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Araştırma Makalesi/*Research Article (Original Paper)*

The Effect of American Grapevine Rootstock on The Chemical Quality Parameters of 'Banazı Karası'

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Abstract: This research was conducted on the grape variety "Banazı Karası" in a grower vineyard located in Konak-Yeşilyurt of Malatya. It has been investigated the effect of the production, made with the ungrafted (cutting) and 41B, 1103P, and 110R rootstocks in the growth of 'Banazı Karası', on some fruit quality characteristies in the study. Five years old and over forty-year-old vinestocks have been used in the ungrafted vinestocks. The pH values ranged from 4.03 to 4.56, the SCKM from 22.50 to 27.00%, the maturity index of 48.91 to 68.97, the drying efficiency of 29.33 to 32.70 and the titration acidity of 0.36 to 0.47% in''Banazı Karası'' grown by being grafted on the rootstocks and by being ungrafted (without rootstock). Rootstock of 99R gave the highest must yield value with 83%. The L* value, representing the skin brightness, varied between 25.34 and 23.74 (41B-1103P), the a* value, showing red and green varied between 0.47 and 1.84 (41B-110R), and the b* value, indicating blue and yellow varied, between -1.32 and -1.91 (1103P-41B). While there have been numerical differences among the rootstocks in the b* value, the ungrafted vines have been monitored to have b*values close to each other (-1.72 and -1.71). The b* value (-1.82) obtained from the 99R tootstock was the closent value to those of the ungragted vines. The effect of the rootstocks on some of the chemical quality parameters in the grape fruits has been found statistically significant.

Keywords: American grapevine rootstock, 'Banazı Karası', quality, Malatya

Amerikan Asma Anaçlarının 'Banazı Karası' Üzüm Çeşidinde Bazı Kimyasal Kalite Özellikleri Üzerine Etkisi

Özet: Bu araştırma, Malatya-Yeşilyurt -Konak beldesindeki çiftçi bağında, 'Banazı Karası' üzüm çeşidinde yürütülmüştür. Çalışmada, 41B, 99R, 1103P, 110R anaçları üzerine aşılı Banazı üzüm çeşidine ait omcalar ile aynı çeşide ait çelikle yetiştirilmiş aşısız omcalar kullanılmış; bu omcalarla yapılan üretimin bazı meyve kalitesi özelliklerine etkileri gözlemlenmiştir. Üzerinde çalışılan omçalar 5 yaşında aşlı-aşısız (genç) ve 40 yaş üstü (yaşlı) aşısız omçalardır. Anaçlarda aşılı ve aşısız (anaçsız) olarak üretilen 'Banazı Karası' üzüm çeşidinde pH değeri 4.03-4.56, SÇKM %22.50-27.00, olgunluk indisi 48.91-68.97, kuruma randımanı 29.33-32.70, titrasyon asitliği ise %0.36-%0.47 arasında değişmiştir. Şıra randımanı; 99R anacı %83 ile en yüksek değeri vermiştir. Kabuk parlaklığını ifade eden L* değeri 25.34-23.74 (41B-1103P), kırmızı ve yeşili ifade eden a * değeri 0.47- 1.84 (41B-110R), mavi ve sarıyı ifade eden b* değeri ise -1.32 ile -1.91 (1103P-41B) arasında değişmiştir. b* değeri bakımından anaçlar arasında sayısal farklılıklar görülürken, aşısız omcalar (-1.72 ile -1.71) birbirine yakın değerler almıştır. b* değerinde aşısız omcalara en yakın değer 99R (-1.82) anacında belirlenmiştir. Anaçların tanede bazı kimyasal kalite özellikleri üzerine etkisi istatistiki olarak önemli bulunmuştur.

Anahtar Sözcük: Amerikan asma anacı, 'Banazı Karası', Kalite, Malatya

Introduction

Turkey is one of the important viticulture centers on the world with its suitable ecological conditions and rich gene potential. According to the data of TÜİK [Turkish Statistical Institute] (2016), 4.000.000 tones grapes, including 1.990.604 tones table, 1.536.269 tones dried, and 472.534 tones wine grapes, were grown totally in the 4.352.269 da. area in our country (Anonymous 2017).

Vitisvinifera L. vine growing has been made since B.C. 6000 – 5000 in our country (Doğer 2004). Because of its climate and soil characteristics, our country has become especially the cradle and center of viticulture historically (Ecevit and Kelen 1999). Vine is an important plant of our country because of its being economic in terms of grape yield and its being rich in varieties in terms of genetic material (Çelik 1998, Çelik et al. 1998). The richness in our vine gene potential creates a major source in both training studies and producing leading local varieties which are economically important.

Phylloxera, which feeds by absorbing in the vine roots and causes the vines to dry due to the tumor occurring in the absorbance places, has spread a lot in our country like the ones where viniculture is made commonly. All of the vineyards in our country are under its effect (Çelik 1996). Because phylloxera is contagious to the soils in our country, the use of resistant rootstocks has become obligatory, and the American grape-vine rootstocks have become essential to our viniculture (Ergenoğlu and Gürsoy 1991). Because of the reasons aforementioned, the American grape-vine rootstocks can affect production yield and quality as well as the vinestocks' growth vigor to varying degrees.

Malatya is a city in whose rural areas viniculture goes on despite the population increase in the center and the expanding urbanization pressure as a result of it. Though the ecology of Yeşilyurt in Malatya provides limited opportunities in terms of achieving the expected yield and quality in dried grape growing, the existence of the local dried grape varieties reaching from past to present is gaining importance, and the demand for dried grape growing is increasing.

'Banazı Karası' is one of the important genetic sources and one of the hopeful grape varieties of the city. It is a local grape variety which is dried as bunches and put on the market naturally. Although it is grown around Malatya, it has been well-adapted to the town, Konak (Banazı) with an elevation of 1000-1300 meters, and the counties, Yeşilyurt and Akçadağ (Koç et al. 2015). The importance of 'Banazı Karası' is increasing day by day because it is an alternative to apricot growing and can be grown under dry conditions in very limy soils not relevant to fruit growing (Koç et al. 2015).

Material and Methods

Material

The study was carried out in a vineyard in Konak, Yeşilyurt, Malatya. The analyses were performed in the research and application laboratories of the Malatya Apricot Research Institute. The vineyard where the study was conducted is in Konak (Yukarı Banazı), Malatya with an elevation of 1290 meters. The study was carried out with five-year-old 'Banazı Karası' grafted on the American grape-vine rootstocks (41B, 99R, 1103P, and 110R), five-year-old ungrafted 'Banazı Karası', and forty-year-old ungrafted 'Banazı Karası'. The research vineyard was established as blocks under dry conditions in 2x2-meter distances under the control of the workers of the Malatya Apricot Research Institute, stake training system was used in the vineyard, and cane pruning was made there.

The Soil Characteristics of the Research Area

The sample soil taken from the experiment area in 0-30 cm depth was analyzed in the Soil Analysis Laboratory of the Malatya Apricot Research Institute. The soil analysis values of the experiment area are presented in Table 1.

Table 1. Some traits of the soil in the experimental area

Saturate (%)	**pH**	**Total salt (%)**	**lime (%)**	**OrganicMatter (%)**	**EC (mS/cm)**	**P (kg/da)**	**K (kg/da)**
51.70	7.75	0.0228	37.90	1.33	690.00	8.48	77.89

As seen in Table 1, the soil of the research vineyard is in the clay-loam soil class because its saturation value is 51.70. It can be stated that the experimental area is salt-less due to its %0.0228 value, is very limy owing to its %37.90 lime ratio, has low amount of organic matter because of its %1.33 ratio, and is sufficient in terms of phosphor with the 8.48 kg/da value and of potassium with the 77.89 kg/da value. It can be concluded that the area is slightly alkali due to its 7.75 pH value, and its electrical conductivity

(EC) value (mS/cm) is 690.00. As a result of the soil analysis, 300-400 g sulphur and 15-20 kg fermented farmyard manure were applied to each vinestock in the early spring term.

Some Climatic Characteristics of the Research Area

Some important meteorological data belonging to the ecology of Malatya-Yeşilyurt where the study was carried out are given in Table 2 (Anonymous 2015).

Table 2. Some climatic data of the research area

	Minimum Monthly Temperature (°C)				Average monthly temperature (°C)			
Months	**2011**	**2012**	**2013**	**2014**	**2011**	**2012**	**2013**	**2014**
January	-5.2	-10.0	-9.6	-4.3	2.4	0.6	0.9	4.1
February	-6.1	-10.0	-4.5	-7.2	3.1	-1.5	-	-
March	-1.7	-6.5	-3.9	-3.4	8.4	3.4	8.8	10.4
April	-0.9	3.6	5.7	1.4	12.2	14.9	14.9	15.4
May	6.6	-	9.5	9.9	17.0	-	19.5	19.6
June	12.9	11.0	12.6	12.4	23.5	25.6	24.5	23.9
July	16.6	13.9	16.1	19.0	29.0	28.7	27.2	30.3
August	15.1	16.4	-	18.8	28.0	28.3	-	30.8
September	13.2	13.8	11.2	8.3	23.1	-	21.8	22.7
October	4.5	8.3	4.0	3.7	14.9	16.6	14.5	15.3
November	-6.1	1.7	1.7	0.5	4.7	10.7	10.6	7.3
December	-4.5	-2.4	-	-0.4	1.7	3.5	-	6.4

Method

It was planned that the experiment would be made in 3 replications and with 6 vinestocks in each replication in the vineyard established as blocks where the study was made. The drying process of grapes, fruit quality analysis, and soil analysis were executed in the Research and Application Laboratories of the Malatya Apricot Research Institute.

The Analyses Related to Quality

Sampling

The samples of bunches were taken from each vinestock in three replications to represent the vinestock as Rankine et al. (1962) mentioned and were brought to the laboratory. The analyses related to the chemical quality parameters in fruit (titratable acid, pH, Total Soluble Solids, maturation index, must yield, color values, and drying yield) were performed on fresh grapes.

Titratable Acid

The berries collected from the vineyards in each replication according to the method of Amerine and Cruses (1960) were squeezed, 10 ml of the squeezed grape juice was taken, and pure water was added to it until its total weight became 100 ml in order to determine the titratable acidity. It was titrated with 0.1 N NaOH to pH 8.1 value, then the titratable acid amount was found (Cemeroğlu 2010).
The following equation was used, and the result was recorded as tartaric acid.
Titration acidity, %= [V.F.E.100]/M
V= 0.1N, the amount of sodium hydroxide used, (ml)
F= The sodium hydroxide factor used (it was accepted as 1 in the study)
E=The equivalent value of the related acid (0.075 g)
M= The real amount of the sample titrated (ml)
The amount of acid equivalent to 1 ml 0.1 N NaOH (It is 0.075 for tartaric acid)

pH

The measurement was performed with the glass electrode pH-meter in the homogenous must made by squeezing the berry samples which were chosen randomly among the bunches in each replication in the cheesecloth, and pH value was recorded (Ough and Amerine 1988).

Total Soluble Solids (TSS)

The berries collected from the vineyards in each replication according to the method of Amerine and Cruses (1960) were put into the cheesecloth and squeezed. The Total Soluble Solids amount was found out in percentages by analyzing one drop of the homogenous must obtained with the digital hand refractometer (Atago RX 7000 Alpha).

Maturation Index

The maturation index was determined by dividing the amount of TSS by titratable acidity.

Must Yield (%)

First, the must was obtained from the berries chosen randomly from the bunches. Then, the must yield was calculated in percentages by using the formula, the must/squeezed grapes x 100.

Color Values (L, a*, b*)*

The color values, a phytochemistry-based parameter, were measured on the L*, a*, and b* color planes by using Minolta C400 colorimeter, and the fruit skin color values were found as L (100: while, 0: black), a (+: red; -: green), and b (+: yellow; -: blue) values in the study.

Drying Yield (%)

The bunches in each replication were weighted freshly and left to dry on the cloth drying yards. The drying yield (%) was calculated by considering the amount of fresh grapes used in drying.

Statistical Analysis

Descriptive statistics for the studied variables were presented as mean ± standard error of mean. One-way ANOVA was performed to compare effect of the rootstocks on the chemical quality parameters of the fruit, and the differences between the averages were determined with Duncan's Multiple Range Test. The averages of 10 bunches taken from 6 vinestocks in each replication (total 3 replications) were used. Statistically significance level was considered as 0.05 and SPSS (ver:13) statistical program was used for all statistical computations.

Results

The Analyses Related to the Chemical Quality in Fruit

The values of the rootstocks related to average acidity, TSS, titratable acidity (TA), maturation index, must yield, and drying yield in 2014 are given in Table 3.

Table 3. The analysis related to the fruit chemical quality parameters

Rootstocks	Acidity (g/l)	TSS (%)	pH	Titratable Acid Amount (g/l00 ml)	Maturation Index	Must Yield (%)	Drying Yield (%)
110R	4.91 c	24.83 c	4.11 c	0.36 c	68.97 a	78.63 c	30.63 c
99R	6.25 a	26.50 a	4.56 a	0.46 a	57.60 bc	83.00 a	32.70 a
41B	6.36 a	27.00 a	4.21 b	0.47 a	57.44 bc	80.53 b	29.83 d
1103P	5.75 b	25.50 b	4.24 b	0.43 b	59.30 b	80.50 b	31.93 b
Old	6.25 a	22.50 d	4.03 d	0.46 a	48.91 d	82.93 a	29.33 d
Young	6.35 a	24.66 c	4.21 b	0.47 a	52.46 cd	80.43 b	29.53 d

$p<0.05$, $P<0.05$ please use lower p instead of capital P. Standard error of mean or standard deviation should be presented with the mean in the tables.

Total Soluble Solids (%)

As seen in Table 3, the TSS values among the rootstocks were found to be statistically significant ($p<0.05$). The TSS values varied between % 22.50 and % 27.00. While the highest TSS value was recorded in the 41B rootstock, the lowest TSS value was found in the old local vinestock. The other TSS values found were % 26.50 in the 99R rootstock, % 25.50 in the 1103p rootstock, % 24.83 in the rootstock, and % 24.66 in the young local vinestock. Ünal (2000) investigated the ampelographic properties of grape varieties and found the TSS values of some grape varieties. The TSS value was %17.5 in Amasya, %17.8 in Köhnü, %20.8 in Tahannebi, %22.2 in 'Banazı Karası' (Siyah Kurutmalık), and %18.3 in Kureyş. Gazioğlu Şensoy and Balta (2010) mentioned that one of the most important criteria to decide which grape variety can be grown in a region is the findings belonging to the stum composition obtained in the maturation period because if a grape variety can not ripen its berries to the expected extent in the ecology of a region, it is not recommended to be grown in that region. According to the results of the analysis, we performed on the grape varieties in the first three harvest seasons especially in this perspective, the TSS values varied between 12.66 and 23.77 brix depending on the year and variety. In addition, it was found out that the rootstocks had an effect on TSS. While Sultani Çekirdeksiz reached the highest TSS value, Hatun Parmağı gave the lowest TSS value.

pH

The highest pH value was obtained in the 99R rootstock, and the lowest value was measured in the old local vinestock. The young local vinestock and 41B rootstock gave the same pH value, 4.21. The pH values of the 110R and 1103P rootstocks were found 4.11 and 4.24 respectively.

Titratable Acid

The 41B rootstock gave the highest value, 0.47 among the rootstocks in terms of the titratable acid amount in the must, and the young local vinestock had the same value. The lowest acidity value was measured in the must obtained from the bunches of the 110R rootstock. While the 99R, 41B, and ungrafted rootstocks were found to be statistically in the same group, the 1103P and 110R rootstocks were considered to be in different groups.

Maturation Index

The maturation index of the rootstocks varied between 68.97 and 48.91. The local vinestocks fell behind the American grape-vine rootstocks in terms of maturation index. The highest maturation index was found in the 110R rootstock, and the lowest maturation index in the old local vinestock. The other maturation indexes were 52.46 in the young local vinestock, 57.44 in the 41B rootstock, 57.60 in the 99R rootstock, and 59.30 in the 1103R rootstock. The maturation index was found to be low in the ungrafted. As seen in Table 3, there is a statistical difference among the rootstocks ($p<0.05$).

The maturation index was affected a lot by whether the vines are grafted or ungrafted. While the lowest maturation index was obtained in the ungrafted vines (% 31.3), higher maturation indexes (% 33.4 and % 33.4) were obtained from the vines grafted on the 1613 C and 1616 C compared to the ungrafted vines (Çelik and Kısmalı 2003). The findings of our study conform the ones of Çelik and Kısmalı (2003)'s study.

Must Yield (%)

The must yield in the study was considered high in general. The 99R rootstock gave the highest must yield, % 83. The 110R rootstock gave the lowest value, %78.63. It was found %82.93 in the old local vinestock and %80.43 in the young local vinestock. The must yields of the 41B and 1103P rootstocks were measured as % 80.53 and % 80.50 in order.

Drying Yield (%)

All of the rootstocks and ungrafted local vinestocks showed different values above % 25. According to the data in Table 3, the dried grape yield among the rootstocks varied between %29.33 and %32.70.

While the lowest value was obtained from the old local vinestock, the highest value was measured in the 99R rootstock. The 1103P rootstock with its %31.93 value ranked above the list in terms of drying yield. The 41B rootstock had the lowest value among the American grape-vine rootstocks. The drying grape yield was recorded to be low in the local rootstocks.

The drying grape yield did not show any difference between the ungrafted ones and the ones grafted on the rootstocks in parallel with the fresh grape yield. The drying grape yield in the ungrafted vines (% 25.3) was lower than the ones of the vines grafted on the 1613 C and 1616 C (% 27.8 and % 26.8). This observed difference was considered to be statistically significant (Çelik and Kısmalı, 2003). The findings of Çelik and Kısmalı's study (2013) conform the ones of our study.

Color (L, a, b) Values

The color changes in the berry skin of each rootstock are given with the averages of the L*, a*, and b* values determined with the colorimeter in Table 4.

Table 4. Color (L, a, b) values

Rootstocks		**L**	**A**	**B**	**Rootstocks**		**L**	**A**	**B**
110 - R	**max**	28.14	5.16	0.34	**1103-P**	**max**	26.34	2.59	0.47
	min	22.32	0.60	-2.97		**min**	21.19	0.34	-2.70
	means	**25.07**	1.84	-1.57		**means**	**23.74**	0.99	-1.32
	sd	1.77	1.30	1.14		**sd**	1.51	0.69	0.85
99-R	**max**	26.23	1.21	-0.54	**Old**	**max**	28.34	2.65	-0.41
	min	22.35	0.48	-2.74		**min**	21.27	0.70	-2.86
	means	**24.25**	0.83	-1.82		**means**	**24.87**	1.30	-1.72
	sd	1.02	0.23	0.58		**sd**	2.14	0.61	0.84
41-B	**max**	27.39	3.38	-0.45	**Young**	**max**	27.19	1.87	0.10
	min	23.48	0.64	-3.04		**min**	22.97	0.60	-1.74
	means	**25.34**	0.47	-1.91		**means**	**24.67**	1.04	-1.71
	sd	1.28	0.84	0.86		**sd**	1.45	0.40	0.86

Standard error of mean or standard deviation should be presented with the mean in the tables.

That the L* value approaches 100 shows that the color whitens, and that it approaches 0 indicates that the color blackens in the numbers between 0 and 100 (Minolta, 1994). When looking at Table 4, the L* color value was found below 26 in all of the rootstocks. The highest value, 25.34 was obtained in the 41B rootstock, while the lowest values, 23.74 was measured in the 1103P rootstock. Compared to the other rootstocks, the brightest berries were obtained in the 41B rootstock.

The a* value is between +60 and -60, the increase in + values means the red color increases, and that the – values increase means the green color increases (Minolta, 1994). According to the data in Table 4, the highest value, 1.84 was measured in the 110R rootstock, and the lowest value, 0.47 was found in the 41B rootstock. The a* values of the ungrafted local vinestocks were recorded as 1.30 and 1.04.

The b* value is between +60 and -60 like the a* value, that the + values increase means the yellow color increases, and that the – values increase means the blue color increases (Minolta, 1994). According to the data in Table 4, the b value varied between -1.91 and -1.32 among the rootstocks. While the ungrafted local vinestocks took the values close to each other, there found to be differences between the values among the American grape-vine rootstocks.

Conclusion

With this study, it was aimed to determine certain quality characteristics of banazı grape varieties, which are well-adapted to Malatya Province, especially Yeşilyurt and Akçadağ Provinces, with grape-gene potential and dried grape seeds.

In addition, the findings obtained in this study from the rootstock-variety performance after the growth of 'Banazı Karası' on the different rootstocks in its original ecology are expected to enlighten the future studies in the scope of the importance of the rootstock-variety relation in the viticulture studies.

The differences among the rootstocks in our study were found to be statistically significant in relation with fruit quality in terms of acidity, TSS, pH, maturation index, must yield, and drying yield.

The pH values were measured between 4.03 and 4.56 ('Banazı Karası' grafted on the old local vinestock and the 99R rootstock), the total acidity between 0.36 and 0.47, the maturation index between 48.91 and 68.97 ('Banazı Karası' grafted on the old local vinestock and the 110R rootstock), must yield between %78.63 and 83.00 (the 110R and 99R rootstocks), and drying yield between % 29.33 and 32.70 (the old ungraftedvinestock and 'Banazı Karası' grafted on the 99R rootstock) among the rootstocks. TSS was found between %22.50 and 27 on the old ungrafted vinestock and 'Banazı Karası' grafted on the 41B rootstock.

The TA in the vinestocks of TrakyaİlkerenTrakyaİlkeren was measured 3.71 g/100 ml in the 110R rootstock and 3.52 g/100 ml in the 41B rootstock (İşçi and Altındişli, 2014).

The TSS values of the ungraftedvinestocks were determined to be lower than the ones of the grafted. Considering the TSS of the old ungraftedvinestock, it is thought that grapes are harvested before the shriveling in the bunches starts and that the harvest should go on during a few days. It was observed in general that the TSS values of all of the rootstocks varied among the relevant values in terms of drying. The ungrafted vinestocks fell behind the grafted rootstocks in terms of maturation index.

The effects of the rootstocks on maturation are ripening period, and TSS and the amounts of acid in grape juice, and the rootstocks have effects on maturation index. The grapes grafted on them affect the ripening periods of grape varieties, the sugar-acid amount of grapes, and maturation index. The rootstocks change the amount of dried matter and acid, so the time period required for bringing the dried matter/acid ratio to the expected ratio is prolonged or shortened, that is, the harvest time changes (Anonymous 2002). The research data reveal the results that support the findings of the similar studies (Çelik 2003).

Çelik and Kısmalı (2003) obtained the low maturation index (% 31.3) in the ungrafted vines, while the vines grafted on the 1613 C and 1616 C provided higher maturation indexes (% 33.4 and % 33.4) than the ungrafted vines in their study. It was mentioned by Oraman (1959) that there found to be some indicators showing that the grafted vines tend to be ready for fruiting earlier and to produce more fruits. In addition, Janick (1986) stated that the place of graft in the grafted vines avoids sending carbohydrate produced in the leaves to the roots to some extent, more carbohydrates are accumulated in the upper parts, and they have positive effects on blooming and the product. Another different view is that the amounts of cytokine produced by the roots show differences depending on the rootstocks and that these different cytokines affect the shoot development of the grafted variety and its maturation differently (Nikolaou et al. 2000).

Because of the reasons mentioned above, the maturation index in the ungrafted vines could have been found less than the one of the grated ones.

Must yield was found high among the rootstocks. This supports the stories that 'Banazı Karası' was used as wine grapes a long time ago and also reveals the different usage areas of this grape variety.

The L* value, representing brightness, varies between 25.34 and 23.74 (41B - 1103P), the a* value, showing read and green, ranges between 0.47 and 1.84 (41B - 110R), and the b* value, indicating blue and yellow, changes between -1.32 and -1.91(1103P - 41B). While there were numerical differences among the rootstocks in the b* value, the ungraftedvinestocks had the values close to one another (-1.72 and -1.71). The closest value to the ones of the ungraftedvinestocks was measured as -1.82 in the 99R rootstock in the b* value.

Considering these data, it is understood that the rootstocks used in this study are effective in terms of fruit quality.

The effects of the rootstocks on the varieties should be investigated in terms of growth vigor, yield, and the physical and chemical properties of fruit by increasing the number of this type of the studies on different rootstocks and more local varieties, and more information about the performances in different rootstock-variety combinations should be learned in the future studies.

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