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ORIGINAL PAPER

INVESTIGATIONS ON SOME PROPERTIES OF CURRANT AND GOOSEBERRY VARIETIES GROWN IN ORGANIC CONDITION

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Abstract

Berry species as strawberry, raspberry, blackberry, currant, gooseberry, blueberry, cranberry are widely consumed in the world. Particularly existence of vitamins, minerals and phenolic components in their content makes these species quite valuable and important. The research focusing on currants with high functional properties and that have positive impacts on health is quite limited. Thus, the current study was designed to investigate some of the currant and gooseberry species for 2010-2011 that can be grown in Black Sea Region, where offers a great potential for organic agriculture. Four currant (Ribes nigrum, Ribes rubrum) species (Ojebyn, Jonkheer van Tets, Tatran, Detvan) and a gooseberry (Ribes uva-crispa) specie (Mucurines) cultivated organically were used as the research material. Botanic, phenological characteristics, natural antioxidant contents and antioxidant capacities of these varieties were determined. According to the results, values for total phenolic components of currant samples were found between 3048.58-5435.01 µg GAE/g fw; total anthocyanin between 110.63-686.50 µg cyd-3-glu/g fw; ascorbic acid between 15.50-37.36 mg/100ml; FRAP between 9.35-13.72 µmol TE/g fw and TEAC between 10.58-20.13 µmol TE/g fw. The values of gooseberry samples were found as total phenolic components 2533.08 µg GAE/g fw; ascorbic acid 13.07 mg/100ml; FRAP 4.42 µmol TE/g fw and TEAC 6.00 µmol TE/g fw.

Keywords: Currant, Gooseberry, Botanic Characteristics, Phenological Characteristics, Antioxidant Capacity

INTRODUCTION

Currants and gooseberries belong to the genus *Ribes*, which consists of approximately 150 species distributed predominantly in northern temperate regions. At present, 10-12 *Ribes* species are cultivated for fruit production, the vast majority of which are black currants (*Ribes nigrum* L.), red and white currants (*Ribes sativum* Syme, *Ribes petraeum* Wulf. and *Ribes rubrum* L.) and gooseberries (*Ribes glossularia* L. and *Ribes hirtellum* Michx.). *Ribes* is a small but economically high value crop and is increasingly recognized as a rich source of vitamin C and anthocyanins, both of which are important for human health. In particular, there is growing interest in expanding *Ribes* production to countries and regions that previously did not cultivate *Ribes* crops, such as the U.S.A. In Europe, which accounts for 99% of *Ribes* cultivation, production had risen by 24% between 1998 and 2007, with Poland being the world's largest producer (Mitchell et al, 2011). Many currant types are monoic but there are also some dioic types like R.alpinum. Whereas commercial types of currants have blossom number of 6-12 on each bunch, red currant's blooming is higher its blossoms are generally inferior and pentamerious (Colak and Alan, 2017; Okatan and Aşkın, 2017).

Strawberry, raspberry, blackberry, currant, gooseberry, blueberry and cranberry are widely consumed berry species in the world. Particularly existence of vitamins, minerals and phenolic components makes these species quite valuable and important. There is a growing interest for inclusion of berries, particularly currants, in human nutrition mainly for the health benefits associated with their consumption (Okatan et al., 2017).

With their special colors, flavors and aroma, fruits from berry species are freshly consumed and there are many fields in food industry that these species are used. These fields include production of fruit juice, concentrated juices, jelly, jam, marmalade, composte, sweets, ice cream, cake and biscuits, liquor, champagne, fruit essence, fruit tea, fruit yoghurt. They are also used in parks and gardens as decoration plants and as inputs of many medicines. Therefore, they have a special position among fruit species (Pehluvan and Guleryuz, 2004).

Currants with their rich content of C vitamin have an important stance in diets of Europeans with their vitamin contents as they include vitamin C 4-5 times more than citrus fruits. As the production of currents in

Turkey is very limited, they are not included in agricultural statistics (Erenoglu and Ozturk, 2002; Okatan, 2018).

As well as making berry fruit cultivation common, developing suitable species, performing adaptation studies in different species, raising awareness on cultivation techniques and providing knowledge of the most accurate production technique have been gaining importance (Colak, 2018).

The research focusing on currants with high functional properties and that have positive impacts on health is quite limited. Thus, the current study was designed to investigate some of the currant and gooseberry species for 2010-2011 that can be grown in Black Sea Region, where offers a great potential for organic agriculture.

MATERIAL AND METHOD

The current study was conducted in 2010 and 2011 in a sample fruit garden established by Nuhoglu Foundation in Hayrat district of Trabzon province of Turkey in 2006. The garden has an organic certificate (ECOCERTSA F32600 (TR OT 03) Certificate No: 5360TR0800Z1t) awarded by EcocertSA. In the study, one of the gooseberry species, Mucurines and four different species of currant aged for four years were used. The currant species were Ojebyn having black colored fruits and Jonkheer van Tets, Tatran, Detvan having red colored fruits. The study was carried out in line with randomized plots experimental design.

Phenological Characteristics

First Blossoming Period

The period when 5-10 % of the flowers were opened was recorded as the first flowering date.

Full Blossoming Period

The period when 70 % of the flowers were opened was recorded as the full flowering date.

First Harvest Period

The date when the first fruit was harvested was determined by completing the development of the fruits and having their own taste and aroma.

Final Harvest Period

that the date when the harvest period of the fruits was completed and the last fruits were harvested.

Botanic Characteristics

Plant Length

The above-ground part was measured by steel tape measure (cm) at the end of vegetative development in order to determine the developmental status of the plants,

Number of Shoots in a Plant

The shoots from the main plant were counted and divided into the number of plants to examine development level of plants.

Number of Bunches

Bunches in the plants were counted in each replica of Currant varieties. A single fruit formation was observed in the bunch of gooseberry fruits.

Number of Fruits in a Bunch

The fruits of all bunches were counted and determined by dividing the number of berries. Since the fruits of Gooseberry variety did not produce more than one fruit, the total number of fruits in the plant was determined.

Productivity

The fruits of the varieties were carefully collected in the harvesting period to determine the yield and weighed on the sensitive scale to determine the average fruit weight in grams and multiplied by the average number of fruits in the plant.

Physical Characteristics

Fruit Weight

The average fruit weight was calculated by weighing 10 randomly selected fruits, which were taken during the harvest period.

Fruit Length and Fruit Width

The average length and width of 10 fruits that were taken randomly were measured with digital caliper and the average length and average width of the fruits belonging to the varieties were determined.

Fruit Color

Color measurement of varieties was made with Konica Minolta CR-400 brand color measuring device. Color was expressed as L (100 aperture; 0 dark), a (+ red; - green), b (+ yellow; blue). White ceramic was used in standardization of the device.

Chemical Characteristics

Soluble Solid Content (SSC)

The SCS value of the fruits were read by dripping the sufficient fruit juice, which was obtained by filtering from the cheesecloth, into the prism of the Greinorm brand hand refractometer.

pH

The pH value of the fruit was measured with the Hanna brand pH meter.

Titratable Acidity (TA)

Ten randomly selected fruit samples were taken into consideration in order to determine the acidity of the fruit. Homogeneous fruit juice mixture was obtained by squeezing the fruits. 10 ml of juice and 20 ml of pure water were placed in the beaker at room temperature. The electrode of the digital hand pH meter was immersed in this mixture and 0.1 N NaOH was added with stirring until the pH meter reached 8.1 (acid-base conversion point in fruit juice). Then all values were determined in the following formula and total acidity was found as % citric acid (Karaçalı, 2002).

% Acidity: (total amount of NaOH consumed x 0.1 x 0.061 / 10 (10 ml fruit juice)) x 10 Base Normality: 0.1 Miliekivalan Value of Citric Acid: 0.061

Determination of Natural Antioxidant Content and Antioxidant Capacity

Determination of Vitamin C

Spectrophotometric method was used to determine level of vitamin C. The 2,6-Diklorofenolindefenol (2,6-D) dye was reduced by utilization of ascorbic acid. For this purpose, standard solution was obtained with solutions prepared with oxalic acid, ascorbic acid and 2,6-D dye. 10 ml squeezed juice was diluted 10 fold with oxalic acid and 1 ml was put in each of the two tubes. Then one of these solutions was mixed with 9 ml of distilled water and the other with 9 ml of 2,6-D dye. The obtained solutions were read on the spectrophotometer at a wavelength of 518 nm. Abs value was placed by the standard curvature and the corresponding amount of ascorbic acid was detected. Since the fruit juice was diluted 10 fold, the result was multiplied by 10 and given in mg/100 ml (Hısıl, 1993).

Determination of Total Phenolic Compounds

The total amount of phenol was prepared using Folin-Ciocalteu’s chemical as described by Singleton and Rossi (1965). Fruit extract, Folin-Ciocalteu's chemical and pure water were mixed with 1:1:18 ratios and kept stable for 8 minutes. Then 7% sodium carbonate was added. After two hours of incubation under darkness, the absorbance of a bluish color solution was measured at the spectrophotometer at a wavelength of 750 nm. The results were calculated as μg gallic acid equivalent/g fresh weight.

Total Anthocyanin Determination

Total anthocyanin content of the fruit was determined according to the absorbance values obtained at different pH intervals spectrophotometrically (Giusti et al., 1999). To measure the diluted extracts, pH 1.0 (hydrochloric acid-potassium chloride) and pH 4.5 (acetic acid-sodium acetate) buffer solutions were prepared and measurements were made at 510 and 700 nm wavelengths. The total anthocyanin content was calculated using the cyanidine-3-glycoside equivalent (molar extinction coefficient = 29600) and the absorbances using the formula $A=[(A_{510}-A_{700})_{pH\ 1.0} - (A_{510}-A_{700})_{pH\ 4.5}]$. Results were expressed as μg cyanidin-3-glycoside/g fresh weight.

Determination of Total Antioxidant Capacity

The antioxidant capacity of the samples were determined by two different methods ; FRAP (Ferric Reducing Antioxidant Power) and TEAC (Trolox Equivalent Antioxidant Capacity), which were recommended by Özgen et al. (2006) and commonly used for plant materials.

For FRAP analysis, buffer solution was prepared as indicated by Benzie and Strain (1996). Then, 2.98 mL of the prepared buffer solution was added to 20 µL of the fruit extract and allowed to stand for 30 minutes. The absorbance value of the extract was measured on the spectrophotometer at a wavelength of 593 nm. The absorbance values obtained were calculated with Trolox (10–100 µmol/L) standard slope chart and µmol Trolox Equivalent/g fresh weight was determined.

For TEAC analysis, according to the method used by Rice-Evans et al. (1995) and modified by Özgen et al. (2006) 2.98 mL of the prepared buffer solution was added to 20 µL of fruit extract and after 10 minutes, the absorbance was measured at 734 nm at the spectrophotometer. The absorbance values obtained were calculated with Trolox (10–100 µmol/L) standard slope chart and µmol Trolox Equivalent/g fresh weight was determined.

RESULTS AND DISCUSSION

Phenological Characteristics

It was determined that the currant species used in the current study, had blossomed in April-May and had started to ripe in June-July and became ripe enough to be eaten in June-August. Gooseberry species Mucurines had blossomed in April and started to ripe in June-July (Table 1).

Table 1. Some Phenological Data of the Species of Currant and Gooseberry for the Period of 2010 and 2011

Species	Years	First blossoming period	Full blossoming period	First harvest period	Final harvest period
Tatran	2010	28.04	10.05	12.07	06.08
	2011	22.04	02.05	01.07	31.07
Detvan	2010	29.04	05.05	07.07	26.07
	2011	15.04	22.04	27.06	17.07
Jonkheer van Tets	2010	02.04	13.04	07.06	27.06
	2011	14.04	24.04	16.06	08.07
Ojebyn	2010	21.04	04.05	02.07	26.07
	2011	12.04	20.04	25.06	17.07
Mucurines	2010	18.04	21.04	25.06	10.07
	2011	10.04	17.04	20.06	08.07

Erenoglu et al. (2003) identified the maturing period of currants in Yalova ecology as the third week of June and the first week of July. Kaplan and Akbulut (2006) identified their first blossoming period in the conditions of Çarşamba Plain of Samsun province of Turkey as April 9 – April 26 and their full blossoming period as April 15 – May 10. Their first harvesting period was determined as June 17 – July 8, and their final harvesting period as June 24 – July 12. Goktas et al. (2006) identified first blossoming period in the conditions of Eğirdir district of Isparta province of Turkey as April 4 – May 1, final blossoming period as April 20 Nisan and May 19, maturing period of the fruits as June 19 – July 18.

Erenoglu et al. (2003) identified the maturing period of gooseberry species. White Smith as the third week of June; Rote Triump and Whinham's Industry as mid-June in Yalova ecology.

The above-mentioned periods were approximately similar with the period of the current study. The differences between the previous findings and current research findings seemed to have stemmed from species, climatic factors and cultural operations.

Botanic Characteristics

While the species having the highest plant length was determined to be Detvan among the currant species according to average lengths of 2010 and 2011 with 118.40 cm, the species having the smallest plant length were Tatran species with 106.90 cm (Table 2).

Kaplan and Akbulut (2006) found the length of shoots ranging between 74 and 137 cm; Goktaş et al. (2006) found the plant length ranging from 98.50 and 150 cm; Eyduran and Agaoglu (2007) reported that the lengths of shoots as average of years were between 58.9 and 97.0 cm. Though our findings and the previous findings reported were similar to each other, there were some differences that might have stemmed from the differences between the species investigated and ecology.

When the average of two years was considered, the highest number of shoots among the currant species was determined to be 56.00 (Jonkheer van Tets) and the smallest number was found to be 24.10 (Detvan) and 20.20 (Tatran) (Table 2).

Goktas et al. (2006) stated that in terms of the number of shoots, Bursa Kırmızısı (51.5) and Tokat 4 (51.0) species come to the fore. The findings reported in the literature were similar to our findings.

Table 2. Data related to Plant Length, the Number of Shoots in a Plant, the Number of Bunches, the Number of Fruits in a Bunch and Productivity of Currant Species in 2010 and 2011

Species	Plant length (cm)	Number of shoots in a plant	Number of bunches	Number of fruits in a bunch	Productivity (g)
Tatran	106.90 b	20.20 c	62.30 b	6.80 a	305.35 a
Detvan	118.40 a	24.10 c	25.20 c	5.20 b	80.65 c
Jonkheer van Tets	112.10 ab	56.00 a	78.10 a	3.40 c	202.45 b
Ojebyn	112.30 ab	33.90 b	27.20 c	3.00 c	72.78 c
Average	114.60	33.50	48.10	4.60	165.30

For plant length LSD species $_{(\%5)}$: 8.93; for the number of shoots LSD species $_{(\%5)}$: 7.08;
For the number of bunches LSD species $_{(\%5)}$: 12.16; for the number of fruits in a bunch LSD species $_{(\%5)}$: 0.95;
For productivity LSD species $_{(\%5)}$: 50.18

Kaplan and Akbulut (2006) determined the number of shoots between 2.4 and 14.8; Eyduran and Agaoglu (2007) between 6.15 and 14.30. These findings were too different in comparison with our findings. The cause of this difference could be attached to differences in species investigated and adaptation capacities shown by different species in ecologic conditions.

When the averages in currant species for 2010 and 2011 were examined, it was seen that the highest amount of fruit bunches was possessed by Jonkheer van Tets (78.10), the smallest number of fruit bunches was possessed by Ojebyn (27.20) species and Detvan (25.20) species. According to the averages of 2010 and 2011, the species having the highest number of fruits in a bunch was Tatran (6.80) and the species having the lowest number of fruits in a bunch was Jonkheer van Tets (3.40) and Ojebyn (3.00) (Table 2).

Erenoglu et al. (2003) found the average number of fruits in a bunch as 11-24; Kaplan and Akbulut (2006) found it as 3.06-16.58; Goktas et al. (2006) as 5.0-11.5; Nikolic et al. (2006) as 3.8-7.4; Demirsoy et al. (2009) as 14.52-21.52. Gercekcioglu et al. (2009) found the average number of bunches in a branch ranging between 1.78 and 2.47 and the average number of fruits in a bunch ranging between 2.39 and 11.33. Afore mentioned differences in species, climatic factors and cultural operations.

According to the average of two years, Tatran was the most productive specy with 305.35 g and the least productive species were Detvan with 80.65 g and Ojebyn with 72.78 g (Table 2).

Goktas et al. (2006) calculated per plant productivity as 422.2 - 4802.59 g; Kaplan and Akbulut (2006) as 460-2.666 g; Eyduran and Agaoglu (2007) calculated fruit productivity per shoot as 106.05-156.10 g. Gercekcioglu et al. (2009) calculated per plant productivity as 910-3949 g and Demirsoy et al. (2009) as 879-1503.7 g. The productivity values reported in the literature were seen to be higher than the values obtained in the current study. The cause of this difference again can be attributed to differences in species, climatic factors and cultural operations. By performing the prune operation that directly affects the productivity, as stated in many resources, the proposition that all the branches aged four years should be removed was confirmed.

Table 3. Data related to Plant Length, the Number of Shoots in a Plant, the Number of Fruits in a Plant and Productivity of Gooseberry Species in 2010 and 2011

Species	Plant length (cm)	Number of shoots in a plant	Number of fruits in a plant	Productivity (g)
Mucurines	101.50	25.50	42.00	117.48

The average plant height of Mucurines was found as 101.50 cm; the number of shoots in the plant was 25.50; number of fruits in a plant was 42 and productivity was 117.48 g (Table 3). When the average values of currant species were examined, it was observed that Mucurines species of the same age was less efficient both in terms of the plant height and the number of shoots.

Physical Characteristics

According to the averages of two years, the weights of the currants range between 1.10 g and 0.62 g, the species having the highest fruit weight was Ojebyn and the species having the lowest fruit weight was Detvan (Table 4).

Table 4. 2010 and 2011 Average Fruit Weight, Fruit Length and Fruit Width Values of the Species of Currant

Species	Fruit Weight (g)	Fruit Length (mm)	Fruit Width (mm)
Tatran	0.74 c	10.19 b	10.61 b
Detvan	0.62 d	8.48 d	8.94 d
Jonkheer van Tets	0.91 b	9.47 c	9.87 c
Ojebyn	1.10 a	11.15 a	11.67 a
Average	0.84	9.84	10.27

For fruit weight LSD species $_{(\%5)}$: 0.08; for fruit length LSD species $_{(\%5)}$: 0.57;
For fruit width LSD species $_{(\%5)}$: 0.58

Erenoglu et al. (2003) reported that the fruit weight ranges between 0.85 and 1.2 g; Goktas et al. (2006) reported that the weight of 10 fruits ranges from 3.62 and 16.77 g; Nikolic et al. (2006) between 0.90 and 2.36 g; Kaplan and Akbulut (2006) between 0.49 and 2.13 g; Eyduran and Agaoglu (2007) between 1.46 and 1.66 g; Gercekcioglu et al. (2009) between 0.39 and 1.55 g; Demirsoy et al. (2009) reported that the weight of 100 fruits range between 42.2 and 74.8 g. The values reported in the literature were close to the detected values. According to the average values of two years, the currant species having the highest fruit length (11.15 mm) and fruit width (11.67 mm) was found to be Ojebyn and the species having the shortest fruit length (8.48 mm) and fruit width (8.94 mm) was found to be Detvan (Table 4).

Nikolic et al. (2006) found fruit width ranging between 10.99 and 15.42 mm and fruit length ranging between 10.9 and 14.70 mm; Kaplan and Akbulut (2006) found fruit width ranging between 9.56 and 14.10 mm and fruit length ranging between 9.36 and 15.26 mm; Gercekcioglu et al. (2009) found fruit width ranging between 8.74 and 14.23 mm and fruit length ranging between 8.01 and 13.99 mm. In this regard, values reported in the literature were similar to our findings and the negligible differences between these findings stem from the use of different species and ecology.

Table 5. 2010 and 2011 Average Fruit Weight, Fruit Length and Fruit Width Values of the Species of Gooseberry

Species	Fruit Weight (g)	Fruit Length (mm)	Fruit Width (mm)
Mucurines	2.79	16.10	15.26

According to the average values of two years, the fruit weight of the gooseberry specy was 2.79 g; fruit length 16.10 mm and fruit width 15.26 mm (Table 5). These values of Mucurines species were higher than the currant species.

In a study on adaptation of some gooseberry species to the Marmara Region Erenoglu et al. (2003) reported that the average fruit weight of Whinham's Industry ranging between 6.5 g and 7.00 g; White Smith as 5 g; Rote Triump as 6 g.

The colors of the fruits were evaluated through Konica Minolta CR-400 color measuring tool and the average values of two years were presented in Table 6.

Table 6. 2010 and 2011 Average L, a, b Values of the Species of Currant and Gooseberry

Species	L	a	b
Tatran	32.43 a	30.49 a	18.92 a
Detvan	28.73 b	31.63 a	18.92 a
Jonkheer van Tets	26.59 c	26.31 b	10.05 b
Ojebyn	22.67 d	0.54 c	1.76 c
Mucurines	39.01	- 7.91	17.08

Chemical Characteristics

In terms of average value of soluble solid content (SSC) for two years, the species having the highest SSC was Ojebyn (13.66%) and the species having the lowest SSC value was Jonkheer van Tets (9.14%) as demonstrated in Table 7.

Table 7. 2010 and 2011 Average SSC, pH and TA Values of the Species of Currant

Species	SSC %	pH Value	TA %
Tatran	9.93 b	2.61 c	2.43 b
Detvan	10.10 b	2.88 b	2.54 b
Jonkheer van Tets	9.14 c	3.15 a	2.85 a
Ojebyn	13.66 a	2.82 b	1.73 c
Average	10.71	2.90	2.38

For SSC LSD species $_{(\%5)}$: 0.79; for pH values LSD species $_{(\%5)}$: 0.08;
For TA LSD species $_{(\%5)}$: 0.26

There were many studies reporting SSC values: Nikolic et al. (2006), 13.2-15.2%; Goktas et al. (2006), 12.00-16.00%; Kaplan and Akbulut (2006), 9.26-15.53%; Erdogan et al. (2007), 8.3-10.8%; Pantelidis et al. (2007), 7.4-10.7%; Eyduran and Agaoglu (2007), 12.25-15.95%; Gercekcioglu et al. (2009), 10.47-14.20%; Demirsoy et al. (2009), 9.94-10.94%. Our findings were similar to the findings reported in the literature. Small differences seen between the findings of the current study and the literature were believed to result from the differences in species under investigation and ecology.

According to the average values of both years, the species having the highest ratio of pH was Jonkheer van Tets (3.15) and the species having the lowest pH ratio was Tatran (2.61) (Table 7). Gercekcioglu et al. (2009), found pH values of currant species ranging from 2.72 from 3.01, in their study conducted in the ecology of Tokat province of Turkey. The findings reported in the literature were similar to our findings.

Titratable acidity (TA) content of the currant species ranges from 1.73 % to 2.85% and the highest titratable acidity value belongs to Jonkheer van Tets and the lowest titratable acidity value belongs to Ojebyn (Table 7).

Kaplan and Akbulut (2006) reported titratable acidity ratios as 0.16-0.68%; Goktas et al. (2006) as 0.89-1.44%; Demirsoy et al. (2009) as 0.20-0.25%. As can be seen there were great differences between the findings reported in the literature and the findings of the current study. These differences were believed to stem from the differences between the species investigated and ecology. It might also have been resulted from different adaptation patterns followed by the species for different regions.

Table 8. 2010 and 2011 Average SSC, pH and TA Values of the Species of Gooseberry

Species	SSC %	pH Value	TA %
Mucurines	12.07	2.97	2.03

According to the average values of both years, the soluble solid content (SSC) value was 12,07; ratio of pH was 2.97; titratable acidity (TA) ratio was 2.03 % of the gooseberry species of Mucurines.

Erdogan et al. (2007), found that the amount of SSC of gooseberry species in frozen and stored fruits varied between 8.5-12.65 % in their study on frozen and stored species of gooseberries and currants in Yalova. They reported that the amount of SSC was higher in the stored frozen fruit than fresh fruit and this could be explained by the loss of water during storage.

Natural Antioxidant Content and Antioxidant Capacity

According to the average values of two years, the species having the highest vitamin C content was black currant Ojebyn (37,36 mg/100 ml) and the species having the lowest vitamin C content was red currant Detvan (15.50 mg/100 ml) as demonstrated in Table 9.

Tosun and Yuksel (2003) reported that some researchers found the ascorbic acid content of black currant species between 10 and 93.9 mg/100 g; red currant species between 5 and 18.7 mg/100 g. Our findings were similar to these values. Total phenolic matter content of the currants range between 3048.58 and 5435.01 µg GAE/g fw due to the values of two years (Table 9).

Moyer et al. (2002) found the total phenolic matter content of black currants between 498 and 1342 mg/100 g; Lugasi et al. (2003) as 52.8 mg/kg; Benvenuti et al. (2004) between as 530.5-888.5 mg/100 g; Tabart et al. (2011) as 0.50 mg/g. Kahkönen et al. (2001) found the total phenolic matter content of red currants 68 mg/100 g (dry matter) and Benvenuti et al. (2004) found it ranging between 371.9 and 501.6 mg/100 g.

In this regard, our findings indicated higher values than red currant reported by Kahkönen et al. (2001) and black currants reported by Lugasi et al. (2003) and Tabart et al. (2011). The findings were consistent with the findings of Moyer et al. (2002) and Benvenuti et al. (2004).

Table 9. 2010 and 2011 Average Vitamin C, Total Phenolic Matter, Total Anthocyanin, FRAP and TEAC Values of the Species of Currant

Species	Vitamin C (mg/100 ml)	Total Phenolic Matter (µg GAE/g fw)	Total Anthocyanin (µg cyd-3-glu/g fw)	FRAP (µmol TE/g fw)	TEAC (µmol TE/g fw)
Tatran	22.23 b	4648.42 b	110.63 d	9.48 c	12.45 c
Detvan	15.50 d	3048.58 c	222.22 c	9.35 c	10.58 d
Jonkheer van Tets	19.75 c	3384.11 c	251.51 b	12.59 b	14.99 b
Ojebyn	37.36 a	5435.01 a	686.50 a	13.72 a	20.13 a
Average	23.71	3934.79	317.71	11.28	14.54

For Vitamin C LSD species $_{(\%5)}$: 2.09; for Total Phenolic Matter LSD species $_{(\%5)}$: 454.16
For Total Anthocyanin LSD species $_{(\%5)}$: 5.55; for FRAP LSD species $_{(\%5)}$: 0.42;
For TEAC LSD species $_{(\%5)}$: 1.66

Total anthocyanin content of the currants for two years range 110.63-686.50 µg/g fw (Table 9).

Benvenuti et al. (2004) determined the total anthocyanin content of red currants between 22.0-33.9 mg/100g and Pantelidis et al. (2007) between 7.5-7.8 mg/100 g. Our findings were higher than that were reported by Pantelidis et al. (2007) and consistent with the findings of Benvenuti et al. (2004).

Total antioxidant capacity of the currant species as FRAP range between 9.35-13.72 µmol/g fw and as TEAC range between 10.58-20.13 µmol/g fw (Table 9).

Halvorsen et al. (2002) found total antioxidant capacity of red currants as FRAP ranging between 1.6-1.92 mmol/100 g (average 1.78 mmol/100 g); Pellegrini et al. (2003) as 44.86 mmol/kg; Pantelidis et al. (2007) ranging between 60.2-63.3 µmol/g and Borges et al. (2010) as 24.6 µmol/g. When the results of the study were examined, it was observed that the values reported by the above researchers were higher than our findings. These differences may caused by species, maturity, season and storage conditions.

Table 10. 2010 and 2011 Average Vitamin C, Total Phenolic Matter, FRAP and TEAC Values of the Species of Gooseberry

Species	Vitamin C (mg/100 ml)	Total Phenolic Matter (µg GAE/g fw)	FRAP (µmol TE/g fw)	TEAC (µmol TE/g fw)
Mucurines	13.07	2533.08	4.42	6.00

According to the average values of two years, the vitamin C content was 13.07 mg/100 ml of gooseberry species Mucurines and the value was lower than the average value (23.71 mg/100 ml) of currant species (Table 10).

Tosun and Yuksel (2003) reported that some researchers found the ascorbic acid content of red gooseberry as 25.6 mg/100g. Tural (2006) reported that Guldas and Turantas (2000) found the ascorbic acid content ranging between 20 and 50 mg/100 g. Erdogan et al. (2007) determined it as between 21 and 41 mg/100 g in Yalova region; Pantelidis et al. (2007) as between 20.3 and 25.4 mg/100 g of yellow and red gooseberry species in Northern Greece. Our findings were lower than the values found by the researchers and these differences were thought to be due to the fact that the ecology of the studies were quite different from each other, due to the different species and the applied cultural processes.

According total phenolic matter content of two years the average value was 2533.08 µg GAE/g fw of Mucurines (Table 10). This value was lower than the average value (3934.79 µg GAE/g fw) of currant species. Kahkönen et al. (2001) found total phenolic matter as 65 mg/100 g (dry matter) and Moyer et al. (2002) as 191 65 mg/100 g. Our findings were higher than these researchers' findings. Since the extract of Mucurines give white color, the anthocyanin reading was not made.

Total antioxidant capacity of Mucurines as FRAP was 4.42 µmol/g fw and as TEAC 6.00 µmol/g fw (Table 10). These values were lower than the average values of currant species.

Halvorsen et al. (2002) found total antioxidant capacity of gooseberry as FRAP 1.45 mmol/100g; Moyer et al. (2002) as 25.2 µmol/g and Pantelidis et al. (2007) between as 62.8-65.1 µmol/g (dry matter). These values of researchers were higher than the current study. These differences may be caused by the degree of harvest maturity, diversity of species, ecological conditions before harvest, post-harvest storage conditions and growing season.

CONCLUSION

The current study was conducted to determine some phenological and pomological characteristics, productivity, total phenolic matter content, total anthocyanin, ascorbic acid and antioxidant capacity of some species of currant and gooseberry organically grown in the Black Sea region of Turkey, where has a great potential for growing currants and gooseberry species. It was intended to provide some insights to studies focusing on the rise and utilization of culture forms of currant and gooseberry. Increasing cultivation of the plants in Black Sea Region can also alleviate the dependency of the region on hazelnut and tea.

The findings of the present study were compared with the limited research on currant and gooseberry species and as a result revealed that these species could be grown in the region.

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