‘Ntoulia 1’ and ‘Ntoulia 2’ Cornelian Cherries (*Cornus mas* L.)

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Cornelian cherry is a minor fruit species that deserves some attention mainly as a result of its economic potential and environmental importance of its cultivation. ‘Ntoulia 1’ and ‘Ntoulia 2’ are two new Greek cornelian cherry cultivars, whereas ‘Electra’ and ‘Naoussa’ are new selected clones. The experiment was conducted in northern Greece for 2 consecutive years. Productivity and fruit weight of ‘Ntoulia 1’ were higher than ‘Ntoulia 2’. ‘Electra’ showed the highest fruit weight followed by ‘Ntoulia 1’, whereas ‘Naoussa’ and ‘Ntoulia 2’ showed lower fruit weight values. ‘Ntoulia 2’ showed the highest value of total soluble solids followed by ‘Ntoulia 1’ and ‘Electra’. Total titratable acidity did not differ between genotypes. In descending antioxidant capacity, the order was: ‘Ntoulia 2’ > ‘Electra’ > ‘Naoussa’ > ‘Ntoulia 1’. Total phenolics in fruits of the cultivar Ntoulia 2 were higher than ‘Ntoulia 1’ and ‘Electra’. Nitrogen, potassium, manganese, and zinc concentrations of ‘Electra’ were higher than the other genotypes, whereas boron concentration was lower. However, concentrations of phosphorus, calcium, and magnesium were not different between genotypes.

Origin

Cornelian cherry belongs to the order Cornales, family Cornaceae, genus *Cornus*, and species *Cornus mas* L. Cornelian cherry is a deciduous shrub to small tree cultivated as a landscape ornamental and/or as the source of fruits to produce syrups and preserves (Tenenbaum, 1994). Homer (8th century B.C.) in his epic poem Iliad refers to the cornelian cherry and reports that the Trojan horse was built from cornelian cherry wood,

which was very hard, cut from the holy forest of the God Apollo (Willcock, 1978). The cornelian cherry plant was described in terms of botany very early by the Greek philosopher Theophrastus (between the 3rd and 4th century B.C.) (Chatzopoulos, 1998). Cornelian cherries have a long history of use in a variety of medicinal tonics, including those used to treat excessive urination, incontinence, excessive sweating, excessive menstrual bleeding, and decreased erectile function (McGuffin et al., 1997). Several cultivars/genotypes were selected worldwide for the color or size of fruits or leaves (Dirr, 1998; Stylianidis et al., 2011). In Greece until now, there was not systematic cultivation of cornelian cherry. However, selection from a high number of seedlings originated from open-pollinated autochthonous cornelian cherry plants in northern Greece by the grower Konstantinos Ntoulis resulted in the cultivars Ntoulia 1 and Ntoulia 2. After selection, the plants were then propagated by semi-hardwood cuttings. ‘Electra’ was selected by the agriculturist Konstantinos Georgiadis, whereas ‘Naoussa’ is natively grown in the area of Naoussa. The evaluation and the description were done over 2 consecutive years (2009 to 2010) in a private orchard that is located in Kipseli Imathias (northern Greece, long. 22°12′0″ E;

lat. 40°28′59″ N; elevation 98 m). Data from the nearest meteorological station showed that the mean maximum temperature of the experimental area is 40 °C in July and 8 °C in January, whereas the mean minimum temperature in January is –9 °C. The objective of this research was to give information about the new Greek cornelian cherry cultivars Ntoulia 1 and Ntoulia 2 and to compare them in terms of fruit quality with the selected clones ‘Electra’ and ‘Naoussa’.

Description

Plant vigor of the cultivars Ntoulia 1 and Ntoulia 2 is weak and growth habit is erect. Attitude of shoots of the cultivar Ntoulia 1 is erect, whereas that of the cultivar Ntoulia 2 is semierect. The density of branches of the cultivar Ntoulia 1 is medium, whereas that of the cultivar Ntoulia 2 is sparse. The color of 1-year-old shoots of the cultivar Ntoulia 1 is purple–brown, whereas that of the cultivar Ntoulia 2 is brown. The length of internodes of both cultivars is medium. Lateral branches are borne from the axils of old wood (more than 2 years) before the leaf buds open. The trees do not have pest and disease infections and are presently cultivated under the organic farming model.

The leaves of ‘Ntoulia 1’ and ‘Ntoulia 2’ have the following dimensions: length of 85 and 65 mm, width of 58 and 42 mm, and leaf area of 3950 and 2184 mm², respectively. Mean pedicel length of ‘Ntoulia 1’ and ‘Ntoulia 2’ is 7 and 5 mm, respectively. Leaf measurements were made with a portable leaf area meter, AM 300 (ADC Bioscientific Ltd., Hertfordshire, U.K.). The leaf arrangement of both cultivars is opposite and the leaf shape is ovate. The shape of the blade apex is strongly pointed, the shape of the base is rounded, and the glossiness is medium for both cultivars. In the petiole of both cultivars, anthocyanin is deposited. In the leaf blade, the pubescence of the lower side is along the veins. Leaf fall occurs mid-November.

Anthesis occurs at the end of February, before shoot sprouting. ‘Ntoulia 1’ and ‘Ntoulia 2’ flowers are self-fertile. Flowers are numerous (15 for ‘Ntoulia 1’, 18 for ‘Ntoulia 2’, 17 for ‘Electra’, and 20 for ‘Naoussa’) and are borne in a subsessile umbel. Pedicels are slender, 3 to 4 mm long, and lengthen to 6 mm with matured flowers. The four petals are

Table 1. Mean fruit weight, total soluble solids, total titratable acidity, total antioxidant capacity, and total phenolics in fruits of the cornelian cherry cultivars Ntoulia 1 and Ntoulia 2 and the selected clones ‘Electra’ and ‘Naoussa’.

Cultivar	Fruit wt (g)	Total soluble solids (% Brix)	Total titratable acidity (%)	Total antioxidant capacity (μmol AAE/g FW)	Total phenolics (mg GAE/g FW)
Ntoulia 1	5.03 b ²	20.7 b	1.25 a	65.5 d	3.0 b
Ntoulia 2	2.18 c	24.0 a	1.24 a	100.8 a	5.6 a
Electra	7.00 a	21.1 b	1.24 a	88.9 b	2.8 b
Naoussa	2.14 c	18.2 c	1.29 a	76.1 c	—

²Means of 50 fruits of 16 trees (four replications × four trees) for 2 years (2009 to 2010). Fruits were pooled from all trees.

³Means followed by the same letter in the same column are not significantly different (Duncan’s multiple range test; *P* < 0.05).

AAE = L-ascorbic acid equivalents; FW = fresh weight; GAE = gallic acid equivalents.

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yellow, spreading, becoming strongly reflexed with age. The four stamens alternate with the petals and bear dorsiflex anthers on 2-mm-long filaments.

The studied trees of the cultivars Ntoulia 1 and Ntoulia 2 were 15 years old, trained as a typical vase shape, and planted at 4 × 4 m within and between rows. First fruiting occurred 3 years after planting of the trees; however, maximum production was reached the ninth year. Both cultivars mature their fruits simultaneously and usually one pick is needed to harvest the whole yield. The trees are not sensitive to any nutrient deficiency according to our observations. The time of harvest is determined by the change of ground color to dark red. The onset of maturity for harvest is mid-August. Premature fruit drop is very low, 1% to 2%. However, when fruits are mature on the tree, this percentage may be higher when winds are blowing. Productivity of 'Ntoulia 1' is higher than 'Ntoulia 2', 31 and 24.8 t·ha⁻¹, respectively. The trees present regular bearing from year to year. 'Electra' showed the highest fruit weight followed by 'Ntoulia 1'. 'Naoussa' and 'Ntoulia 2' showed

lower fruit weight values (Table 1; Fig. 1A–B). A recent research on 10 cornelian cherry genotypes in Serbia revealed that the average fruit weight ranged from 3.42 to 6.64 g (Bijelic et al., 2010). In other research in Turkey, average fruit weight values of cornelian cherry genotypes ranged between 2.09 g and 9.17 g (Yilmaz et al., 2009) and 1.496 to 4.116 g (Demir and Kalyoncu, 2003). The shape of the fruit base is pear-shaped in 'Ntoulia 1' and 'Electra' and elliptic in 'Ntoulia 2' and 'Naoussa'. Fruit color of all studied genotypes is red.

'Ntoulia 2' showed the highest value of total soluble solids followed by 'Ntoulia 1' and 'Electra'. Yilmaz et al. (2009) reported that total soluble solids content of cornelian cherry genotypes were recorded between 12.53% and 21.17%. Total titratable acidity did not differ between genotypes. In descending antioxidant capacity, the order was: 'Ntoulia 2' > 'Electra' > 'Naoussa' > 'Ntoulia 1'. Tural and Koca (2008) reported that the antioxidant capacity values of Turkish cornelian cherries were between 16.21 and 94.43 mmol·g⁻¹. Comparative analysis of the total antioxidant capacity of 62 cultivars from 17 species revealed that the cornelian cherries showed the highest value (Petridis et al., 2010). Total phenolics in fruits of the cultivar Ntoulia 2 were higher than 'Ntoulia 1' and 'Electra'. Other researchers reported that the total phenolic contents of cornelian cherry genotypes were in the range of 26.59 to 74.83 mg gallic acid equivalents (GAE) per gram dry weight basis (Yilmaz et al., 2009). Furthermore, Gulcin et al. (2005) reported that a wide variation was observed in the total phenolic content in fruits of cornelian cherry (25.90 to 26.50 mg GAE/g dry weight basis). Total soluble solids were measured with the Atago PR-1 electronic refractometer (Atago Co. Ltd., Tokyo, Japan), total titratable acidity as described by Koukourikou-Petridou et al. (2007), and total phenolics as described by Singleton et al. (1999). Total phenolics were expressed as equivalents GAE (gallic acid)/g fresh weight. Sample extracts were analyzed for their antioxidant capacity by the ferric-reducing antioxidant power (FRAP) assay (Benzie and Strain, 1996) using a Camspec M106 spectrophotometer (Camspec Analytical Instruments Ltd., Leeds, U.K.) at 593 nm. The FRAP values of the samples were expressed as μmol of L-ascorbic acid equivalents/g fresh weight.

For determining fruit nutrient concentrations, flesh analysis was carried out from samples taken at harvest. Nitrogen was determined by the Kjeldahl procedure; phosphorus colorimetrically by the ammonium phosphovanadomolybdate method; potassium, calcium, magnesium, iron, manganese, and zinc by atomic absorption spectrometry (Model 2380; Perkin Elmer, Wellesley, MA) (Page et al., 1982); and boron by the azomethine-H method (Wolf, 1974). Nitrogen, potassium, manganese, and zinc concentrations of 'Electra' were higher than the rest of the genotypes, whereas boron concentration was lower (Table 2). However, concentrations of phosphorus, calcium, and magnesium were not different between genotypes. Cornelian cherry is a good source of potassium and its concentration is relatively high compared with other fruits (Sotiropoulos et al., unpublished data). Specifically, potassium concentration of cornelian cherries was higher than 'Kristalli' pear and 'Golden Delicious' apple; it was in the same level with that of banana, 'Hayward' kiwifruit, and 'Everts' peach; and it was lower than 'Bebeco' apricot.

In conclusion, 'Ntoulia 1' and 'Ntoulia 2' are promising cornelian cherry cultivars.

Availability

'Ntoulia 1' and 'Ntoulia 2' cornelian cherries were described and patented by the European Community Plant Variety Office in 2010 and are available from the Ntoulia nursery (<http://www.krano.gr>; e-mail: info@krano.gr).

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Fig. 1. (A) Fruits and leaf of the cornelian cherry cultivar Ntoulia 1. (B) Fruits and leaf of the cornelian cherry cultivar Ntoulia 2.

Table 2. Fruit nutrient concentrations of the cornelian cherry cultivars Ntoulia 1 and Ntoulia 2 and the selected clones 'Electra' and 'Naoussa'.

Cultivar	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Iron	Manganese	Zinc	Boron
	(mg·g ⁻¹ DW)					(μg·g ⁻¹ DW)			
Ntoulia 1	0.25 b ²	0.08 a	0.88 c	0.02 a	0.05 a	19 b	2 b	3 b	14 a
Ntoulia 2	0.24 b	0.09 a	1.08 b	0.02 a	0.05 a	42 a	1 b	3 b	12 a
Electra	0.50 a	0.08 a	1.32 a	0.02 a	0.04 a	45 a	4 a	5 a	9 b
Naoussa	0.26 b	0.09 a	0.91 bc	0.03 a	0.04 a	21 b	2 b	3 b	13 a

²Means of 50 fruits of 16 trees (four replications × four trees) for 2 years (2009 to 2010). Fruits were pooled from all trees.

³Means followed by the same letter in the same column are not significantly different (Duncan's multiple range test; *P* < 0.05).

DW = dry weight.

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