Athens Institute for Education and Research
ATINER

ATINER's Conference Paper Series
AGR2014-1105

Some Physicochemical Properties of White Mulberry (*Marus alba* L.) Genotypes from Southeast Anatolia Region of Turkey

Deniz Erogul
Researcher
Ege University
Turkey

Halil Ibrahim Oguz
Associate Professor
Adiyaman University
Turkey

Fatih Sen
Associate Professor
Ege University
Turkey

ATINER CONFERENCE PAPER SERIES No: AGR2014-1105

An Introduction to ATINER's Conference Paper Series

ATINER started to publish this conference papers series in 2012. It includes only the papers submitted for publication after they were presented at one of the conferences organized by our Institute every year. The papers published in the series have not been refereed and are published as they were submitted by the author. The series serves two purposes. First, we want to disseminate the information as fast as possible. Second, by doing so, the authors can receive comments useful to revise their papers before they are considered for publication in one of ATINER's books, following our standard procedures of a blind review.

Dr. Gregory T. Papanikos
President
Athens Institute for Education and Research

This paper should be cited as follows:
Erogul, D., Oguz, H.I. and Sen, F., (2014) **"Some Physicochemical Properties of White Mulberry (*Marus alba* L.) Genotypes from Southeast Anatolia Region of Turkey",** Athens: ATINER'S Conference Paper Series, No: **AGR2014-1105.**

Athens Institute for Education and Research
8 Valaoritou Street, Kolonaki, 10671 Athens, Greece
Tel: + 30 210 3634210 Fax: + 30 210 3634209 Email: info@atiner.gr
URL: www.atiner.gr
URL Conference Papers Series: www.atiner.gr/papers.htm

ISSN: **2241-2891**
01/08/2014

Some Physicochemical Properties of White Mulberry (*Marus alba* L.) Genotypes from Southeast Anatolia Region of Turkey

Deniz Erogul
Researcher
Ege University
Turkey

Halil Ibrahim Oguz
Associate Professor
Adiyaman University
Turkey

Fatih Sen
Associate Professor
Ege University
Turkey

Abstract

In this study, total phenolic content, antioxidant activity and some selected physicochemical properties of six white mulberry (*Marus alba* L.) genotypes harvested from Southeast Anatolia region of Turkey was investigated. Total phenolic content and antioxidant activity of methanol extract of white mulberry fruits were determined to Folin-Ciocalteu and ferric reducing antioxidant power (FRAP) assays, respectively. Total phenolic content was observed in white mulberry fruits between 68.3 – 82.3 mg gallic acid equivalent in 100 g fresh basis. The antioxidant activity of genotypes varied between 5.46 - 6.92 μmol trolox equivalent in g fresh basis. The average colour C^* and h^o values were 23.0 and 91.8 respectively. The total soluble solids content was found from 26.3 to 30.5%, moisture content from 64.6 to 81.3%. Fruit weight, length and width of mulberry fruits were determined between 2.00 – 4.32 g, 17.8 – 26.8 mm and 11.5 – 15.4 mm respectively. The results of the study are helpful for attempting crop improvement in white mulberry for bringing to cultivation.

Key words: White Mulberry, Phenolic, Antioxidant Activity, Color, Fruit Size

Introduction

Mulberry, of the genus *Morus* of the family *Moraceae*, is a fast growing deciduous plant surviving in different climates in the world including the tropical, subtropical and temperate (Arabshahi-Delouee and Urooj, 2007). Such a range of climatic conditions covers regions with an altitude variation of 0 – 4000 m between the tropics and the sub-arctic (Machii et al., 2000).

The native hometown of white mulberries is the western parts of Asia, including Turkey (Doymaz, 2004). The mulberry (*Morus alba*) is as significant a fruit in Turkey, where the agricultural conditions in the region are very suitable for high quality production (Erdogan, 2003), as other species of temperate climate including apricots, walnuts and sour cherries. Mulberry agriculture is familiar on the Turkish landscape for more than 400 years and the annual production in 2013 was recorded as 74 600 tons (Anonymous, 2014). The mulberry species planted in Turkey are *M. alba* (95%), *M. rubra* (3%) and *M. nigra* (2%) (Ercisli, 2004).

The fruits of the mulberry tree may be consumed either fresh or dried. The mulberry fruit is suitable for processing into juice, paste, marmalade, jam, pulp or jelly, as well (Maskan and Gogus, 1998). Mulberry fruits are used in the preparation of several traditional delicacies including pekmez and kome in Turkey (Erdogan, 2003; Sengul *et al*., 2005; Yogurtcu and Kamisli, 2006). Several other uses of the fruit are as follows but are not limited to being a worming agent, a remedy for dysentery, a lavative, an odontalgic, anthelmintic, expectorant, hypoglyceamic or an emetic agent (Baytop, 1996).

Morus alba, *Morus rubra*, and *Morus nigra* are the most significant and widely grown anthocyanin rich *Morus* species. *Morus alba* fruits, with its sweet tasting, lowly acidic white and purple color, are perishable and preferred for fresh consumption. The antioxidant and free-radical scavenging activities of anthocyanins have previously been reported (Stintzing *et al*., 2002 and Wang *et al*., 1997). Furthermore, berries and red fruits were reported to contribute to health benefits including reduced risk of coronary heart disease, stroke, certain types of cancers and as well as slowing down the signs of aging owing to their anthocyanin content (Zafra-Stone *et al*., 2007). Well defined methods were developed for identifying and quantifying anthocyanin and phenolic content as well as other antioxidant properties of red fruits and especially berries (Ozgen *et al*., 2007, Sun *et al*., 2002; Celik *et al*., 2008). The health benefits of the fruits were also discussed in detail individually in numerous publications.

In this study, our objective was to investigate total phenolic content, antioxidant activity and some selected physicochemical properties of six white mulberry (*Marus alba* L.) genotypes harvested from Southeast Anatolia region of Turkey.

Material and Method

Material

Mulberry fruits were harvested from selected *Marus alba* genotypes from Southeast Anatolia region of Turkey. At least five different plants for each genotype and samples of berries were taken from the same plants throughout the experiment. All berries were picked in full mature stage (June 2013). Undamaged, uniformity of shape and colour berries were selected. 30–40 fruits were stored at −20°C until analyzed.

Physical Analysis

Fruit weight was determined by the mean value of the 30 fruits collected. The size was also determined by measuring the dimension of the principal axes; major diameters of 30 randomly selected mulberry fruit using a digital caliper (SC-6, Mitutoyo, Japan) with a sensitivity of 0.01 mm.

Quality Attributes

Moisture content (%) was measured by drying in an oven (UM400; Memmert, Schwabach, Germany) up to a constant weight (AOAC, 1990) and calculating the percentage weight loss.

Color was measured at the fruit equator on both sides of 20 mulberry fruit with a Minolta Chroma Meter (CR-300; Minolta, Osaka, Japan) (Ruiz *et al.*, 2005). Color values were displayed as L^*, a^*, and b^* values representing a light-dark spectrum with a range of 0 (black) to 100 (white), the green-red spectrum with a range of −60 (green) to +60 (red), and the blue-yellow spectrum with a* range of −60 (blue) to +60 (yellow) dimensions. The colorimeter has an 8 mm diameter viewing area and was calibrated with a white tile. C^* (chroma) changes from 0 (dull) to 60 (vivid) and $h°$ (hue angle) is expressed in degrees: 0° (red), 90° (yellow), 180° (green), and 270° (blue) and were calculated by using the following equation: $C^* = (a^{*2}+b^{*2})^{1/2}$ $h° = \arctan(b^*/a^*)$.

The total soluble solids (TSS) content of the juice was determined with a digital refractometer (PR-1, Atago, Tokyo, Japan) and expressed as percentage.

Total Phenolics and Antioxidant Activity

Fruit extracts were prepared using the method of Thaipong et al. (2006), with some modifications for total phenolic and antioxidant activity (in methanol extract) analysis. Five grams of mulberry tissue were mixed with 25 ml methanol and homogenized using the homogenizer (Ultra-Turrax T18 Basic; Ika, Staufen, Germany). The homogenates were kept at 4^{o}C for 12 h and then centrifuged using a centrifuge (Thermo Scientific SL 16 R; Thermo Electron LED GmbH, Osterode, Germany).

Total phenolic content was determined by the Folin-Ciocalteu method basing upon method of Swain and Hillis (1959) with an incubation time of 120 min for color development. The absorbance was measured at 725 nm using a spectrophotometer (Carry100 Bio, Varian, Mulgrave, Australia) and results

were expressed as mg gallic acid equivalent (GAE)/100 g fresh weight (FW) using a gallic acid (0-0.1 mg/ml) standard curve.

The FRAP assay was performed as previously described by Benzie and Strain (1996) where reductants (''antioxidants'') in the sample reduce Fe (III)/tripyridyltriazine complex to the blue ferrous form, with an increase in absorbance at 593 nm. The final results are expressed in μmol trolox equivalents (TE)/g fresh weight (FW), using a trolox (25-500 μmol) standard curve

Statistical Analysis

The experiment was conducted as completely randomized design. Significant differences among groups were determined using Duncan's multiple range tests at $P \leq 0.05$. Standard deviation of the mean (SD) was also calculated from the replicates. All data were subjected to analyses of variance (ANOVA) by using IBM® SPSS® Statistics 19 statistical software (IBM, NY, USA).

Results and Discussion

The fruit weight and TSS content of white mulberry genotypes are given Figure 1. The differences in fruit weight and TSS content among different genotypes were statistically significant ($P \leq 0.01$). The average fruit weight of mulberry fruit ranged from 2.00 g to 4.32 g. Genotype 2 had highest fruit weight, followed by genotype 6 (3.74 g), and genotype 4 (3.66 g). TSS content of mulberry genotypes ranged between 26.3% (genotypes 4) and 30.5% (genotypes 3 and genotypes 6).

In a previous study, it was reported that fruit weight and TSS content of white mulberry fruits which grown in Turkey are 3.49 g and 21.3–28.5% (Gungor and Sengul, 2008; Ercisli and Orhan, 2008). Erdogan (2003) reported that TSS content of fruit ranged between 14% and 25%. Our results were found similar by minor differences compared with above studies. The variation of fruit weight and TSS content in white mulberry fruits could be due to different genotypes, ripening stage, climatic conditions, and agricultural practices.

Figure 1. *Fruit Weight and TSS Content of White Mulberry Genotypes. Results are the Means of five Replicate Samples ±SD.*

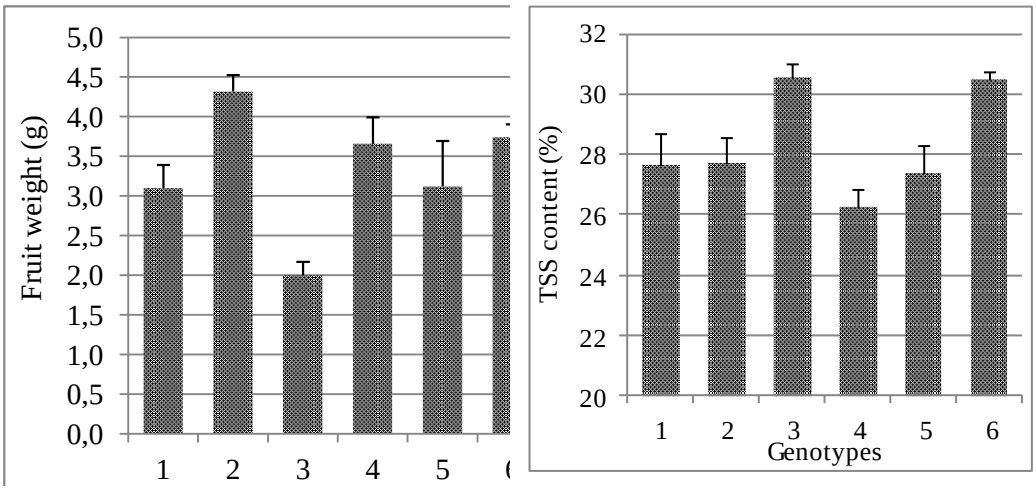


Table 1 show the fruit length, width and moisture content of white mulberry fruits. Significant differences ($P \leq 0.01$) were found among the genotype in fruit length and width of white mulberry. Fruit length and width of genotypes were 17.80-26.77 mm and 11.54-15.39 mm respectively. Genotype 2 had the highest fruit length and width. It was previously showed that white mulberry fruit length and width were 25.75-34.85 mm and 15.32-21.28 mm respectively. Our fruit length and width results in general were within in the limits of these studies. Fruit length and width of white mulberry fruits depend on many factors, such as genotypes, degree of maturity at harvest, climatic conditions, and agricultural practices.

There were statistically differences among white mulberry genotypes in terms of moisture content of fruits ($P \leq 0.05$). Moisture content of white mulberry genotypes ranged between 64.62% (genotype 3) and 81.34% (genotype 2). In a previous study, it was reported that white mulberry fruit contained 71.5% (Ercisli and Orhan, 2007).

Table 1. *Fruit Length, Width and Moisture Content of White Mulberry Genotypes. Results Are the Means of Five Replicate Samples ±SD.*

Genotypes	Fruit length (mm)	Fruit width (mm)	Moisture content (%)
1	22.89±1.09 c[z]**	13.06±0.28 bc**	76.41±3.36 ab
2	26.77±0.75 a	15.39± 0.48a	81.34±2.17 a
3	17.80±0.51 d	11.54±0.21 d	64.62±2.00 b
4	24.48±1.19 abc	14.34±0.59 ab	77.78±2.97 ab
5	23.92±1.26 bc	12.87±0.94 c	67.76±2.73 b
6	25.69±1.37 ab	13.00±0.70 bc	67.35±2.44 b

[z]Means separation within columns by Duncan's multiple range test, P<0.05.
*, **, Significant at P<0.05 or P<0.01, respectively.

The color of mulberry fruits is given Table 2. No significant differences were detected in fruit color (L^*, a^*, b^*, C^*, h^o) of mulberry genotypes. Fruit

colors of mulberry genotypes were determined as *L** value 70.7, *a** value -0.75, *b** value 23.02, *C** value 23.04, and *h*º value 91.8. Ercisli and Orhan (2007) found that mulberry fruit *L**, *a** and *b** value were 78.4, -13.6 and 16.2 repectively.

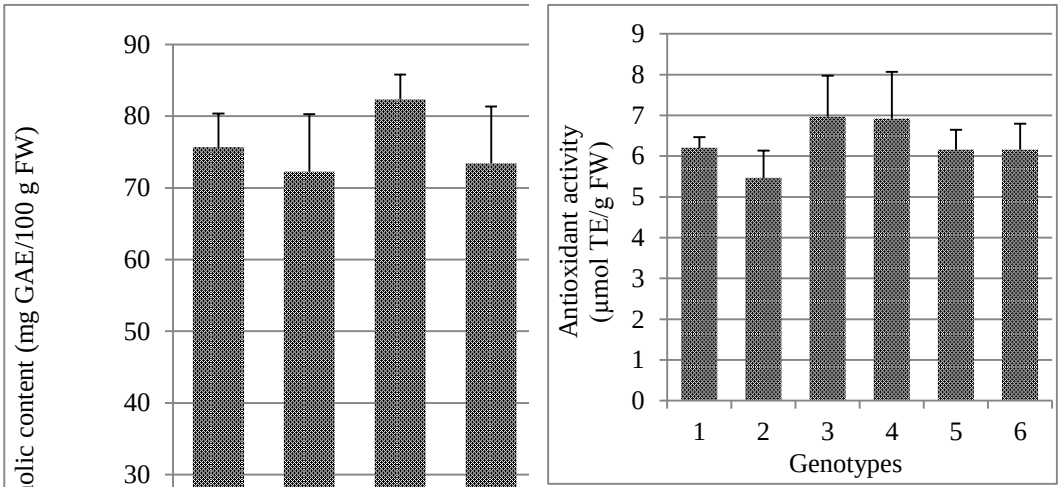
Table 2. *Fruit Colour of Mulberry Genotypes. Results Are the Means of Five Replicate Samples ±SD.*

Genotypes	*L**	*a**	*b**	*C**	hº
1	71.3±3.0^{NS}	0.16±0.47^{NS}	21.23±0.48^{NS}	21.23±0.48^{NS}	89.6±1.52^{NS}
2	71.6±3.3	-1.45±0.12	21.72±0.37	21.76±0.37	93.8±1.12
3	71.5±1.9	-0.44±0.21	24.32±0.48	24.32±0.48	91.0±0.52
4	72.7±1.2	-1.39±0.18	23.44±0.65	23.48±0.65	93.4±1.10
5	68.7±2.1	-1.37±0.19	24.27±0.21	24.30±0.21	93.2±0.78
6	68.4±1.2	0.00±0.49	23.16±0.58	23.17±0.58	90.0±1.21

^{NS}, Nonsignificant.

The total phenolic content and antioxidant activity of white mulberry genotypes are shown in Figure 2. No significant differences were detected total phenolic content and antioxidant activity of mulberry genotypes. The total phenolic content and antioxidant activity of genotypes were 68.3 – 82.3 mg GAE/100 g FW and 5.46 ile 6.97 µmol TE/g FW respectively. The variation in total phenolic content of white mulberry fruits is in agreement with previously published reports (Gungor and Sengul, 2008). Ercisli and Orhan (2007) reported that white mulberry fruit contained 181 mg GAE/100 g fresh mass. It is reported that genotype, (Scalzo et al., 2005), cultivation (Hakkinen and Torronen, 2000) affected total phenolic content in fruit content. They are may contribute to reducing human diseases such as cancer, arteriosclerosis, brain disorders and hearth diseases (Cano and Arnao, 2005).

Figure 2. *Total Phenolic Content and Antioxidant Activity of White Mulberry Genotypes. Results Are the Means of Five Replicate Samples ±SD.*



As a conclusion, white mulberry, being highly cross pollinated and mostly seed propagated exists in innumerable types forms, with different characteristic (Ercisli and Orhan, 2008). According to these results the highest fruit weight (4.32 g), length (26.77 mm), width (15.39 mm) and moisture content (81.34%) were found for genotype 2. When comparing the six genotypes fruit color, total phenolic content and antioxidant activity were similar. The total phenolic content and antioxidant activity of white mulberry genotypes were 68.3 – 82.3 mg GAE/100 g FW and 5.46 ile 6.97 µmol TE/g FW respectively. Mulberry fruit is a good sources of phenolic substances and antioxidant. The results of the study are helpful for attempting crop improvement in white mulberry for bringing to cultivation.

References

Anonymous, 2005. Agricultural structure and production in Turkey Statistical Institute of Turkey.

Arabshahi-Delouee, S. and Urooj, A. 2007. Antioxidant Properties of Various Solvent Extracts of Mulberry (*Morus indica* L.) Leaves. *Food Chem.*, *102* (4), 1233–1240.

Baytop, T. (1996). Türkiye'de Bitkiler ile Tedavi. I.U. Yayinlari No:3255, Eczacilik Fak., 40:444 (in Turkish).

Cano, A. and Arnao, M. B. 2005. Hydrophilic and Lipophilic Antioxidant Activity in Different Leavesof Three Lettuce Varieties. *International Journal of Food Properties*, 8 (3), 521–528.

Çelik, H., Özgen, M., Serçe, S., Kaya, C. 2008. Phytochemical accumulation and antioxidant capacity at four maturity stages of cranberry fruit. *Sci. Hortic.* 117, 345–348.

Doymaz, I. 2004. Pretreatment Effect on Sun Drying of Mulberry Fruits (*Morus alba* L.). *J. Food Eng.* 65 (2), 205–209.

Ercisli, S. 2004. A short review of the fruit germplasm resources of Turkey. *Genetic Resources and Crop Evaluation,* 51, 419–435.

Erdoğan, Ü. 2003. *Ispir ve Pazaryolu Ilçelerinde Yetiştirilen Dutlarin (Morus spp.) Seleksiyon Yoluyla Islahi Üzerinde Bir Araştirma*. Atatürk Üniv. Fen Bilimleri Enstitüsü Bahçe Bitkileri Ana Bilim Dali, Doktora Tezi: Erzurum, Turkey.

Hakkinen, S. H. and Torronen, A. R. 2000. Content of flavonols and selected phenolic acids in strawberries and Vaccinium species: influence of cultivar, cultivation site and technique. *Food Res. Int.* 33, 517–524.

Maskan, M. and Göğüş, F. 1998. Sorption Isotherms and Drying Characteristics of Mulberry (*Morus alba*). *J. Food Eng.* 37 (4), 437–449.

Ozgen, M., Serce, S., Gunduz, K., Yen, F., Kafkas, E., Paydas, S. 2007. Determining total phenolics and antioxidant capacities of selected Fragaria genotype. *Asian J. Chem.* 19, 5573–5581.

Scalzo, J., Politi, A., Pellegrini, N., Mezzetti, B., Battino, M. 2005. Plant genotype affects total antioxidant capacity and phenolic contents in fruit. *Nutrition* 21, 207–213.

Sengül, M., Ertugay M. F., Sengül, M. 2005. Rheological, Physical and Chemical Characteristics of Mulberry Pekmez. Food Control, 16 (1), 73–76.

Sun, J., Chu, Y. F., Wu, X., Liu, R. H. 2002. Antioxidant and antiproliferative activities of common fruits. *J. Agric. Food Chem.* 50, 7449–7454.

Stintzing, F. C., Carle, R., Frei, B., Wrolstad, R. E. 2002. Color and antioxidant properties of cyanidin-based anthocyanin pigments. *J. Agric. Food Chem.* 50, 6172–6180.

Yoğurtçu, H. and Kamişli, F. 2006. Determination of Rheological Properties of Some Pekmez Samples in Turkey. *J. Food Eng.*, 77 (4),1064–1068.

Wang, H., Cao, G., Prior, R. L. 1997. Oxygen radical absorbing capacity of anthocyanins. *J. Agric. Food Chem.* 45, 304–309.

Zafra-Stone, S., Yasmin, T., Bagchi, M., Chatterjee, A., Vinson, J. A., Bagchi, D. 2007. Berry anthocyanins as novel antioxidants in human health and disease prevention. *Mol. Nutr. Food Res.* 51, 675–683.