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YELLOW WILD OLIVES (*Olea europaea* L. subsp. *oleaster*) FROM WESTERN TURKEY

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Abstract

The wild olive (*O. europaea* L. subsp. *oleaster*) is widely distributed along the coastal zones of Anatolia (Asia Minor). The Aegean Region (Western Anatolia) in particular has a rich olive population, including genuine wild individuals as well as feral forms. *Oleaster* olives *in situ*, which have diverse morphological and pomological characteristics, differ from cultivated olives. The ripe olive fruit has a purple-black color because of the accumulation of anthocyanin. As in cultivated olives, the yellow color in ripe fruits of the *oleaster* olive is unusual. This yellow color in ripe fruits of *oleaster* olives has not been reported so far. Thus it is potentially significant for further breeding strategies. This paper assesses the morphological characteristics of two *oleaster* ecotypes (YO1 and YO2) with yellow fruits that were coincidentally located in the İzmir Province. Significant differences are found between the two ecotypes both in terms of their quantitative characteristics as well as the oil content of their fruit. Fruit weight (1.2 g), length (15.5 mm), width (11.2 mm) and percentage of oil in dry weight (15.7%) are significantly higher in YO1. Apart from the differences between the quantitative stone characteristics, the stone morphology and surface texture are also considerably different. Besides potential agronomic considerations, they both have high potential for use as ornamental trees.

Key words: wild olive, *oleaster*, ecotype, yellow fruit, oil, stone

INTRODUCTION

The olive (*Olea europaea* L.) is one of the oldest among cultivated fruit trees, the products of which have been used since ancient times. The olive originated in the Mediterranean region, where 97% of the world's olive cultivation is still conducted [Therios 2009].

The cultivated olive (*O. europaea* L. subsp. *europaea*) [Green 2002] shows close affinity to a group of wild and 'weedy' olives that are traditionally called *oleaster* olives, and are distributed over large areas in the Mediterranean basin. In the Mediterranean region, *oleasters* thrive as constituents of maquis and garrigue formations [Zohary and Hopf 2004]. *Oleaster* olives differ from cultivated olives by their smaller elliptical fruits, small roundish leaves and often, also by their spiny juvenile branches. Moreover, their fruit has a less fleshy mesocarp and contains less oil than cultivated olives [Zohary and Spiegel-Roy 1975, Zohary 1994, Zohary and Hopf 2004]. The Mediterranean wild olives are associated with olive cultivation and hardy stock material for grafting cultivar scions [Zohary and Hopf 2004]. In some regions of the Mediterranean basin (e.g. Western Anatolia – Turkey, Sardinia – Italy), top working of *oleaster*

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olives with specific cultivars *in situ* is an old tradition despite that it is complicated and a costly process [Fabbri et al. 2004, Zohary and Hopf 2004]. However, wild olives may present a useful source of genetic variability for some important agronomic traits such as disease and pest resistance, low vigor, and adaptation to adverse conditions in olive breeding [Belaj et al. 2011]. The molecular and morpho-agronomical characteristics of wild olive trees from different parts of the Mediterranean basin confirm the high diversity within wild populations [Mulas 1999, Mulas et al. 2002, Breton et al. 2006, Belaj et al. 2011].

The olive tree is one of the oldest cultivated plants of Anatolia (Asia Minor) [Can and İsfendiyaroğlu 2006]. The beginnings of olive processing in Anatolia probably date back to the third millennium BC [Yörük and Taşkın 2014]. Today, 89 registered domestic cultivars in the National Germplasm Collection are reported [ZAE 2015]. The *Oleaster* olive has a wide distribution area, particularly in the coastal zones of the Mediterranean, Aegean and Black Seas, from 50 to 750 m a.s.l. in Anatolia [Yaltırık 1978]. The analysis of nuclear and cytoplasmic DNA polymorphisms reveals that *oleasters* from Turkey and the Near East differ from the other Mediterranean populations [Besnard and Berville 2000, Besnard et al. 2002, Lumaret et al. 2004, Breton et al. 2006]. Molecular analysis also showed that wild olives from the Aegean Region (Western Anatolia) are different from those in other areas [Breton et al. 2006]. This might indicate that some of the individuals from the Aegean population can be considered genuine wild olives that spread in the areas where feral forms are still present [Yörük and Taşkın 2004, Breton et al. 2006].

Anthocyanins give the ripe olive fruit its characteristic purple-black color [Kailis and Harris 2007]. In exceptional cases, such as the cultivars 'Leucocarpa Margareta' [Lavee 1986], 'Marfil' (Blanca) [Tous and Romero 1998] and 'Bajda' [Mazzitelli 2014], the anthocyanin synthesis is blocked, and the fully-ripe fruit is either white or white-ivory in color. Some of them have good quality oil and consequently have been utilized for medicinal purposes, as well as having high potential for use as ornamental trees, because of the unique colored fruit [Tous and Romero 1998]. Up to now, unusual white or yellow color in ripe fruit has not reported in *oleaster* olives.

In this paper, the morphological traits of two wild olive ecotypes having yellow fruits found in Western Anatolia are presented.

MATERIAL AND METHOD

According to information received from a local shepherd in 2013, two *oleaster* ecotypes (YO1 and YO2) with unusual yellow mature fruit were found *in situ*, in the north of the İzmir Province. Both plants were on low plain at about 100 m a.s.l. together with other maquis elements. They were easily distinguished by their yellow fruits as they were neighboring the usual black-fruited wild olives. The morphological examination of both individuals was performed during bloom (April 2013) and fruit ripening (February 2014) stages. The olive descriptors file developed by IOC was used to discern some qualitative and quantitative characteristics. Forty mature leaves from the middle section of 10 of the most representative one-year-old shoots on the south-facing side of the tree were taken for sampling. Inflorescence and fruit samples were taken from the fruiting shoots (the previous year's growth) as described in leaf sampling [Barranco et al. 2000]. Fruit oil content was calculated from only the fruit pulp, because the stones were used for seedling rootstock propagation. Samples weighing 10 g of pulp oils were extracted with n-hexane in a soxhlet apparatus for 8 h. Data was submitted to ANOVA using SPSS (version 16.0, Inc., USA) software. Mean separation was performed by Duncan's Multiple Range Test. Results were interpreted according to the value of probability ($P < 0.05$).

RESULTS AND DISCUSSION

The Passport Data section of the file was not used, since the introduced *oleaster* trees are represented as unique individuals in the wild. Some of the morphological descriptors were not used either, because they pertain to the cultivars that are currently grown under normal cultural practices. In fact, their vigor, growth

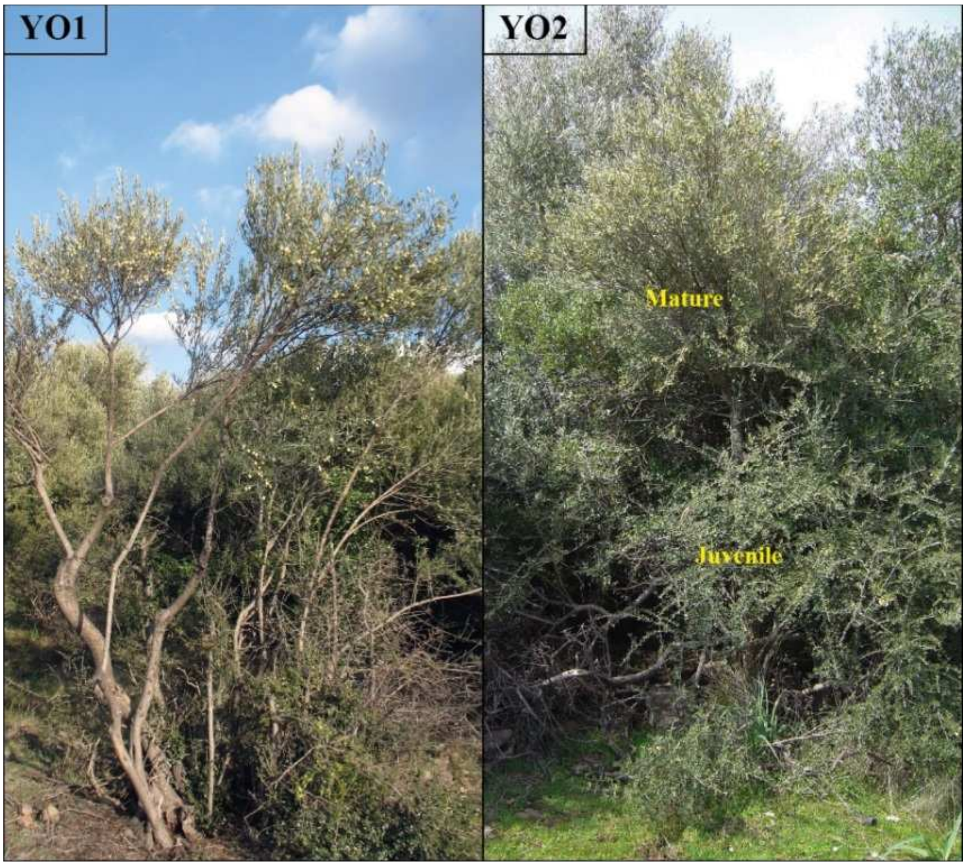

Fig. 1. Juvenile (lower) and mature (upper) shoots in YO2

habit and canopy densities were highly diverse compared with those of the cultivated trees.

Both individuals (YO1 and YO2) were multi-stemmed bushes, their stems had signs of damage from ruminant grazing and firewood cuts. This was particularly clear in YO2, with the regrowth of new shoots that showed strong juvenility (fig. 1).

The results of the morphological characterization of the two ecotypes during bloom and fruit ripening are given below.

The mean leaf length and width figures of selected individuals were not significantly different from each other. However, leaf dimensions were higher in YO1. They also showed the same leaf morphology (tab. 1). Non-significant differences were found among inflorescences with the exception of mean fruit number, which was significantly higher in YO1 (tab. 2). Figures of quantitative characteristics (leaf, inflorescence) were not significantly different, taking into account the same traits, from the large *oleaster* population formerly evaluated on the island of Sardinia [Mulas 1999, Mulas et al. 2002]. However, flower and fruit numbers per inflorescence were found to be quite high (up to 26 flowers and 3 fruits) in wild olive populations from two different locations in Tunisia [Hannachi and Marzouk 2012], which is quite distant from Western Anatolia. Nevertheless, all the figures belonging to the quantitative characteristics of YO1 and YO2 were significantly lower than the lowest figures predicted for cultivated olives [Barranco et al. 2000].

Table 1. Quantitative and qualitative leaf characteristics of ecotypes

Ecotype	Leaf length (cm)	Leaf width (cm)	Leaf shape	Longitudinal curvature of the blade
YO1	4.43	0.87	elliptic lanceolate	hyponastic
YO2	3.61	0.73	elliptic lanceolate	hyponastic
P	0.061	0.101		
SEM	0.645	0.124		

P – probability, *SEM* – standard error mean

Significant differences were found between quantitative fruit characteristics and oil content on a dry weight basis ($P < 0.01$). The mean figures of YO1 were markedly higher than YO2 (tab. 3). Among 20 *oleaster* selections from the Sardinia, fruit weights ranged between 0.10–0.65 g [Mulas et al. 2002], but the highest fruit weight was 1.26 g among 48 wild olives examined in Andalusia [Belaj et al. 2011]. Thus, the fruit weight of YO1 in particular seems to be quite high. On the other hand, in the white-fruited cultivated 'Marfil' olive, the mean fruit weight, pulp : stone ratio and oil content (in dry matter basis) were measured as 2.18 g, 4.53 and 40.53% respectively [Tous and Romero 1998], which are much higher than those of YO1. As for qualitative fruit characteristics, all of them were found to be the same in both individuals (tab. 4, fig. 2).

Table 2. Quantitative inflorescence characteristics of ecotypes

Ecotype	Inflorescence length (mm)	Number of flowers/ inflorescence	Number of fruits/ inflorescence
YO1	23.50	9.25	1.23 a
YO2	15.93	5.38	1.00 b
P	0.085	0.328	0.001
SEM	0.625	0.272	0.036

P – probability, *SEM* – standard error mean

Table 3. Quantitative fruit characteristics of ecotypes

Ecotype	Fruit weight (g)	Fruit length (mm)	Fruit width (mm)	Pulp : stone ratio	Oil in fresh weight (%)	Oil in dry weight (%)
YO1	1.26 a	15.50 a	11.28 a	1.88 b	6.95	15.76 a
YO2	0.53 b	10.69 b	8.70 b	1.99 a	6.25	9.71 b
P	0.002	0.001	0.012	0.041	0.311	0.008
SEM	0.044	0.283	0.154	0.2871	0.310	1.457

P – probability, *SEM* – standard error mean

Table 4. Qualitative fruit characteristics of ecotypes

Ecotype	Fruit shape	Fruit symmetry	Position of maximum fruit transverse diameter	Fruit apex	Fruit base	Fruit tip nipple	Presence of lenticels	Size of lenticels
YO1	ovoid	slightly asymmetric	central	rounded	rounded	absent	few	small
YO2	ovoid	slightly asymmetric	central	rounded	rounded	absent	few	small

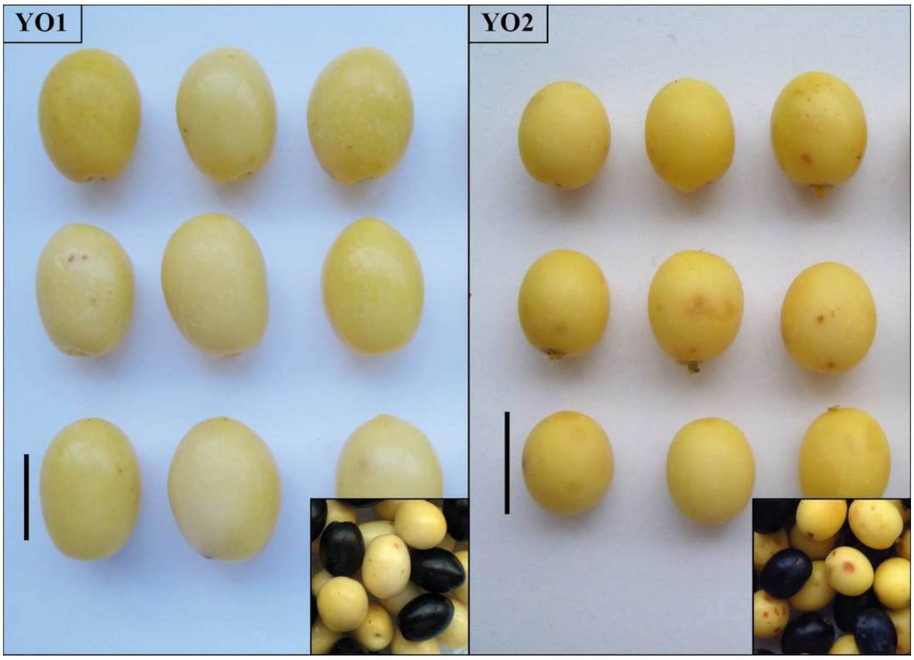

Fig. 2. Fruit morphology of ecotypes. Bar = 1 cm

In the olive (*Olea europaea* L.), stone features including surface texture and shape are highly reliable to describe cultivars [Barranco et al. 2000]. Moreover, computer image analyses of stone characteristics using mathematical tools such as fractal geometry are also used for this purpose [Bari et al. 2003]. There were significant differences among stone quantitative characteristics of the two ecotypes. Parameters belonging to YO1 were higher than YO2, while the mean groove number of YO2 was significantly ($P < 0.05$) higher than YO1 (tab. 5). As for the qualitative characteristics, four of them differed from each other (tab. 6). Apart from stone apex formation, a scabrous stone surface in YO2 was quite obvious (fig. 3).

Table 5. Quantitative stone characteristics of ecotypes

Ecotype	Stone weight (g)	Stone lenght (mm)	Stone width (mm)	Number of grooves
YO1	0.35 a	12.51 a	6.77 a	0.80 b
YO2	0.11 b	8.08 b	4.73 b	2.93 a
P	0.004	0.000	0.000	0.013
SEM	0.015	0.261	0.119	0.163

P – probability, *SEM* – standard error mean

Table 6. Qualitative stone characteristics of ecotypes

Ecotype	Stone shape	Stone symmetry	Position of maximum transverse diameter	Stone apex	Stone base	Stone surface	Termination of the apex
YO1	ovoid	slightly asymmetric	towards apex	pointed	rounded	smooth	with mucro
YO2	ovoid	slightly asymmetric	central	rounded	rounded	scabrous	without mucro

Fig. 3. Stone morphology of ecotypes. Bar = 1 cm

In the formerly assessed Sardinian *oleaster* population, stone weights of 20 selections ranged between 0.05–0.25 g [Mulas et al. 2002]. Furthermore, the highest stone weight, length and width were reported as 0.36 g, 1.49 cm and 0.65 cm respectively for the Andalusian *oleaster* selections [Belaj et al. 2011], which were similar to the figures of YO1.

CONCLUSION

In this work, most of the morphological characteristics of two yellow-fruited *oleaster* olives were evaluated, but agronomic and commercial considerations were not. Due to insufficient fruit numbers and low oil content, the oil composition and characteristics could not be measured. However, the unusual fruit coloration or blockage of anthocyanin biosynthesis in maturity might influence the biochemical composition of oils, which might be important in terms of medical and cosmetic uses. The examined ecotypes could also be considered as ornamental trees with contrasting colors of fruit compared with black-fruited olives. Moreover, they might also be useful for container growing because of their possible low vigor.

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