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Research Article

Pomological and Quality Characteristics of Foxy Grape (*Vitis labrusca* L.) Cultivars Grown in Samsun Ecological Conditions

Hüseyin ÇELİK*[1], Seda ATEŞ[2]

[1]Ondokuz Mayis University, Agricultural Faculty, Samsun, Türkiye
[2]Zonguldak, Türkiye

[1]https://orcid.org/0000-0003-1403-7464, [2]https://orcid.org/0000-0002-7662-347X

*Corresponding author e-mail : huscelik@omu.edu.tr

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Abstract: In this study, fully mature bunch and berry characteristics of foxy grape (*Vitis labrusca* L.) cultivars ('Rizessi', 'Rizpem', 'Rizellim', 'Ülkemiz', and 'Çeliksu') which were selected and registered from the Black Sea Region of Türkiye were determined. 'Çeliksu', 'Ülkemiz', and 'Rizessi' cultivars had the highest cluster weight, while the 'Rizpem' had the lowest. 'Çeliksu' had the highest value of berry width (16.02 and 16.47 mm), berry length (17.79 and 17.86 mm), and berry weight (3.25 and 3.29 g), respectively over the years. 'Rizpem' had the lowest data for all the berry properties. Among foxy grape cultivars, 'Rizpem' in terms of total soluble solids (TSS%) (14.48% and 15.70) and titratable acidity (2.00 and 2.31 g/100cc) and 'Ülkemiz' in terms of pH (3.46 and 3.22) had the highest values. In addition, the highest average fruit juice (33.54 and 31.77) and berry skin (32.63 and 40.57) *L** value was determined in the 'Rizpem' cultivar in both years.

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1. Introduction

The reason why grapes play an important role in human nutrition is the carbohydrates, vitamins, mineral substances, protein, and anthocyanins they contain. Grape; besides its consumption as fresh fruit; It is consumed by drying, processing into fruit juice, making wine, molasses, vinegar, jam, marmalade, or processing local products such as sausage, fruit pulp, and butter or seed by-products (Kokargül et al., 2020; Sönmez Yıldız et al., 2023). Foxy grapes (*Vitis labrusca* L.) are consumed by processing especially sweet grape juice, jam, jelly, marmalade, or as a table grape (Çelik, 2004; Çelik et al., 2020). It is widely cultivated in the mild cold and rainy areas of the world and Türkiye due to many reasons such as the productivity of grapes, having alternative evaluation possibilities, maintaining the level of economic production in different ecologies and not being very selective in terms of climate and soil (Baykul et al., 2018). *Labrusca* grapes with foxy aroma also love acidic soils. On the other hand, grape cultivars belonging to the *Vitis vinifera* L. species cannot be grown in the Eastern Black Sea region of Türkiye, as it is very difficult to control fungal diseases in this region due to the annual precipitation of more than 1000 mm, mostly during the summer development period. For this reason, grape types have been into the *V. labrusca* L. species, which are resistant to fungal diseases, have a

special aroma reminiscent of strawberry taste, are seeded, thick-skinned, and easily separated from the flesh part, are grown in this region (Çelik, 2004; Çelik et al., 2020). These grapes are also important for their phenolics and antioxidant properties for human health (Tahmaz et al., 2022).

Approximately one-third of the total grape production in Türkiye belongs to table consumption, and the main characteristics desired during sales are the berry uniformity, the berry size of the cultivars grown for this consumption type, and the color specific to the cultivar (Sabir et al., 2010). The difference in the number of clusters varies according to the cultivar, the age of the vine, the position of the winter bud on the one-year-old cane, and the nutritional status of the vine. On the other hand, many factors affect the weight and size of the cluster and the firmness of the berry. Among these factors, the position of the winter buds on the one-year-old grapevine wood, the climatic factors in the berry setting period, the amount of precipitation, soil type, and fertilization are important. In addition, it can affect the cluster and berry properties according to the pruning method and the use of chemical substances (growth regulators and herbicides). On the same summer shoot, the first cluster usually develops more than the second and third clusters. The clusters on the vigorously developing 1-year-old shoots and the berries on these clusters can be larger. On the other hand, as the amount of light entering the canopy decreases, all these features can be negatively affected (Yılmaz and Dardeniz, 2009). According to Deryaoğlu and Canbaş (2003), the genetic structure of the grape cultivar, climate, cultivation techniques, and the number of seeds per berry affect the berry weight and size.

Until it reaches a suitable structure according to the purpose of use, grape berries go through four different stages, starting from the berry setting stages, such as green growth (cork), veraison, maturity, and extreme maturity. The maturity stage, which starts from the veraison (coloring) and continues until the harvest, is the most important stage in which the characteristic features of the grapes occur, affecting and determining the quality of the products (Otağ, 2015). With the veraison, the ripeness of the grapes begins. During the harvest period, the quality of the grape depends on the color, sugar-acid ratio, and aromatic substance content in the berry, but total soluble solids (TSS), organic acids, pH, anthocyanins, phenolic substances, and other compounds affect the content and quality of the berry. At the beginning of development, the amount of general acidity in the grapes is very high and the amount of TSS is negligible, while an increase in the amount of TSS and a decrease in acidity occur in parallel with the berry development (Cangi et al., 2011). Çelik et al. (2020) stated that foxy grape types and/or cultivars grow easily without spraying for fungal diseases in rainy regions like the northeastern part of Anatolia. They noticed that foxy grapes (*Vitis labrusca* L.) have blue-black, pink, copper-red, white, or black-colored and seeded slip-skin berries. These grapes had special foxy aromas and they were called aromatic black grapes, Isabella, strawberry grape, foxy grape, American grape, or black grape by inhabitants. They are also resistant to fungal diseases and are used as table wine, mild-fermented must, molasses (pekmez), or grape juice in Türkiye. These slip-skin foxy grapes also are used as sweet grape juice and molasses, fruit pulp, and a kind of local pudding called '*pepeçura'.* These foxy grapes are good for slightly fermented grape juice and they can easily grow in low pH (acidic) soils and are known as resistant to fungal diseases (Çelik, 2004).

Çelik et al. (2020), investigated berry samples taken from foxy grape cultivars at different maturity stages (large unripe, veraison, 50% coloring, harvest time, and overripe period). They observed that the weight of berries at harvest time ranged between 3.20 g ('Rizpem') and 3.93 g ('Çeliksu'). Berry's weight and TSS continued to increase during the over-ripe period. Total phenolic compounds decreased during the maturation. 'Rizpem' gave the highest total phenolics (4116.53 mg kg^{-1}) at harvest time while it had the 7666.33 mg kg^{-1} total phenolics at a large unripe period. Cangi et al. (2006a and 2006b) and Çelik et al. (2008) also determined the bunch, berry, and phenological and ampelographic characters of different foxy grape types grown in Trabzon, Artvin, Giresun and Samsun. Çelik et al. (2008) conducted many trials for decades and they searched out the seven important cities along the Black Sea Region and detailed 86 different grape types with foxy aroma. Cangi et al. (2006a and 2006b) managed several identification studies in Trabzon during 2003-2004 and they identified ten different grapes with their flower characteristics. At the end of the presented studies, five foxy grape cultivars ('Ülkemiz', 'Rizellim', 'Rizpem', 'Rizessi', and 'Çeliksu') registered and protected (Çelik et al., 2018). Several studies also managed by Melek and Çelik (2005), Çelik et al. (2009), Çelik and Köse (2017), Köse and Çelik (2017), Çelik and Köse (2018), Çelik et al. (2018) on foxy grapes grow naturally along Black Sea Coastal region of Türkiye. Karabulut et al. (2023) also noticed that the cultivation of *Vinifera* table grapes is difficult to grow along the Black Sea Coastal area with high humidity due to powdery

and downy mildew known as fungal diseases. Researchers stated that grapes with foxy taste adapted well to these humid and high rainy conditions and can grow inherently in this zone. According to the researcher, selection breed *Vitis labrusc*a L. cultivars like 'Rizessi', 'Çeliksu', 'Ülkemiz', 'Rizellim', and 'Rizpem' are suitable for labrusca viticulture from Artvin to Sinop coastline areas.

In the present study, the five new foxy grape cultivars selected from humid and rainy areas of the Northeastern party of Türkiye, especially Black Sea Region, were tested by their phenological stages and full mature bunch and berry quality characteristics determined under Samsun ecological conditions.

2. Material and Methods

2.1. Plant material

The research was carried out in an 8-decare vineyard area in Samsun Ondokuz Mayis University Faculty of Agriculture, during 2016 and 2018. The 15-year-old own-rooted vines of 'Rizessi', 'Rizpem', 'Rizellim', 'Ülkemiz' and 'Çeliksu' (*Vitis labrusca* L.) cultivars were used as the research material (Figure 1 and 2). These new and first registered foxy grape cultivars were grown on their roots with a trellis support system and they were trained in a high-trunked double-arm cordon and curtain training system. The vines were planted at 1.5*3.0 meters distance in and between rows. In the winter pruning, the vines of foxy grape cultivars were pruned medium-long, leaving 50 buds per vine. All of the grape cultivars examined in the experiment show foxy aroma characteristic, which is the typical character of *Vitis labrusca*. It is used as a table and mostly juice grapes by the local people living in Türkiye and especially in the north-eastern part of the Black Sea Region. Some specific characteristics of the selected grape cultivars with foxy taste are as follows (Çelik et al., 2018; Karabulut and Çelik, 2022; Karabulut et al., 2023);

'Rizessi': Berries are seeded and skin color is black. The shoot tip is fully open, it has a hermaphrodite flower. It bears 2-3 moderately dense and short clusters. The large berries are round with thick skins. It has short tendrils and the leaf has three lobes. It has juicy berries with a foxy taste. The new leaf lamina is yellowish-green. It is mid mid-season cultivar (Figure 1 and 2).

'Çeliksu': Berry's skin is blue-black with seeds. Its flower is androgynous. Its berries are juicy and have a foxy taste. Old leave has three lobes. It has an average of 2-3 flower clusters. Cluster and tendrils are short. The current shoot tip is open. Çeliksu has large and round bery and skin is too thick. The young leaf lamina is bright yellowish green. It is a late-season cultivar (Figure 1 and 2).

'Ülkemiz': This cultivar has blue-black, seeded, and foxy taste juicy berries. Their flowers are hermaphrodite and create two flower clusters and medium-long tendrils. The current shoots have broad and open tips. It has a tiny and short cluster. The berries are medium in size, and round in shape with thick skins. It has complete leaves without lobes. The new leaves have a green color with heavy anthocyanin. This foxy grape cultivar is mid mid-season cultivar for harvest (Figure 1 and 2).

'*Rizellim'*: Berries are seeded and their skin color is blue-black. It has a hermaphrodite flower. It bears 2-3 clusters. Clusters are short and too small. Their tendril is short. It has three lobe leaves. The current season shoot tip is a fully open shoot tip. Their medium-sized berries have round shapes and their skin is too thick. This cultivar has a foxy taste and with much juice. The young leaves are yellow-green. This cultivar ripens late (Figure 1 and 2).

'*Rizpem'*: This grape cultivar has seeded berries with a foxy taste and its berry color is pinky. It has hermaphrodite flowers. It has less clusters (1-2). The current season shoot tip is fully open. Its clusters are short and small. Mature leaves are lobeless and it has short tendrils. Its berries are juicy with medium size, round shape, and thick skin. The young leaf lamina is light copper-reddish. It is a late-harvested cultivar (Figure 1 and 2).

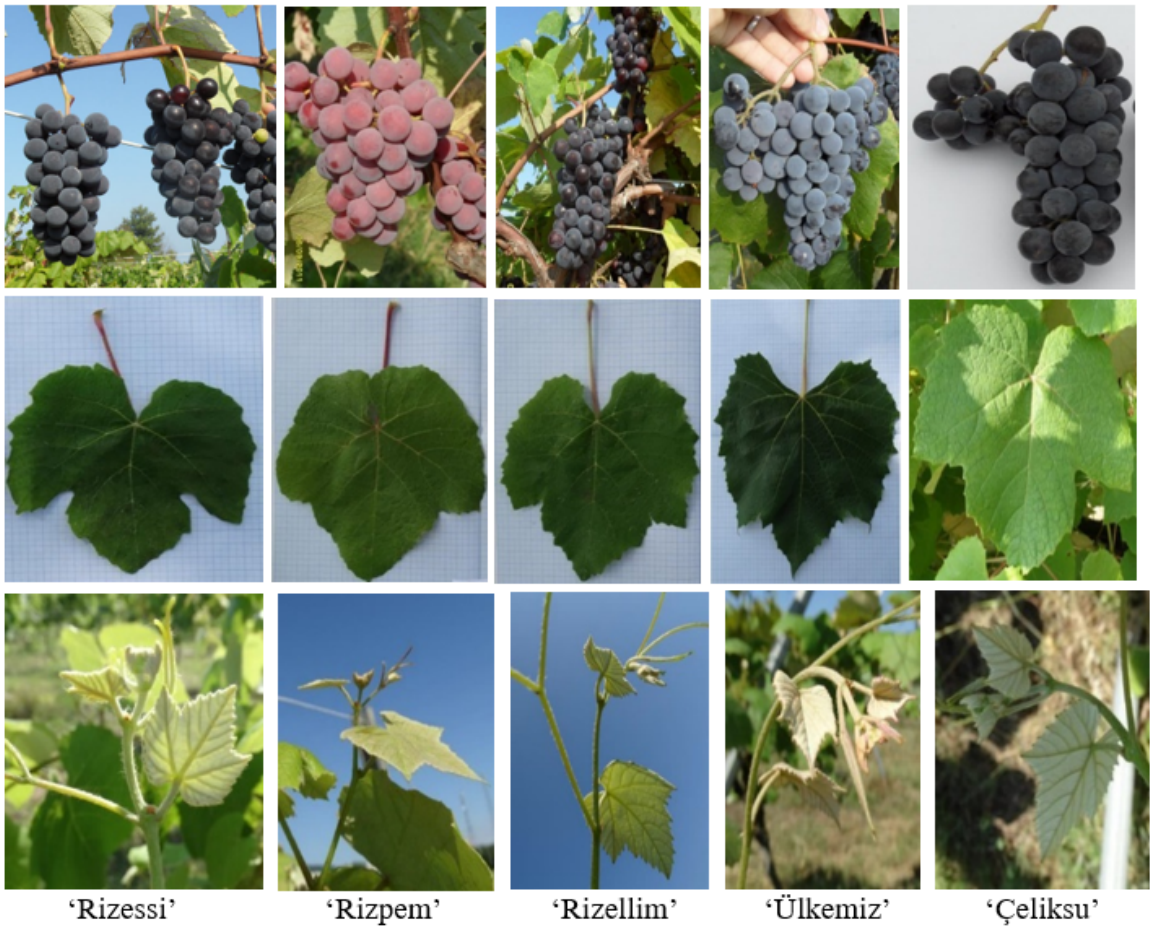

Figure 1. Registered foxy grape cultivars (mature cluster, full leaves, and shoot tip) (Çelik et al., 2020; Karabulut et al., 2023).

Figure 2. The fully ripened grape bunches of registered foxy grape cultivars grown in Samsun ecological conditions.

2.2. Methods

Twenty clusters randomly selected from each vine of foxy grape cultivars were harvested from the vines at the full maturity stage and transported to the laboratory in accordance with the technique. Harvesting was carried out at full maturity by looking at the cluster stem color and berry size, shape, and color, in which all the berries in the cluster acquired the specific color of the cultivar. In addition to the phenological stages of foxy grape cultivars, the following quality and quantity characteristics of harvested clusters and berries were examined.

The skeletal length, width, and stem (cm) of the cluster were measured with a ruler. The weight of the cluster (g) and the rachis weight of the cluster (g) free of all were determined by weighing them on a 0.01 g. sensitive scale. The number of berries in the cluster (berry number/cluster) was determined by counting all the berries in each cluster. The number of berries per hundred grams (bery number/100 g) was determined by counting the berries that reached a total weight of 100 g, including all berries together. For each cultivar, in 40 randomly selected berries from the end, middle, and near the stem of the fully mature clusters; berry width and length (mm) with the help of 0.01 mm sensitive caliper, berry size (g) with a scale sensitive to 0.01g, and berry skin color (CIE *L**, *a** and b*) after removing the haze layer on the skin of the berries with a Minolta color measuring device (CR-300). The color of the fruit juice (CIE *L**, a* and b*) was determined by squeezing the berries with the help of cheesecloth to obtain the juice, filtering the juice again to avoid any residue before putting it into the Glass cell apparatus, and then using the Minolta color measuring device (CR-300). The amount of water-soluble total soluble solids (TSS%) was determined by dripping 1-2 drops of the juice obtained from the berries with the help of cheesecloth into the chamber of the digital refractometer. Titration acidity (g/100 cc), after adding 5 ml of fruit juice to 45 ml of distilled water placed in an Erlenmeyer flask, 2 - 3 drops of phenolphthalein indicator was added, and the resulting mixture was titrated with 0.1N NaOH solution until it turned pink. The amount of NaOH spent at the end of the titration was recorded and the acid content in grape berry juices was calculated in terms of tartaric acid using the equation given by Kılıç et al., (1991). The pH in the juice was determined directly in the juice with a tabletop pH meter with glass electrodes.

2.2. Trial design and statistical analyses

The experiment was set up in a randomized complete block design with three replications and five vines in each replication. A total of 75 grapevines belonging to 5 newly selected breeds and registered foxy grape cultivars used in the experiment were studied, and all measurements and analyses of phenological and quality characteristics were repeated for two years. The variance analysis was performed on the data obtained from the experiment in the SPSS 17.0 statistical program. The differences among the means were determined at the level of 0.05 Duncan Multiple Range Test.

3. Results and Discussion

3.1. Phenological characteristics

The dates of the phenological periods and leaf fall leaf color (CIE *L*, a*,* and *b**) determined in foxy grape cultivars are presented in Tables 1 and 2. Accordingly, in the first year of the experiment, all grape cultivars except 'Rizpem' (22 April) bud busted towards the end of March, while in the second year, all cultivars started to bud burst in the first week of April. 'Rizessi' was the earliest cultivar in terms of the bursting of winter buds in the registered new foxy grape cultivars, and 'Rizpem' was the latest bud-busted cultivar. While the 'Rizessi' cultivar was determined as the cultivar that bloomed in the first week of June and the latest, flowering in other cultivars started towards the end of May. Veraison started to occur in almost all cultivars in the first two weeks of August and the 'Rizpem' and 'Rizessi' cultivars were the earliest maturing cultivars in year one. The harvest period extended to the first week of October in the second year of the research. It is known that harvest periods could be affected by vineyard micro or macroecology. The Autumn leaf color of all cultivars was yellow. It is evidence that grape phenology can vary over the years and they depend on both the genetic structure of the cultivar and terroir (Ağaoğlu, 1999; Melek, 2005; Yeşilyurt, 2009; Yılmaz and Dardeniz, 2009; Doğan et al., 2018; Kokargül et al., 2020; Yağcı and Bozkurt, 2020). Uluocak (2010) determined that harvest time differed according to year and grape cultivars, and ripening extended between 4-7 weeks. According to

the studied foxy grape cultivar, ripening is completed in between 3-8 weeks determined from veraison to harvest. It is evidence that this process differs according to the year and cultivars.

Table 1. Changes in some phenological characteristics of foxy grape (*Vitis labrusca* L.) cultivars grown in Samsun ecological conditions

Phenological Stage	'Rizessi'		'Rizpem'		'Rizellim'	
	1st Year	*2nd Year*	*1st Year*	*2nd Year*	*1st Year*	*2nd Year*
Bud burst	25 March	05 April	22 April	06 April	22 March	06 April
Flowering	05 June	07 June	30 May	07 June	30 May	07 June
Veraison	10 August	15 August	15 August	21 August	12 August	15 August
50% coloring	20 August	25 August	22 August	30 August	30 August	30 August
Maturity	15 September	25 September	05 September	25 September	05 October	15 October
Leaf Fall color	*L*=56.63±2.95 *a*= -4.25±1.71 *b*=33.36±2.03 (Yellow)	*L*= 64.05±2.80 *a*= -5.53±1.49 *b*= 39.63±3.92 (Yellow)	*L*=48.36±5.25 *a*= -2.06±2.08 *b*=24.87±4.23 (Yellow)	*L*= 65.01±3.20 *a*= -7.48±2.26 *b*= 43.93±3.55 (Yellow)	*L*=53.57±3.67 *a*= -3.10±1.46 *b*=31.47±3.42 (Yellow)	*L*=64.65±2.46 *a*=-5.72±1.64 *b*=41.07±4.29 (Yellow)

Table 2. Changes in some phenological characteristics of foxy grape (*Vitis labrusca* L.) cultivars grown in Samsun ecological conditions

Phenological Stage	'Ülkemiz'		'Çeliksu'	
	1st Year	*2nd Year*	*1st Year*	*2nd Year*
Bud burst	25 March	07 April	30 March	10 April
Flowering	31 May	10 June	31 May	10 June
Veraison	10 August	09 August	10 August	17 August
50% coloring	25 August	22 August	21 August	05 September
Maturity	04 September	11 October	17 September	10 October
Leaf fall color	L=45.73±6.75 a= -1.59±0.98 b=27.45±6.15 (Yellow)	L=60.13±3.32 a=-3.65±2.01 b=45.00±3.13 (Yellow)	L=51.24±6.76 a= -5.23±2.53 b=31.29±5.43 (Yellow)	L=64.05±2.80 a= -5.53±1.49 b=39.63±3.92 (Yellow)

3.2. Bunch properties

The cluster characteristics of the foxy grape cultivars used in the experiment are given in Table 3. Accordingly, there are significant differences between the foxy grape cultivars for cluster length, width, and weight in both years (Table 3). The lowest values in terms of average cluster length, width, and weight in foxy grape cultivars were obtained from the 'Rizpem' cultivar (11.44 and 10.50 cm; 7.49 and 6.04 cm; 121.09 and 70.16 g) in both years. The highest cluster length was obtained from the 'Rizellim' and 'Çeliksu' cultivars (12.47 cm) in the first year however the highest bunch width and weight in the second year belonged to the cultivar 'Çeliksu' (8.17 cm and 141.53 g) (Table 3). Bunch and berry characteristics vary according to grape cultivars, and it is known that physical and chemical changes occur in the berries towards maturity. This situation has been detected by many researchers (Ağaoğlu, 1999; Ağaoğlu, 2002; Melek, 2005; Yeşilyurt, 2009; Yılmaz and Dardeniz, 2009; Doğan et al., 2018; Kokargül et al., 2020; Yağcı and Bozkurt, 2020). On the other hand, cluster size, weight, shape, density, and color are affected by many factors, although they are varietal characteristics. Because cluster and berry characteristics can change depending on the positions of winter buds on the one-year-old cane, climate characteristics during flowering and berry set, rainfall, soil structure, pruning, fertilization, hormone and use of growth regulating chemicals (Ağaoğlu, 1999; Ağaoğlu, 2002; Çelik, 2011). In fact, in studies conducted by some researchers, it was determined that cluster length varied between 10.04-19.90 cm, cluster width between 4.69-10.20 cm, and cluster weight between 81.5-235.40 g. (Gökdemir, 2016; Melek, 2005; Sabır, 2008).

In the present study, it was determined that the number of berries in clusters of new foxy grape cultivars was different and significant in both years. It was determined that the lowest number of berries per bunch was in 'Rizpem' (47.70 and 33.15) and the highest was in 'Rizessi' (54.23 and 40.02) in both years (Table 3). The number of berries obtained in the study was lower in the second year compared to the first year. Accordingly, one of the most important reasons for the decrease in the bunch width, length, and weight values in the second year may be affected by to decrease in the number of berries in the

bunches in this year compared to the first year. In some studies conducted with various foxy grape types (*Vitis labrusca* L.), it was determined that the average number of berries per bunch during the harvest period varied between 34.30 and 104.00 (Cangi et al., 2006a and 2006b). On the other hand, 'Rizpem' (12.10 cm) and 'Rizessi' (10.92 cm) had the shortest bunches, while 'Rizellim' (13.55 cm) and 'Ülkemiz' (12.12 cm) cultivars had the longest rachis length. Among the foxy grapes, 'Rizpem' (3.81 and 2.53 g) had the lowest rachis weight, while 'Çeliksu' had the highest (4.19 and 2.84 g) (Table 3). This situation may vary according to the genetics of the grape cultivar, growing conditions, irrigation, fertilization, and cultivation type (Ağaoğlu, 1999; Ağaoğlu, 2002; Yeşilyurt Er, 2009).

Table 3. Grape bunch and cluster characteristics of foxy grape (*Vitis labrusca* L.) cultivars grown in Samsun ecological conditions

Cultivar	Bunch Length	Bunch Width	Bunch Weight	Berry number per bunch	Bunch Stem Length	Bunch Stem Weight
			1st Year			
'Rizessi'	12.41 a*	7.90 ab*	134.85 ab*	54.23	13.35 ab*	3.89
'Rizpem'	11.44 b	7.49 b	121.09 c	47.70	12.10 c	3.81
'Rizellim'	12.47 a	7.71 b	129.79 bc	50.39	13.55 a	3.91
'Ülkemiz'	12.26 a	8.14 a	131.44 abc	51.67	12.78 b	3.87
'Çeliksu'	12.47a	8.17 a	141.53 a	51.65	13.46 ab	4.19
			2nd Year			
'Rizessi'	11.07 ab*	6.42 b*	88.71 ab*	40.02 a*	10.92	2.65 ab*
'Rizpem'	10.50 c	6.04 c	70.16 c	33.15 b	11.32	2.53 b
'Rizellim'	11.44 a	6.54 b	84.46 b	34.22 b	11.63	2.80 a
'Ülkemiz'	10.73 bc	6.84 a	90.42 a	34.86 b	12.12	2.71 ab
'Çeliksu'	11.13 ab	6.70 ab	85.33 b	33.23 b	11.27	2.84 a

*There is a statistical difference between the groups have different letters in the same column ($p<0.05$).

3.3. Berry properties

It was determined that the berry morphological properties of the foxy grape cultivars were also different. While the lowest berry width, length and weight in foxy grape cultivars were obtained from the 'Rizpem' (15.55 and 15.11 mm; 16.43 and 15.84 mm; 2.85 and 2.56 g, respectively, according to the years), the highest values according to the years were obtained from the 'Çeliksu' (16.02 and 16.47 mm; 17.79 and 17.86 mm; 3.25 and 3.29 g) (Table 4). It has been determined in many studies that berry characteristics in grapes vary according to cultivar, year, rootstock, ecological conditions, and vine management (Ağaoğlu, 2002; Deryaoğlu and Canbaş, 2003 and 2004; Şen, 2008; Uluocak, 2010; Çelik, 2011; Kunter et al., 2013; Yağcı and Bozkurt, 2020). Indeed, it was determined by Çelik et al. (2008) that berry width, length, and weight in the foxy grape cultivar defined as Isabella were 15.5 mm, 17.0 mm, and 2.66 g, respectively. Gökdemir (2016) also found that berry length was between 13.60 - 20.00 mm and berry width could vary between 11.70 - 20.10 mm in different grape genotypes of the *Vitis labrusca* L. species. In addition, according to Sabır (2008), it was stated that the average berry size in the Isabella cultivar can reach up to 3.95 g and this may be related to nutrition. Here we also determined the number of berries per 100 g. weight was in the 'Rizpem' cultivar (42.09 and 47.02 pieces) which has the smallest berry. There can be significant differences in weight, size, content, and development between the berries in each bunch as well as between the bunches on grapevines (Ağaoğlu, 1999; Ağaoğlu, 2002; Yılmaz and Dardeniz, 2009).

It was determined that there were differences among the foxy grape cultivars for CIE *L*, a*, b** examined for berry color, which is one of the quality indicators in grapes. In terms of berry skin color, the lowest *L** value in both years was obtained from the 'Ülkemiz' (31.08 and 36.26), while the highest was obtained from the 'Rizpem' (32.63 and 40.57). However, increasing positive *a** values indicate an increase in red color, while increasing negative *a** values indicate an increase in green color. In this study, it was determined that the *a** values corresponding to the least intensity in terms of green color in both years during the ripening period were in the cultivar 'Rizpem' (-1.48 and -1.71), while the *a** values corresponding to the most intense green color were in the cultivar 'Ülkemiz' (-3.03 and - 3.90) (Table 4). An increase in positive *b** values indicates an increase in yellow color, while an increase in

negative *b** indicates an increase in blue color. In this study, it was determined that the *b** values corresponding to the least intensity of blue color in both years were in the 'Rizpem' cultivar (5.88 and 9.21), and the *b** values corresponding to the most intense blue color were in the 'Ülkemiz' cultivar (3.58 and 5.07). This situation was also determined by Mucalo et al. (2015) in *Vinifera* cultivars and it was stated that berry color parameters are also related to cultivar, ecology, vine climate, sun exposure, and vine management (Ağaoğlu, 1999; Ağaoğlu, 2002). Keller (2010) also states that foxy grape clusters with berries, as shown in Concord grapes, could display various stages of color change.

Table 4. Berry characteristics of foxy grape (*Vitis labrusca* L.) cultivars grown in Samsun ecological conditions

Cultivar	Berry width	Berry length	Berry weight	Berry number per 100 g	Berry skin color		
					*L**	*a**	*b**
				1st Year			
'Rizessi'	15.71 b*	17.37 b*	3.06 b*	41.07 ab*	31.23	-2.28 b*	4.35 b*
'Rizpem'	15.55 b	16.43 d	2.85 c	42.09 a	32.63	-1.48 a	5.88 a
'Rizellim'	15.69 b	17.41 b	3.10 b	39.38 b	32.01	-2.44 b	4.36 b
'Ülkemiz'	15.99 a	16.71 c	3.04 b	39.47 b	31.08	-3.03 c	3.58 c
'Çeliksu'	16.02 a	17.79 a	3.25 a	36.89 c	31.78	-2.28 b	3.74 c
				2nd Year			
'Rizessi'	15.59 b*	16.76 b*	2.80 b*	43.80 b*	38.30 b*	-2.35 b*	6.38 b*
'Rizpem'	15.11 c	15.84 c	2.56 c	47.02 a	40.57 a	-1.71 a	9.21 a
'Rizellim'	16.41 a	17.71 a	3.24 a	38.18 cd	37.37 c	-2.86 c	5.34 c
'Ülkemiz'	16.38 a	16.76 b	3.18 a	38.62 c	36.26 d	-3.90 d	5.07 c
'Çeliksu'	16.47 a	17.86 a	3.29 a	36.79 d	37.76 c	-2.64 c	5.38 c

*There is a statistical difference between the groups have different letters in the same column ($p<0.05$).

3.4. Quality characteristics

The total soluble solids (TSS%), titratable acidity (g./100cc), and pH values of foxy grape cultivars selected and registered from the Black Sea Region also showed significant differences according to the years (Table 5). In terms of TSS, the lowest value was found in 'Rizessi' (12.44% and 13.48%) and the highest in 'Rizpem' (14.48% and 15.70%) in both years. In terms of titratable acidity determined as tartaric acid (g/100 cc), the lowest values were found in 'Ülkemiz' (1.55) and 'Rizellim' (1.82) cultivars, while the 'Rizpem' (2.00 and 2.31) cultivar had the highest acidity in both years. It was determined that the pH value in the berry, which is important for quality, was the lowest in the cultivars 'Rizessi' and Rizpem' (3.05) and 'Çeliksu' (2.91) according to the years, and the highest in the cultivar 'Ülkemiz' (3.46 and 3.22) in both years (Table 5). While the amount of dry matter in grape berries increases during the ripening period, the acidity decreases, and with a significant increase in pH throughout the ripening period, the pH value in mature grapes may generally vary between 3-4 (Ağaoğlu, 2002; Şen, 2008). It is known that TSS, acidity, and pH in grape berries may depend on the year, cultivar, and vineyard microclimate as well as the vineyard and regional climate and vineyard management (Ağaoğlu, 1999; Ağaoğlu, 2002; Şen, 2008; Uluocak, 2010). *Labrusca* grapes had more acidity than *Vinifera* ones and they are mostly used as grape juice, due to most rainy and low sunshine periods around the Black Sea region. On the other hand, as grapes mature, total acidity decreases while dry matter and pH increase (Ağaoğlu, 1999; Ağaoğlu, 2002; Doshi et al., 2006; Andjelkovic et al., 2013; Doğan et al., 2018). In fact, in studies conducted on the foxy grape types and/or cultivars, it was determined that dry matter varied between 12.00 - 20.40%, titratable acidity varied between 0.30 - 1.17% and pH varied between 3.21 - 3.44 (Çelik et al., 2008; Sabır, 2008; Gökdemir, 2016; Silva et al., 2017).

The flesh of the foxy grape cultivars examined in the experiment was colorless, but there were significant dissimilarities among the cultivars for most CIE color amounts in both years. According to the cultivars, it was determined that the lowest grape juice *L** values belonged to 'Rizellim' (31.13 and 29.59), and the highest to 'Rizpem' (33.54 and 31.77); in terms of juice average *a** parameter, the lowest red color intensity was recorded in 'Rizpem' cultivar (0.61 and 0.77) in both years, the highest red color intensity was recorded in 'Rizessi' (1.34) in the first year and 'Çeliksu' (1.67) in the second year, while

in grape juice *b** color values, the lowest blue color intensity was recorded in 'Çeliksu' (-2.29) and 'Rizellim' (-1.97) cultivars and the highest blue color intensity was recorded in 'Rizpem' (-1.35) and 'Ülkemiz' (-1.17) cultivars (Table 5). The flesh of the grape berry, which is colorless and transmits light in many cultivars, can be light or red in some grape cultivars. The coloration of the berry generally occurs in the skin, but there are also grape cultivars with colored flesh, such as Alicante Bouschet (Çelik et al., 1998; Ağaoğlu, 1999; Ağaoğlu, 2002).

Table 5. Quality characteristics of foxy grape (*Vitis labrusca* L.) cultivars grown in Samsun ecological conditions

Cultivar	Total Soluble Solids (%)	Tartaric Acid (g/100 cc)	pH	Juice color		
				*L**	*a**	*b**
			1st Year			
'Rizessi'	12.44 c*	1.88 b*	3.05 c*	31.33 c*	1.34 a*	-1.96 b*
'Rizpem'	14.48 a	2.00 a	3.05 c	33.54 a	0.61 b	-1.35 a
'Rizellim'	12.94 b	1.79 c	3.16 b	31.13 c	1.15 a	-2.13 bc
'Ülkemiz'	12.61 bc	1.55 d	3.46 a	31.97 b	0.69 b	-1.42 a
'Çeliksu'	12.98 b	1.74 c	3.13 b	32.13 b	1.23 a	-2.29 c
			2nd Year			
'Rizessi'	13.48 c*	1.95 b*	2.94 c*	29.66 c*	1.64 a*	-1.68 b*
'Rizpem'	15.70 a	2.31 a	2.92 c	31.77 a	0.77 b	-1.89 b
'Rizellim'	14.28 b	1.82 c	3.01 b	29.59 c	1.57 a	-1.97 b
'Ülkemiz'	13.99 b	1.86 bc	3.22 a	30.64 b	1.39 a	-1.17 a
'Çeliksu'	14.00 b	1.89 bc	2.91 c	29.62 c	1.67 a	-1.93 b

*There is a statistical difference between the groups have different letters in the same column ($p<0.05$).

Conclusion

In the foxy grapes (*Vitis labrusca* L.) selected and registered from the Black Sea Region of Türkiye, generally the cultivars 'Rizellim' and 'Çeliksu' were prominent in cluster length; 'Çeliksu' and 'Ülkemiz' in cluster width; and 'Çeliksu', 'Ülkemiz' and 'Rizessi' in cluster weight; while the cultivar 'Rizessi' had the highest values in terms of the number of berries in the cluster and 'Çeliksu' in terms of rachis weight in both years. The best cultivar in terms of berry width, length, and size was 'Çeliksu', while 'Rizpem' had the lowest values. On the other hand, the highest *L** value in berry skin was detected in 'Rizpem', the most intense green color in terms of *a** value was detected in 'Ülkemiz' and the most intense blue color in terms of *b** value was detected in 'Ülkemiz'. While the 'Rizpem' cultivar stands out in terms of TSS and titratable acidity averages, the 'Ülkemiz' cultivar had the highest values in terms of pH. During the same period, it was also determined that the highest average fruit juice *L** values belonged to 'Rizpem' in both years, the highest red color density averages in terms of *a** parameter belonged to 'Rizessi' in the first year and 'Çeliksu' in the second year, and the highest yellow color density averages in terms of *b** color values belonged to 'Rizpem' in the first year and 'Ülkemiz' in the second year.

Turkish viticulture has a very old history. However, viticulture in the Black Sea Region has fallen behind. Although viticulture is carried out in provinces such as Tokat, Çorum, and Amasya, it is insufficient. On the other hand, coastal cities in the Black Sea have much rain, and viticulture with vinifera cultivars is very limited. Because the ecological conditions here affect *Vitis vinifera* grape cultivars in terms of diseases. Grapes known as foxy grapes and resembling strawberry taste grow well in these conditions and can produce quality grapes. The foxy grapes, which are evaluated by the local people as table grapes, grape juice, molasses, pepeçura, and table wine, are resistant to diseases. These foxy grape cultivars and types with color and thick skin. In the last decade, five of them have been registered with selection breeding. With these foxy grape cultivars, whose phenological, morphological, and some quality characteristics were determined by growing in the same environment in our study, regional viticulture will develop, and raw materials will be provided for the fresh-sweet grape juice industry. Hybridization studies can be carried out with these cultivars. Foxy grape viticulture will be

added to the tea and hazelnut farming that is dominant in the region, and new R&D studies such as vine management and training can be carried out and contributions can be made to the national economy.

Ethical Statement

Ethical approval is not required for this study.

Conflict Interest

The authors declare that there are no conflicts of interest.

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Author Contributions

HÇ and SA contributed to the study conception, design, and data collection, they also performed the data analysis. HÇ wrote the first draft of the manuscript. All authors commented on previous versions of the manuscript and read and approved the final manuscript.

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