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DETERMINATION OF POMOLOGICAL AND BIOCHEMICAL COMPOSITIONS ON BERRIES IN DIFFERENT PARTS OF CLUSTERS IN SOME TABLE GRAPE VARIETIES

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Abstract

This research work has been conducted in the trail areas of the 'Research and Application Vineyard of Table Grape Varieties' situated in 'COMU Dardanos Campus' during the years 2013 and 2014 in order to determine pomological and biochemical compositions on berries in different parts of clusters of some table grape cultivars namely, 'Cardinal', 'Yalova Cekirdeksizi' and 'Yalova Incisi'. In the research, the samplings have been done from the berries randomly on top of clusters (TC), middle outer side of clusters (MOC), middle inner side of clusters (MIC) and tip of cluster (TIC) of grape varieties (initial clusters). The heaviest amount of berries has been obtained from the MOC of the 'Cardinal', 'Yalova Cekirdeksizi' and 'Yalova Incisi' cultivars. The ripest berries (SSC TA^{-1}) had been taken in TC in 'Cardinal', TC, MOC and MIC in 'Yalova Cekirdeksizi' and TC, MOC and MIC in 'Yalova Incisi' cultivars. In particular, berries of TIC were found more small–light, and a little bit unmatured than berries of other parts of clusters in 'Cardinal' and 'Yalova İncisi' grape cultivars. Pomological and biochemical compositions of berries on different parts of cluster may vary considerably, and also it has been changed at different grape cultivars. For this purpose, the regular monitoring of the maturity level of table and wine grape cultivars should be done by following the precautionary measures. It has also been determined that the samplings should have to be done in equal number from at least 3 different parts such as top, middle and tip sides of clusters. Nevertheless, the tip portions, having the latest blooming on flower clusters to be cut in certain proportions just after the berry formation, have been projected that they will provide an increase in that of the volume and maturity in those berries remaining on clusters.

Key words*: Vitis vinifera* L.*, table grape, position of grape on cluster, pomological and biochemical composition of grape berries, grape quality.*

INTRODUCTION

According to FAO statistical data; there were 67,067,128 tons fresh grape produced in 6,969,373 ha of vineyards in 2012 in the world. In the same year, the total fresh grape production was recorded as 4,275,659 tons in 462,296 ha grapevine area in Turkey (FAO, 2014). Clusters, uniform in size and colour, have bigger berries is an important factor for increasing the market values of table grapes. Therefore, many researches have been carried out related to the training system and development of new hybrid grape types and varieties aimed to improve the grape quality.

Every berry fertilized on flower cluster, has occurred from pericarp that has juicy pulp and skin (Agaoglu, 1999). Size of berries may vary by variety, growing power of vine stock, water uptake, berry set, berry count and maturity (Celik, 2011). Balance between direct sun exposure on leaf area and size of berries is significantly affected the yield and quality of product (Reynolds et al., 1994). Stoev (1974) reported that leaves found in same direction have been supported by roots in same direction. Similarly, nutrition of bunch on shoot was affected by shoot that have bunches. Todorov (1970) explained that there is a positive correlation between sizes of cluster and shoot having the cluster. The same author also reported that the clusters and berries on strong and productive shoots are more heavy clusters and berries than that of others. However, there are many factors that control the development and composition of grape berries. Therefore, there are significant differences on pomological and biochemical composition between clusters

on a vine stock or first and second clusters on same summer shoot or berries of same clusters (Smart et al., 1985; Yılmaz and Dardeniz, 2009). Yılmaz and Dardeniz (2009) mentioned that the best developing clusters in terms of fruit width, length and weight were first clusters on summer shoots. Moreover, maturity indexes of first clusters have been found higher than second clusters in case of 'Amasya' and 'Cardinal' grape cultivars. Besides, clusters located on summer shoots from growing on second bud showed a better development in terms of cluster width, length and weight than those that located on summer shoots growing on first bud. Though there were not any significant differences found on maturity index by the pruning of 2 buds.

Nowadays, different application methods are being used for the improvement of grape quality. For example, Ilgin (1997) reported that the thinning of cluster at the level of 25% in 'Yalova Cekirdeksizi' grape cultivar decreased the yield of grafted vineyards but had not effect on ungrafted vineyards. Although the grape yields decreased 50% of thinning of 75% of flower clusters in ungrafted vineyard while the grape quality has been increased by 25% level of thinning found more of flower clusters in ungrafted vineyard. Dardeniz and Kismali (2002) determined the effect of cluster thinning, a week before blooming at 0%, 30% and 60% levels, on the yield and quality of grapes, and also on the vegetative growth of 'Amasya' and 'Cardinal' cultivars. But in this study, authors have not recommended 30% levels of cluster thinning of 'Amasya' cultivar, but 60% level of cluster thinning has been recommended only in southern latitudes. In case of 'Cardinal' variety, 30% level of cluster thinning at was enough for grape quality.

Florescence starts from top to bottom on the flower clusters. After berry set, berries on the bottom of the cluster impair the quality and image of whole of the cluster because of smaller and late maturing berries. Therefore bunch thinning is recommended for these berries on the bottom of cluster in 2 or 3 weeks after berry set at 25% or 33% level. Thus either enlargement for cluster or increase in berry size was provided. Also it is possible to harvest at 3–7 days early to clusters that have good coloured, allured and uniform size. When the berries were 5–7 mm, the clusters were tipped at 1/3rd, 1/6th and 1/12th of the cluster length on 'Cardinal' and Uslu table grape cultivars by Dardeniz (2014). In Uslu, cluster length (cm), cluster width (cm), cluster compactness (1–9), number of berries/cluster (n), berry weight (g) and titratable acidity (TA) (%) parameters were affected by the applications. In 'Cardinal', cluster length (cm), cluster compactness (1–9), number of berries/cluster (n), berry weight (g), total soluble solid (TSS) (%), titratable acidity (TA) (%) and maturity index parameters were affected by the applications. Yield was not affected by cluster tipping in both grape cultivars. It was concluded that the cluster tipping applied to the Uslu in a proportion of one–third and to the 'Cardinal' in a proportion of one–sixth of the cluster length would be positively sufficient in terms of increasing the grape quality.

Dardeniz et al. (2012a) compared the growth and productivity of primary and secondary summer shoots, which primary summer shoots were cut at the base following 10–15 cm of growth and secondary buds were forced to sprout giving rise to new summer shoots, of two different table grape varieties, 'Yalova İncisi' ('Honusu' x 'Siyah Gemre') and 'Yalova Cekirdeksizi' ('Beyrut Hurması' x 'Perlette'). In both years (2010 and 2011), vinestock that has secondary shoots showed significant decreases in the levels of fresh grape yield, with especially small grape bunches obtained. In terms of maturity of the grapes, significant differences were not observed among the applications due to low sprout growth on secondary shoots. The results of this study show that some grape products still may be harvested even if primary buds from summer sprout are damaged in cases of late spring frost.

Another research has also been carried out by Dardeniz et al. (2012b) evaluating the changes in chlorophyll content on 8 different table grape varieties leaves in 3 different (5th node, 10^{th} node and 15^{th} node) branch nodes, at 4 periods (15^{th} of June, 1^{st} of August, 15^{th} of September and 1^{st} of November) by SPAD digital chlorophyll meter. Although chlorophyll contents were low on the leaves of 10^{th} and 15^{th} nodes, chlorophyll contents were observed to be equal during the 2^{nd} measurement period in

leaves at the 5th and 10th nodes, and also during the 3rd measurement period in leaves at the 10th and 15th nodes. Additionally during the last study period, a reduction of chlorophyll content was observed in leaves at the 5th and 10th nodes. 3–5 leaves per lateral shoot, the terminal 3 leaves at the tip of the shoot contained low chlorophyll content during the 1st study period; however a gradual increment in chlorophyll content was observed in subsequent periods. High total chlorophyll content was observed in lateral shoot leaves throughout all periods of study when compared to leaves at the tip of the shoot. Turker and Dardeniz (2014) aimed to determine the effects of 3 different levels of axillary shoot removal applications (High Level Axillary Shoot Removal (HLASR); Normal Level Axillary Shoot Removal (NLASR); None Axillary Shoot Removal (NASR) on the yield and quality characteristics of the 6 different varieties of *Vitis vinifera* L. As far as the HLASR application is concerned, it reduced the yield of table grape by causing a decrease in the potential of vine stock in all grape varieties especially in the second year of research. Consequently, this application in which all of the axillary shoots are taken from the bottom of vine stock is not recommended for any variety of table grapes. In the case of well–organized spraying program, NASR method of application will contribute to high yield, good quality and early grape production in all table grape varieties.

A research that carried out on 'Horoz Karasi' and 'Gok uzum' grape varieties, was to determine the effects of 1 3^{-1} cluster reduction (CR), 1 3^{-1} CR + herbagreen (HG) and 1 3^{-1} CR + humic acid (HA) applications on grape yield and quality of cultivars were examined. It was suggested that 1 3^{-1} CR + HA application increased grape yield, berry weight, berry red and blue colour intensity values of Horoz Karasi grape variety and 1 3^{-1} CR application increased grape yield and maturity index values of Gok üzüm grape variety (Akin, 2011).

Akin et al. (2012) reported that the combined leaf fertilizer (TARIS–ZF) significantly increased quality parameters such as berry length, berry weight, maturity index, juice yield and drying index of grapevine cv. 'Gok uzum'. Increasing crop load values (16, 21, and 26 buds/vine) increased fresh grape yield and juice yield; however, maturity index and drying index decreased in comparison to the control. As a result of this study, it was suggested that produce a high yield and to increase quality parameters 16 buds/vine pruning, and fertilization by TARİŞ–ZF may be applied on grapevine cultivation especially on 'Gok uzum' cultivar.

A research that in order to determine the effects of 9 different winter and summer pruning practices in 'Yalova İncisi' grape cultivar is suggested that the thinning practices such as EP + CT (early pruning + cluster thinning) and EP + CT + BT (early pruning + cluster thinning + bunch thinning) have been found recommenddable for acquiring early and high–quality crop yields in those regions of our country where early spring frosts are not considered as dominant. By applying pruning on normal date with high level axillary shoot removal practice; the increases both in the average yield and quality, and ripeness of grapes were quite satisfactory resulting to the increase in leaf size and vine stock potential. On the other hand, overall ripening of grapes resulting by the increase found in leaf size and vine stock potential after the application of GB+SUB practice (Sezen and Dardeniz, 2015).

However, it is known that different treatments affected quality of table grapes, for determinate to effect of these treatment it is required to sample the right way on every cluster. Because it is seen that some grape cultivars' berries on different parts of clusters have significantly pomological and biochemical differences. Therefore, this research in order to determine pomological and biochemical compositions on berries in different parts of clusters in some table grape cultivars such as 'Cardinal', 'Yalova Cekirdeksizi' and 'Yalova İncisi'.

MATERIALS AND METHODS

This research has been conducted in the trail area of the 'Research Vineyard of Table Grape Varieties' situated in 'COMU Dardanos Campus' in the years 2013 and 2014 in 'Yalova İncisi' which has white colour berries with seeds on short cluster and very early cultivar, 'Cardinal' which has red colour berries with seeds on middle–long cluster and early cultivar and 'Yalova Cekirdeksizi' which has white colour seedless berries on middle–short cluster

and mid early cultivar. Plant materials, used in this research, have been grafted onto 41B American grape rootstock ('Yalova Incisi' cultivar) and 5BB American grape rootstock ('Cardinal' and 'Yalova Cekirdeksizi' cultivars) in 11 years old. Vines were trained to unilateral cordon system. The spacing in between rows and within rows was 3.0 m and 1.5 m; respectively. The soil was loamy clay, slightly alkaline, medium calcareous and unsalted. Summer shoots that reached sufficient lengths were bended between first and second wire and tipped above 20–30 cm on second wire. 2nd offshoot tipping treatments did 1 month later after 1st treatments. Tipping of offshoots was cut above 1st or 2nd leaves on bottom of the offshoots by secateurs.

All grape cultivars were thinned first and second leaves of summer shoots, lateral, offshoot, water sprouts, and secondary and tertiary shoots just before full blooming in both 2 years (2013–2014). While harvest time was coming, first clusters of grape cultivars packed with plastic bags and labelled and brought to Pomology Laboratory in Canakkale Onsekiz Mart University, Faculty of Agriculture, and Department of Horticulture.

In this experiment grape berries were sampling randomly on Top of Clusters (TC), Middle Outside of Clusters (MOC), Middle Inside of Clusters (MIC) and Tip of Clusters (TIC); and berry width (mm), berry length (mm), berry weight (g of 1 berry), Chroma value of berry, Hue value of berry, soluble solid content (SSC) (Brix%), Titratable acidity (TA) (mg tartaric acid 100 g^{-1}), maturity index (SSC TA^{-1}) and total phenolic compounds (TPC) (mg GAE 100 g^{-1}) were investigated with these berries.

This research, was settled in randomized plot factorial design with 3 replications and each replication was had 100 berries which took 1st clusters on 4 vine stock. LSD multiple comparison test was used determining the differences among treatments. All of the data analyses were done with SAS system for Windows (ver. 9) statistical package program.

RESULTS AND DISCUSSIONS

Statistical data, in order to determine the pomological and biochemical compositions found into the berries in different parts of clusters of some table grape cultivars, are given in Table 1–6.

In the light of the results of this research, the values regarding to the highest berry width and length have been determined on the TC (20.98 mm and 21.68 mm, respectively) and MOC (21.61 mm and 21.61 mm, respectively) in 'Cardinal' cultivar, when MOC (6.46 g) and TC (6.01 g) had the heaviest level of berries. However; the shortest, narrowest and the lightest berries have been found at the TIC and MIC, respectively. The lowest values of chroma were measured into the MOC (8.67) and TC (9.57). Berries on the TC were found more red tones and good coloured as compared to the other parts of clusters due to their highest values of Hue, shown in Table 1.

The highest SSC have been recorded in those berries which were found on the TC (14.00%) while the lowest SSC were calculated on the berries located at the TIC (12.62%) and MIC (13.16%). The lowest TA was determined in TIC (0.817%) for 'Cardinal' grape cultivar. The highest pH values have been found on the TC (3.47) and MOC (3.42). The ripest berries (SSC TA^{-1}) have been obtained from the TC in case of 'Cardinal' cultivar. Berries of TIC (2029 mg GAE 100 ml^{-1}) and MOC (2056 mg GAE 100 ml^{-1}) had significantly lower TPC in comparison to the other parts of clusters. TC (2112 mg GAE 100 ml^{-1}) having the highest content of phenolic compound, shown in Table 2.

Table 1. Some pomological compositions on berries of different parts of clusters in 'Cardinal' cultivar*

Parts of clusters	Berry width (mm)	Berry length (mm)	Berry weight (g of 1 berry)	Chroma value	Hue value
	2013–2014	2013–2014	2013–2014	2013–2014	2013–2014
TC	20.98 a	21.68 a	6.01 ab	8.67 c	49.32 b
MOC	20.88 a	21.61 a	6.46 a	9.57 bc	62.30 a
MIC	19.97 b	20.91 b	5.60 b	10.15 b	57.82 a
TIC	19.99 b	20.27 c	5.46 b	11.18 a	59.95 a
LSD	0.5855	0.3418	0.6523	0.9553	5.6721

*: Means of 2 years data. TC: Top of clusters, MOC: Middle outer side of clusters, MIC: Middle inner side of clusters, TIC: Tip of clusters.

Table 2. Some biochemical compositions on berries of different parts of clusters in 'Cardinal' cultivar*

Parts of clusters	SSC (%)	TA (%)	pH	Maturity index (SSC TA^{-1})	TPC (mg GAE 100 ml^{-1})
	2013–2014	2013–2014	2013–2014	2013–2014	2013–2014
TC	14.00 a	0.663 b	3.47 a	22.24 a	2112 a
MOC	13.21 ab	0.678 b	3.42 a	20.43 b	2056 b
MIC	13.16 b	0.671 b	3.39 ab	20.88 ab	2068 ab
TIC	12.62 b	0.817 a	3.30 b	16.84 c	2029 b
LSD	0.7965	0.0429	0.0972	1.5628	58.9

*: Means of 2 years data. TC: Top of clusters, MOC: Middle outer side of clusters, MIC: Middle inner side of clusters, TIC: Tip of clusters.

Although, the highest values of the width of berry have been calculated from the MOC (16.03 mm), MIC (15.14 mm) having the narrowest berries. The largest berries in their sizes have been observed into the MOC (19.21 mm) and TC (18.79 mm). While the berries that located onto the MOC (3.34 g) bearing the heaviest number of berries. On the other hand, the berries found on the MIC (2.77 g) possessing the lowest values of weight. There were no any significant differences found in the berries located on different parts of clusters in accordance to the values of Chroma and Hue, given in Table 3.

Table 3. Some pomological compositions on berries of different parts of clusters in 'Yalova Cekirdeksizi' cultivar*

Parts of clusters	Berry width (mm)	Berry length (mm)	Berry weight (g of 1 berry)	Chroma value	Hue value
	2013–2014	2013–2014	2013–2014	2013–2014	2013–2014
TC	15.74 ab	18.79 a	3.06 ab	13.85	106.59
MOC	16.03 a	19.21 a	3.34 a	13.95	106.61
MIC	15.14 b	17.63 b	2.77 b	14.24	106.79
TIC	15.68 ab	17.60 b	3.04 ab	14.72	106.40
LSD	0.6022	1.1285	0.4548	NS[1]	NS

*: Means of 2 years data. TC: Top of clusters, MOC: Middle outer side of clusters, MIC: Middle inner side of clusters, TIC: Tip of clusters.
[1]NS= Non–significant.

Differences between SSC and TA berries, found on different parts of clusters, have not been significantly different when the lowest pH values, maturity index values and TPC values have been determined into the berries located at the TIC which were 3.12, 13.52 and 1890 mg GAE 100 ml^{-1}, respectively.

The highest pH values were measured in berries that found on the TC and MOC. Statistical analyses showed that the berries while taking place on the TC, MOC and MIC had the highest maturity (15.32, 15.03 and 14.80, respectively) while the berries found on the MIC (1963 mg GAE 100 ml^{-1}) and TC (mg GAE 100 ml^{-1}) having the highest numbers of the total phenolic compounds. Monagas and Bartolomé (2005), reported that the maturation and sun exposure factors affected synthesis of phenolic compounds especially flavones are found in the skins of berries for the berries against sun burn (Table 4.).

Table 4. Some biochemical compositions on berries of different parts of clusters in 'Yalova Cekirdeksizi' cultivar*

Parts of clusters	SSC (%)	TA (%)	pH	Maturity index (SSC TA^{-1})	TPC (mg GAE 100 ml^{-1})
	2013–2014	2013–2014	2013–2014	2013–2014	2013–2014
TC	14.53	0.951	3.20 a	15.32 a	1959 a
MOC	14.18	0.943	3.20 a	15.03 a	1907 ab
MIC	14.55	0.984	3.18 ab	14.80 a	1963 a
TIC	13.89	1.029	3.12 b	13.52 b	1890 b
LSD	NS[1]	NS	0.0716	0.9129	45.41

*: Means of 2 years data. TC: Top of clusters, MOC: Middle outer side of clusters, MIC: Middle inner side of clusters, TIC: Tip of clusters.
[1]NS=Non–significant.

According to the results of this research work, the highest berry width have been determined on MOC (19.29 mm) and the lowest berry width have been calculated on MIC (18.00 mm) in 'Yalova Incisi' cultivar.
Berries on MOC and TC (24.41 mm and 23.94 mm, respectively) had the longest berries. When MOC (5.79 g) had the heaviest berries, berries on TIC (4.67 mm) and MIC (4.68 mm) had the lightest grapes.
The lowest chroma values were measured on MIC (13.04), MOC (13.58) and TC (13.65). Berries on TC had more yellow tones and good coloured than the other parts of clusters due to the highest values of Hue (Table 5).

Table 5. Some pomological compositions on berries of different parts of clusters in 'Yalova Incisi' cultivar*

Parts of clusters	Berry width (mm)	Berry length (mm)	Berry weight (g of 1 berry)	Chroma value	Hue value
	2013–2014	2013–2014	2013–2014	2013–2014	2013–2014
TC	19.01 ab	23.94 a	5.54 b	13.65 b	106.74 c
MOC	19.29 a	24.41 a	5.79 a	13.58 b	108.16 b
MIC	18.00 c	23.07 b	4.68 c	13.04 b	109.58 a
TIC	18.54 bc	23.01 b	4.67 c	15.46 a	107.46 bc
LSD	0.5548	0.8148	0.1656	0.8094	1.3988

*: Means of 2 years data. TC: Top of clusters, MOC: Middle outer side of clusters, MIC: Middle inner side of clusters, TIC: Tip of clusters.

The highest SSC have been recorded in berries on TC (13.47%) while the lowest SSC were calculated on the berries of TIC (12.35%).
The lowest TA was determined in MIC (0.472%) for 'Yalova Incisi' grape cultivar. The highest pH values were found on MOC (3.84) and TC (3.81). The ripest berries (SSC TA^{-1}) have been obtained from MIC (28.24), TC (27.59) and MOC (26.95) in 'Yalova Incisi' cultivar.
Berries of TIC (1900 mg GAE $100ml^{-1}$) had significantly lower TPC in comparison to other parts of clusters. MIC (1924 mg GAE $100ml^{-1}$) was highest content of phenolic compound (Table 6).

Table 6. Some biochemical compositions on berries of different parts of clusters in 'Yalova Incisi' cultivar*

Parts of Clusters	SSC (%)	TA (%)	pH	Maturity Index (SSC TA^{-1})	TPC (mg GAE 100 ml^{-1})
	2013–2014	2013–2014	2013–2014	2013–2014	2013–2014
TC	13.47 a	0.488 ab	3.81 a	27.59 a	1911 ab
MOC	12.99 b	0.483 ab	3.84 a	26.95 a	1904 ab
MIC	13.29 ab	0.472 b	3.73 b	28.24 a	1924 a
TIC	12.35 c	0.528 a	3.67 b	23.55 b	1900 b
LSD	0.3795	0.0460	0.0534	2.4693	21.101

*: Means of 2 years data. TC: Top of clusters, MOC: Middle outer side of clusters, MIC: Middle inner side of clusters, TIC: Tip of clusters.

CONCLUSIONS

According to research results, the largest berries were determined on TC and MOC in 'Cardinal' cultivar and on MOC in 'Yalova Cekirdeksizi' and 'Yalova Incisi' grape cultivars. The largest berries were taken from TC and MOC in case of all cultivars, though grape berries of MOC had the heaviest berries in all cultivars.
The ripest berries (SSC TA^{-1}) have been obtained from the TC in 'Cardinal'; TC, MOC and MIC in 'Yalova Cekirdeksizi' and the TC, MOC and MIC in 'Yalova Incisi' cultivars. Particularly, the berries of TIC have been found tinier, lighter and lesser mature as compared to the berries of other parts of the clusters in case of 'Cardinal' and 'Yalova Incisi' grape cultivars.
Pomological and biochemical compositions of berries on different parts of clusters may vary considerably and also they have changed in different grape cultivars. Therefore, the tip reduction for monitoring maturity on table and

wine grape cultivars should be treated with caution and it was determined that samplings have to be done equally at least 3 different parts (top, middle and tip) of clusters. Nevertheless, the tip portions, having the latest blooming on flower clusters to be cut in certain proportions just after the berry formation, have been projected that they will provide an increase in that of the volume and maturity in those berries remaining on clusters.

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