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Fatty acids Sterols and Vitamin E composition of seed oil of *Opuntia Ficus Indica* and *Opuntia Dillenii* from Morocco

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Abstract
Two species of prickly pear from Morocco, *Opuntia ficus indica* (OFI) and *Opuntia dillenii* (OD) were investigated for fatty acids, sterols and vitamin E composition of the seed oil. Oils are obtained by hexane maceration under ambient temperature and analyzed by GC-MS. The main fatty acids of (OFI) and (OD) seed oil were respectively: linoleic acid: 58.79 and 79.83%, Palmitic acid: 11.18 and 13.52%. In both oils, stearic acid was present at low percentage: 1.50 and 2.75%. The content of unsaturated fatty acids was high, at 58.79% and 79.83% for (OFI) and (OD), respectively. The sterolic fraction was composed by β-sitosterol: 21.93 and 2.80%, campesterol: 3.75 and 0.51%, stigmasterol: 1.64 and 0% and fucosterol: 0 and 0.27% respectively. The sterol marker, β-sitosterol, accounted for 80.27% and 78.21% of the total sterol content in (OFI) and (OD) seed oils. In both oils, vitamin E, γ-tocopherol was present with low quantities 1.23% and 0.29% of total lipids respectively.

Key words: Opuntia Ficus Indica, Opuntia Dillenii, Seed oil, Fatty acids, Sterols, Vitamin E.

1. Introduction
Cactus plant of the Cactaceae family [1], originated from Mexico, was introduced into North Africa in the 16th century [2]. About 1500 species of cactus are in the genus Opuntia and are distributed in Europe, the Mediterranean countries, Africa, the southwest U.S., northern Mexico and other areas [3]. Many species of Opuntia produce edible fruit and very fragrant [4]. Cactus pear grows wild in arid and semiarid regions, where the production of more succulent food plants is severely limited. Low water exigency and a high water-use efficiency ratio favor the extension of cactus production, as underlined by the Food and Agriculture Organization [5].
Opuntia Ficus Indica grows everywhere in Morocco. However, *Opuntia dillenii* was found in west and northeastern. They play a strategic role in subsistence agriculture. The fruit of the prickly pear *Opunia ficus indica*, is mainly consumed as fresh fruit. However, *Opuntia dillenii* is less appreciated, due to its acidic taste and the presence of a large number of seeds. The fruits of *O. ficus-indica* and *O. dillenii*, have anti-inflammatory and analgesic effects [6], anti-hyperglycemia and hypocholesterolemic effects [7], probably due to the fatty acid composition of the prickly pear seeds oil [8]. Butera et al. [9] reported that prickly pear *O. ficus-indica* white fruit extracts showed the highest protective effects of all models of lipids oxidation due to its high content of betalains, which contributes to the antioxidant activity of prickly pear fruit. Kanner et al. [10] also specified betalain as a new class of dietary cationized antioxidant. The peel of *Opuntia* fruits accounts for 33 to 55% while the pulp accounts for 45 to 67%. Seeds contained in the pulp, accounts for 2 to 10% [11,12]. Several research studies have been carried recently reported the chemical composition of seeds oil of *O. ficus indica*. However little information was found in the literature concerning the fatty acids profile of *O. dillenii* seeds oil. Salvo et al. [13] reported that oil content from Italian cultivar was about 9.14%. Moreover, Ramadan and Morsel [14] also reported that oil content from German cactus was about 9.9%. Ennouri et al. [8] reported that

oil content was 11.05% for cultivar from Tunisia. Labuschagne and Hugo [15] reported that oil content from South Africa was 5.69%. Yuan-Gang Zu and al. [16] reported that oil content from China was 6. 01%.

According to literature data [17-19], oil processed from the seeds is characterized by a high degree of unsaturation wherein linoleic acid is the major fatty acid (56.1–77%). In a previous study Ennouri [8] showed that cactus pear seed oil was rich in oleic (C18:1) and linoleic (C18:2) acids (16.7% and 70.3%, respectively), which represented 87% of the total fatty acids. The sterol fraction accounted for 0.94% of TL. β-sitosterol was the sterol marker accounted for 72% of the total sterol content in seed oil. Vitamin E level accounted for only 0.04% of TL.

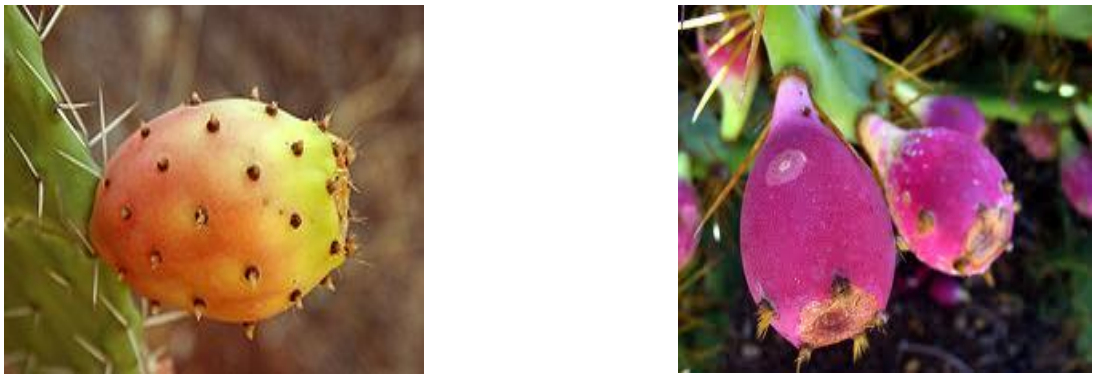
Total lipid extraction was usually performed with chloroform: methanol (2:1 v/v) [14,20], with hexane in a Soxhlet extractor [21] for 9 h, with petroleum ether in a Soxhlet extractor [22] for 6 h and with supercritical carbon dioxide extraction [16] during 2.79h at a pressure of 46.96MPa.

Therefore, the aim of this work is to study the lipid fraction profile in terms of fatty acids, sterols and vitamin E of *opuntia ficus indica* and *opuntia dillenii* seed oil, harvested in eastern Morocco (Oujda). The chemical composition of the seed oil was analysed by GC–MS. The comparison between the two species prickly pear will serve as a basis for further detailed chemical investigation and nutritional evaluation.

2. Materials and methods

2.1. Sample collection and preparation:

The mature fruits of prickly pear, Opuntia Ficus Indica and Opuntia Dillenii (Figure 1) were collected respectively, in June and February 2011 from the same area (Oujda, Morocco). They were peeled then seeds were isolated by pressing the whole edible pulp, washed with distilled water, dried at room temperature to calculate the percentage of seeds in the edible fraction, ground to a fine powder using a coffee grinder and stored at -20 °C until use.



(a) (b)

Figure 1: (a), Opuntia Ficus Indica; (b), Opuntia Dillenii

2.2. Extraction of total lipids (TL):

Ground seed (10 g) was used for lipid extraction in a 250-mL round-bottom flask. Hexane (25 mL) was added and the mixture was stirred under ambient temperature for 2 h. After filtration, the solvent was concentrated on a rotary evaporator under reduced pressure at 40°C. Oil was dried with Magnesium sulfate and left overnight in a refrigerator at 4°C. Oil obtained from the seeds constitutes 5.7% and 5.1% for OD and OFI respectively of whole seed weight.

2.3. Analytical procedures:

The oils were analyzed by gas chromatography-mass spectrometry (GC-MS) using an Agilent 5973N mass selective detector coupled with an Agilent 6890N gas chromatograph. The MS operating parameters were as follows: ionization potential, 70 eV; ionization current, 2 A; ion source temperature, 200°C, resolution, 1000. Mass units were monitored from 30 to 450 m/z. The oil components were identified by comparison of their retention times and mass spectra with the NIST mass spectral library23. The chromatographic conditions were identical to those used for GC analysis.

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3. Results and discussion

Figure 2 shows a typical chromatogram of fatty acids profile detected in OD and OFI seeds oil.

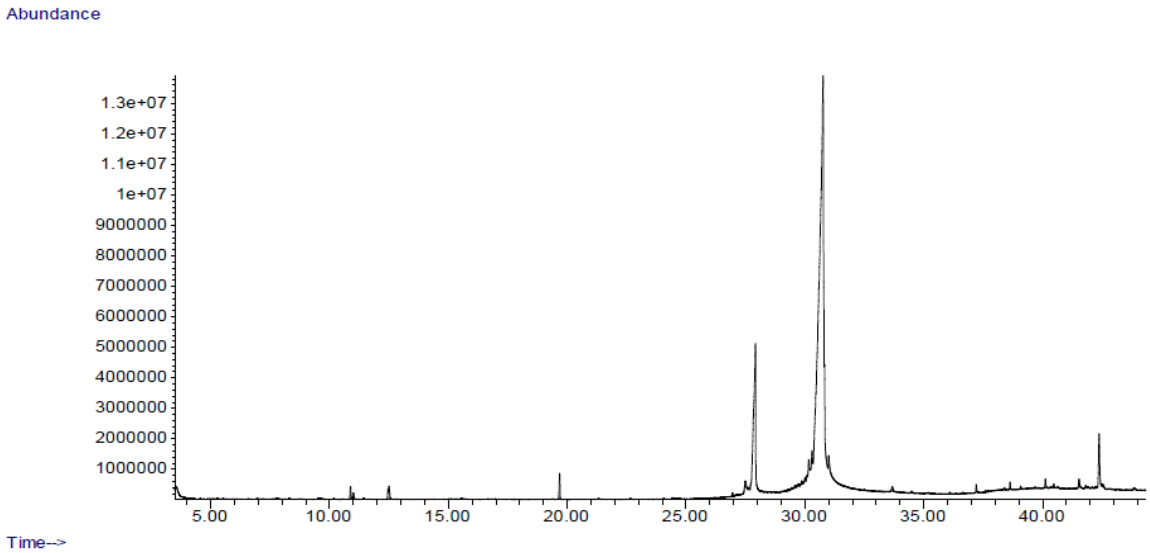


Figure 2a: GC chromatogram of total lipid of OD seeds oil

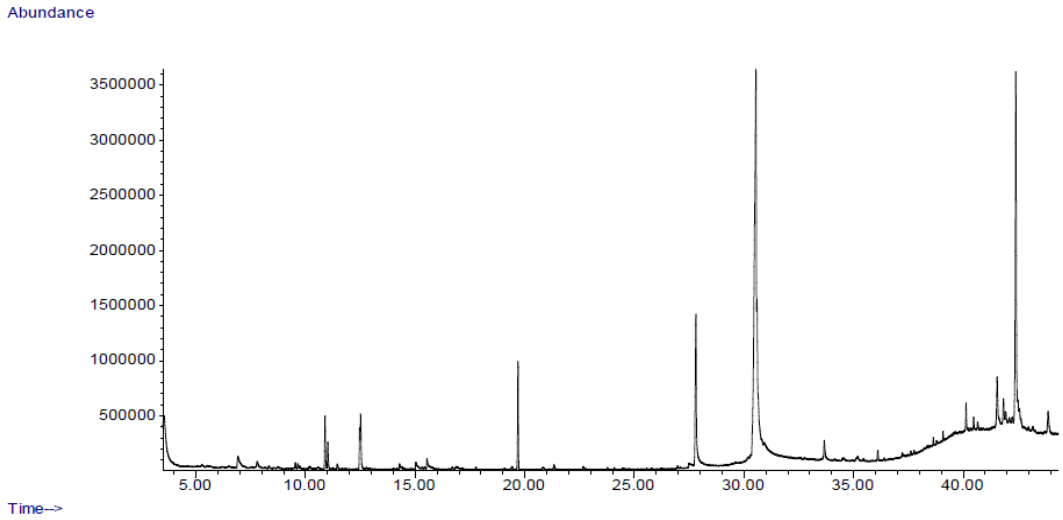


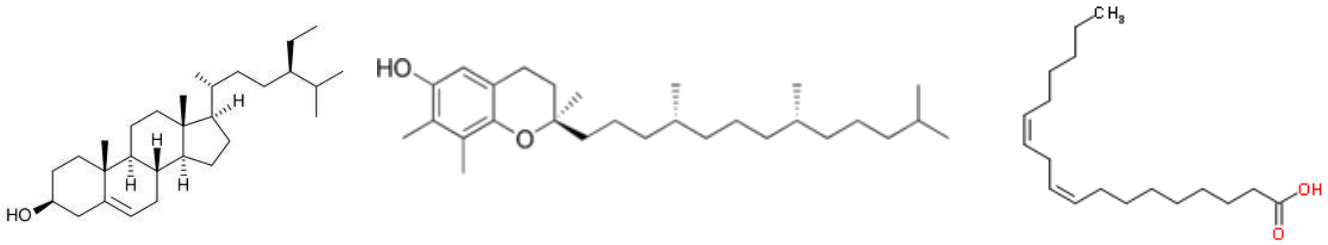
Figure 2b: GC chromatogram of total lipid of OFI seeds oil

The composition of fatty acids, sterols and vitamin E in the total lipid of OD and OFI seeds oil is shown in Table 1. In both oils, linoleic acid was the dominating fatty acid with an exceptional level, up to 79.83% for OD and 58.79% for OFI oil followed by palmitic acid (13.52 and 11.18%) and stearic acid (2.75 and 1.50%) for OD and OFI oil respectively. Linoleic acid is an essential fatty acid and a precursor of arachidonic acid biosynthesis, the substrate for eicosanoid synthesis. According to Keys and al. (1957) [24], linoleic acid has hypocholesterolemic effects. These results showed that OD oil was more rich in fatty acids than OFI oil. Our results are in agreement with those published recently by Tlili and al. (2011) [25] for OFI oil: linoleic acid content (56.6%), palmitic acid (12.24%) and stearic acid (3.69%). Moreover, Yuan-Gang and al. (2009)[16] reported that linolenic acid constituted the main fatty acids (66.56%) in OD total lipid oil followed by palmitic acid (19.78%), stearic acid (9.01%) and linoleic acid (2.65%). However, linolenic and oleic acids were not detected in our both seed oils. The observed difference is possibly due to the degree of maturity of the fruit; indeed, these authors suggested that there was an increase in saturated fatty acid content towards the end of fruit maturation. The content of unsaturated fatty acids was 79.83% and 58.79% for OD and OFI oil respectively.

However, saturated fatty acids (SFA) fraction was characterized by a lower level (16.27 and 12.68%) for OD and OFI oil respectively. Recently, it was proven by clinical evidence that PUFAs are able to alleviate symptoms of certain diseases such as coronary heart disease, stroke and rheumatoid arthritis [26]. Also, linoleic acid has beneficial properties for skin, and for this purpose it is used by the cosmetics products industry [27,28]. These results bring attention to the possible use of cactus seed oil as a natural source of PUFAs for nutritional, industrial or pharmaceutical purpose. Indeed, different means are used to increase, directly or indirectly, the human consumption of PUFAs [29].

The sterolic fraction was composed by β-sitosterol: 21.93 and 2.80%, campesterol: 3.75 and 0.51%, stigmasterol: 1.64 and 0% and fucosterol: 0 and 0.27% for OD and OFI oil respectively. The sterol marker β-sitosterol, accounted for 80.27% and 78.21% of the total sterol content in (OFI) and (OD). OD seed oil contained a low quantitie of sterols 3.58%. On the contrary, OFI contained a higher amount of sterols 27.32%. Similar values were published by Ramadan and Morsel (2003) [14] for the sterol content in OFI seed oil. Recently, sterols have been added to vegetable oils as an example of a successful functional food [30]. This type of product is now available and has been scientifically proven to lower blood LDL cholesterol by around 10–15% as part of a healthy diet [31].

In both oils, vitamin E was represented by only γ-tocopherol. The vitamin E level was higher in OFI oil 1.23% than in OD oil 0.29%. High levels of vitamin E, detected in the oils, may contribute to great stability toward oxidation.



γ-tocopherol β-sitosterol linoleic acid

Figure 3: The main fatty acids, sterols and vitamin E of seed oil opuntia

Table 1: Fatty acids, sterols and vitamin E in the total lipid composition of OD and OFI seeds oil

Lipid Composition		**Concentration (%)**	
		OD	**OFI**
Fatty acids	Linoleic C18:2	79.83	58.79
	Palmitic C16:0	13.52	11.18
	Stearic C18:0	2.75	1.50
	SFA[a]	16.27	12.68
	PUFA[b]	79.83	58.79
	PUFA/SFA[c]	4.91	4.63
Sterols	β-sitosterol	2.80	21.93
	Campesterol	0.51	3.75
	Fucosterol	0.27	nd
	Stigmasterol	nd	1.64
Vitamin E	γ-tocopherol	0.29	1.23

nd: Not detected; a: SFA = (C16:0 + C18:0); b: PUFA = C18:2;
c: Unsaturation ratio = C18:2/(C16:0 + C18:0).

Conclusion

This study shows that Opuntia Dillenii seed oil was found to be more unsaturated: 79.83% than Opuntia Ficus Indica: 58.79%. Linoleic acid was the dominating fatty acid with an exceptional level, up to 79.83% for OD and 58.79% for OFI oil. OFI contained a higher amount of sterols: 27.32% in total lipid oil. These results bring attention to the possible use of cactus seed oil as a natural source of PUFA for nutritional, industrial or pharmaceutical purpose.

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