Journal of Scientific Agriculture 2021, 5: 32-35
doi: 10.25081/jsa.2021.v5.5481
http://updatepublishing.com/journal/index.php/jsa

Research Article

ISSN: 2184-0261

'Chemlali Mhassen': New olive cultivar derived from crossbreeding program in Tunisia with high oil quality and productivity

I. Guellaoui[1], F. Ben Amar[2]*, M A. Triki[2], M. Ayadi[2], M. Boubaker[1]

[1]Department of Agronomy, High Agronomic Institute of Chott Mariem, Sousse 4042, Tunisia, [2]Laboratory of Improvement and Protection of Olive Genetic Resources, Olive Tree Institute, Aeroport Road, PB 1087, 3000 Sfax, Tunisia

ABSTRACT

The new olive cultivar 'Chemlali Mhassen' was derived from the autopollination of the Tunisian oil cultivar 'Chemlali Sfax'. The main morphological differences between the two cultivars were observed on the endocarp (symmetry, position of maximum diameter, apex, base and surface). On the agronomic plan, this cultivar is distinguishable from the original cultivar due to its medium earliness of bearing (4 years), medium alternate bearing (0.44), early ripening, moderate sensitivity to verticillium and its high olive production per tree (7.7 kg). Concerning oil quality, 'Chemlali Mhassen' had higher performances than the original cultivar for oleic acid content (70 to 77 %) and lower contents for palmitic acid (9.2 to 11.5 %) and linoleic acid (9.3 to 14.7 %). Similar performances were recorded between the new and the original cultivars for rhizogenesis behavior and pollen compatibility.

Received: April 19, 2019
Revised: May 12, 2021
Accepted: June 10, 2021
Published: July 02, 2021

***Corresponding author:**
F. Ben Amar
E-mail: fathibenamar@yahoo.fr

KEYWORDS: Agronomy, Breeding, Chemlali sfax, Morphology, Oil quality.

INTRODUCTION

Among the *Olea* genus, olive (*Olea europaea* L.) is the only species living in the Mediterranean basin. Around 2,600 cultivars are attributed to olive (Rugini and Lavee, 1992) and more than 3,000 synonyms seem to exist (Bartolini *et al.*, 1998). In recent years, much work has been done to collect, characterize, evaluate and identify olive germplasm. For instance, 139 varieties from 23 countries were catalogued (Barranco *et al.*, 2000). Attempts to develop new olive cultivars have been carried out in some olive-producing countries (Italy, Turkey, Israel, Spain, Tunisia, Egypt, Iran, China, Ukraine and Turkmenistan) (Bellini *et al.*, 2008). Most of these programs are focused on cross breeding among the most outstanding cultivars in their respective countries.

The main objectives for olive oil are high yield, resistance to parasites and stresses, adaptability to specific cultural practices and environmental conditions, self-fertility, abundant flower differentiation and fruit set, reduced fruit drop, low alternate bearing and short unproductive period (Bellini *et al.*, 2008). The definition of quality for olive oil is more complex, being associated to richness in aromas, long storability, high content of antioxidant compounds (tocopherols and polyphenols) and good ratio between saturated and unsaturated acids (Lavee & Avidan, 2000). Attempts to develop new olive cultivars have been carried out in some Mediterranean olive-producing countries (León *et al.*, 2004).

In Tunisia, a breeding program of 'Chemlali Sfax' was started in 1993 to obtain new olive cultivars with mainly better oil quality. Indeed, 'Chemlali Sfax' has low oleic acid (55%) and high palmitic acid (19.6%) (Zarrouk *et al.*, 2009). Also, this local cultivar was classified as sensitive to verticillium (Triki *et al.*, 2011). The cultivar 'Chemlali Sfax' has been crossed with both autochthonous and foreign pollinators, yielding 1,200 seedlings. Many works were undertaken on 'Chemlali Sfax' seedlings regarding to morphological description (Laaribi *et al.*, 2014; Guellaoui *et al.*, 2014) and acidic composition of the oil (Manaï *et al.*, 2007; Rjiba *et al.*, 2009; Dabbou *et al.*, 2010; Guellaoui *et al.*, 2014). Morphological characteristics of the 'Chemlali Sfax' olive tree seedlings showed a high genetic variability. Also, these studies revealed high variability in the main fatty acid concentrations and several seedlings had a chemical composition more interesting than that of

the original cultivar. According to the International Olive Oil Council (Guellaoui *et al.*, 2019), the low content of oleic acid and the high alternate bearing for 'Chemlali Sfax' olive cultivar were considered as major deficiencies that need to be resolved.

Recently, five new cultivars obtained in the Tunisian crossbreeding program were registered and published in the Official Journal of Republic of Tunisia (JORT, 2017). The variability of quantitative morphological characters and their correlation studies for these new cultivars were evaluated (Guellaoui *et al.*, 2019). The objective of this study was to describe the main morphological, agronomic and oil quality traits for one of the new cultivars 'Chemlali Mhassen'.

MATERIALS AND METHODS

'Chemlali Mhassen' is a new olive (*Olea europaea* L.) cultivar obtained by controlled crossing program in Tunisia. It was obtained from autopollination of 'Chemlali Sfax' carried out in 1993/1994 season. The cross was performed by pollination of 'Chemlali Sfax' flowers on bagged branches with fresh pollen grain of the same flowers. Resulted embryos were grown in vitro conditions and forced growth of seedlings was carried out in a greenhouse to shorten the juvenile period. Seedlings were planted in two open fields during 1997-1998 with a density of 1250 trees ha^{-1} (4m x 2m) located in the Olive Institute headquarters at Sfax (lat 34° 44′ N, long 10° 46′) and the Research Station 'Taous' (lat 34° 56′ N, long 10° 36′). Seedling evaluation was carried out for three consecutive harvest seasons (2000-2002). The original seedling of 'Chemlali Mhassen' was selected mainly on the basis of their fatty acid composition. After vegetative propagation by semi-hardwood stem cuttings, propagated trees of 'Chemlali Mhassen' together with other selected seedlings were planted in comparative trial since 2005 at 6 × 4 m spacing at the experimental farm 'Taous'. Morphological description was carried out according to the International Olive Council (1997) norms by using a total of 19 characters related to the fruit and the endocarp.

The agronomic characteristics of 'Chemlali Mhassen' have been evaluated on the observations of 3 trees over a period of three years (2013-2015), while olive yield per tree and alternate bearing index were recorded over the period 2007-2015. The attributes for each agronomic character (earliness of bearing, rhizogenesis rate, ripening, alternate bearing and compatibility) of the new cultivar were determined according to the IOOC norms (Barranco *et al.*, 2000). To study the tolerance to *V. dahlia*, one year old plants were inoculated by the fungi in the greenhouse and the tolerance was recorded by two methods: the first one is based on Sesli *et al.* 2010 study by the estimation of the Area Under the Disease Progress Curve and the second method is based on the percentage of dead plants. Variance analysis with one factor was carried out for each scoring method and the separation of means was performed by the Duncan test at 5 % level. The analytical methods for the determination of fatty acid composition were described in regulation EEC 2568/91 (EEC, 1991). The fatty acid composition of the oil was determined by gas chromatography. We present in this paper the major fatty acids, oleic acid, palmitic acid and linoleic acid.

RESULTS AND DISCUSSION

The morphological attributes of the fruit and endocarp of the new cultivar were presented in Table 1. Fruits of the new cultivar were asymmetrical, truncate base's shape, with low weight, central maximum diameter, many lenticels, rounded apex's shape and without nipple. At maturity stage, the location of start of color change was towards apex and the color at the end of maturity was black. 'Chemlali Mhassen' had asymmetric endocarp with low weight, elliptic shape, rounded base shape, pointed apex shape, maximum diameter toward apex, rugose surface and regular distribution of grooves. The apex termination was with mucro.

According to Table 1, 'Chemlali Mhassen' showed fruit and endocarp traits which differed from the typical of 'Chemlali Sfax' (7 traits in total). The major differences between the two cultivars were found at the level of the endocarp (5 traits). This information may indicate that the endocarp parameters were more descriptive than the fruit ones which is in agreement with the conclusions of several authors (IOC, 1997; Barranco *et al.*, 2000). On the other hand and despite the low fruit weight, 'Chemlali Mhassen' is suitable mainly to oil purpose, according to the IOC norms (IOC, 1997; Barranco *et al.*, 2000).

Agronomic characteristics of 'Chemlali Mhassen' were presented in table 2. Thus, this cultivar showed a medium unproductive period with a first significant bearing four years

Table 1: Description of the main morphological characteristics of olive cultivar Chemlali Mhassen' compared with the control 'Chemlali Sfax'

Organ	Trait	Chemlali Mhassen	Chemlali Sfax (Barranco et al., 2000)
Fruit	Weight	Low	Low
	Shape	Ovoid	Ovoid
	Symmetry	Asymmetric	Symmetric
	PDM	Central	Central
	Apex	Rounded	Rounded
	Base	Truncate	Truncate
	Nipple	Absent	Absent
	Colour change	Toward Apex	-
	Lenticels	Many	Few
	Maturity color	Black	Black
Endocarp	Weight	Low	Low
	Shape	Elliptic	Elliptic
	Symmetry	Asymmetric	Symmetric
	PDM	Toward apex	Central
	Apex	Pointed	Rounded
	Base	Rounded	Pointed
	Surface	Rugose	Smooth
	Distribution of groves	Regular	-
	Apex termination	With mucro	With mucro

Table 2: Description of the main agronomic characteristics of the new olive cultivar compared with the control 'Chemlali Sfax'

Trait	Chemlali Mhassen	Chemlali Sfax (Barranco et al., 2000)
Earliness of bearing (years)	Medium (4)	Late
Olive yield per tree (kg)	High (7.7)	High
Rhizogenesis rate (%)	Low (37.2)	Low
Alternate bearing	Medium (0.44)	High
Ripening (November)	Early (3.2)	Late
Compatibility	Self-compatible	Self-compatible
Verticillium	Moderate	Sensitive

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

Trait	Chemlali Mhassen	Chemlali Sfax	IOC norm
Oleic acid	73 ± 3.6	55	55 – 83
Palmitic acid	10.6 ± 1.2	19.6	7.5 – 20
Linoleic acid	12.3 ± 2.8	18	– 21

after planting. During the period 2007-2015, the average yield per tree was classified as high with medium alternate bearing index. 'Chemlali Mhassen' is considered with early ripening occurring in November (end of autumn) and was found to be self-compatible by comparing fruit set following self-pollination to that following crosspollination. Thus, cross-pollination is not needed for this cultivar.

With respect to verticillium fungi, the preliminary results indicate that 'Chemlali Mhassen' was moderately susceptible to *Verticillium dahliae* Kleb with a significant difference when compared to 'Chemlali Sfax' (Table 2). The selection of the new cultivar will reduce for sure the incidence of the fungi on olive tree mortality and harvest losses reported by several authors (Triki *et al.*, 2011; López-Escudero and Mercado-Blanco, 2011). The development of breeding programs aimed to produce resistant cultivars is likely the most economically-effective and environmentally-friendly control measure to be implemented in an integrated disease management strategy (López-Escudero and Mercado-Blanco, 2011).

'Chemlali Mhassen' cultivar is distinguishable from the original cultivar 'Chemlali Sfax' due to its considerably better fatty acid composition (Table 3). Thus, the concentration of oleic acid, the main monounsaturated fatty acid, ranged from 70 to 77 % with an average of 73 %, while the level of palmitic acid, the major saturated fatty acid in olive oil, varied between 9.2 and 11.5 % with an average of 10.6 %. The content of linoleic acid, another important monounsaturated acid, is within the range of 9.3 – 14.7 %.

As the Chemlali Sfax cultivar leads to the production of an olive oil fatty acid composition characterized by high levels of palmitic and linoleic acids and low levels of oleic acid as shown in Table 3 (Zarrouk *et al.*, 2009), the new cultivar showed an important genetic gain in terms of better oil acid composition. Thus, healthy dietary oil must be with high oleic acid content, low palmitic acid content and medium linoleic acid content, according to previous works (Zarrouk *et al.*, 2009).

With respect to IOC (1997) norms, 'Chemlali Mhassen' is considered with high oil quality and its fatty acid composition is within the norms.

CONCLUSION

'Chemlali Mhassen' was registered by the Tunisian Ministry of Agriculture, Hydraulic resources and Fisheries (MARHP) under number 191 in January 2017. The propagation of this new cultivar will be undertaken in greenhouse conditions by semi-hardwood cuttings method. The crossbreeding program in Tunisia has allowed selection of superior olive genotypes which could increase the economic input of the oil sector.

REFERENCES

Barranco, D., Cimato, A., Fiorino, P., Rallo, L., Touzani, A., Castaneda, C., Serafini, F., & Trijillo, I. (2000). *World catalogue of olive varieties*. International Olive Oil Council, Madrid, Spain.

Bartolini, G., Prevost, G., Messeri, C., Carignani, G., & Menini, U. G. (1998). *Olive Germplasm*. Cultivars and World-Wide collections, FAO, Rome.

Bellini, E., Giordani, E., & Rosati, A. (2008). Genetic improvement of olive from clonal selection to cross-breeding programs. *Advances in Horticultural Science, 22*(2), 73-86.

Dabbou, S., Rjiba, I., Echbili, A., Gazzah, N., Mechri, B., & Hammami M. (2010). Effect of controlled crossing on the triglyceride and fatty acid composition of virgin olive oils. *Chemistry & Biodiversity, 7*(7), 1801-1813. https://doi.org/10.1002/cbdv.200900385

Guellaoui, I., Ben Amar, F., Ayadi, M. & Boubaker, M. (2019). Chemometric classification of new *Olea europaea* L. cultivars developed through a crossbreeding program in Tunisia. *Journal of Scientific Agriculture, 3*, 22-27. https://doi.org/10.25081/jsa.2019.v3.5453

Guellaoui, I., Ben Amar, F., Boubaker, M., Ayadi, M., Ayadi, A., Yengui, A., & Ben Belgacem N. (2014). Performance of olive hybrids (*Olea europaea* L.) derived from hybridization program in Tunisia. 5th International Conference on "Olive Culture, Biotechnology and Quality of Olive Tree Products" OLIVEBIOTEQ proceedings.

IOC. (1997). Méthodologie pour la caractérisation des variétés d'oliviers. Projet sur la conservation, caractérisation, collecte et utilisation des ressources génétiques de l'olivier. Communauté Européenne. Conseil Oléicole International.

JORT. (2017). Official Journal of Republic of Tunisia, n° 33. Retrieved from http://www.iort.gov.tn/WD120AWP/WD120Awp.exe/CTX_18640-266-HZawGTeYJ/RechercheJORT/SYNC_-1499557964

Laaribi, I., Meaghani-Aiachi, M., & Mars, M. (2014). Phenotypic diversity of some olive tree progenies issued from a Tunisian breeding program. *European Scientific Journal*, *10*(6), 292-313.

Lavee, S., & Avidan, B. (2000). Olive germplasm development past and present approaches to genetic improvement. *Acta Horticulturae, 586*, 47-56. https://doi.org/10.17660/ActaHortic.2002.586.1

León, L., Uceda, M., Jiménez, A., Martín, L. M., & Rallo, L. (2004). Variability of fatty acid composition in olive (*Olea europaea* L.) progenies. *Spanish Journal of Agricultural Research*, *2*(3), 353-359. http://dx.doi.org/10.5424/sjar/2004023-89

López-Escudero, F. J., & Mercado-Blanco J. (2011). Verticillium wilt of olive: a case study to implement an integrated strategy to control a soil-borne pathogen. *Plant Soil, 344*, 1–50. https://doi.org/10.1007/s11104-010-0629-2

Manaï, H., Mahjoub-Haddada, F., Trigui, A., Daoud, D., & Zarrouk, M. (2007). Compositional quality of virgin olive oil from two new Tunisian cultivars obtained through controlled crossings. *Journal of the Science of Food and Agriculture, 87*(4), 600-606. https://doi.org/10.1002/jsfa.2732

Rjiba, I., Debbou, S., Gazzah, N., Cherif, I., & Hammami M. (2009). Profiles of volatile compounds from nine new hybrids obtained by controlled crossings on olive 'Chemlali' cultivar and mediterranean varieties. *Natural Product Research, 23*(7), 622-632. https://doi.org/10.1080/14786410802155939

Rugini, E., & Lavee, S. (1992). Olive. In F. A. Hammerschlag and R. E. Ltz (Eds.), *Biotechnology of perennial fruit crop* (pp. 371-382) CAB International, Wallingford, UK.

Sesli, M., Onan, E., Oden, S., Yener, H., & Yegenoglu, E. D. (2010). Resistance of olive cultivars to Verticillium dahliae. *Scientific Research and Essays, 5*(12), 1561-1565. https://doi.org/10.5897/SRE.9000806

Triki, M. A., Krid, S., Hsairi, H., Hammemi, I., Ioos, R., Gdoura, R., & Rhouma, A. (2011). Occurrence of *Verticillium dahliae* defoliating pathotypes on olive trees in Tunisia. *Phytopathologia Mediterranea, 50*, 267−272.

Zarrouk, W., Baccouri, B., Taamalli, W., Trigui, A., Daoud, D., & Zarrouk, M. (2009). Oil fatty acid composition of eighteen Mediterranean olive varieties cultivated under the arid conditions of Boughrara (Southern Tunisia). *Grasas y Aceites, 60*(5), 498-506. http://dx.doi.org/10.3989/gya.021109