water, 7:3 (v/v) at a flow rate of 1 ml/min, and the injection volume was 20 μl. The compounds were identified by chromatographic comparisons with authentic standards. The results are expressed in g/100 g of fresh weight, and calculated by internal standard normalization of the chromatographic peak area.

2.5. Determination of fatty acids by GC/FID

Fatty acids were determined by gas chromatography with flame ionization detection (GC/FID)/capillary column as described previously by the authors (Barros, Venturini, Baptista, Estevinho, & Ferreira, 2008), and after the following trans-esterification procedure: fatty acids were methylated with 5 ml of methanol:sulphuric acid:toluene 2:1:1 (v:v), during at least 12 h in a bath at 50 °C with agitation (160 rpm); then 3 ml of deionized water were added, to obtain phase separation; the FAME were recovered with 3 ml of diethyl ether by mixing in vortex , and the upper phase was passed through a micro-column of anhydrous sodium sulphate, in order to eliminate the water; the sample was recovered in a vial with a Teflon cap, and before injection the sample was filtered with 0.2 μm nylon filter from Millipore (MA, USA). The fatty acid profile was analysed with a DANI model GC 1000 instrument equipped with a split/splitless injector, a flame ionization detector (FID) and a Macherey-Nagel (PA, USA) column (OPTIMA 225: 50% cyanopropyl-methyl – 50% phenylmethylpolysiloxane) with 30 m × 0.32 mm ID × 0.25 μm d_f. The oven temperature program was as follows: the initial temperature of the column was 50 °C, held for 2 min, then a 10 °C/min ramp to 240 °C and held for 11 min. The carrier gas (hydrogen) flow rate was 4.0 ml/min (0.61 bar), measured at 50 °C. Split injection (1:40) was carried out at 250 °C, and for each analysis 1 μl of the sample was injected. Fatty acid identification was made by comparing the relative retention times from samples with FAME peaks (standards). The results were recorded and processed using CSW 1.7 software (DataApex 1.7) and expressed in relative percentage of each fatty acid.

2.6. Statistical analysis

For each part of the plant three samples were analysed and all the assays were carried out in triplicate. The results are expressed as mean values and standard deviation (SD). The results were analysed using one-way analysis of variance (ANOVA) followed by Tukey's HSD Test with $\alpha = 0.05$. This treatment was carried out using SPSS v. 16.0 software.

3. Results and discussion

The macronutrients profiles and the energy contents (expressed on fresh weight basis) of the different parts of fennel (shoots, leaves, stems and inflorescences) are shown in Table 2. Leaves and stems revealed the highest moisture content (76.36 and 77.46 g/100 g, respectively), while inflorescences showed the lowest content (71.31 g/100 g). Carbohydrates were the most abundant macronutrients in all the parts and ranged from 18.44 g/100 g in leaves to 22.82 g/100 g in inflorescences. Reducing sugars are only a small part of carbohydrates due to the abundant presence of polysaccharides such as starch (major polysaccharide used for energy storage in plant cells) and cellulose (structural polysaccharide found as the major component of cell walls in plants) (Zubay, 2006).

Proteins and fat were the less abundant macronutrients; proteins varied between 1.08 g/100 g in stems and 1.37 g/100 g in inflorescences. Once more, inflorescences revealed the highest fat content (1.28 g/100 g) among all the fennel parts. On the basis of the proximate analysis, it can be calculated that a fresh portion of 100 g of these parts yields, on average, 94 Kcal. The highest values were obtained for inflorescences, while leaves and stems gave the lowest energetic contribution (Table 2).

The highest ash content was found in leaves (3.43 g/100 g), while the lowest value was found in stems (1.62 g/100 g). This is in agreement with other authors who reported higher levels of minerals in fennel leaves than in fruits (Özcan & Akbulut, 2007). Several minerals could be included in ash content and particularly, Ag, Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, In, K, Li, Mg, Mn, Na, Ni, P, Pb, Se, Sr, Tl, V and Zn were already described in fennel (Özcan et al., 2008). The most abundant minerals found in this plant were K, Ca, Mg, P and Na.

In what concerns sugars composition (Table 3), fructose, glucose and sucrose were detected in all the fennel parts, with the exception of sucrose in stems. These sugars are naturally occurring and widely distributed in plants. Glucose was the most abundant sugar in all the parts, despite the reports of sucrose as the most important sugar in plants. In this study, some percentage of sucrose could have suffered hydrolyze to their monosaccharide's constituents, contributing to an increase in glucose and fructose levels (Table 3). This is in agreement with the results described by Cataldi et al. (1998) reporting D-glucose and D-fructose as mains sugars in fennel. These authors used a different methodology for the analysis: high performance anion-exchange chromatography (HPAEC) coupled with integrated pulsed amperometry using gold working electrodes. In the present study, the separation of all the sugars by HPLC/RI was achieved in only 15 min, faster than the 25–35 min described by other authors (Cataldi et al., 1998).

Shoots revealed the highest concentration of sugars (6.57 g/100 g) due to the contribution of fructose, glucose and sucrose. Otherwise, leaves revealed the lowest content (1.29 g/100 g). This decrease in sugars content could be explained by the fact that the collected leaves were in a mature growth stage, consuming sugars for the photosynthetic process.

Total sugars (Table 3) were higher than reducing sugars (Table 2) due to the contribution of non reducing sugars such as sucrose.

The results of fatty acid composition, total saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA) of the different parts of fennel are shown in Table 4. The most abundant fatty acid in shoots, stems and

Table 2
Macronutrients composition (g/100 g) and energetic value (Kcal/100 g) of the different parts of fennel in a fresh weight basis (mean ± SD; $n = 3$). In each row, different letters mean significant differences ($p < 0.05$).

	Shoots	Leaves	Stems	Inflorescences
Moisture	73.88 ± 0.83 ba	76.36 ± 0.33 a	77.46 ± 1.03 a	71.31 ± 4.01 b
Ash	2.39 ± 0.02 c	3.43 ± 0.04 a	1.62 ± 0.12 d	3.23 ± 0.02 b
Fat	0.49 ± 0.05 b	0.61 ± 0.16 b	0.45 ± 0.07 b	1.28 ± 0.28 a
Proteins	1.33 ± 0.04 a	1.16 ± 0.03 b	1.08 ± 0.00 b	1.37 ± 0.05 a
Carbohydrates	21.91 ± 0.55 ba	18.44 ± 0.06 b	19.39 ± 0.65 ba	22.82 ± 3.06 a
Reducing sugars	1.14 ± 0.10 b	0.72 ± 0.04 c	1.49 ± 0.29 a	1.20 ± 0.19 b
Energy	97.37 ± 2.44 ba	83.90 ± 1.34 b	85.91 ± 3.02 b	108.23 ± 10.37 a

Table 3
Sugars composition (g/100 g of fresh weight) of the different parts of fennel (mean ± SD; $n = 3$). In each row, different letters mean significant differences ($p < 0.05$).

	Shoots	Leaves	Stems	Inflorescences
Fructose	1.51 ± 0.06 a	0.49 ± 0.05 c	1.49 ± 0.04 a	1.10 ± 0.04 b
Glucose	4.71 ± 0.15 a	0.76 ± 0.12 d	3.43 ± 0.20 b	2.94 ± 0.11 c
Sucrose	0.35 ± 0.06 a	0.04 ± 0.00 b	nd	0.03 ± 0.00 b
Total sugars	6.57 ± 0.17 a	1.29 ± 0.20 d	4.92 ± 0.23 b	4.07 ± 0.16 c

nd – not detected.

inflorescences was linoleic acid (C18:2), followed by α-linolenic (C18:3) and palmitic (C16:0) acids. Otherwise, α-linolenic acid predominated in leaves (43.55%). Vardavas et al. (2006) also reported the prevalence of α-linolenic acid followed by oleic and palmitic acids in a Greece fennel sample. Besides the three main mentioned fatty acids, eighteen more were identified and quantified. PUFA were the main group of fatty acids in all the fennel parts (Table 4). Other authors reported MUFA as the main group of fatty acids in fennel (Vardavas et al., 2006). Nevertheless, UFA ranged from 66% to 80%, and predominated over SFA.

Linoleic acid is an essential fatty acid and originates the omega-6 fatty acids series. The dietary ω-6 fatty acids are associated with a lower prevalence of hypertension and lower systolic blood pressure (Djousse et al., 2005). Studies reveal that dietary ω-6 fatty acids play a role in nerve conduction velocity due to their incorporation in membrane phospholipids (Coste et al., 1999) and posses antitumor properties against prostate (Bidoli et al., 2005), breast (Menendez, Ropero, Lupu, & Colomer, 2004) and pancreas cancers (Agombar, Cooper, & Johnson, 2004), among others.

Table 4
Percentages of the total detected fatty acids in the different parts of fennel. The results are expressed as mean ± SD ($n = 3$). In each column different letters mean significant differences ($p < 0.05$).

	Shoots	Leaves	Stems	Inflorescences
C6:0	0.06 ± 0.00	0.02 ± 0.00	0.19 ± 0.01	0.41 ± 0.02
C8:0	0.33 ± 0.00	0.08 ± 0.00	0.48 ± 0.03	0.37 ± 0.01
C10:0	0.06 ± 0.00	0.04 ± 0.00	0.13 ± 0.01	0.09 ± 0.00
C11:0	0.07 ± 0.00	0.25 ± 0.02	0.04 ± 0.00	0.29 ± 0.01
C12:0	0.21 ± 0.02	0.31 ± 0.02	0.11 ± 0.01	0.43 ± 0.06
C14:0	0.75 ± 0.03	1.43 ± 0.01	0.49 ± 0.06	1.68 ± 0.10
C14:1	0.17 ± 0.03	0.61 ± 0.04	0.37 ± 0.04	0.28 ± 0.02
C15:0	0.18 ± 0.00	0.17 ± 0.00	0.41 ± 0.04	0.35 ± 0.03
C16:0	12.78 ± 0.09	20.15 ± 0.09	25.43 ± 0.00	23.89 ± 0.07
C17:0	0.24 ± 0.02	0.74 ± 0.00	0.61 ± 0.04	0.58 ± 0.02
C18:0	1.53 ± 0.08	1.61 ± 0.08	1.99 ± 0.06	2.62 ± 0.04
C18:1n9c	2.55 ± 0.33	4.35 ± 0.37	4.35 ± 0.52	5.05 ± 0.00
C18:2n6c	39.99 ± 0.68	23.25 ± 0.07	38.22 ± 0.68	38.94 ± 0.23
C18:3n3	36.84 ± 0.52	43.55 ± 0.40	22.86 ± 1.31	17.55 ± 0.00
C20:0	1.06 ± 0.09	0.56 ± 0.00	0.84 ± 0.03	1.78 ± 0.06
C20:1c	*nd*	*nd*	0.06 ± 0.00	0.26 ± 0.03
C20:2c	0.38 ± 0.07	0.08 ± 0.01	0.14 ± 0.00	0.31 ± 0.01
C20:3n3 + C21:0	0.12 ± 0.01	0.16 ± 0.02	0.19 ± 0.00	0.15 ± 0.01
C22:0	1.12 ± 0.02	0.77 ± 0.04	1.20 ± 0.03	1.52 ± 0.04
C23:0	0.36 ± 0.15	0.82 ± 0.13	0.68 ± 0.01	1.89 ± 0.11
C24:0	1.20 ± 0.08	1.03 ± 0.04	1.21 ± 0.02	1.58 ± 0.02
Total SFA	19.95 ± 0.12 d	27.99 ± 0.02 c	33.81 ± 0.06 b	37.47 ± 0.25 a
Total MUFA	2.72 ± 0.36 c	4.96 ± 0.40 ba	4.78 ± 0.57 b	5.59 ± 0.13 a
Total PUFA	77.33 ± 0.24 a	67.05 ± 0.42 b	61.41 ± 0.62 c	56.94 ± 0.12 d

nd- not detected.
Caproic acid (C6:0); Caprylic acid (C8:0); Capric acid (C10:0); Undecanoic acid (C11:0); Lauric acid (C12:0); Myristic acid (C14:0); Myristoleic acid (C14:1); Pentadecanoic acid (C15:0); Palmitic acid (C16:0); Heptadecanoic acid (C17:0); Stearic acid (C18:0); Oleic acid (C18:1n9c); Linoleic acid (C18:2n6c); α-Linolenic acid (C18:3n3); Arachidic acid (C20:0); Eicosanoic acid (C20:1); *cis*-11,14-Eicosadienoic acid (C20:2c); *cis*-11,14,17-Eicosatrienoic acid + Heneicosanoic acid (C20:3n3 + C21:0); Behenic acid (C22:0); Tricosanoic acid (C23:0); Lignoceric acid (C24:0).

Table 5
ω3 and ω6 content (percent) in the different parts of fennel. The results are expressed as mean ± SD ($n = 3$). In each row different letters mean significant differences ($p < 0.05$).

	Shoots	Leaves	Stems	Inflorescences
ω3	36.96 ± 0.51 b	43.72 ± 0.36 a	23.04 ± 1.30 c	17.69 ± 0.01 d
ω6	39.99 ± 0.68 a	23.25 ± 0.07 c	38.22 ± 0.68 b	38.94 ± 0.23 b
ω6/ω3	1.08 ± 0.03 c	0.53 ± 0.00 d	1.66 ± 0.12 b	2.20 ± 0.01 a

α-Linolenic is an essential fatty acid and it is precursor of the omega-3 fatty acids series in humans. Essential ω-3 fatty acids revealed antitumor properties against various types of cancers including breast (Klein et al., 2000), prostate (Terry, Terry, & Rohan, 2004) and colorectal cancers (Reddy 2004). Furthermore, dietary ω-3 fatty acids possibly play a vital role in inflammatory diseases, hypertension and coronary heart disease (Dokholyan et al., 2004; Wijendran & Hayes, 2004).

The highest concentration of n-3 fatty acids was found in fennel leaves, while the lowest concentration was found in inflorescences (Table 5). The ratio of ω-6 to ω-3 fatty acids has an important role in the human diet, and is also presented in Table 5. The highest levels of n-3 fatty acids found in leaves contributed to its lowest ratio of ω-6 to ω-3 fatty acids. The lowest levels of n-3 fatty acids found in inflorescences contributed to its highest ratio of ω-6 to ω-3 fatty acids. Leaves were the only part presenting a ratio lower than 1 (0.53), and even lower than the ratio reported by Vardavas et al. (2006) in a Greece sample of fennel (0.89). Those authors stated that low ratios could reduce the potential for lung cancer, asthma and may prevent thrombosis and atherosclerosis; while a high serum n-6:n-3 ratio is associated with major depression and may increase the risk of coronary heart disease (Vardavas et al., 2006).

The studied plant plays an important role in the traditional diet of the Portuguese rural areas, mainly in Trás-os-Montes and Alentejo since fennel is daily consumed, raw in salads and snacks, or stewed, boiled, grilled or baked in several dishes and drunk as herbal teas or spirits. A diet rich in this perennial umbelliferous herb could bring potential health benefits due to their valuable nutritional composition in essential fatty acids. The sugars identified in the samples, such as glucose and fructose, occupy key roles in the energetic metabolism and supply carbon skeletons for the synthesis of other compounds. As far as we know, nothing has been reported on macronutrients composition of all the fennel parts: shoots, leaves, stems and inflorescences.

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