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MORPHOLOGICAL DIVERSITY ON FRUIT CHARACTERISTICS AMONG SOME SELECTED MULBERRY GENOTYPES FROM TURKEY

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ABSTRACT

Turkey has important mulberry genetic resources. In contrast to the other mulberry producing countries, in Turkey mulberry tree is used only for fruit production not for sericulture purposes. Some selected morphological fruit characteristics such as seed formation, fruit weight, SSC (Soluble solid content), titratable acidity, juice yield and pH of 34 selected mulberry genotypes found together in an *ex-situ* collection parcel in Malatya Fruit Research Institute in Turkey were investigated. The collection parcel has been established in 1996 year with 3x5 m row spacing. The morphological fruit characteristics are represented of 3 years average data (2006-2008). The results showed that there were big differences among genotypes in terms of most of the fruit characteristics. Fruit weight varied from 0.66 (Istanbul dutu 2) to 3.07 (Gumushaci beyaz); SSC varied from 17.33% (Erzincan karadut 16) to 30.67% (Lokum dut); titratable acidity varied from 0.06% (Angut 9) to 1.62% (Gumushaci karadut 8) and pH varied from 2.19 (Kemaliye karadut 9) to 5.86 (Mersin mor dut), respectively.

Key words: Mulberry, biodiversity, plant science, fruit characteristics.

INTRODUCTION

Mulberries are found from temperate to subtropical regions of the Northern hemisphere to the tropics of the Southern hemisphere and they can grow in a wide range of climatic, topographical and soil conditions. These are widely spread throughout all regions from the tropics to the sub-arctic and from sea level to altitudes as high as 4000 m in the world (Tutin 1996).

Morus is a complex genus, which belongs to Moraceae. According to plant scientists, it's includes 12 (Freeman 1978); 14 (Huo 2002); 30 (Martin et al. 2002) or 68 species (Datta 2002). Among species, *Morus alba* (white mulberry), *Morus nigra* (black mulberry) and *Morus rubra* (red mulberry) are wide spread throughout world. *Morus alba* originated in Southwest China, *Morus rubra* originated in North America and *Morus nigra* originated in Iran (Datta 2002; Ercisli 2004; Machii et al. 2000).

Turkey is accepted an important germplasm center for mulberries and almost all parts of Anatolia has own characteristic mulberry production. Mulberry trees from *M. alba* (white or purple colored mulberry), *M. nigra* (black bulberry), *M. rubra* (red bulberry), and *M. laevigata* (long-fruited mulberry) can be found in Turkey but among them *M. alba* is the dominant species in cultivation (95%) (Ercisli 2004). Indeed, mulberry species have been known and cultivated in Turkey for more than 400 years (Ercisli and Orhan 2007).

In Turkey, mulberry trees are mainly grown for fruit production. A few mulberry trees are used for sericulture purposes in Bursa and Eskisehir provinces. Therefore productivity of trees and fruit characteristics both in quantitative and qualitative aspects is the long-term goal for mulberry breeders in Turkey. As well known, the genetic improvement of any fruit species depends on the availability of genetic variability in germplasm. Selection of suitable genotypes from gene pool requires a thorough knowledge on fruit characters of different genotypes for utilizing them in hybridization studies.

The breeding efforts on mulberries in Turkey made so far were restricted to selection of relevant genotypes from different regions (Cam 2000; Erdogan 2003; Koyuncu 2004). In fact the mulberry improvement programme on sound scientific base have just started in the early 1990's in Turkey, the scientist could able to identify a lot of promising clones in different part of Turkey (Erdogan 2003; Gunes and Cekic 2004; Koyuncu 2004; Lale and Ozcagiran 1996; Ozdemir and Topuz 1998). Different research institutes belongs to Ministry of Agriculture and collaboration with different universities selected promising mulberry genotypes mostly from *Morus alba* (white mulberry), *Morus nigra* (black mulberry) and *Morus rubra* (red mulberry) through conventional selection breeding studies. A few germplasm collections in different parts of Turkey with selected promising genotypes have been established.

However there was no study on the morphological characterization of mulberry germplasm

collections in Turkey so far. Therefore the aim of this study to make morphological characterization of mulberry germplasm found in Malatya-Turkey.

MATERIALS AND METHODS

Collection and preparation of mulberry fruit samples: In 1988 year, the mulberry survey and selection studies were started aimed to find mulberries which had high productivity capacity and better fruit characteristics. Up to 1996 years, 34 promising genotypes has been selected and in 1996 year a collection parcel with these selected genotypes has been established with 3x5 m row distances including 3 trees per genotypes. During 2006, 2007 and 2008 years, several fruit characteristics of these 34 genotypes were investigated. There were no statistical significant differences in the fruit characteristics being analyzed in consequence three years; therefore the data of the different years were pooled. All berries were picked ripe stage which selected according to uniformity of shape and color then transported to laboratory for analysis.

Determination of seed formation, fruit weight, SSC (Soluble solid content), titratable acidity, juice yield and pH of mulberry fruits: 50 fruits from each genotype were used for analyses. Fruit weight was measured by using a digital balance with a sensitivity of 0.001 g. The fruit juice yield and titratable acidity were determined by AOAC (1). Soluble solid contents (SSC) were determined by a refractometer. The pH measurements were made using a digital pH meter. Panelists determined seed formation.

Statistical analysis: The experiment was a completely randomized design with four replications. Data were subjected to analysis of variance (ANOVA) and means were separated by Duncan multiple range test at $P<0.05$ significant level.

RESULTS AND DISCUSSION

Species, seed formation, fruit weight, SSC (Soluble solid content), titratable acidity, juice yield and pH in the mulberry fruits: Among 34 mulberry genotypes, 28 genotypes were belonging to *Morus alba*, 4 genotypes belongs to *Morus nigra* and 2 genotype belong to *Morus rubra* (Table 1). In fact, among mulberry species found in Turkey, *Morus alba* is the dominant species in cultivation (95%) (Ercisli 2004). Turkish growers prefer this species because of its better fruit properties for processing into very special mulberry products such as 'Mulberry pekmez', 'Mulberry kome' and 'Mulberry pestil' (Ercisli and Orhan 2008; Ozgen et al. 2009).

The seed formation, fruit weight, SSC (Soluble solid content), titratable acidity, juice yield and pH of selected 34 mulberry genotypes are given in Table 1. There were statistical differences in terms of seed formation, fruit weight, SSC (Soluble solid content), titratable acidity, juice yield and pH content among mulberry genotypes (Table 1).

Among mulberry genotypes Angut 4, Angut 9, Meloz 10, Topuz beyaz 2, Istanbul dutu 1, Istanbul dutu 2 and Lokum dut was found to be seedless (Table 1). The other genotypes had low, medium and high level of seeds. The seedless mulberry fruits are preferred for dried in Turkey**.** However these fruits can not be used to produce seedling rootstocks

Average fruit weight values of mulberry genotypes ranged between 0.66 g (Istanbul dutu 2, 24-12) and 3.07 g (Gumushaci beyaz) (Table 1). Previously, fruit weight of mulberry genotypes grown in different agro-climatic region of Turkey was reported between 0.90-3.82 g (Aslan 1998; Cam 2000; Lale and Ozcagiran 1996; Ozdemir and Topuz 1998).

The highest SSC content was observed in Lokum dut genotype as 30.67%, while the lowest was in Erzincan karadut 16 (17.33%). The SSC content of genotypes belongs to *Morus alba* were average over 25%. Fan et al. (1988), Gerasopoulos and Stavroulakis (1997) and Gunes and Cekic (2004) reported that SSC content strongly varied among mulberry species. Lale and Ozcagiran (1996) and Ozdemir and Topuz (1998) indicated that SSC content was the highest in *Morus alba* genotypes compared to *Morus nigra* and *Morus rubra*.

According to 3 years average values, the pH of genotypes were the highest in *Morus rubra* genotype 'Mersin mor dut' as 5.86 and the lowest in *Morus nigra* genotype 'Kemaliye karadut 9' as 2.19 (Table 1). According to Gunes and Cekic (2004) pH is strongly varied among *Morus alba, Morus rubra* and *Morus nigra*. Lale and Ozcagiran (1996) and Ozdemir and Topuz (1998) revealed that *Morus* species can be classified according to pH values in order *Morus alba>Morus rubra>Morus nigra*.

The differences in fruit juice yield among different genotypes were statistically significant ($p<0.05$, Table 1). The genotype 'Erzincan karadut 16' had the highest fruit juice yield (72%). The lowest fruit juice yield was observed in genotype 'Gumushaci beyaz' as 39% (Table 1). All black mulberries (*Morus nigra*), except Hikmet 1 had the higher fruit juice yield ratio than *Morus alba* and *Morus rubra* genotypes. *Morus nigra* preferred for processing into mulberry juice in Turkey. Indeed, mulberry fruit juice industry is a new developing industry in Turkey, not surprisingly, using only *Morus nigra* fruits. *Morus nigra* fruits are also has good combination of SSC and acidity and therefore it is also preferred as fresh fruit (Ercisli and Orhan 2007). Traditionally *Morus nigra* fruits have been frequently

Table 1. Fruit characteristics of mulberry genotypes

Genotypes	Species	Seed formation	Fruit weight (g)	SSC (%)	Acidity (%)	Juice yield (%)	pH
Sebinkarahisar	*M. alba*	Medium	1.40g-j	27.50a-d	0.23ef	64.67b	5.11abc
Poser	*M. alba*	Low	1.64d-g	23.50c-h	0.16fg	56.00e-h	4.87bc
Kolik	*M. alba*	Low	1.20ijk	28.40abc	0.17fg	49.67ij	4.86bc
Gemirgap 5	*M. alba*	Low	1.14jk	25.00b-g	0.19fg	46.67jkl	5.23abc
Gemirgap 6	*M. alba*	Low	0.86lmn	26.27a-e	0.15fg	55.67e-h	5.31abc
Akdut 2	*M. alba*	High	2.53b	19.00h-j	0.13gh	46.67jkl	5.22abc
Angut 3	*M. alba*	Medium	2.57b	24.67b-g	0.31d	45.33j-m	4.57c
Angut 4	*M. alba*	Seedless	1.16jk	26.83a-e	0.13gh	53.00f-i	5.49ab
Angut 7	*M. alba*	Low	2.03c	22.33e-i	0.13gh	61.67b-e	5.41abc
Angut 9	*M. alba*	Seedless	0.75mn	25.50b-f	0.06h	56.00e-h	5.30abc
Arapgir 11	*M. alba*	Low	2.39b	27.97abc	0.16fg	50.33hij	5.21abc
Arapgir 12	*M. alba*	Medium	2.08c	26.83a-e	0.13gh	61.67b-e	5.32abc
Meloz 10	*M. alba*	Seedless	0.98klm	22.77d-h	0.14gh	56.33e-h	5.53ab
Topuz beyaz 1	*M. alba*	Low	0.94k-n	29.40ab	0.15fg	57.33def	5.51ab
Topuz beyaz 2	*M. alba*	Seedless	0.97klm	26.07a-f	0.15fg	58.67c-f	5.37abc
Istanbul dutu 1	*M. alba*	Seedless	0.68mn	27.67a-d	0.17fg	51.00g-j	5.19abc
Istanbul dutu 2	*M. alba*	Seedless	0.66n	24.67b-g	0.13gh	42.00lm	5.37abc
Tosya beyaz	*M. alba*	Low	3.04a	25.00b-g	0.14fgh	54.67f-i	5.46abc
Kastamonu beyaz	*M. alba*	Medium	2.07c	19.03hij	0.11gh	62.33bcd	5.39abc
Gumushaci beyaz	*M. alba*	Low	3.07a	17.80ij	0.15fg	40.67m	5.41abc
Amasya beyaz	*M. alba*	Low	1.40g-j	26.50a-e	0.13gh	51.00g-j	5.43abc
Sebil beyaz dut	*M. alba*	Low	1.69d-g	24.17c-g	0.27de	57.67def	5.36abc
Lokum dut	*M. alba*	Seedless	1.20ijk	30.67a	0.18fg	43.33klm	5.15abc
Yediveren	*M. alba*	Low	2.56b	25.00b-g	0.90c	57.67def	5.17abc
Elazig iri cekirdekli	*M. alba*	Medium	0.96klm	28.33abc	0.13gh	53.00f-i	5.11abc
Elazig cekirdekli	*M. alba*	Medium	0.79mn	27.00a-e	0.13gh	48.67ijk	5.46abc
Cekirdekli 6-14	*M. alba*	Medium	1.75def	26.00a-f	0.15fg	53.00f-i	5.36abc
Çekirdekli mor dut	*M. alba*	Medium	1.29hij	24.67b-g	0.17fg	49.00ijk	5.30abc
Mersin mor dut	*M. rubra*	Low	1.51fgh	25.67a-f	0.12gh	50.33hij	5.86a
Dortyol mor dut	*M. rubra*	Medium	1.88cd	25.17b-f	0.12gh	42.00lm	5.60ab
Erzincan karadut, 16	*M. nigra*	Medium	1.60d-g	17.33j	1.44b	72.00a	3.10d
Kemaliye karadut 9	*M. nigra*	Medium	1.49f-i	18.00ij	1.48b	65.33b	2.19e
Gumushaci karadut 8	*M. nigra*	Medium	1.80cde	20.17g-j	1.62a	63.67bc	2.25e
Hikmet 1	*M. nigra*	Medium	1.58e-h	21.17f-j	0.86c	57.00d-g	3.29d

*Values in the same column with different lower-case letters are significantly different at $P<0.05$.

using to treat mouth lesions in Turkey so a long time as well (Baytop 1996; Kafkas et al., 2008).

The titratable acidity values of mulberry genotypes are shown in Table 1. The highest acidity was observed in *Morus nigra* genotype 'Gumushaci Karadut' as 1.62%, while the lowest acidity was in *Morus alba* genotype 'Angut 009' as 0.06%. In general, *Morus nigra* genotypes had higher acidity values compared to *Morus rubra* and *Morus alba* genotypes (Table 1). Gerasopoulos and Stavroulakis (1997), Lale and Ozcagiran (1996), Ozdemir and Topuz (1998) and Gunes and Cekic (2004) reported that *Morus nigra* genotypes had the highest acidity values.

Our fruit weight, SSC, titratable acidity, juice yield and pH results in general were within limits of these studies. The variation of fruit weight, SSC, acidity, juice yield and pH in mulberry fruits could be due to different species, genotypes and rootstocks used as well. However the difference of the mulberry genotypes in terms of above characteristics is supposed to its genetic derivation as well because all plants found same age and ecological conditions. It is previously reported that plant genotype (Scalzo et al. 2005) effect the content of berry group fruits.

As a conclusion it can be said that the most divergent genotypes obtained in this study can be used in future breeding studies.

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