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Evaluation of Some Berry Quality Characteristics in *Vitis vinifera* cv. Kalecik Karasi Clones

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ABSTRACT

Some quality characteristics of berries i.e., total sugar, titrable acidity, pH and soluble solid were determined for 23 clones of *Vitis vinifera* L. cv. Kalecik Karasi. Significant differences ($p<0.05$) were recorded for the quality characteristics among clones. Glucose and fructose content ranged from 120.59 to 136.45 and 112.505 to 123.185 g L^{-1}, respectively; whereas glucose/fructose ratio ranged from 0.900 to 0.955. Likewise, soluble solids, total acidity and pH ranged from 21.00 to 25.60%, 0.30 to 0.55% and 3.00 to 3.70, respectively. The overall similarity level of all clones was found 80.278%. As a result, it can be concluded that three Kalecik Karasi clones: 6, 18 and 19 may be considered to have reasonable performance in terms of evaluated characteristics in the study. © 2012 Friends Science Publishers

Key Words: Grape; pH; Soluble solid; Sugar; Titrable acidity

INTRODUCTION

Some characteristics of berries, such as total sugar, titrable acidity pH and soluble solid are important for fruit quality as well as better for vineyard management and harvest techniques. Glucose and fructose are the most common sugars in fruits especially grapes. These are located in the pulp and represent about 99% of the sugar contents at the end of grape maturation (Varandas *et al.*, 2004). Sucrose is the major translocated sugar in grapevines; however, glucose and fructose make the bulk of the sugar in the grape berry at all stages of development (Hardy, 1968). During the early stages of berry development, the total sugar concentration is low and glucose exceeds fructose by up to five times. At the onset of ripening, the concentrations of glucose and fructose increase rapidly and soon become equal (Kliewer, 1965).

In addition to sugar, pH, soluble solid, and titrable acidity play an important role in the quality, e.g., flavor of the grape berries. These characteristics are also major indicators of the grape maturity for determination of harvest time. Although there is no diversity in morphological or phenotypical characteristics of the cultivars reproduced asexually and grown in vineyard, it is possible that there are different individuals in terms of yield and quality characteristics. The permanent differences in the individuals largely due to natural bud mutations are the basis of clone selection studies. These kinds of variations or mutations may be lead to some changes in the sugar levels and some characteristics of grape cultivars or clones. Thus, determination of the sugar levels as well as other quality characteristics for cultivars and clones is important for the clone selection studies.

The nature and amount of sugars as well as acids of the grape berry has been investigated for the last few decades. However there are only few reports (Lott & Barrett, 1967; Petric *et al.*, 2009) about relationships between clone and some quality characteristics of berries. Thus, aim of the present study was to determine and compare some quality characteristics of berries in Kalecik Karasi grape cultivar clones.

MATERIALS AND METHODS

Plant material: For the study, plant materials of the 23 Kalecik Karasi clones were collected from Kalecik Viticulture Research and Application Station of Faculty of Agriculture in Ankara University. This station is located at 700 m altitude and the between 40º 06' 44. 5" North latitudes and 33º 25' 43.3" East longitudes in the north part of Ankara (Turkey). Annual average temperature and rainfall at the station is 12.2°C and 34.8 mm, respectively. For the vineyard soil characteristics pH was 7.65, total lime was 14.6%, organic substance was 2.18% and salinity was 0.130 mmhos/cm.

Determination of fructose and glucose levels: Sugars were determined by modified methods of Torije *et al.* (1998) and Karkacier *et al.* (2003). Whole berries were crushed and ground with a hand blender and made into a mesh. Three grams grape samples were ground into mortar

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and pestle with 25 mL of methanol (80%). The mixture was homogenized in an Ultra Tissue Lysis (Ultrasonic Processor, Jenway Ltd. UK) and incubated in magnetic stirrer at 65ºC for 30 min. Then, it was centrifuged at 2000 rpm for 15 min. Methanol was removed by rotary evaporator and the residue was dissolved in 5 mL double distilled water. Extracts were passed through Sep-Pack C18 cartridge. Samples were injected directly into High performance Liquid Chromatography (HPLC). Then refractive index was used to analyze fructose and glucose levels of clones.

Determination of soluble solid, titrable acidity and pH levels: The soluble solid content of juices was determined as °Brix using a handheld temperature-compensated refractometer (Atago Pal-1, Japan). The pH of berry juices was determined with a pH meter (Mettler Toledo MP220, Zurich, Switzerland) and the titratable acidity (TA) by titrating 10 mL sample with 0.1 N NaOH at pH 8.1 and was expressed as g tartaric acid/L.

Chromatographic conditions: Sugars were determined as 2 replications by using an HPLC (Hewlett Packard Series 1525, Binary HPLC Pump, Hewlett Packard Gmbh, Waldbronn, Germany) system. Detector: Hewlett Packard refractive index 2414 detector (HP 2414, Tokyo, Japan); Column: 5 µm NH_2 carbohydrate analysis column (Waters; 4.6 x 250 mm Catalog PSS831115); Mobile phase: 83% Acetonitrile. The column was calibrated by fructose and glucose standards.

Statistical analyses: Descriptive statistics were expressed as Mean and Standard Error for the studied variables. One-way ANOVA test was used to compare means of clone groups. Tukey multiple comparisons test was used to compare the determinations of different clones. In addition to univariate test, cluster analysis was carried out to make easy for better understanding of the similarities among the clones. Statistical significance levels were considered as 5%. SPSS (ver. 13) statistical program was used for all statistical computations.

RESULTS AND DISCUSSION

Significant differences ($p<0.05$) were recorded for the quality characteristics among clones (Table I & II). Soluble solids, total acidity and pH ranged from 21.00 to 25.60%, 0.30 to 0.55%, and 3.00 to 3.70, respectively (Table I). Likewise, glucose and fructose content ranged from 120.59 to 136.45 and 112.505 to 123.185 g L^{-1}, respectively; whereas, glucose/fructose ratio ranged from 0.900 to 0.955 (Table II). Similar variations in the quality characteristics have also been reported earlier (Amerine *et al*., 1967; Amerine, 1973; Khan *et al*., 2011).

The cluster analyses (Table III; Fig. 1) revealed that 23 clones can be clustered into three groups. The first and second groups consisted of nine clones each. First group had clone 1, 2, 3, 4, 5, 6, 7, 12 and 16; whereas the second group had clone 8, 13, 15, 17, 18, 20, 21, 22 and 23. The third group consisted of five clones, i.e., 9, 10, 11, 14 and 19. Similarity levels for these groups (group 1, 2 & 3) were found 88.163, 84.421 and 88.009%, respectively (Table III; Fig. 1). The overall similarity level of all clones was found 80.278% (Fig. 1) with the highest similarity (97.588%) of clone 11 and 14.

Grape organoleptic quality greatly depends on both the content and composition of sugars and these are important factors in the selection of a new cultivar. Of the two main hexoses, fructose is twice as sweet as glucose, a fact which is of special importance when considering the glucose/fructose ratio. Sucrose, which is found in considerable amounts in the brush, pedicels and stems, is hydrolyzed into glucose and fructose during its movement into the berry, but a small amount (1-3 g L^{-1}**)** enters the berries in *V. vinifera* and a little more in *V. labrusca* than the other cultivars (Soulis & Avgerinos, 1984). The predominant sugars are glucose and fructose, with only trace sucrose content in grape berries of most cultivars, and a few high-sucrose content cultivars are detected in *V. rotundifolia* and hybrids between *V. labrusca* and *V. vinifera* (Liu *et al*., 2006). According to Boulton *et al.* (1996), higher sugar as well as lower acid content, rich color and full varietals fruitiness are major indicators for harvest. However, different definitions of grape maturity are currently in use: industrial maturity corresponds to an optimum pulp sugar/acidity ratio; whereas, technological maturity is defined as the stage at which skin aroma and phenolic compounds. Glucose/fructose ratio is one of the important parameters for determination of (industrial) maturity in grapes. Amerine *et al.* (1972) pointed out that glucose/fructose ratio was about 1; however, this varied from 0.71 to 1.45 in genotypes. In this study, glucose/fructose ratio ranged from 0.900 to 0.955. This finding supports results of Amerine *et al.* (1972). There may be, however, large variation in fructose/glucose ratio being 0.1 in green berry for Boal and Verdelho to 1.0 in harvest for Loureiro and Trajadura (Varandas *et al.,* 2004). Ribéreau-Gayon (1978) reported that sugar amount of Cabernet sauvignon in Bordeaux region ranged from 164 to 200 g L^{-1}. The quality of grapes at harvest is the main factor that influences wine and grape juice quality.

According to Amerine and Thoukis, (1958), in the production of grape juice from grapes grown in cool climates, use of grapes high in fructose would result in sweeter tasting musts at lower total sugar contents. On the other hand, for grapes grown in warm climatic regions where sugar production is frequently too high for balanced grape juice high-glucose varieties would yield less sweet and better-balanced musts. Since, it is apparently the sweet-ness-to-acid taste, which is important, a wide range of fructose to titratable acidity relationships is possible.

The clone will have their bud burst at the same time; their shoots will grow at the same speed and direction, which makes canopy management much easier. All plants of a clonal vineyard will require crop protection at the same

Table I: Soluble solids, titrable acidity and pH of clones

	Soluble solid		Titrable Acidity		pH	
Clones	**Mean**	**Std. Error**	**Mean**	**Std. Error**	**Mean**	**Std. Error**
1	22.45 bc*	0.863	0.49 abcd	0.037	3.03 j	0.033
2	22.72 bc	0.290	0.55 a	0.031	3.03 j	0.042
3	22.90 abc	0.700	0.46 abcdef	0.049	3.40 cde	0.041
4	22.25 bc	0.415	0.50 abc	0.031	3.20 fghj	0.033
5	21.35 bc	1.112	0.39 efghj	0.024	3.31 efg	0.047
6	24.30 ab	1.335	0.41 cdefgh	0.011	3.31 efg	0.051
7	21.00 c	0.789	0.50 abcd	0.013	3.19 fghj	0.042
8	22.91 abc	0.583	0.44 bcdefg	0.034	3.30 defg	0.037
9	21.85 bc	0.778	0.46 abcde	0.027	3.40 cde	0.031
10	23.40 abc	1.387	0.35 ghj	0.031	3.10 hj	0.065
11	22.00 bc	1.329	0.38 efghj	0.024	3.20 fgh	0.097
12	23.05 abc	0.434	0.40 defgh	0.034	3.00 j	0.032
13	21.48 bc	1.032	0.41 defgh	0.036	3.40 cde	0.095
14	21.95 bc	1.117	0.36 fghj	0.009	3.50 bc	0.016
15	23.15 abc	0.832	0.41 cdefgh	0.017	3.70 a	0.121
16	22.40 bc	1.095	0.52 ab	0.011	3.35 cdefg	0.026
17	22.00 bc	0.721	0.40 efghj	0.019	3.15 ghj	0.037
18	23.65 abc	0.427	0.30 j	0.012	3.45 bcd	0.041
19	23.63 abc	0.123	0.33 hj	0.008	3.40 cde	0.016
20	22.35 bc	0.245	0.40 cdefgh	0.025	3.31 efg	0.028
21	23.55 abc	0.453	0.41 cdefgh	0.011	3.35 cdefg	0.076
22	23.65 abc	0.294	0.44 bcdefg	0.005	3.37 cdef	0.032
23	25.60 a	0.765	0.32 hj	0.061	3.65 ab	0.034

*: Different lower cases represent different clones' mean ($p<0.05$)

Table II: Glucose, fructose and glucose/fructose ratio of clones

Clones	**Glucose**		**Fructose**		**Glucose/Fructose ratio**	
	Mean	**Std. Error**	**Mean**	**Std. Error**	**Mean**	**Std. Error**
1	125.840 defgh *	1.040	114.880 bc	0.470	0.910 b	0.010
2	120.590 h	0.280	112.505 c	0.255	0.930 ab	0.001
3	124.965 efgh	4.935	115.055 bc	1.945	0.920 ab	0.020
4	122.500 fgh	0.330	114.405 bc	1.165	0.935 ab	0.015
5	122.000 gh	2.360	113.035 c	0.315	0.925 ab	0.015
6	122.475 fgh	1.275	114.235 bc	0.235	0.930 ab	0.010
7	122.125 gh	2.925	114.480 bc	1.160	0.935 ab	0.015
8	127.935 bcdefgh	0.650	117.760 abc	0.040	0.920 ab	0.001
9	135.720 ab	1.810	123.185 a	0.785	0.905 b	0.005
10	136.450 a	1.420	122.480 a	1.480	0.900 b	0.000
11	133.055 abcd	0.145	122.810 a	2.610	0.920 ab	0.020
12	122.075 gh	2.275	113.290 c	1.010	0.930 ab	0.010
13	129.500 abcdefg	2.600	119.950 ab	0.950	0.925 ab	0.025
14	133.265 abcd	2.405	122.550 a	3.300	0.920 ab	0.010
15	129.402 abcdefg	2.618	119.697 ab	1.784	0.927 ab	0.006
16	124.700 efgh	0.570	114.605 bc	0.925	0.920 ab	0.001
17	127.030 cdefgh	1.721	117.730 abc	0.873	0.930 ab	0.002
18	128.920 abcdefg	2.580	117.455 abc	0.255	0.915 ab	0.015
19	134.715 abc	0.215	122.895 a	2.095	0.915 ab	0.015
20	131.290 abcde	1.740	119.415 ab	0.055	0.910 b	0.010
21	130.170 abcdef	2.930	121.100 a	4.400	0.930 ab	0.010
22	127.345 cdefgh	1.355	121.835 a	0.815	0.955 a	0.005
23	127.955 bcdefgh	1.825	119.435 ab	1.665	0.930 a	0.001

*: Different lower cases represent different clones' mean ($p<0.05$)

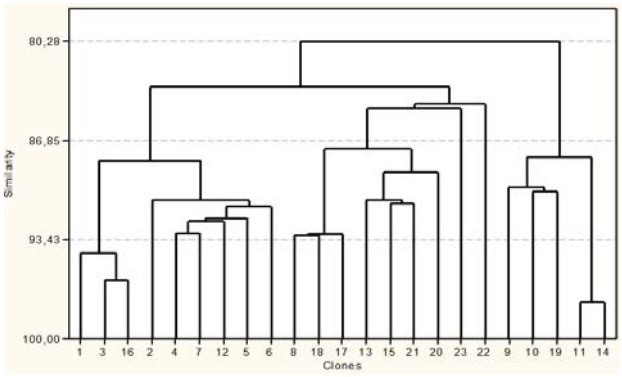
time and at the same dosage, which increases efficiency, reduces costs, the amount of pesticides used and their impact on the environment. At the end of the growing season, all plants of a clonal vineyard will commence ripening simultaneously and will all be ready for harvesting at the same time. So, all grapes can be harvested at the right time with a maximum quality. Therefore, the use of clonal material has many economical and ecological advantages (Forneck *et al.*, 2009).

Because of long-term vegetative propagation, a grapevine variety can be composed of a range of clones differing in minor genetic and phenotypic characteristics (Wegscheider *et al.*, 2009). Studies indicate that different clones of the same variety also show significant differences regarding chemical composition of their grapes. Some clones have the capacity to produce wine with distinct color, aromatic profile and phenolic content (Santesteban & Royo, 2006; Burin *et al.*, 2011).

Table III: Similarity and distance values for clusters of clones

Step	No. of clusters	Similarity level	Distance level	Clusters joined		New cluster	Number of. Observations. in new cluster
1	22	97,588	0,452	11	14	11	2
2	21	96,122	0,727	3	16	3	2
3	20	94,314	1,066	1	3	1	3
4	19	93,143	1,286	8	18	8	2
5	18	93,103	1,293	8	17	8	3
6	17	93,028	1,307	4	7	4	2
7	16	92,246	1,454	4	12	4	3
8	15	91,995	1,501	4	5	4	4
9	14	91,217	1,647	4	6	4	5
10	13	91,011	1,685	15	21	15	2
11	12	90,836	1,718	13	15	13	3
12	11	90,834	1,719	2	4	2	6
13	10	90,273	1,824	10	19	10	2
14	9	89,973	1,880	9	10	9	3
15	8	88,998	2,063	13	20	13	4
16	7	88,163	2,219	1	2	1	9
17	6	88,009	2,248	9	11	9	5
18	5	87,397	2,363	8	13	8	7
19	4	84,750	2,859	8	23	8	8
20	3	84,421	2,921	8	22	8	9
21	2	83,334	3,125	1	8	1	18
22	1	80,278	3,698	1	9	1	23

Fig. 1: Dendogram of cluster analysis



CONCLUSION

There was considerable variation in the composition and content of sugar and some quality characteristics of grape berry clones evaluated in this study. These variations can be useful for clone selection studies in the future for production of more profitable clones of Kalecik Karasi. Thus, it can be concluded that three Kalecik Karasi clones: 6, 18 and 19 may be considered to have reasonable performance in terms of evaluated characteristics in the study. However, further researches are needed to better understand the relationships between clones and some quality characteristics.

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