

Zeitoun Ennwader - A new olive (*Olea europaea* L.) oil cultivar in Tunisia with high oil quality and low alternate bearing

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Abstract

The most outstanding olive oil cultivar ‘Chemlali Sfax’ has low oleic acid level and high palmitic acid content and a tendency to biennial bearing. Cross breeding program of this cultivar was undertaken in Tunisia since 1994 using local and foreign cultivars. Selected hybrids were planted in a comparative trial since 2005. This study aims to characterize a new olive cultivar ‘Zeitoun Ennwader’ better than the original cultivar. Data on morphologic, agronomic and oil quality were recorded for the new cultivar. This cultivar is distinguishable from the original cultivar due to its morphological parameters of the fruit (shape, symmetry and apex) and the endocarp (symmetry, position of maximum transverse diameter and apex). This cultivar is agronomically different from the original variety by its low alternate bearing, its early bearing and its moderate sensitivity to *Verticillium*. The oil of the new cultivar is different from the original variety by its superior fatty acid composition (higher oleic acid content and lower palmitic acid content). The adoption of this cultivar will be of great benefit to farmers (high and more regular production) and to exporters (high oil quality).

Key words: Olive, Chemlali Sfax, Improvement, Oleic acid, Alternate bearing, Agronomy, Morphology

Zeitoun Ennwader: Un nouveau cultivar d’olive à huile en Tunisie à bonne qualité d’huile et à alternance de production faible

Résumé

Le cultivar d’olive à huile le plus remarquable ‘Chemlali Sfax’ a un faible niveau d’acide oléique, une teneur élevée en acide palmitique et une tendance à une alternance biennale. Le programme de croisement de ce cultivar a été entrepris en Tunisie depuis 1994 en utilisant des cultivars locaux et étrangers. Des hybrides sélectionnés ont été plantés dans un essai comparatif depuis 2005. Cette étude vise à caractériser un nouveau cultivar d’olivier ‘Zeitoun Ennwader’ supérieur à celui du cultivar d’origine. Des données sur les caractères morphologiques, agronomiques et chimiques de l’huile ont été enregistrées pour le nouveau cultivar. Ce cultivar se distingue du cultivar original par ses paramètres morphologiques du fruit (forme, symétrie et Apex) et de l’endocarpe (symétrie, position du diamètre transversal maximal et apex). Ce cultivar est différent de la variété originale sur le plan agronomique par son faible indice d’alternance, son entrée précoce en production et sa sensibilité modérée au *Verticillium*. L’huile du nouveau cultivar est différente de la variété originale par sa meilleure composition en acides gras (teneur plus élevée en acide oléique et plus faible en acide palmitique). L’adoption de ce cultivar sera d’un grand intérêt pour les agriculteurs (production élevée et plus régulière) et pour les exportateurs (huile de bonne qualité).

Mots clés: Olive, Chemlali Sfax, Amélioration, Acide oléique, Alternance, Agronomie, Morphologie

INTRODUCTION

In order to select new interesting and more competitive olive genotypes, cross breeding can be used to increase the genetic variability. For this reason, breeding programs were carried out in most olive-producing countries (Israel, Italy, Spain, Turkey, Morocco, Iran and Egypt) to select new cultivars better than the main cultivars in their respective countries (Laaribi *et al.*, 2014; Bellini *et al.*, 2008). In Spain, significant differences were reported between crosses for all the fatty acids analyzed and the wide variability observed represents a very promising base to obtain new olive cultivars (Leon *et al.*, 2004a). ‘Chiquitita’ was the first olive cultivar developed by the cooperative breeding program carried out by the University of Cordoba and the Institute of Agricultural and Fishery Research and Training (IFAPA) (Rallo *et al.*, 2008).

In Tunisia, a breeding program by controlled crosses has been carried out since 1994 among the most outstanding cultivar ‘Chemlali Sfax’. This olive variety has high oil content and productivity and is well adapted to arid conditions (Trigui *et al.*, 2006). Nevertheless, its low oleic acid content of and its high alternate bearing are considered as

deficiencies that need to be resolved (IOC, 1997). Indeed, ‘Chemlali Sfax’ has low oleic acid (55 %) and high palmitic acid (19.6 %) (Zarrouk *et al.*, 2009) and a tendency to biennial bearing (Trigui *et al.*, 2006).

The cultivar ‘Chemlali Sfax’ have been crossed with both local and foreign pollinators. Most studies were interested in screening progenies mainly for a more interesting chemical composition than that of the cultivar ‘Chemlali Sfax’, which allows the selection of some descendants (Manai *et al.*, 2007; Rjiba *et al.*, 2009; Dabbou *et al.*, 2010). Other works were undertaken on ‘Chemlali Sfax’ seedlings regarding morphological description (Laaribi *et al.*, 2014; Ben Amar *et al.*, 2015).

Recently, five new cultivars obtained in the Tunisian crossbreeding program were released and published in the Official Journal of Republic of Tunisia (JORT, 2017). ‘Zeitoun Ennwader’ is the most interesting cultivar with mainly low alternate bearing and high oleic acid content. It was released under number 195.

The aim of this study was to describe the main morphological, agronomic and oil quality traits of the new registered olive cultivar ‘Zeitoun Ennwader’.

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MATERIAL AND METHODS

Plant material

'Zeitoun Ennwader' is a new olive (*Olea europaea* L.) cultivar obtained in a crossbreeding program in Tunisia initiated during the period 1993-1996. It was derived from a cross pollination between 'Chemlali Sfax' (female) and 'Lucques' (male), two cultivars from different geographical origins: 'Chemlali Sfax' from Sfax in the center-East of Tunisia and 'Lucques' from France.

Seedlings were planted in two open fields during 1997-1998 with a density of 1250 trees ha⁻¹ (4 m x 2 m) at the experimental station of the Olive Institute at Sfax (Central Tunisia, Lat 34° 44' N, long 10° 46') and the Research Station of 'Taous', which is about 26 km far from Sfax (Lat 34° 56' N, long 10° 36'). Seedling evaluation was carried out for three consecutive harvest seasons since 2000. The original seedlings of 'Zeitoun Ennwader' were selected mainly on the basis of their fatty acid composition. After vegetative propagation by semi-hardwood stem cuttings (2002 to 2004), propagated trees of 'Zeitoun Ennwader' together with other selected seedlings were planted in comparative trial in 2005 at 6 x 4 m spacing at the experimental farm of Taous in the region of Sfax (Tunisia). Standard cultural practices were followed in this orchard to ensure tree growth, mainly in relation to irrigation and fertilization.

Methodology

Morphological, agronomical and oil chemical characters have been used for descriptive purposes of the new cultivar. After that, these results were compared with those reported in literature for the cultivar Chemlali Sfax.

Morphological description was carried out during three years (2013-2015) according to the primary characterization of olive varieties recommended by the International Olive Council (IOC, 1997) by using a total of 21 characters of the leaf, fruit and endocarp.

Agronomical characteristics have been evaluated on the observations of 3 trees according to the IOC norms (IOC, 1997). Bearing earliness was performed by counting the number of years of the first significant bearing after planting. The average production per tree and alternate bearing index were recorded for the period 2007-2015. The ripening index on a sample of 100 fruits collected in November was determined according to Hermoso *et al.*, (1991) based on an evaluation of the olive skin and pulp colors for three years (2013-2015). Compatibility behavior was recorded by comparing fruit sets obtained from free and self-pollination. The tolerance test to *Verticillium* was undertaken in greenhouse conditions and the severity attack of the fungi was estimated according to Triki *et al.* (2012) with tolerant class having less than 33 % of the plant death.

Olive oil is produced by grinding 2.5 kg stoned olives and extracting the oil by mechanical means. Representative sample was handpicked in November for three years (2013-2015). The procedure for monovariety oil production followed the standard methods used in oil factories, including milling and malaxation. The fatty acid composition of the oils was determined by gas chromatography (GC) as fatty acid methyl esters. A chromatographic analysis was performed in a Hewlett-Packard model 4890D gas chromatograph. Fatty acids were identified

by comparing their retention times with those of standard compounds. Three fatty acid concentrations were evaluated in this study, palmitic acid (C16:0), oleic acid (C18:1) and linoleic acid (C18:2) and were compared with those of the original cultivar 'Chemlali Sfax'.

Data analysis

In this work, morphological and agronomic parameters were determined according to the different classes reported by IOC (1997) for each character. Oil chemical parameters were presented as a range values for the three years (minimum and maximum).

RESULTS AND DISCUSSION

Morphological characterization

The olive new cultivar was characterized using 21 morphological parameters related to the leaf, the fruit and the stone (Table 1 and figure 1). These parameters were recorded according to the methodology for primary characterization of olive varieties cited by the International Olive Oil Council (IOC, 1997).

Leaves of 'Zeitoun Ennwader' were similar to those of 'Chemlali Sfax', with elliptic-lanceolate shape and flat longitudinal curvature. Fruits of 'Zeitoun Ennwader' cultivar were asymmetrical, truncate base's shape, with low weight, central maximum diameter, many lenticels, pointed apex's shape and with nipple. The location of start of colour change at maturity stage was towards apex and the colour at the end of maturity was black.

The stone of 'Zeitoun Ennwader' was asymmetric, with low weight, elliptic shape, rounded base's shape, pointed apex's shape, maximum diameter towards apex, smooth surface and regular distribution of grooves. The apex termination was with mucro.

This new cultivar showed fruit and endocarp traits which differed from the typical of 'Chemlali Sfax' described by Barranco *et al.* (2000) and Trigui et Msallem (2002). It is distinguishable from 'Chemlali Sfax' due to its shape, symmetry, apex and lenticels of the fruit and symmetry, PDM, apex and base of the endocarp. These results corroborate with other studies (Laaribi *et al.*, 2014; Ben Amar *et al.*, 2015) carried out in the same hybrid collection based on morphometric characters. According to our study, fruit and endocarp sizes seemed to be the most discriminating traits when compared with leaf traits.

Agronomic characterization

The evaluation of agronomic traits of 'Zeitoun Ennwader' is presented in Table 2. This cultivar showed a short unproductive period as well with a first significant bearing 3 years after planting. During the period 2007-2015, the average yield per tree was considered as high with low alternate bearing index. 'Zeitoun Ennwader' is a late ripening cultivar with optimum ripening period occurring in early January, the maturity index was for 2.4 in December.

In relation to the main biotic stresses, preliminary results indicate that the reaction of 'Zeitoun Ennwader' was classified as moderately susceptible to *Verticillium dahliae* Kleb, with better behavior when compared to 'Chemlali Sfax'.

Table 1: Description of the main morphological characteristics of olive cultivar ‘Zeitoun Ennwader’ compared with the control ‘Chemlali Sfax’

Organ	Trait	Zeitoun Ennwader	Chemlali Sfax*
Leaf	Shape	Elliptic-Lanceolate	Elliptic-Lanceolate
	Longitudinal curvature	Flat	Flat
Fruit	Weight	Low	Low
	Shape	Elongated	Ovoid
	Symmetry	Asymmetric	Symmetric
	PDM	Central	Central
	Apex	Pointed	Rounded
	Base	Truncate	Truncate
	Nipple	Absent	Absent
	Colour change	Towards apex	-
	Lenticels	Many	Few
	Maturity colour	Black	-
Endocarp	Weight	Low	Low
	Shape	Elliptic	Elliptic
	Symmetry	Asymmetric	Symmetric
	PDM	Toward apex	Central
	Apex	Pointed	Rounded
	Base	Rounded	Pointed
	Surface	Smooth	Smooth
	Distribution of groves	Regular	-
	Apex termination	With mucro	With mucro

Characteristics reported by Barranco et al. (2000), PDM: Position of Maximum transverse Diameter

Table 2: Main agronomic characterization of new olive cultivar compared with the check ‘Chemlali Sfax’

Trait	Zeitoun Ennwader	Chemlali Sfax*
Earliness of bearing	Early	Late
Olive yield per tree	High	High
Alternate bearing	Low	High
Ripening	Late	Late
Compatibility	Self-compatible	Self-compatible
Verticillium	Moderate	Sensitive

*Performances reported by Barranco et al. (2000)

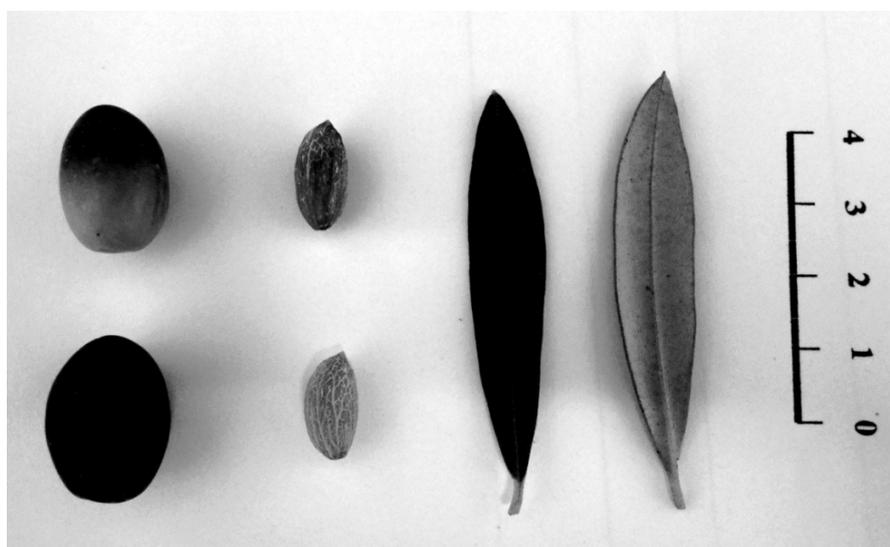


Figure 1: Leaf, fruit and endocarp of ‘Zeitoun Ennwader’ olive cultivar

Table 3: Minimum and maximum fatty acid concentrations (%) of the new cultivar during three years (2013-2015)

Trait	Zeitoun Ennwader	Chemlali Sfax*	IOC norm**
Oleic acid	70.4 - 73.8	55.0	55 - 83
Palmitic acid	11.2 - 15.3	19.6	7.5 - 20
Linoleic acid	9.90- 12.6	18.0	2.5 - 21

*Values reported by Zarrouk et al. (2009), ** IOC (1997)

Agronomical evaluation demonstrated that 'Zeitoun Ennwader' had earlier bearing, lower alternate bearing index and better tolerance to *Verticillium dahliae* Kleb than 'Chemlali Sfax' while both cultivars had similar performances for the other traits. Short unproductive period and high olive production were also reported for the new Spanish cultivar 'Chiquitita' (Rallo et al., 2008).

Fatty acid composition characterization

'Zeitoun Ennwader' cultivar presents good oil quality performance in comparison with the original cultivar 'Chemlali Sfax' due to its considerably better fatty acid composition (Table 3). Thus, the concentration of the main monounsaturated fatty acid (oleic acid) ranged from 70.4 to 73.8 %, while the level of palmitic acid, the major saturated fatty acid in olive oil, varied between 11.2 and 15.3 %. The content of linoleic acid, the main polyunsaturated acid, is within the range of 9.9 – 12.6 %. 'Zeitoun Ennwader' is considered with high oil quality and its fatty acid composition is within the norms of IOC (1997).

Significant differences were found between 'Zeitoun Ennwader' and 'Chemlali Sfax' for all the fatty acids analyzed (Table 4). Thus, the selection of this cultivar had permitted an important increase in oleic acid content and decrease in palmitic acid content in comparison with the fatty acid composition reported for 'Chemlali Sfax' by Zarrouk et al., (2009). It has been reported that new olive cultivars with high oil quality were obtained from crosses between the olive cultivars 'Arbequina', 'Frantoio' and 'Picual' (Leon et al., 2004b). The improvement of the fatty acid composition of 'Chemlali Sfax' was achieved due to the high oil quality of the French table olive cultivar 'Lucques' reported by Zarrouk et al., (2009).

This cultivar represents a significant advance mainly in terms of oil quality and alternate bearing and it is suitability for cultivation in intensive and irrigated conditions in Tunisia. The adoption of 'Zeitoun Ennwader' will be of great benefit for the olive oil sector in Tunisia.

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