



Determination of Some Important Pomological and Biochemical Properties of the Genotypes of Strawberry Tree (*Arbutus unedo L.*) Selected in Bolu Province in Turkey

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ABSTRACT

This study was carried out to determine some important pomological and biochemical characteristics of strawberry tree genotypes selected in Bolu province in Turkey. Twenty genotypes, which were found to be most promising according to the data obtained during the two years in the study, were examined. Fruit length was changed between 15.48-21.44 mm, fruit width was 14.07-21.46 mm and fruit weight was between 2.94-7.47 g in the examined genotypes. Soluble solid contents (SSC) was changed 13.95-21.75%, fruit juice pH value 3.40-3.83, titratable acid (TA) 0.48-0.83%; ash content 0.428-0.848%, moisture content 63.78-77.93%, nitrogen content 0.110-0.300% and protein content 0.760-1.850% respectively. The results obtained suggest that the comparison of that results of the studies done in our country and the international data shows that the genetically domesticated genotypes that have grown in the region constitute a promising potential and that selection studies should be continued under controlled conditions.

Keywords: Arbutus, Biochemical content, Pomology, Strawberry tree.

Türkiye'de Bolu İlinde Seçilen Kocayemiş Ağacı (*Arbutus unedo L.*) Genotiplerinin Bazı Önemli Pomolojik ve Biyokimyasal Özelliklerinin Belirlenmesi

ÖZ

Bu çalışma, Türkiye'de Bolu ilinde seçilen çilek ağacı genotiplerinin bazı önemli pomolojik ve biyokimyasal özelliklerini belirlemek amacıyla gerçekleştirilmiştir. Çalışmada iki yıl boyunca elde edilen verilere göre en umut verici olduğu tespit edilen 20 genotip incelendi. İncelenen genotiplerde meyve uzunluğu 15.48-21.44 mm, meyve genişliği 14.07-21.46 mm ve meyve ağırlığı 2.94-7.47 g arasında değişti. Çözünür katı içerikler (SSC)% 13.95-21.75, Meyve Suyu pH değeri 3.40-3.83, titre edilebilir asit (TA) % 0.48-0.83, kül içeriği % 0.428-0.848, nem içeriği % 63.78-77.93, azot içeriği % 0.110-0.300 ve protein içeriği sırasıyla% 0.760-1.850 değişmektedir. Elde edilen sonuçlar, ülkemizde yapılan çalışmaların sonuçları ile uluslararası verilerin karşılaştırılmasının, bölgede yetişen genetik olarak yerel genotiplerinin umut verici bir potansiyel oluşturduğunu ve seleksiyon çalışmalarının kontrollü koşullarda sürdürülmesi gerektiğini göstermektedir.

Anahtar Kelimeler: Arbutus, Biyokimyasal içerik, Pomoloji, Kocayemiş ağacı.

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1. Introduction

Turkey is the homeland of many fruit species cultured in the world thanks to its geographical location and climate conditions. Many of the fruit species grown for commercial purposes were created in Anatolia and cultivated here. There are many fruit species that are not native to Turkey and brought to Anatolia from different regions of the world and which are easily adapted to the Anatolian climate [1, 2, 3]. One of the fruits species, which is a natural growth area of Turkey, whose value is understood more with the presentation of its content and whose usage areas for nutritional and medical purposes are starting to increase, is undoubtedly strawberry tree *Arbutus spp.* [4, 5, 6].

There are two common species of *Arbutus unedo L.* and *Arbutus andrachne L.* that grow naturally in our kinship country in the *Ericaceae* family. It is reported that *A. unedo* species is widespread in Western Black Sea Region and Marmara Region where Bolu is located and both species naturally grow up in moist wooded areas in Black Sea, Marmara, Aegean and Mediterranean regions above sea level (700-1000 m). It is also reported that it is a plant that is more resistant to cold than others, like siliceous, acidic and granitic soils [3, 7, 8, 9, 10, 11].

It is also called locally as strawberry tree, mountain chisel or strawberry tree in the regions that grows in our country [12, 13, 14, 15]. In general, they have a plant habitat in the form of shrubs or small trees in forest areas. It is also used in landscaping areas with shrub or shrub forms, impressive flowers and fruit with green leaf structure and it is grown for these purposes [4, 9, 16]. Along with all the fruits, the importance of *Arbutus unedo* has increased by their understanding of their nutritional and medical and pharmacological properties. Under the conditions of our country, *Arbutus unedo* blooms between November and March can mature the fruit all year round. In the regions where it naturally grows, it is possible to find its fruits especially in the local markets during the autumn until the end of November [6, 17, 18, 19].

Arbutus unedo fruits are heterogeneous and the shape has a heterogeneous structure in terms of weight, coloration and ripening. Mature fruits are generally round with a diameter of 20-30 mm and red in different tones. Because of its fruity, it has antiseptic, diuretic, laxative properties. Its leaves use in anti-diabetic, hypertension and anti-inflammatory treatment. Both leaves and fruits are anti cancerous thanks to the phenolic substance and antioxidant content of the fruit [20, 21, 22, 23, 24, 25, 26, 27, 28, 29].

Due to these characteristics, research has been started in our country related to this fruit species which has been increasing in importance and emphasis has been given to selection studies in order to determine the type of fruit. Agronomic and medical studies are continuing along with selection studies in the Black Sea Region, especially in the Çanakkale, Marmara and Mediterranean Region [3, 6, 16, 17, 18, 19, 30].

This study was carried out in order to determine and compare some important pomological and biochemical characteristics of the genotypes identified in the selection study that was initiated two years ago in the central district of Bolu and its surroundings, which are accepted as transition areas between the Marmara Region and the Western Black Sea Region, and transfer these characteristics to the national and international data.

2. Material and Methods

2.1. Materials

This study was conducted between 2013 and 2014 in the central districts and affiliated villages of Bolu province. Twenty genotypes selected as important in the study were obtained in two years. Fruit samples were taken from the genotypes in each tree, shrub and shrub form that were grown entirely naturally in forest areas and evaluated based on the weighed scale. Genotypes were labeled by giving the plate code

of the province of Bolu (14), then the genus name abbreviation (KCY) and then the sequence number (e.g 14KCY-01).

2.2. Methods

Genotypes were selected in the first step by considering the fruit characteristics and plant characteristics from the naturally grown populations. In terms of herbal characteristics, criteria such as the form of the tree, being healthy, being at the same age were taken into consideration. Major morphological characteristics affecting fruit quality of 20 selected genotypes are fruit size, fruit weight, fruit shape, soluble solids content (SSC), refractive index, pH of fruit juice, ash ratio, moisture content, titratable acidity, nitrogen and protein ratios were determined. The fruit sizes were made by digital calipers with a sensitivity of 0.01 mm over 10 fruits. The amount of soluble solids content (SSC) was measured by hand refractometer and pH of fruit juice measured by the digital pH meter. Titratable acid is calculated as g / 100 ml in terms of malic acid by titration method. In addition, moisture, ash, nitrogen and protein determinations were determined as percentage values in the samples taken.

3. Results and Discussion

Some important pomological characteristics of the genotypes selected in this study were determined to determine some important fruit characteristics of the genotypes selected in the province and its villages in Bolu province. The pomological characteristics of the genotypes examined are presented in Table 1 and the chemical properties are summarized in Table 2. In addition, mean values of these properties and the variation intervals of these values according to genotypes are given in Table 3. As can be seen from the Table 1, the mean fruit size of the selected genotypes was 18.47 mm. This value varied between 15.48 and 21.44 mm according to the genotypes. The fruit width was found to be 17.31 mm on average and the value ranged from 14.07 mm to 21.46 mm. The shape index values obtained from these values were 1.07 on average. This value varied between 0.95 and 1.18 among the genotypes. All genotypes analyzed according to shape index values were evaluated as "Round" shape (Table 1).

The obtained data are in accordance with the results of other studies conducted in our country and the literature. As a matter of fact, similar results were obtained in selection studies carried out in different regions of Turkey. In the genotypes examined in a study carried out in the Çanakkale region, the fruit length varied between 9.52-29.32 mm and the fruit width varied between 11.15-27.47 mm. Whole genotypes were evaluated as fruit-shaped round [12].

In another research conducted in Trabzon, the fruit length varied between 16.17-24.54 mm and the fruit width ranged from 10.74-17.06 mm, and the genotypes were completely rounded in fruit shape [17]. In different investigation conducted in the Marmara Island genotypes, the fruit length varied between 10.87-27.64 mm and the fruit width varied between 12.81 and 25.64 mm [3]. According to the results of an experiment conducted in Giresun, fruit width average was found as 27.96 mm, fruit size average was found as 24.37 mm [18]. It was reported that the fruit length varied between 9.96-25.07 mm and the fruit width varied between 11.47-29.29 mm [19].

The fruit weight is one of the important selection criteria for *Arbutus unedo*. In the genotypes examined, fruit weight ranged from 2.48 g to 7.47 g, mean fruit weight was found to be 4.39 g. The fruit weights of the selected genotypes are also compatible with those obtained in other studies conducted in our country. As a matter of fact, in a study carried out in the Marmara Island, the fruit weights of the genotypes ranged from 1.14 g to 8.19 g [3].

Table 1. Some important morphological fruit characteristics of genotypes.

Genotypes	Fruit length (cm)	Fruit width (cm)	Shape index	Fruit weight (g)	Fruit Shape	Refractive index
14KCY-01	20.61	19.22	1.07	5.36	Round	1.365
14KCY-02	21.44	18.97	1.13	5.46	Round	1.363
14KCY-03	21.04	21.46	0.98	5.97	Round	1.361
14KCY-04	19.98	17.41	1.15	4.60	Round	1.365
14KCY-05	18.92	18.25	1.04	4.07	Round	1.366
14KCY-06	19.59	16.54	1.18	4.57	Round	1.366
14KCY-07	18.48	17.31	1.07	4.40	Round	1.355
14KCY-08	18.45	15.58	1.18	4.21	Round	1.365
14KCY-09	19.31	17.57	1.10	5.02	Round	1.359
14KCY-10	21.06	21.01	1.00	7.47	Round	1.366
14KCY-11	17.83	16.72	1.07	4.54	Round	1.359
14KCY-12	17.55	18.50	0.95	3.97	Round	1.360
14KCY-13	16.82	16.23	1.04	3.30	Round	1.366
14KCY-14	19.06	18.00	1.06	4.83	Round	1.356
14KCY-15	18.47	17.30	1.07	4.39	Round	1.364
14KCY-16	15.48	14.07	1.10	2.48	Round	1.370
14KCY-17	16.23	15.34	1.06	3.47	Round	1.370
14KCY-18	15.61	15.62	1.00	3.12	Round	1.356
14KCY-19	17.06	16.16	1.06	3.71	Round	1.364
14KCY-20	16.50	14.92	1.11	2.94	Round	1.364

Fruit weights in the genotypes examined in Çanakkale region ranged from 0.96 g to 13.63 g [12]. It is reported that fruit weights, which are low in these two studies, belong to *Arbutus andrachne L.* [3]. In a study conducted in Giresun, the average fruit weight was reported to be 10.71 g [18]. In terms of fruit weight, it can be said that the variation between studies is due to genetic properties. However, the climatic characteristics of the regions where the studies carried out on fruit weights. Especially in the Black Sea Region, high humidity ratio increases the fruit weight together with fruit dimensions. It is also reported that the weight of fresh fruits is close to these values in foreign sources [3, 16].

The values of soluble solid content, fracture index, fruit juice pH, titratable acidity quantity, which are important criteria in the examined genotypes, are given in Table 2 and the average values and variation intervals of these values are given in Table 3.

The average value of SSC in genotypes was 18.94%, which varied between 13.95 and 21.75. The mean pH value in fruit juice was 3.65, which ranged from 3.40 to 3.83. The titratable acid value ranged from 0.048 to 0.083 and was averaged to 0.061 (Table 2).

When compared these values with other studies, there are some differences and close values. As a matter of fact, the amount of soluble substance in water varies between 12.0% and 24.4% in the Marmara study [31]. It was changed between 18.5-32.0% in the study conducted in Trabzon [30].

On the other hand, the study conducted in Çanakkale reported that the mean score of SSC was 16.0% [31]. In a study conducted at Ünye district, it was reported that this value changed between 16.62-24.02% [16]. [13] reported that this value was 32.0% in their study. In another study conducted in Trabzon, it has been reported that the value of SSC varies between 16.50-27.00% [19]. We can say that the values are similar in terms of fruit juice, pH and titratable acidity. As a matter of fact, in a study conducted by [3], it was reported that pH grades changed between 3.86-4.80 and vibrational acid value changed between 0.47-1.68 g / ml [3].

Table 2. Some important biochemical properties in fruit of genotypes.

Genotypes	SSC (%)	PH	Ash (%)	Moisture (%)	Acidity (%)	Nitrogen (%)	Protein (%)
14KCY-01	20.45	3.70	0.569	69.02	0.050	0.180	1.090
14KCY-02	19.50	3.40	0.615	72.16	0.077	0.190	1.170
14KCY-03	18.20	3.52	0.495	73.90	0.055	0.170	1.090
14KCY-04	21.10	3.56	0.682	69.26	0.063	0.110	0.710
14KCY-05	18.44	3.73	0.608	72.15	0.056	0.200	1.280
14KCY-06	20.85	3.60	0.621	67.30	0.055	0.170	1.420
14KCY-07	13.95	3.75	0.486	65.94	0.059	0.210	1.850
14KCY-08	19.40	3.52	0.428	68.15	0.064	0.200	1.240
14KCY-09	15.25	3.77	0.662	66.83	0.049	0.260	1.630
14KCY-10	21.75	3.73	0.540	69.28	0.048	0.130	0.800
14KCY-11	17.00	3.74	0.848	69.93	0.068	0.210	1.320
14KCY-12	17.70	3.56	0.823	66.27	0.083	0.190	1.190
14KCY-13	19.60	3.75	0.689	67.33	0.066	0.120	0.750
14KCY-14	21.10	3.52	0.652	70.26	0.070	0.170	1.090
14KCY-15	19.75	3.81	0.639	67.18	0.059	0.230	1.410
14KCY-16	19.70	3.62	0.544	72.63	0.064	0.200	1.290
14KCY-17	13.60	3.61	0.705	67.20	0.062	0.170	1.070
14KCY-18	15.25	3.83	0.716	68.76	0.049	0.220	1.360
14KCY-19	15.00	3.63	0.585	77.93	0.059	0.170	1.060
14KCY-20	19.80	3.68	0.486	63.78	0.066	0.150	1.620

As a matter of fact, in a study conducted by [3], it was reported that pH grades changed between 3.86-4.80 and vibrational acid value changed between 0.47-1.68 g / ml [3]. Moreover, in a study conducted in Çanakkale, the pH average was around 5.00 [31]. In a study conducted at Ünye, it was reported that the pH values changed between 3.70 and 4.01 and the acidity was 0.4% [16]. Namely it was reported that pH values ranged from 3.41 to 4.25 and titratable acidity values varied from 1.51 to 3.45 [30]. On the other hand this value varied between 0.74 and 2.04% [19]. Also the amount of acidity [TA] in *Arbutus unedo* was around 4% [31]. It can be argued that the changes in SSC and other chemical contents, as well as genetic differences, may change depending on the regional differences and especially on the maturation ratios of the analyzed fruits [3, 16].

Moisture, ash, nitrogen and protein ratios of the selected genotypes were also determined in fruit samples. The obtained values are summarized in Table 3 and the mean values of these values and the intervals of these values are given in Table 3.

Table 3. Mean values and the intervals of important fruit characteristics of genotypes.

Fruit Properties	Average Values	Change Interval
Fruit length (cm)	18.47	15.48-21.44
Fruit width (cm)	17.31	14.07-21.46
Shape index	1.07	0.95-1.18
Fruit weight (g)	4.39	2.94-7.47
Refractive index	1.36	1.35-1.37
Soluble solid content (%)	18.94	13.95-21.75
Fruit juice pH (%)	3.65	3.40-3.83
Ash content (%)	0.63	0.43-0.85
Moisture content (%)	69.51	63.78-77.93
Titratable acidity (%)	0.06	0.05-0.08
Nitrogen content (%)	0.19	0.11-0.30
Protein content (%)	1.22	0.76-1.85

As can be seen from Table 3, the ash contents in the fruits ranged from 0.428% to 0.848% and the average value was calculated as 0.63%. As it known, the ash content is an important fruit feature in terms of revealing the mineral content of the fruits. This property is also consistent with the results of other studies. As a matter of fact [15] reported that the rate of ash in the samples was 2.82% and the obtained proportion can be considered low.

Nitrogen content in the examined genotypes was 0.190% on average, and this value varied from 0.110% to 0.300% according to the genotypes. Protein ratios in the genotypes parallel to the nitrogen ratio have similar results. As a matter of fact, the average protein ratio was 1.220% and this value varied between 0.760% and 1.850% according to the genotypes. These values are in accordance with other study results. In a study conducted, it was reported that the crude protein ratio in the genotypes examined was 3.36% [13].

4. Conclusions

As a result, *Arbutus unedo* has become a type of fruit which has recently been emphasized both abroad and in our country, with its full content and health implications. It has been shown that the genotypes which are examined in this study conducted in and around Bolu province, which is a transit point between the Black Sea Region and the Marmara Region, it was determined that the genotypes examined are promising in terms of fruit characteristics.

At the same time, this study is also important in terms of revealing the potential of the area. If these values are thought to be derived from natural plants that grow in completely natural conditions and have no cultural practice, it is possible to say that these genotypes will have superior values when cultivated under controlled conditions. In this respect, it is necessary to determine the appropriate varieties and to provide the cultivars as standard varieties by considering the continuity of these studies as beginning and the usage purposes

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