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## Determination of Characteristics of Grape Berry Skin in Some Table Grape Cultivars (*V. vinifera* L.)

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**Abstract:** This research was carried out in nursery conditions of Tekirdađ Research Institute, in Turkey in 2000 year by using of 13 table grape cultivars. Experiment was established according to randomized complete blocks design consisting of 4 replicates. In the study, weight loss in grape berry ( $\text{mg berry}^{-1}$ ), wax layers weight in grape berry skin ( $\text{mg berry}^{-1}$ ,  $\text{mg cm}^{-2}$ ,  $\text{mg cm}^{-3}$ ) and skin thicknesses of grape berry (mm) were examined according to cultivars. While the values concerning weight loss in grape berry in cultivars were differing according to measurement dates; the lowest value from wax layer weight per grape berry of cultivars was obtained from Cv. Dklgen ( $0.004 \text{ mg berry}^{-1}$ ) and the highest value was obtained from Cv. Alphonse Lavalle ( $0.045 \text{ mg berry}^{-1}$ ). Among the averages concerning wax layer weight per skin area of grape berry, the lowest value was  $9.485 \text{ mg cm}^{-2}$  for Cv. Yapıncak and the highest value was  $16.785 \text{ mg cm}^{-2}$  for Cv. Alphonse Lavalle. From the standpoint of wax layer weight per skin volume of grape berry, while the lowest value was obtained from cvs. Cinsaut, Karagevrek and Dklgen ( $0.002 \text{ mg cm}^{-3}$ ), the highest value was obtained from Cv. Hns ( $0.010 \text{ mg cm}^{-3}$ ). Regarding skin thickness of grape berry, the lowest values were 27.50 mm for cvs. Yapıncak, Razakı and Tahannebi and the highest value was 89.38 mm for Cv. Hns.

**Key words:** *V. vinifera* L., grape berry characteristics, skin, wax layer

### INTRODUCTION

The leaf and fruit surface of higher plants are covered by the cuticle or cuticular membrane. Therefore, the plant cuticle constitutes the interface between the plant tissue and the environment<sup>[1]</sup>.

The number of layers in the skin of grape berries and their size and volume are cultivar specific. The outer epidermis is covered by non-living layers, namely cuticle, lenticels, wax and collenchymatous hypodermal cell<sup>[2,3]</sup>.

Rosenquist and Morrison<sup>[4]</sup> stated that the cuticular membrane has duty of protective barrier against fungal pathogens and it decreases water loss by transpiration and contributes to control of gaseous exchanges.

Marois *et al.*<sup>[5,6]</sup> reported that epicuticular wax has an important duty on the resistance of grape berries to infection by *Botrytis cinera*.

While the epicuticular wax layer of grape berries is playing an important physiological role during berry development, it also effects the economic aspects of all viticulture commodities<sup>[7]</sup>. The wax bloom scatters light and imparts a frosted appearance to the berry<sup>[8]</sup>, which is considered attractive and desirable by consumers of table grapes<sup>[9]</sup>.

Banks and Whitecross<sup>[10]</sup>, Reed and Tukey<sup>[11]</sup> emphasized that environmental variables can also affect the amount or structure of epicuticular wax on many plant surface. Morphological differences in wax structure have been observed under conditions of varying light intensity, humidity and temperature.

Grapes are subjected to serious water loss after harvest, which can cause stem drying and browning, berry shatter and even wilting and shriveling of berries<sup>[9]</sup>. Therefore, after harvest, grapes should be cooled as soon as possible.

Transpiration through the cuticle is main avenue of water loss in grape berries and increases with fruit development<sup>[12]</sup>. Thus, the thickness and toughness of the skin are factors, which contribute to resistance of table grapes to handling injury during harvest, packing, transport and storage<sup>[3]</sup>.

The quality loss of table grapes is generally related with weight losses, which is occurred by the loss of water in grape berry. Hence, the aim of this research was to determine the characteristics of grape berry skin, which are very important for quality losses of table grapes in 13 table grape cultivars.

## MATERIALS AND METHODS

This research was carried out in nursery conditions of Tekirdağ Research Institute in year 2000, in Turkey.

Thirteen table grape cultivars such as Cinsaut, Yapıncak<sup>[13]</sup>, Çavuş, Alphonse Lavallée, Italia, Dökülgen, Razakı, Hönüsü, Müşküle, Muscatel of Iskenderiye, Tahannebi and Hafızalı<sup>[14]</sup>, which were extensively grown in Turkey, were used in this research.

Experiment was established according to randomized complete blocks design consisting of 4 replicates<sup>[15]</sup>.

**Measurement of weight loss in grape berry (mg berry<sup>-1</sup>):** At maturity time of cultivars, 40 berries with pedicel/replicate from each cultivar were collected and only pedicels of grape berries were dipped into paraffin wax for prevention of water loss from pedicel. Later, grape berry weights were weighed by sensitive balance. After beginning measurement of grape berries, they were left under conditions of room temperature (approximately at 20°C) and subsequent weight measurements of grape berries were performed by 1 week intervals until grape berries shriveled up.

**Measurements of wax layer weight in grape berry (mg berry<sup>-1</sup>, mg cm<sup>-2</sup>, mg cm<sup>-3</sup>):** During the maturity time of cultivars, 10 grape berries/replicate were taken from each cultivar and by cutting of grape berry pedicels from their bottoms, first grape berries with wax layer were weighed by sensitive balance without touching of haze layer on grape berry skin. For determination of wax layer weight, grape berries in same replicate were rinsed with chloroform by 30 sec and they were waited by 3-4 min for drying. After chloroform evaporated, weights of grape berries were weighed again. While the wax layer weights were compared, 3 criteria such as weight of wax layer in grape berry skin (mg berry<sup>-1</sup>), weight of wax layer per skin area of grape berry (mg cm<sup>-2</sup>) and weight of wax layer per skin volume of grape berry (mg cm<sup>-3</sup>) were taken into consideration.

Averages of grape berries in each replicate were calculated for weight of wax layer per grape berry and they were divided into values from (weight of grape berry with wax)-(weight of grape berry without wax) for determination of wax layer weight per grape berry skin (mg berry<sup>-1</sup>).

For determination wax layer weight per skin area of grape berry (mg cm<sup>-2</sup>), height and width of berry were measured and then by using area calculation of globe, each grape berry area was determined. After this, area averages of each replicate were calculated and these

values were divided into values from (weight of grape berry with wax)-(weight of grape berry without wax).

From the standpoint of weight of wax layer per skin volume of grape berry (mg cm<sup>-3</sup>), height and width of grape berry were firstly measured and by using volume calculation of globe, each grape berry volume was determined. After that, averages of each replicate were calculated and these values were divided into values from (weight of grape berry with wax)-(weight of grape berry without wax).

**Measurement of grape berry skin thickness (mm):** At the beginning of maturity time in all cultivars, 10 grape berries/replicate were collected from each cultivar. Later, cross sections from equator of grape berry in width were taken and they were measured under the binocular microscope by ocular micrometer as 4 sided from the place that put together skin and berry flesh.

## RESULTS AND DISCUSSION

**Measurements of weight loss in grape berry of cultivars (mg berry<sup>-1</sup>):** The averages of weight loss in grape berry of all cultivars were statistically found to be significant at 5% level according to measurement dates (Table 1-13).

Table 1: The measurement of weight loss in grape berry of Cv. Çavuş (mg berry<sup>-1</sup>)

Number of measurement	Measurement date	Average value
At the beginning	22 August 2000	76.47a
1st week	29 August 2000	68.31b
2nd week	08 September 2000	59.98c
3rd week	14 September 2000	52.28d
4th week	18 September 2000	52.28d
5th week	27 September 2000	44.50e

Mean values having different letter(s) differ significantly (P<0.05)

\* P<0.05 LSD values of weight loss in grape berry: 2.63

Table 2: The measurement of weight loss in grape berry of Cv. Dökülgen (mg berry<sup>-1</sup>)

Number of measurement	Measurement date	Average value
At the beginning	18 September 2000	40.61a
1st week	27 September 2000	35.58b
2nd week	03 October 2000	32.62c
3rd week	10 October 2000	29.91d
4th week	18 October 2000	29.96d
5th week	26 October 2000	24.89e

Mean values having different letter(s) differ significantly (P<0.05)

\* P<0.05 LSD values of weight loss in grape berry: 2.28

Table 3: The measurement of weight loss in grape berry of Cv. Karagevrek (mg berry<sup>-1</sup>)

Number of measurement	Measurement date	Average value
At the beginning	18 September 2000	42.81a
1st week	27 September 2000	39.15b
2nd week	03 October 2000	37.06c
3rd week	10 October 2000	35.32d
4th week	16 October 2000	34.14d
5th week	26 October 2000	31.29e

Mean values having different letter(s) differ significantly (P<0.05)

\* P<0.05 LSD values of weight loss in grape berry: 1.003

Table 4: The measurement of weight loss in grape berry of Cv. Alphonse Lavalée (mg berry<sup>-1</sup>)

Number of measurement	Measurement date	Average value
At the beginning	18 September 2000	76.36a
1st week	27 September 2000	76.86ab
2nd week	03 October 2000	74.39bc
3rd week	10 October 2000	72.10c
4th week	16 October 2000	65.13d
5th week	26 October 2000	64.15e

Mean values having different letter(s) differ significantly (P<0.05)

\* P<0.05 LSD values of weight loss in grape berry: 2.719

Table 5: The measurement of weight loss in grape berry of Cv. Yapıncak (mg berry<sup>-1</sup>)

Number of measurement	Measurement date	Average value
At the beginning	27 September 2000	28.76a
1st week	03 October 2000	27.33ab
2nd week	10 October 2000	25.38bc
3rd week	16 October 2000	26.06bc
4th week	26 October 2000	24.06cd
5th week	01 November 2000	23.00de
6th week	08 November 2000	22.58de
7th week	15 November 2000	21.09e
8th week	21 November 2000	18.07f

Mean values having different letter(s) differ significantly (P<0.05)

\* P<0.05 LSD values of weight loss in grape berry: 2.273

Table 6: The measurement of weight loss in grape berry of Cv. Razakı (mg berry<sup>-1</sup>)

Number of measurement	Measurement date	Average value
At the beginning	27 September 2000	54.78a
1st week	03 October 2000	52.36b
2nd week	10 October 2000	50.20c
3rd week	16 October 2000	42.27d
4th week	26 October 2000	46.13d
5th week	01 November 2000	43.38e
6th week	08 November 2000	41.05f
7th week	15 November 2000	39.10g
8th week	21 November 2000	36.96h

Mean values having different letter(s) differ significantly (P<0.05)

\* P<0.05 LSD values of weight loss in grape berry: 1.845

Table 7: The measurement of weight loss in grape berry of Cv. Höntüsü (mg berry<sup>-1</sup>)

Number of measurement	Measurement date	Average value
At the beginning	27 September 2000	63.17a
1st week	03 October 2000	63.80a
2nd week	10 October 2000	57.68b
3rd week	16 October 2000	54.63bc
4th week	26 October 2000	52.75cd
5th week	01 November 2000	49.96de
6th week	08 November 2000	47.25ef
7th week	15 November 2000	44.69fg
8th week	21 November 2000	42.21f

Mean values having different letter(s) differ significantly (P<0.05)

\* P<0.05 LSD values of weight loss in grape berry: 3.711

Table 8: The measurement of weight loss in grape berry of Cv. Italia (mg berry<sup>-1</sup>)

Number of measurement	Measurement date	Average value
At the beginning	27 September 2000	72.89a
1st week	03 October 2000	69.84b
2nd week	10 October 2000	67.25c
3rd week	16 October 2000	65.37d
4th week	26 October 2000	62.07e
5th week	01 November 2000	59.07f
6th week	08 November 2000	55.95g
7th week	15 November 2000	53.87h
8th week	21 November 2000	52.09i

Mean values having different letter(s) differ significantly (P<0.05)

\* P<0.05 LSD values of weight loss in grape berry: 1.317

Table 9: The measurement of weight loss in grape berry of Cv. Müşküle (mg berry<sup>-1</sup>)

Number of measurement	Measurement date	Average value
At the beginning	27 September 2000	56.57a
1st week	03 October 2000	54.83b
2nd week	10 October 2000	53.28c
3rd week	16 October 2000	52.46c
4th week	26 October 2000	49.96d
5th week	01 November 2000	48.33e
6th week	08 November 2000	46.84f
7th week	15 November 2000	44.89g
8th week	21 November 2000	43.60h

Mean values having different letter(s) differ significantly (P<0.05)

\* P<0.05 LSD values of weight loss in grape berry: 0.832

Table 10: The measurement of weight loss in grape berry of Cv. Muscatel of Isekenderiye (mg berry<sup>-1</sup>)

Number of measurement	Measurement date	Average value
At the beginning	19 September 2000	66.19a
1st week	27 September 2000	61.92b
2nd week	03 October 2000	59.72bc
3rd week	10 October 2000	57.77cd
4th week	16 October 2000	56.69d
5th week	26 October 2000	53.42e
6th week	01 November 2000	51.21ef
7th week	08 November 2000	49.70f
8th week	15 November 2000	46.98g
9th week	21 November 2000	45.19h

Mean values having different letter(s) differ significantly (P<0.05)

\* P<0.05 LSD values of weight loss in grape berry: 2.327

Table 11: The measurement of weight loss in grape berry of Cv. Cinsaut (mg berry<sup>-1</sup>)

Number of measurement	Measurement date	Average value
At the beginning	18 September 2000	52.58a
1st week	27 September 2000	47.94b
2nd week	03 October 2000	45.19b
3rd week	10 October 2000	39.98c
4th week	16 October 2000	32.28d

Mean values having different letter(s) differ significantly (P<0.05)

\* P<0.05 LSD values of weight loss in grape berry: 3.163

Table 12: The measurement of weight loss in grape berry of Cv. Hafızali (mg berry<sup>-1</sup>)

Number of measurement	Measurement date	Average value
At the beginning	10 October 2000	68.20a
1st week	16 October 2000	66.98a
2nd week	26 October 2000	60.11b
3rd week	01 November 2000	55.90c
4th week	08 November 2000	54.52c
5th week	15 November 2000	51.40d
6th week	21 November 2000	49.76e

Mean values having different letter(s) differ significantly (P<0.05)

\* P<0.05 LSD values of weight loss in grape berry: 2.413

Table 13: The measurement of weight loss in grape berry of Cv. Tahannebi (mg berry<sup>-1</sup>)

Number of measurement	Measurement date	Average value
At the beginning	27 September 2000	51.67a
1st week	03 October 2000	48.88ab
2nd week	10 October 2000	45.77b
3rd week	16 October 2000	39.81c

Mean values having different letter(s) differ significantly (P<0.05)

\* P<0.05 LSD values of weight loss in grape berry: 4.82

As seen in Table 1, while the lowest value of Cv. Çavuş was obtained from 27 September in 2000 (44.50 mg berry<sup>-1</sup>); the highest value was 76.47 mg berry<sup>-1</sup> on 22 August 2000.

Table 14: Average values from wax layer weight per grape berry ( $\text{mg berry}^{-1}$ ), wax layer weight per area in grape berry ( $\text{mg cm}^{-2}$ ), wax layer weight per volume in grape berry ( $\text{mg cm}^{-3}$ ) and skin thickness of grape berry (mm)

Cultivars	Wax layer weight per grape berry skin ( $\text{mg berry}^{-1}$ )	Wax layer weight per skin area of grape berry ( $\text{mg cm}^{-2}$ )	Wax layer weight per skin Volume of grape berry ( $\text{mg cm}^{-3}$ )	Skin thickness of grape berry (mm)
Çavuş	0.04ab	16.387a	0.008ab	39.81f
Cinsaut	0.005d	11.773e	0.002d	68.41cd
Karagevrek	0.005d	11.827de	0.002d	31.97g
Dökülgen	0.004d	9.509f	0.002d	65.15de
Muscatel of Iskenderiye	0.012cd	13.239bc	0.004cd	32.49g
Italia	0.013cd	14.846bc	0.003cd	70.82cd
Yapıncak	0.005d	9.485f	0.005bcd	27.50h
Alphonse Lavalée	0.045ab	16.785a	0.003cd	75.80b
Razakı	0.017bcd	12.039de	0.006bcd	27.50h
Hönüsü	0.035abc	13.209cd	0.010ab	89.38a
Tahannebi	0.019bcd	12.510cde	0.003cd	27.50h
Müşküle	0.014cd	11.811e	0.004cd	63.77e
Hafızali	0.026abcd	16.424ab	0.006bc	66.17de
* $P < 0.05$ LSD Values	0.023	1.380	0.040	0.023

Mean values having different letter(s) differ significantly ( $P < 0.05$ )

In Cv. Dökülgen, the lowest value was measured on 26 October 2000 ( $24.89 \text{ mg berry}^{-1}$ ) and the highest value was measured on 18 September 2000 ( $40.61 \text{ mg berry}^{-1}$ ) (Table 2).

As shown in Table 3, the lowest value of Cv. Karagevrek was obtained from 26 October 2000 ( $31.29 \text{ mg berry}^{-1}$ ); the highest value was  $42.81 \text{ mg berry}^{-1}$  on 18 September 2000.

While the lowest value of Cv. Alphonse Lavalée was measured on 26 October 2000 ( $64.15 \text{ mg berry}^{-1}$ ); the highest value was measured on 18 September 2000 ( $79.36 \text{ mg berry}^{-1}$ ) (Table 4).

The lowest value of Cv. Yapıncak was obtained from 21 November 2000 ( $18.07 \text{ mg berry}^{-1}$ ) and the highest value was  $28.76 \text{ mg berry}^{-1}$  on 27 September 2000 (Table 5).

While the lowest value of Cv. Razakı was measured on 21 November 2000 ( $36.96 \text{ mg berry}^{-1}$ ); the highest value was measured on 27 September 2000 ( $54.78 \text{ mg berry}^{-1}$ ) (Table 6).

As given in Table 7, lowest value of Cv. Hönüsü was obtained from 21 November 2000 ( $42.21 \text{ mg berry}^{-1}$ ) and the highest value was  $63.17 \text{ mg berry}^{-1}$  on 27 September 2000.

The results from this study showed that the lowest value of Cv. Italia was measured on 21 November 2000 ( $52.09 \text{ mg berry}^{-1}$ ) and highest value was measured on 27 September 2000 ( $72.89 \text{ mg berry}^{-1}$ ) (Table 8).

The lowest value from Cv. Müşküle was obtained from 21 November 2000 ( $43.60 \text{ mg berry}^{-1}$ ) and the highest value was  $56.57 \text{ mg berry}^{-1}$  on 27 September 2000 (Table 9).

While the lowest value of Cv. Muscatel of Iskenderiye was measured on 21 November 2000 ( $45.19 \text{ mg berry}^{-1}$ ); the highest value was measured on 19 September 2000 ( $66.19 \text{ mg berry}^{-1}$ ) (Table 10).

The results from Cv. Cinsaut exhibited that the lowest value of was obtained from 16 October 2000 ( $32.28 \text{ mg berry}^{-1}$ ) and the highest value was  $52.58 \text{ mg berry}^{-1}$  on 18 September 2000 (Table 11).

The results from the Cv. Hafızali demonstrated that the lowest value was measured on 21 November 2000 ( $49.76 \text{ mg berry}^{-1}$ ) and the highest value was measured on 10 October 2000 ( $68.20 \text{ mg berry}^{-1}$ ) (Table 12).

While the lowest value of Cv. Tahannebi was obtained from 16 October 2000 ( $39.81 \text{ mg berry}^{-1}$ ); the highest value was  $51.67 \text{ mg berry}^{-1}$  on 27 September 2000 (Table 13).

After harvest of table grapes, water loss from grape berry may cause serious quality problems, which are also reported by Nelson<sup>[9]</sup>. When it is examined the weight loss of cultivars in this experiment, it is appear that values are altering from one cultivar to another according to measurement dates.

#### **Measurements of wax layer weight in grape berry skin Wax layer weight per grape berry skin ( $\text{mg berry}^{-1}$ ):**

The averages of wax layer weight per grape berry skin in all cultivars were statistically found to be significant at 5% level (Table 14).

From the standpoint of wax layer weight per grape berry skin, the lowest value from cultivars was obtained from Cv. Dökülgen ( $0.004 \text{ mg berry}^{-1}$ ); the highest value was observed on Cv. Alphonse Lavalée ( $0.045 \text{ mg berry}^{-1}$ ) (Table 14).

#### **Wax layer weight per skin area of grape berry ( $\text{mg cm}^{-2}$ ):**

The averages of wax layer weight per skin area of grape berry in cultivars were statistically found to be significant at 5% level (Table 14).

Among the results from wax layer weight per skin area of grape berry in cultivars, the lowest value was

obtained from Cv. Yapıncak ( $9.485 \text{ mg cm}^{-2}$ ); the highest value was observed on Cv. Alphonse Lavalée ( $16.785 \text{ mg cm}^{-2}$ ) (Table 14).

**Wax layer weight per skin volume of grape berry ( $\text{mg cm}^{-3}$ ):** The averages of wax layer weight per skin volume of grape berry in cultivars were statistically determined as significant at 5% level (Table 14).

The results from wax layer weight per skin volume of grape berry in cultivars demonstrated that the lowest values were obtained from cvs. Cinsaut, Karagevrek and Dökülgen ( $0.002 \text{ mg cm}^{-3}$ ) and the highest value was observed on Cv. Hönüsü ( $0.01 \text{ mg cm}^{-3}$ ) (Table 14).

The bloom or wax on the surface of grape berry is a very important quality factors. The reports of Rosenquist and Morrison<sup>[4,7]</sup>, Marois *et al.*<sup>[5,6]</sup> support the importance of wax layer on grape berry skin. According to experimental results concerning wax layer weight per grape berry skin and wax layer weight per skin area of grape berry, it can be thought that Cv. Alphonse Lavalée will be the most resistance to fungal pathogens and has superior characteristics about controlling of gaseous exchanges and reducing of water loss in grape berry; on the other hand, Cv. Dökülgen (for wax layer weight per grape berry skin) and Cv. Yapıncak (for wax layer weight per skin area of grape berry) will be the least resistance to fungal pathogens and have the least proper characteristics about controlling of gaseous exchanges and reducing of water loss in grape berry. It is understood from the results of wax layer weight per skin value of grape berry that while Cv. Hönüsü is able to be the most resistance to fungal disease and has superior characteristics about controlling of gaseous exchanges and reducing of water loss in grape berry; Cinsaut, Karagevrek, Dökülgen are able to be the least resistant cultivars to this type of diseases and have the least proper characteristics about controlling of gaseous exchanges and reducing of water loss in grape berry.

**Measurement of grape berry skin thickness (mm):** According to characteristic of grape berry skin thickness, averages from cultivars were statistically found to be significant at 5% level (Table 14).

Regarding grape berry skin thickness of cultivars, while the lowest values were obtained from cvs. Yapıncak, Razakı and Tahannebi (27.5 mm); the highest value was obtained from Cv. Hönüsü (89.38 mm) (Table 14).

Winkler *et al.*<sup>[3]</sup> point out that skin thickness and toughness are factors that contribute to resistance of table grapes to handling injury during harvest, packing, transport and storage. Results from skin thickness of grape berry in cultivars show that while Cv. Hönüsü is

becoming the most proper for transport and storage; Yapıncak Razakı and Tahannebi are becoming the least proper cultivars for the same duties.

In this study, characteristics of grape berry skin in 13 table grape cultivars were examined and significant differences were determined among them.

Characteristics of healthy and high quality in grape berry are desirable element, which is demanded by consumer, especially for table grapes. Water loss in grape berry mostly creates quality losses in table grapes. Under the light of research results, with regard to wax layer weight per grape berry skin, cvs. Dökülgen, Cinsaut, Karagevrek and Yapıncak had the lowest values and Alphonse Lavalée had the highest value. Concerning wax layer weight per skin area of grape berry, while cvs. Yapıncak and Dökülgen had the lowest values; Cv. Alphonse Lavalée had the highest value. Regarding wax layer weight per skin volume of grape berry, while cvs. Cinsaut Karagevrek and Dökülgen had the lowest values; cvs. Hönüsü and Çavuş had the highest values. Lastly, concerning skin thickness of grape berry, cvs. Yapıncak and Razakı had the lowest values and Cv. Hönüsü had the highest value.

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