J Food Sci Technol (January–February 2012) 49(1):82–88
DOI 10.1007/s13197-011-0253-z

ORIGINAL ARTICLE

Biochemical compositional and technological characterizations of black and white myrtle (*Myrtus communis* L.) fruits

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Revised: 6 April 2010 / Accepted: 7 April 2010 / Published online: 14 February 2011

Abstract Biochemical and technological properties were determined in developing *Myrtus communis* L. fruits (myrtle) from Mersin to investigate potential uses. Completely ripe black and white fruits contained ash, crude protein, crude oil, water- and alcohol soluble extracts, tartaric, malic and citric acids, and minerals including Ca, K, P, Mg and Na. Proximate compounds (%) for black and white fruits were: 7.47 and 6.36 protein, 3.487 and 3.453 oil, 3.02 and 2.30 ash, 24.28 and 26.09 dry matter, respectively. Fruits were found to be rich in some minerals such as Ca (6719.88 mg/kg and 4676.14 mg/kg), K (22647.78 mg/kg and 18339.84 mg/kg), Mg (2145.19 mg/kg and 1408.88 mg/kg), Na (3336.16 mg/kg and 2976.59 mg/kg) and P (4336.07 mg/kg and 3927.4 mg/kg). Also, physical properties such as length (14.94 mm and 13.64 mm), mass (0.94 g and 0.94 g), geometric mean diameter (12.73 mm and 12.31 mm), sphericity (0.85 and 0.90), diameter (11.76 and 11.70), projected area (1.48 cm^2 and 1.65 cm^2), kernel density (757.47 $kg/m^3$and 752.09 kg/m^3), porosity (41.41% and 39.05%), bulk density (426.50 kg/m^3 and 431.05 kg/m^3), terminal velocity (8.42 m/s and 8.49 m/s), volume (1.32 mm^3 and 1.35 mm^3), repture strenth (1.77 N and 2.06 N), static (0.26–0.33 and 0.20–0.28) and dynamic coefficient (0.22–0.29 and 0.17–0.24) of friction of black myrtle and white myrtle fruits species were measured at 75.72% and 73.91% moisture content levels, respectively. These results show that both myrtle fruits may be useful for the evaluation of dietary information in important food crops.

Keywords Myrtle · *Myrtus communis* · Composition · Minerals · Physical properties

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Nomenclature

D	diameter (mm)
D_g	geometric mean diameter (mm)
L	length of myrtle fruits (mm)
M	mass of myrtle fruits (g)
Pa	projected area (cm^2)
ρ_b	bulk density (kg/m^3)
ρ_f	true density (kg/m^3)
q	torque arm (cm) (10.5 cm)
T_m	average value of the torque (Ncm)
V	volume of fruit (mm^3)
V_t	terminal velocity (m/s)
W	sample weight (10 N)
$Ø$	sphericity of myrtle fruits
ε	porosity of myrtle fruits (%)
μ_s	static coefficient of friction
μ_d	dynamic coefficient of friction

Introduction

Myrtle (*Myrtus communis* L.) is a typical representative of the Mediterranean flora. It is a pleasant annual shrub growing in several regions all over the world. In addition, myrtle tree is sometimes cultivated in home gardens. It is distributed in Asia, Africa, America and Europe (Davis

1982; Akgül 1993; Chalchat et al. 1998; Özek et al. 2000; Özcan and Chalchat 2004; Senatore et al. 2006). In Turkey, myrtle tree is found growing in pine forests and riversides, particularly in the Taurus mountains, from just above sea level to 500–600 m. Myrtle is called as “hambeles”, “mersin” or “murt” in Turkish. Its leaves are commonly known due to its presence of essential oils and their composition determine the specific aroma of plants and the flavour of the condiment. Several uses of this plant oil are known for culinary purposes. Its fresh and/or dried leaves oils are used in cosmetics sauces, confectionery and beverage industry (Karamanoğlu 1972; Akgül and Bayrak 1989; Boelens and Jimenez 1992; Akgül 1993; Oğur 1994; Özek et al. 2000).

Myrtle leaves contain some important constituents with aromatic and medicinal properties. Various constituents of *M. communis* leaves were found to be pharmacologically active. The essential oil of *M. commumis* leaves has been the subject of many chemical and pharmacological studies. Also, leaves and berries of this plant have been used internally as antimicrobic, for constipation, appetizing, antihemorrhagic and externally for wound healing (Garg and Dengre 1988; Özek et al. 2000; Twaij et al. 1989). The berries of this plant are very astringent and are used as a condiment as a substitute for pepper (Canhoto et al. 1998). At the folk medicine, leaf and fruits decoction or infusion of this plant are used as stomachic, hypoglysemic, cough and oral diseases, antimicrobic, for constipation, appetizing, antihemorrhagic and externally for wound healing (Baytop 1984; Duke 1988; Twaij et al. 1989; Oğur 1994; Özek et al. 2000). The oils extracted by steam distillation of fruits are used both in flavour and fragrance industries (Doğan 1978; Lawrence 1989).

The objective of this work was to determine the chemical composition, mineral content and physical properties such as length, mass, diameter of fruit, volume, geometric mean diameter, bulk density, porosity, projected area and fruit density of myrtle fruits.

Materials and methods

Materials

Myrtle (*Myrtus communis* L.) fruits were collected from plants growing wild in Mersin province (Büyükeceli-Gülnar) of Turkey in October 2006. All foreign matter, crushed and immature fruits were removed. The initial moisture content of fruits was determined by using a standard method and was found to be 75.72 and 73.91% (dwt) at the 105 °C±2 for 24 h.

Biochemical analyses

Biochemical compositions (moisture, crude oil, crude protein, ash, pH, acidity and water- and alcohol soluble extract, malic, tartaric and citric acids) were analysed according to AOAC (1984). Nitrogen was determined by the micro-Kjeldahl method, described by AOAC (1984) and the percentage nitrogen was converted to crude protein by multiplying by 6.25. The crude fat was determined by extracting a known weight of powdered fruit sample with petroleum ether, using a Soxhlet apparatus; the ash content was determined by incineration at 600±15 °C (AOAC 1984).

For organic acids extraction, approximately 500 g of each frozen sample were used and each replicate was used separately, then from this homogenized material 1 g of sample was weighed and powdered with liquid nitrogen in a mortar and mixed with 20 ml of aqueous meta-phosphoric acid (3%) at room temperature for 30 min using a shaker. This mixture was filtered and made up to 25 ml with the same solvent, then used for HPLC analysis.

The high-performance liquid chromatographic apparatus (Shimadzu LC 10A vp, Kyoto, Japan) consisted of an in-line degasser (DGU-20A5), pump and controller coupled to a photodiode array detector (Shimadzu SPD-M20 A) equipped with an automatic injector (20 μL injection volume) interfaced to a PC running Class VP chromatography manager software (Shimadzu, Japan). Separations were performed on a 250 mm 4.6 mm i.d., 5 μm, reverse-phase Inertsil ODS3 analytical column (GL Sciences, Japan) operating at 30 °C (column oven CTO-10AS vp) with a flow rate of 0.5 ml/min. Detection was carried out with a sensitivity of 0.1 a.u.f.s. between the wavelengths of 200 and 360 nm. Elution was isocratic with 0.5% aqueous meta-phosphoric acid. Components were identified by comparison of their retention times to those of authentic standards under analysis conditions and UV spectra with an in-house PDA library. A 10 min equilibrium time was allowed between injections. All the samples were directly injected to the reverse phase chromatography column. For the stock solution of the organic acid standards, L-ascorbic acid, malic acid, tartaric acid and citric acid, were dissolved in methanol at a concentration of 1 mg/ml. All samples and standards were injected three times each and mean values were used (Kafkas et al. 2006).

Determination of mineral contents

About 0,5 g of dried and ground black and white myrtle fruits was put into burnig cup with 15 ml of pure NHO_3. The sample was incinerated in a MARS 5 microwave oven at 180 °C. Distilled deionized water and ultrahigh-purity commercial acids were used to prepare all reagents, standards, and walnut samples. After digestion treatment, samples were filtrated through whatman No 42. The filtrates were collected in 50 ml Erlenmayer flasks (and analysed by ICP-AES). The mineral contents of the samples were quantified against standard solutions of known concentrations (Skujins 1998).

Working conditions of ICP-AES:	
Instrument:	ICP-AES (Varian-Vista)
RF Power:	0,7–1,5 kw (1,2–1,3 kw for Axial)
Plasma gas flow rate (Ar):	10,5–15 L/min. (radial) 15″ (axial)
Auxilary gas flow rate (Ar):	1,5″
Viewing height:	5–12 mm
Copy and reading time:	1–5 s (max.60 s)
Copy time:	3 s (max. 100 s)

Determination of physical properties

All physical properties of the black myrtle fruits 73.91% and white myrtle fruits 75.72% (m.c.d.b.) were determined at natural moisture content at 20 repetitions.

To determine the size of the fruits, ten groups of samples consisting of 100 fruits have been selected randomly. Ten fruits have been taken from each group and their linear dimensions—length, diameter and projected areas have been measured. A micrometer (Mitotyo, 0–150 mm) measured linear dimensions to an accuracy of 0.01 mm.

Projected area (P_a) of fruits was determined by using a digital camera (Canon A 200) and Sigma Scan Pro 5 program (Trooien and Heermann 1992). The weights of fruits mass (*M*) were measured by an electronic balance to an accuracy of 0.001 g.

The bulk density (ρ_b) was determined with a hectoliter tester, which was calibrated in kg per hectoliter (Deshpande et al. 1993). The black and white myrtle fruits were dropped down into a bucket from a height of approximately 15 cm. The excess fruits were removed by sweeping the surface of the bucket. The fruits were not compressed in any way.

Table 1 Physical and biochemical properties of black and white myrtle fruits

Properties	Values	
	Black	White
Dry matter (%)	24.28±2.34[a]	26.09±1.17
Weight (g)	0.88±0.09	0.88±0.11
Crude oil (%)	3.48±0.45	3.45±0.32
Crude protein [b] (%)	7.47±0.53	6.36±0.34
Ash (%)	3.02±0.17	2.30±0.32
Titratable acidity (%)	0.10±0.01	0.10±0ç03
pH	4.39±0.76	4.59±0.82
Malic acid (%)	0.30±0.03	0.17±0.05
Citric acid (mg/L)	1104.85±11.27	732.69±7.62
Tartaric acid (mg/L)	0.30±0.02	0.29±0.03

[a] mean±standard deviation

[b] Nx6.25

Table 2 Mineral contents of black and white myrtle fruits

Minerals (mg/kg)	Values	
	Black	White
Al	103.65±8.43[a]	108.11±8.56
B	58.50±6.39	56.47±17.64
Ca	6719.88±79.99	4676.14±87.65
Cu	12.79±0.24	9.52±0.21
Fe	105.31±2.66	61.40±1.85
K	22647.78±375.55	18339.84±293.47
Mg	2145.19±16.49	1408.88±20.69
Mn	42.09±1.20	27.72±0.79
Mo	0.91±0.139	0.96±0.428
Na	3336.16±435.73	2976.59±139.29
Ni	1.62±0.08	1.51±0.66
P	4336.07±333.94	3927.4±167.59
Pb	1.82±1.66	0.77±0.864
Se	1.54±0.70	1.12±0.36
Zn	43.41±1.10	36.89±0.19

Drymatter

[a] mean±standard deviation

The myrtle volume (*V*) and its fruits density (ρ_f), as a function of moisture content, were determined by using the liquid displacement method. Toluene (C_7H_8) was used instead of water because grains to a lesser extent absorb it. Also, its surface tension is low, so that it fills even shallow dips in a grain and its dissolution power is low (Mohsenin 1970; Sitkei 1976).

The porosity (ε) was determined by the following equation:

$$\varepsilon = 1 - \rho_b/\rho_f \quad (1)$$

(Mohsenin 1970; Thompson and Isaacs 1967).

Hardness of myrtle, were determined with Test Instrument of Biological Materials using the procedure described by Aydın and Öğüt (1991). The device has three main

Table 3 Dimensional properties of black and white myrtle fruits

Properties	Black	White
Mass (g)	0.94±0.02	0.94±0.02
Length (mm)	14.94±0.15	13.64±0.14
Diameter (mm)	11.76±0.11	11.70±0.11
Geometric mean diameter (mm)	12.73±0.12	12.31±0.11
Sphericity	0.85±0.004	0.90±0.00

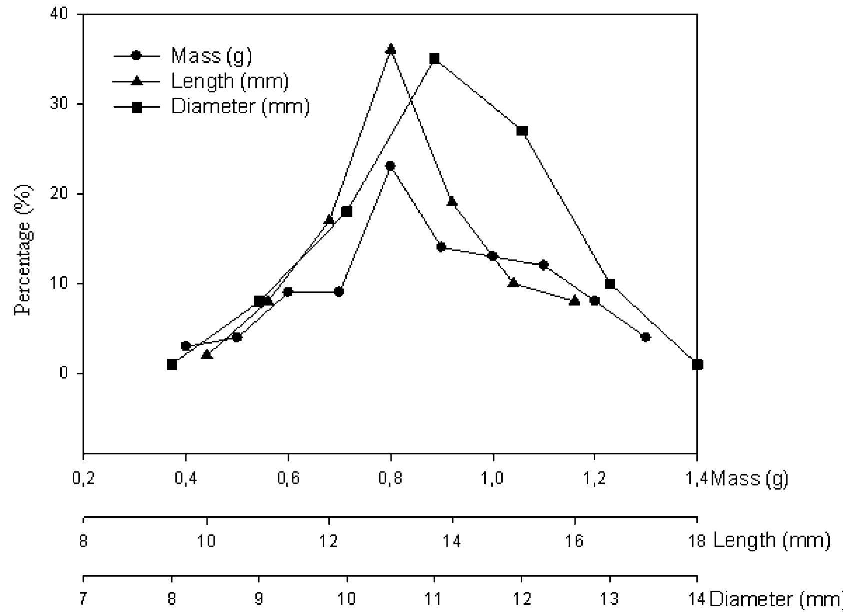

Fig. 1 Frequency distribution curves for diameter and lenght, mass of black myrtle fruits at a moisture content of 75.72% d.b.

components, which are stable up and motion bottom of platform, a driving unit (AC electric motor and electronic variator) and the data acquisition (Dynamometer, amplifier and XY recorder) system. Hardness force of myrtle was measured by the data acquisition system. The fruit was placed on the moving bottom platform and was pressed with stationary platform. Probe used in experiment with 1.20 mm diameter was connected to dynamometer. Experiment was conducted at a loading velocity at 50 mm/min.

The terminal velocities (V_t) of myrtle fruits were measured using an air column. For each test, a sample was dropped into the air stream from the top of the air column, up which air was blown to suspend the material in the air stream. The air velocity near the location of the seed suspension was measured by electronic anemometer having a least count of 0.1 m/s (Joshi et al. 1993; Hauhouout-O'hara et al. 2000) (Fig. 2).

Geometric mean diameter (D_g) and sphericity ($Ø$) values were found using the following formula; (Mohsenin 1970).

$$D_g = (LD^2)^{0.333}$$
$$Ø = (LD^2)^{0.333}/L$$

The coefficient of friction myrtle fruits were measured using a friction device modified by Tsang-Mui-Chung et al. (1984) and improved by Chung and Verma (1989). Also, both the static and dynamic coefficient of friction with an

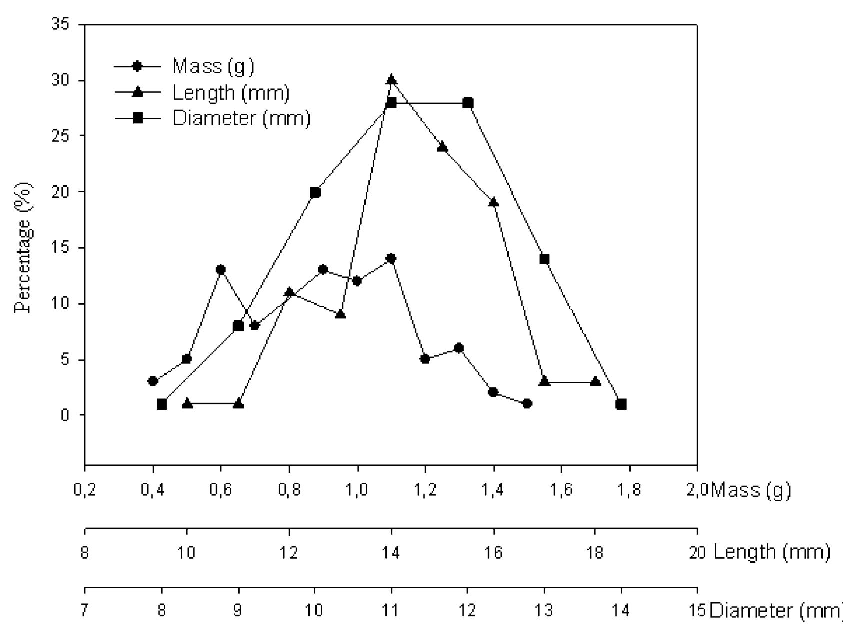

Fig. 2 Frequency distribution curves for diameter and lenght, mass of white myrtle fruits at a moisture content of 73.91% d.b.

applied torque was measured and calculated using the equation (Chung and Verma 1989).

$$\mu_s = Ta/W.q \quad \mu_d = Tm/W.q \tag{3}$$

Statistical analyses

Results of the research were analysed for statistical significance by analysis of variance (Püskülcü and İkiz 1989). This research was performed by three duplicates with a replicate.

Results and discussion

Biochemical properties and mineral contents

The composition and mineral contents of the black and white myrtle fruits growing wild in Turkey are presented in Table 1. Fresh weights of black and white myrtle fruits were determined as average 0.885 and 0.884 g. Proximate compounds (%) for black and white fruits were: 7.47 and 6.36 protein, 3.48 and 3.45 oil, 3.02 and 2.30 ash, 24.28 and 26.09 dry matter, 21.61 and 24.865 water-soluble extract and 17.535 and 18.92 alcohol-soluble extract, respectively. Ash, crude protein, crude oil and water soluble extract contents of both samples were clearly higher according to findings to Demir and Özcan (2001), Özcan and Hacıseferoğulları (2007) and Özcan et al. (2005) (except for water soluble extract). These differences could be probably due to growth conditions, environmental factor,and fruit variety and sizes. Aydın and Özcan (2007) studied the nutritional and physical properties of white myrtle fruit. They established 2.37% oil, 4.17% protein, 17.41% crude fiber, 0.725% ash and 52.94% water-soluble extract. In addition, pH, tartaric, malic and citric acid contents for both fruits were established as 4.39 and 4.59; 0.30 mg/100 g and 0.29 mg/100 g; 0.30 mg/100 g and 0.17 mg/100 g and 1104.85 mg/100 g and 732.69 mg/100 g, respectively. The amounts of citric, malic and ascorbic acids were reported as 3.21, 1.11 and 0.19 g/kg of FW in strawberry fruits by Perez et al. (1997). Tartaric, malic and citric acid contents of some apple cultivars ranged from 0.014 to 0.030 mg/L, 2.73 to 7.07 mg/L and 0.044 to 0.093 mg/L, respectively (Wu et al. 2007).

The mineral contents of black and white myrtle fruits were determined by ICP-AES (Table 2). Fruits were found to be rich in some minerals such as Ca (6719.9 mg/kg and 4676.1 mg/kg), K (22647.8 mg/kg and 18339.8 mg/kg), Mg (2145.2 mg/kg and 1408.9 mg/kg), Na (3336.2 mg/kg and 2976.6 mg/kg) and P (4336.1 mg/kg and 3927.4 mg/kg). Özcan et al. (2005) reported as 3046.37 mg/kg Ca, 1477.88 mg/kg P, 13531.96 mg/kg K, 1502.55 mg/kg Mg and 312.18 mg/kg Na in hawtorn fruit. Also, Özcan and Hacıseferoğulları (2007) established 4959.02 mg/kg Ca, 14909.08 mg/K, 1315.57 mg/kg Mg, 3668.56 mg/kg P and 701.26 mg/kg Na in strawberry fruits. Demir and Özcan (2001) determined 890.5 and 1023.9 mg/kg K, 1,850 and 2,200 mg/kg P, 162.7 and 183.9 mg/kg Mg and 146.7 and 133.3 mg/kg Ca in rose fruit samples growing wild in Hadim

Table 4 The correlation coefficient of myrtle fruits

Particulars	Ratio	Degrees of freedom	Correlation coefficient
a. Black myrtle fruits			
D/M	12.44	98	0.91[a]
D/L	0.787	98	0.75[a]
D/Dg	0.92	98	0.97[a]
D/Ø	13.83	98	0.30[a]
b.White myrtle fruits			
D/M	12.36	98	0.93[a]
D/L	0.85	98	0.81[a]
D/Dg	0.95	98	0.97[a]
D/Ø	13.00	98	0.11

[a] significant at 1% level

Table 5 Some technological properties of black and white myrtle fruits

Properties	Black	White
Volume (mm^3)	1.32±0.11	1.35±0.12
Kernel density (kg/m^3)	757.47±31.32	752.09±31.88
Bulk density (kg/m^3)	426.50±2.61	431.0±4.45
Porosity (%)	41.41±2.11	39.05±2.32
Projected area (cm^2)	1.48±0.04	1.65±0.05
Terminal velocity (m/s)	8.42±0.10	8.49±0.21
Repture stregth (N)	1.77±0.14	2.06±0.21

Table 6 Relationships between friction coefficients and moisture content of black and white myrtle fruits for various material surfaces

Materials	Static friction coefficient	Dynamic friction coefficient
a. Black myrtle fruits		
Galvanized steel	0.26±0.07	0.22±0.06
Iron sheet	0.29±0.09	0.25±0.09
Plywood	0.33±0.09	0.29±0.09
b. White myrtle fruits		
Galvanized steel	0.20±0.07	0.17±0.06
Iron sheet	0.23±0.07	0.19±0.07
Plywood	0.28±0.08	0.24±0.07

(Konya) and Kastamonu provices, respectively. Calcium is the major component of bone and assists in teeth development (Brody 1994). Decreasing of toxic elements (Al, Cu, Ni, Pb, Zn) contents is an advantage. The highest mineral contents were P, K, Ca, Mg, Na and P. This work attempts to contribute to knowledge of the nutritional properties of these seeds. These findings may be useful for dietary information, which requires prior knowledge of the nutritional composition of edible fruits. The high organic acid contents and the pleasent taste suggest that this fruit can be of use in the food industry. The consumption of myrtle fruits is rising around the world owing to the increasing popularity of natural products. It may be useful for the evaluation of dietary information in important food crops.

Physical properties

Dimensional properties, sphericity and the values of geometric mean diameter of the black and white myrtle fruits are given in Table 3. The frequency distributions of these fruits and dimensional properties are given in Figs. 1 and 2. At the same time, these values are shown in Table 4. Some technological properties of myrtle fruits used in experiment are shown in Table 5. Similar investigations have been made to evaluate the projected area, volume, bulk density, fruit density and terminal velocity by Demir and Özcan (2001) for rose fruits. The static and dynamic coefficients of friction for myrtle fruit determined with respect to iron sheet and galvanized steel surfaces are represented in Table 6.

Ninety six percent of the measured black myrtle fruits between 0.5 and 1.4 g in terms of moisture content of 73.91% in weight, 96% of them is between 11 and 17 mm in length, 98% of them is between 9 and 14 mm in diameter.

Ninety five percent of white myrtle fruits is between 0.5 and 1.4 g in terms of moisture content of 75.72% in weight, 92% of them is between 10 and 16 mm in length, 98% of them is between 9 and 14 mm in diameter.

The following general expression can be used to describe the relationship among the average dimensions black myrtle at 75.72% (d. b.) moisture content:

$$D = 0.787 \times L = 12.444 \times M = 0.924 \times Dg = 13.835 \times Ø$$

The relationship between diameter, length, weight, geometric mean diameter and sphericity of white myrtle has been determined at the 73.91% moisture level. This relationship was found to be as the follows.

$$D = 0.857 \times L = 12.368 \times M = 0.950 \times Dg = 13.0 \times Ø$$

The coefficients of correlation (Table 4) show that the *D/L, D/M, D/Dg* and *D/Ø* rations of white myrtle fruit were found significant.

While the fruit density, porosity and projected area values of medlar fruits were established high, bulk density value was found low according to literature value (Demir and Özcan 2001). In addition, volume, projected area and terminal velocity values of medlar fruits were found higher than those of Demir and Özcan (2001). At the same moisture contents, both the static and dynamic coefficients of friction were greatest for myrtle fruits on iron sheet.

Conclusions

These findings may be useful for dietary information, which requires prior knowledge of the nutritional composition of edible fruits. The high organic acid contents and the pleasent taste suggest that this fruit can be of use in the food industry. Ninety six percent of the measured black myrtle fruits between 0.5 and 1.4 g in terms of moisture content of 73.91% in weight, 96% of them is between 11 and 17 mm in length, 98% of them is between 9 and 14 mm in diameter.

Also, it is important, however, to know, the physical properties of equipment used in plantation, harvesting, transportation, storage and processing of fresh myrtle fruits.

Acknowledgement This study was supported by Selcuk University Scientific Research Project (S.Ü.-BAP, Konya-Turkey). The authors wish to thank to BAP Staffs.

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