



Phenological, Pomological and Technological Characteristics of Seedless White Mulberry in Mulberry Genetic Resources of Turkey

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ABSTRACT

This study carried out in 2015 and 2016 to determine phenological, pomological and some technological characteristics of 19 seedless mulberry genotypes of the Malatya Apricot Research Institute. Full-bloom periods of the genotypes varied between 27th of April (Poser 24-07) and 3rd of May (24 MRK 02); start of harvest dates varied between 15th of May (Poser 24-07) and 31st of May (Yediveren 24-08); end of harvest dates varied between 5th of July (Angut 009) and 30th of August (Yediveren 24-08). Fruiting durations varied between 50 days (Angut 009) and 95 days (Gemirgap Dutu 24-05). Of the pomological characteristics, average fruit weights varied between 0.77 g (Angut 009) and 2.46 g (Poser 24-07); water soluble dry matter (WSDM) contents varied between 15.50% (Topu Beyaz 1) and 29.60% (Angut 009). Of the technological characteristics, drying efficiency values varied between 15.79% (44 KE 10) and 39.94% (Angut 009), dry fruit color L values varied between 25.97 (Poser 24-07) and 50.20 (İstanbul Dutu 24-12). Based on present findings, Poser 24-07 genotype was found to be prominent with early fruiting and availability for fresh consumption; Yediveren 24-08 genotype with late fruiting; İstanbul Dutu 24-12 genotype with drying efficiency and Gemirgap Dutu 24-05 and Gemirgap Dutu 24-06 genotypes with their longer fruiting durations. Current findings may be beneficial in mulberry breeding programs.

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ÖZ

2015-2016 yıllarında yürütülen bu çalışmada Malatya Kayısı Araştırma Enstitüsünde bulunan 19 adet çekirdeksiz dut genotipinin fenolojik, pomolojik ve bazı teknolojik özelliklerinin belirlenmesi amaçlanmıştır. Çalışmada; tam çiçeklenme zamanının 27 Nisan (Poser 24-07)-03 Mayıs (24 MRK 02), hasat başlangıcının 15 Mayıs (Poser 24-07)-31 Mayıs (Yediveren 24-08), hasat sonunun ise 5 Temmuz (Angut 009)-30 Ağustos (Yediveren 24-08) tarihleri arasında değiştiği belirlenmiştir. Meyve verme süresi 50 gün (Angut 009) ile 95 gün (Gemirgap Dutu 24-05) arasında değişmiştir. Pomolojik özelliklerden ortalama meyve ağırlığı 0,77 g (Angut 009) ile 2,46 g (Poser 24-07) arasında, SÇKM değeri ise %15,50 (Topu Beyaz 1) ile %29,60 (Angut 009) arasında değişmiştir. Teknolojik özelliklerden kurutma randımanı %15,79 (44 KE 10) ile %39,94 (Angut 009) arasında, kuru meyvede L renk değeri ise 25,97 (Poser 24-07) ile 50,20 (İstanbul Dutu 24-12) arasında değişmiştir. Çalışmada sonunda; Poser 24-07 genotipi erkenciliği ve sofralık tüketime uygunluğuyla, Yediveren 24-08 genotipi geççiliğiyle, İstanbul Dutu 24-12 genotipi kurutmalık özelliğiyle, Gemirgap Dutu 24-05 ve Gemirgap Dutu 24-06 genotipleri ise uzun süreli meyve vermesi ile ön plana çıkmıştır. Mevcut bulgular dut ıslah programlarına katkı sağlayabilir.

Introduction

Mulberry is classified under *Morus* species of Urticales order. There are about 100 species of *Morus* genus identified in mild-climate regions of the world. Of these species, 10-12 are commonly grown and the most common cultivars are identified as *Morus alba* (white mulberry), *M. nigra* (black mulberry) and *M. rubra* (purple mulberry) (De Candolle, 1967). Since mulberries have several species, they have quite high adaptation capacity to different climate and soil conditions. Mulberry has a great genetic diversity and widespread throughout the various parts of the world. The mulberry genotypes grown for the fruits are classified among *M. alba* L. (white mulberry), *M. nigra* L. (black mulberry) and *M. rubra* L. (red-purple mulberry) species (Bellini et al., 2000).

Anatolia is the origin center and natural spread of several fruit species. Mulberry culture has more than 400 years history and 95% of mulberries grown in Turkey belongs to *M. alba* L., 3% belongs to *M. rubra* L. and 2% belongs to *M. nigra* L. species (Ercişli, 2004; Orhan, 2009).

Previous researches on mulberries have mostly focused on sericulture, leaf yield and nutritional composition of leaves. However, some other studies have recently been conducted on organic mulberry culture, phenolics and biochemical characteristics of mulberry fruits. Mulberry fruits are quite rich in phenolics compounds and thus there is an increasing interest in mulberries (Keskin, 2016).

Beside fresh consumption, mulberry fruits are also used as processed food stuff. Fruits are used in production of molasses, jam, churchkela, mashed mulberry, fruit flavored ice-cream, vinegar, fruit juice concentrate and spirit. Mulberry trees usually grow home gardens, road sides and rarely in special orchards (Anonymous, 2013). Together with increasing interest in mulberry fruits, commercial orchards have started to be established. Seedless white mulberries of *M. alba* species are consumed as dried appetizer in Anatolia. Seedless white mulberries do not have any registered cultivars and they are commonly used as fresh table-type and appetizer. Seedless mulberry genotypes collected from different regions of Turkey have been under preservation in mulberry genetic resources plot of Malatya Apricot Research Institute.

Phenological, pomological and morphologic identifications have been performed for various fruit species in the world. Fruit species are characterized with these identifications. Identification of cultivar characteristics provides significant contributions for both breeding programs and cultivar registration. Fruit cultivar characteristics play significant roles also in culture techniques.

This study was conducted to determine phenological, pomological and some technological characteristics of seedless white mulberries preserved at mulberry genetic resources plot of Malatya Apricot Research Institute. In this way, the genotypes in this genetic resource plot will be employed efficiently in further breeding programs and cultural practices.

Material and Method

Material

As the plant material of the study, 19 seedless white mulberry genotypes, belonging to *M. alba* species, available in mulberry genetic resources plot of Malatya Apricot Research Institute were used. The mulberry genotypes were 10-25 years old and they were at yielding stage.

Method

Phenological observations were performed in accordance with Orhan (2009) and Erkaleli (2015). Fruit physical measurements were performed in accordance with Orhan (2009) over randomly selected 30 fruits from different sides of the trees of each genotype. Water soluble dry matter (WSDM) contents were measured in accordance with Cemeroglu (1992) and acidity with Altan (1989). For drying efficiency, 100 g ripened fresh fruits of each genotype were weighted, then they were dried and dry weights were determined. Drying efficiency was expressed in %. Dry fruit color parameters (L, a, b) were measured with a Minolta CR-400 color meter. Color measurements were performed twice over 10 fruits of each genotype and presented as average.

Results and Discussion

This study was conducted to determine phenological, pomological and some technological characteristics of 19 mulberry genotypes of *M. alba* species in mulberry genetic resources plot of Malatya Apricot Research Institute.

Phenological Findings

Phenology mostly depends on the observations of the visible changes throughout the life cycle of the plants. The data gathered through phenological observations yield significant information about vegetation periods, growth and development of plants (Çepel, 1988). Present phenological observations revealed that full-bloom of female flowers varied between 27th of April (Poser 24-07) and 3rd of May (24 MRK 02). Fruit color turn dates varied between 10th of May (Poser 24-07) and 28th May (Yediveren 24-08); start of harvest dates varied between 15th of May (Poser 24-07) and 31st of May (Yediveren 24-08); end of harvest dates varied between 5th of July (Angut 009) and 30th of August (Yediveren 24-08); fruiting durations varies between 50 days (Angut 009) and 95 days (Gemirgap Dutu 24-05 and Gemirgap Dutu 24-06); Full defoliation dates varied between 2nd of November (24 KE 05) and 7th of November (Topu Beyaz 2-24-03) (Table 1). Orhan (2009) reported in study carried out in Olur and Oltu towns of Erzurum province for 26 mulberry genotypes of *Morus alba* species that full-bloom dates varied between 9th of April and 22nd of May; fruit color turn dates varied between 23rd of May and 5th of July; fruit ripening dates varied between 26th May and 14th of July; end of harvest dates varied between 25th of June and 29th August. Çam and Türkoğlu (2004) carried out a study on mulberries of Edremit and Gevaş region and reported that full-budding dates varied between 5-7th of May; the first bud burst dates varied between 6-18th of May; full

bloom dates varied between 20th of May and 3rd of June; the first fruit set dates varied between 6-19th of May and start of fruit ripening dates varied between 28th of June and 10th of July. Present phenological findings partially different from the findings of previous studies. Such differences resulted from the different genotypes and different ecological conditions.

Fruit Physical Parameters

Usually the weight, size and shape of the fruits are measured as physical characteristics. Such characteristics

designate cultural practices, breeding programs, marketing and consumption of fruits. Average fruit weights of 19 mulberry genotypes varied between 0.77 g (Angut 009) and 2.46 g (Poser 24-07), average fruit widths varied between 8.86 mm (Angut 009) and 14.13 mm (Poser 24-07), average fruit lengths varied between 16.69 mm (Angut 009) and 26.34 mm (24 MRK 01). Average fruit stalk lengths varied between 5.56 mm (44 MRK 05) and 11.07 mm (Meloz 0010), fruit stalk thicknesses varied between 0.51 mm (Meloz 0010) and 1.33 mm (24 MRK 01) (Table 2).

Table 1 Phenological characteristics of mulberry genotypes

No	Genotype	GPD	MEP	FBP	FCT	SH	EH	FD	FDF
1	24 KE 05	13 April	15 April	3 May	16 May	19 May	15 August	88	2 November
2	24 MRK 01	14 April	16 April	3 May	23 May	26 May	1 August	67	5 November
3	24 MRK 02	14 April	16 April	3 May	20 May	23 May	5 August	74	5 November
4	44 KE 10	11 April	13 April	30 April	15 May	19 May	1 August	74	7 November
5	44 MRK 05	11 April	13 April	30 April	15 May	28 May	15 August	79	5 November
6	Angut 004	11 April	13 April	30 April	25 May	28 May	25 July	58	5 November
7	Angut 009	11 April	13 April	30 April	12 May	16 May	5 July	50	7 November
8	Arapgir Yediveren	11 April	13 April	29 April	12 May	15 May	17 July	63	5 November
9	Gemirgap Dutu 24-05	12 April	14 April	1 May	12 May	16 May	19 August	95	2 November
10	Gemirgap Dutu 24-06	12 April	14 April	1 May	12 May	16 May	19 August	95	5 November
11	İstanbul Dutu 24-10	12 April	14 April	1 May	15 May	19 May	25 July	67	5 November
12	İstanbul Dutu 24-12	12 April	14 April	1 May	15 May	19 May	25 July	67	5 November
13	Kolik Dut 24-11	12 April	14 April	1 May	12 May	16 May	15 August	91	7 November
14	Lokum Dut 24-13	12 April	14 April	1 May	12 May	16 May	15 August	91	7 November
15	Meloz 0010	12 April	14 April	1 May	15 May	19 May	25 July	67	7 November
16	Poser 24-07	10 April	14 April	27 April	10 May	15 May	10 July	56	5 November
17	Topu Beyaz 1-24-01	12 April	14 April	1 May	12 May	17 May	27 July	71	5 November
18	Topu Beyaz 2-24-03	11 April	13 April	1 May	12 May	16 May	15 August	91	7 November
19	Yediveren 24-08	11 April	13 April	30 April	28 May	31 May	30 August	91	5 November

GPD: Green Bud Period; MEP: Mouse Ear Period; FBP: Full Bloom Period (female flower); FCT: Fruit Color Turn Period; SH: Start of Harvest; EH: End of Harvest; FD: Fruiting Duration (day); FDF: Full Defoliation

Table 2 Physical characteristics of mulberry genotypes

No	Genotype	Fruit weight (g)	Fruit width (mm)	Fruit length (mm)	Fruit stalk length (mm)	Fruit stalk thickness (mm)
1	24 KE 05	0.99 ^{ij}	9.97 ^j	21.24 ^d	9.12 ^b	0.93 ^{fgh}
2	24 MRK 01	1.71 ^{cd}	11.69 ^{efg}	26.34 ^a	6.41 ^f	1.33 ^a
3	24 MRK 02	1.27 ^{fg}	11.86 ^{ef}	21.08 ^d	5.78 ^f	1.08 ^{cd}
4	44 KE 10	1.19 ^{fgh}	11.79 ^{efg}	19.31 ^{ef}	8.78 ^{bc}	0.93 ^{fgh}
5	44 MRK 05	1.29 ^{fg}	12.28 ^{cde}	21.45 ^d	5.56 ^f	0.90 ^{gh}
6	Angut 004	1.11 ^{hi}	11.79 ^{efg}	20.95 ^d	8.37 ^{bcd}	1.19 ^b
7	Angut 009	0.77 ^k	8.86 ^k	16.69 ^h	7.41 ^e	0.59 ^{jk}
8	Arapgir Yediveren	1.08 ^{hi}	11.20 ^{gh}	21.48 ^d	8.57 ^{bc}	0.76 ⁱ
9	Gemirgap Dutu 24-05	0.89 ^{jk}	9.27 ^k	18.32 ^{fg}	7.65 ^{de}	0.59 ^{jk}
10	Genirgap Dutu 24-06	1.35 ^f	10.73 ^{hi}	19.47 ^e	8.10 ^{cde}	0.88 ^{gh}
11	İstanbul Dutu 24-10	1.13 ^{ghi}	10.71 ^{hi}	22.94 ^c	8.75 ^{bc}	1.06 ^{cde}
12	İstanbul Dutu 24-12	1.57 ^{de}	10.61 ^{hi}	24.45 ^b	10.53 ^a	0.64 ^j
13	Kolik Dut 24-11	1.61 ^{de}	11.99 ^{def}	19.35 ^{ef}	10.36 ^a	1.03 ^{cdef}
14	Lokum Dut 24-13	1.89 ^b	13.21 ^b	21.67 ^d	10.54 ^a	1.10 ^{bcd}
15	Meloz 0010	0.81 ^k	10.32 ^{jk}	17.28 ^{gh}	11.07 ^a	0.51 ^k
16	Poser 24-07	2.46 ^a	14.13 ^a	24.19 ^b	6.04 ^f	1.13 ^{bc}
17	Topu Beyaz 1-24-01	1.70 ^{cd}	11.60 ^{fg}	19.71 ^e	8.57 ^{bc}	0.95 ^{efgh}
18	Topu Beyaz 2- 24-03	1.77 ^{bc}	12.77 ^{bc}	20.94 ^d	8.02 ^{cde}	1.0 ^{defg}
19	Yediveren 24-08	1.53 ^e	12.50 ^{cd}	21.08 ^d	6.37 ^f	0.84 ^{hi}
F		65.751	42.448	40.847	33.711	31.922
Sig.		0.000	0.000	0.000	0.000	0.000

Table 3 Chemical characteristics, drying efficiency and dry fruit color parameters of mulberry genotypes

No	Genotype	WSDM (%)	pH	TA (%)	Drying Efficiency (%)	L	a	b
1	24 KE 05	23.20	5.85	0.13	25.95	42.91	0.15	15.49
2	24 MRK 01	25.80	1.40	0.37	33.41	42.99	1.64	16.29
3	24 MRK 02	22.20	5.92	0.15	29.72	34.84	1.53	12.70
4	44 KE 10	16.20	5.85	0.06	15.79	45.55	-0.39	14.58
5	44 MRK 05	22.50	5.82	0.06	23.27	35.77	0.91	13.45
6	Angut 004	21.30	5.87	0.06	19.68	34.70	1.37	12.18
7	Angut 009	29.60	5.95	0.13	39.94	39.15	1.50	14.10
8	Arapgir Yediveren	21.30	5.98	0.06	20.42	36.29	0.55	13.66
9	Gemirgap Dutu 24-05	23.00	5.84	0.10	26.60	34.57	0.08	12.62
10	Gemirgap Dutu 24-06	23.00	5.86	0.10	23.42	37.78	0.70	13.54
11	İstanbul Dutu 24-10	21.09	5.96	0.06	23.80	42.85	-0.52	14.56
12	İstanbul Dutu 24-12	19.10	6.18	0.06	17.83	50.20	-0.32	16.56
13	Kolik Dut 24-11	21.40	5.88	0.07	25.47	27.27	1.22	10.63
14	Lokum Dut 24-13	21.20	5.79	0.10	23.69	37.64	0.81	13.52
15	Meloz 0010	22.20	5.94	0.10	21.41	29.09	1.24	10.63
16	Poser 24-07	20.00	6.17	0.06	20.13	25.97	2.36	10.48
17	Topu Beyaz 1-24-01	15.50	6.00	0.07	16.78	39.65	0.24	13.18
18	Topu Beyaz 2-24-03	16.20	6.02	0.06	16.21	33.46	0.57	11.20
19	Yediveren 24-08	24.90	5.72	0.14	26.35	32.20	1.98	13.03

Orhan (2009) in a selection study carried out with mulberry genotypes of *M. alba* species in Olur and Oltu towns of Erzurum reported fruit weights as between 1.36-5.77 g, fruit widths as between 9.97 -17.36 mm and fruit lengths as between 19.75-31.03 mm. Yılmaz (2004) in another selection study carried out in Adana province, reported fruit weights of selected mulberry genotypes as between 2.96-6.42 g, fruit widths as between 1.50-2.10 cm and fruit lengths as between 2.20-3.43 cm. Keskin (2016) reported fruit weights of promising mulberry genotypes selected from Gümüşhane province as between 1.92-5.27 g, fruit widths as between 11.85-18.23 mm and fruit lengths as between 19.28 -33.95 mm. Yılmaz et al.(2012) reported average fruit weights as between 0.66-3.07 g. Present findings were quite similar with the earlier reports.

Chemical Parameters, Drying Efficiency and Dry Fruit Color

Chemical analyses reveal technological characteristics of the fruits and color analyses on dried fruits designate potential use of fruits in food technology. Water soluble dry matter (WSDM) contents of mulberry genotypes varied between 15.50% (Topu Beyaz 1) and 29.60% (Angut 009), pH values varied between 1.40 (24 MEK 01) and 6.18 (İstanbul Dutu 24-12), titratable acidity (TA) values varied between 0.06% (44 MRK 05) and 0.37% (24 MRK 01) and drying efficiency values varied between 15.79% (44 KE 10) and 39.94% (Angut 009). Color measurements revealed that L values varied between 25.97 (Poser 24-07) and 50.20 (İstanbul Dutu 24-12), a values varied between -0.52 (İstanbul Dutu 24-12) and 2.36 (Poser 24-07) and b values varied between 10.48 (Poser 24-07) and 16.56 (İstanbul Dutu 24-12) (Table 3). Yılmaz (2004) in a selection study carried out in Adana province, reported WSDM contents of mulberry genotypes as between 9.30-26.2%, pH values as between 2.29-6.21 and titratable acidity values as between 0.04-

1.31%. Orhan (2009) reported WSDM contents of *Morus alba* species as between 13.2-23.1% and drying efficiency values as between 20.96-38.16%. Yılmaz et al. (2012) carried out a study in Malatya province with 34 malberry genotypes and reported WSDM contents of the genotypes as between 17.33-30.67%, titratable acidity values as between 0.06-1.62% and pH values as between 2.19-5.86. Keskin (2016) reported WSDM contents of 26 promising mulberry genotypes of *Morus alba* species as between 14.80-24.40%, pH values as between 5.67-6.59, TA values as between 0.02- 0.07% and drying efficiency values as between 19.26 -25.56%. Keskin (2016) also reported color L values as between 22.81-49.65 in the first year and as between 24.79-52.05 in the second year of the experiments. Present findings comply with those earlier reports.

Conclusion and Recommendations

The present study was conducted to determine phenological stages, pomological and some technological characteristics of mulberry genotypes in mulberry genetic resources plot of Malatya Apricot Research Institute.

While the earliest flowering and harvest periods were observed in Poser 24-07 genotype, the latest periods were observed in Yediveren 24-08 genotype. The longest fruiting durations were observed in Gemirgap Dutu 24-05 and Gemirgap Dutu 24-06 genotypes. Considering the phenological stages, the genotype Poser 24-07 was found to be prominent with early fruiting, Yediveren 24-08 genotype with late fruiting and the genotypes Gemirgap Dutu 24-05 and Gemirgap Dutu 24-06 with their longer fruiting durations. Poser 24-07 genotype with the heaviest and large-size fruits was found to be suitable for fresh consumption. Considering the technological characteristics, Angut 009 genotype had the greatest WSDM content and drying efficiency. The greatest L value indicating the brightness of dry fruits was observed

in İstanbul Dutu 24-12 genotype and this genotype was found to be prominent as a dry genotype.

Present findings may be used for cultivar recommendations to new orchards to be established and may also provide significant contributions to further mulberry breeding programs.

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