SUITABILITY OF SOME MID-SEASON TABLE GRAPE CULTIVARS AND TYPES FOR MINIMALLY PROCESSED PRODUCE

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Abstract

Aims: The objectives of this study were to evaluate whether some mid-season table grape cultivars and types can be used as minimally processed produce and to investigate the negative effects of minimal processing on the quality of the table grapes.

Methods and results: Changes in quality losses as defects, weight loss, soluble solids, titratable acidity and pH by minimally processed 13 cultivars and 4 types were recorded during a 10-day storage period at 4 °C. Browning on the stem end was the major defect followed by collapse on the stem end, decay both on the stem end and on the berry surface, and splitting on the berry surface. Big Perlon, Hatun Parmagi and Ribol among the cultivars/types were found be less prone to defects after minimal processing and storing at 4 °C.

Conclusion: The defects or problems which minimally processed table grapes most likely to face are collapse, browning and decay on the stem end, and splitting and decay on the berry surface. The quality losses in Big Perlon, Hatun Parmagi and Ribol cultivars with a very large berry size were lower than other 14 cultivars/types after 10 days, suggesting that berry size is very important attribute for choosing table grape cultivars as minimally processed produce.

Significance and impact of study: The study involving 13 cultivars and 4 types with different colored skin, berry sizes and types presents reliable information of suitability of the grapes for fresh-cut produce. Furthermore, the quality assessment used for this study provides a very detailed clarification what kind of problems minimally processed table grapes might face.

Keywords: minimal processing, quality loss, stem end collapse, stem end browning

Résumé

Objectif . Les objectifs de cette étude ont été d'évaluer si les cépages et les variétés de raisins de table peuvent être consommés avec un traitement minimal après récolte et pour comprendre les effets négatifs de ce type de traitement sur leur qualité.

Méthodes et résultats : Les changements dans la perte de qualité, la perte de poids, les solides solubles, l'acidité titrable et le pH ont été enregistrés pendant une période de stockage de 10 jours à 4 °C. Le brunissement de la tige a été le défaut majeur suivi par le flétrissement, le pourrissement à la fois de la tige et de la surface de la baie. Big Perlon, Hatun Parmagi et Ribol sont, parmi les cépages et les variétés étudiés, ceux présentant le moins de défauts après un traitement minimal et un stockage à 4 °C.

Conclusion : Les défauts ou les problèmes rencontrés par les raisins de table ayant eu un traitement minimal sont le flétrissement, le brunissement, le pourrissement de la tige et l'éclatement et le pourrissement de la surface de la baie. Les baisses de qualité des cépages Big Perlon, Hatun Parmagi et Ribol avec une taille de baie très grosse sont plus faibles que pour les autres cépages après 10 jours. La taille de la baie est donc un paramètre important pour choisir une variété de raisin de table avec un traitement minimal.

Signification et impact de l'étude : L'étude a été menée sur 13 cépages, et 4 variétés de différentes couleurs de peaux, de tailles de baie. Elle présente une information pertinente utile pour les raisins fraichement cueillis. Cette étude montre clairement quels types de problème peuvent être rencontrés par les raisins de table.

Mots-clés : traitement minimal perte de qualité, flétrissement de la tige, brunissement de la tige

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INTRODUCTION

Fresh-cut or minimally processed produce is one the fastest growing fruit and vegetable processing category in the world due to its convenience and increase in the consumers' awareness of health benefits of fruits and vegetables. Fresh-cut/minimally processed fruits and vegetables retain most of fresh-like quality, which results in presence of antioxidant constituents such as vitamins and phenolics that are associated with a lowered risk of cancer, diabetes, cardiovascular and neurological diseases (Kaur and Kapoor, 2001; Del Caro *et al.*, 2004). Minimal/fresh-cut processing involves washing, sorting, trimming, slicing, etc. which do not affect the fresh-like quality of the crops (Wiley, 1994). Although minimally processed or fresh-cut produce should offer consumers fresh-like quality, highly nutritious, convenient and healthy food, preparation of minimally processed produce leads to some physiological and biochemical changes such as increased respiration and ethylene production, stimulated phenol metabolism, and increased enzyme activities (Rolle and Chism, 1987; King and Bolin, 1989). Numerous studies have been carried out for the retention of the quality of fresh-cut or minimally processed produce which generally lost during the preparation. Washing, sanitizing, low temperature storage, modified atmosphere packaging, hot water treatment and coating are the most common applications used for deterring the quality loss of minimally processed or fresh-cut produce (Soliva-Fortuny and Martin-Belloso, 2003; Rico *et al*., 2007).

The number of crops used for fresh-cut or minimally processed produce has been constantly broadened and table grape has been recently included into this group. The preparation of table grape as minimally processed produce is very simple and trouble-free; current commercial procedure involves removal of stems and/or stem caps. Few studies related to minimally processed table grapes have been published so far (Mattiuz *et al.*, 2004; Kou *et al.*, 2006a; Conte *et al.*, 2007). Dark colored table grapes seem to be more suitable for minimally processed produce than white colored table grapes (Mattiuz *et al.*, 2004). Decay and quality losses are the main problems for minimally processed table grapes due to injuries occurred during removal of cap stems (Kuo *et al.*, 2006a; Kou *et al.*, 2006b). The injury during minimal processing causes grape berries susceptible to microbial growth, decay and quality losses (Kou *et al.*, 2007). In a study with chloride, ethanol and hot water treatments have been shown to reduce decay in minimally processed table grapes, with ethanol (50 %) having greater effects than hot water or chloride treatment (Scrocco *et al.*, 2007). Kou and his/her co-workers (2007) treated table grapes with hot water (45 °C for 8 min), stored 14 days and found that hot water treatment maintained a significantly lower decay rate while having of any negative impact on grape color, texture and flavor.

The objectives of this study were to evaluate whether some mid-season table grape cultivars and types can be used as minimally processed produce and to investigate the negative effects of minimal processing on the quality of table grapes during storage.

MATERIALS AND METHODS

Plant material: Grapes were obtained from the vineyard of Kahramanmaras Agricultural Research Institute, Kahramanmaras, Turkey. Grapevines received only regular cultural practices; no pesticides, insecticides or related compounds were applied during the harvesting period. A total of 13 cultivars and of 4 types were use in this study. The cultivars were Amasya Beyazi, Atasari, Big Perlon, Bozcaada Cavusu, Flame Seedless, Helwani, Hatun Parmagi, Imperatrice, Mahrabasi, Muskule, Ribol and Trakya Ilkeren; and the types were Patagonia, Regimalazolia, 130/1 and 5/2.

Sample preparation: Grape clusters were manually harvested only by the experts in the morning, then transported the Horticultural Laboratory and used immediately. After washing with tap water, berries were carefully detached from the rachis followed by removal of stems with hand at room temperature. The berries were selected on the basis of uniform color, size, firmness and absence of blemishes and diseases/decays, and prepared for packaging and storage.

Packaging and storage: The berries were randomized into rigid, vented PET clamshells (volume of 250 ml and dimension of 2.5 x 10 x 10 cm). Each container held 20 berries and each cultivar/type 21 containers, 3 of which for the weight loss measurement. The containers were placed into a 4-°C cold room for 10 days. On a 2-day interval 3 containers for quality assessments and 3 containers for weight loss measurements, and on a 5-day interval randomly selected 3 containers for chemical analyses were removed from the cold room. The containers in the cold room were arranged as a complete randomized block design with 3 replications and each berry in the containers represented a subsample.

Quality assessments: Berry quality as defect ratio was determined on a 2-day interval by assessing decay, collapse, shriveling, splitting and browning on the berry surface; and decay, collapse and browning on the stem end. Presence of softening was determined by applying light pressure on each fruit with the thumb and fore finger, and weight loss by weighing the containers. The berries (20) in the containers were individually examined and each berry was rated for only one defect. Decayed fruits

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were removed from the containers while adding ratio to the following day assessment.

Chemical analysis: The juice used for total soluble solids concentrations (SSC), pH and total titratable acidity (TA) was extracted from berries (20) with a fruit juice extractor (Premier, PR-603, Hong Kong). SSC was measured with a hand-held refractometer (Atago NI, Japan) and pH a pH meter (WTW 526, Germany). TA was quantified by titrating 6 mL of berry flesh juice with 0.1 M NaOH to an end-point of pH 8.2 and expressed as percentage of tartaric acid.

Statistical analysis: Statistical procedures were performed using PC-SAS software package. All data were subject to analysis of variance, and means were compared using Duncan multiple range test.

RESULTS AND DISCUSSION

Weight loss: The weight loss gradually increased with storage time in all cultivars/types, ranging from 0.29 % (Patagonia) to 0.73 % (130/1) after 2 d, from 0.38 % (Mahrabasi and Patagonia) to 0.94 % (130/1) after 4 d, from 0.42 % (Hatun Parmagi) to 1.20 % (130/1) after 6 d, from 0.52 % (Mahrabasi) to 1.43 % (130/1) after 8 d and from 0.60 % (Mahrabasi) to 1.69 % (130/1) after 10 d (Table 1). At the end of the storage time, total weight loss of Perlette, 130/1 and 5/2 was significantly higher than other cultivars/types whose weight loss percentages were 1 % or under 1 % except for Imperatrice. The cultivar Imperatrice and Perlette and types 130/1 and 5/2 have thin and tender skin, which may be the reason for this significant water loss.

Quality assessments: The cultivars and types showed large differences in some quality attributes (as defect ratios) after 2 d, with Helwani, Mahrabasi and Ribol exhibiting no defects whatsoever (Table 2). Browning on the stem end was the main problem followed by decay on berry surface, collapse on the stem end, softening, collapse on the berry surface and browning on the berry surface. No splitting incidence was observed in any cultivars/types on day 2. Amasya Beyazi, 130/1 and 5/2 showed significantly higher total defect ratios over other cultivars/types.

The total defect ratios by the cultivars and types increased through day 4 (Table 2). Flame Seedless, Imperatrice, Muskule, Patagonia, Perlette, Trakya Ilkeren, 130/1 and 5/2 had a total defect ratio of 50 % or over 50 %, on the other hand, Big Perlon, Helwani, Hatun Parmagi, Mahrabasi and Ribol of 20 % or under 20 %. Collapse on the stem end was rated as the major defect on day 4 unlike on day 2. Furthermore, splitting became serious problem proceeded by browning on the stem end, decay on the stem end, decay on the surface, and preceded by softening, browning on the berry surface and collapse on the berry surface.

The rise in the total defects by the cultivars/types continued through day 6, with showing similar patterns to those of day 4 values (Table 3). The highest total defect ratios (80 % or over 80 %) were noted in Flame Seedless,

Table 1 - Cumulative weight loss (%) of minimally processed table grape cultivars/types during cold storage at 4 ºC

Cultivar/type	Time				
	Day 2	Day 4	Day 6	Day 8	Day 10
Amasya Beyazi	0.61 abc	0.63 bc	0.69 bc	0.79 cd	0.85 b
Atasari	0.32 d	0.43 bc	0.51 c	0.64 cd	0.70 b
Big Perlon	0.48 bdc	0.58 bc	0.68 bc	0.78 cd	0.87 b
Bozcaada Cavusu	0.42 bdc	0.44 bc	0.49 c	0.63 cd	0.70 b
Flame seedless	0.48 bdc	0.52 bc	0.58 c	0.72 cd	0.88 b
Helwani	0.46 bdc	0.52 bc	0.61 c	0.80 cd	1.00 b
Hatun Parmagi	0.38 bdc	0.40 c	0.42 c	0.54 d	0.58 b
Imperatrice	0.58 abc	0.61 bc	0.71 bc	0.92 bcd	1.06 b
Mahrabasi	0.36 cd	0.38 c	0.44 c	0.52 d	0.60 b
Muskule	0.40 bdc	0.44 bc	0.49 c	0.66 dc	0.75 b
Patagonia	0.29 d	0.38 c	0.44 c	0.59 cd	0.65 b
Perlette	0.49 bdc	0.61 bc	0.76 bc	1.05 abc	1.20 ab
Regimalazolia	0.46 bdc	0.48 bc	0.51 c	0.64 cd	0.73 b
Ribol	0.52 abcd	0.54 bc	0.59 c	0.74 cd	0.84 b
Trakya Ilkeren	0.40 bdc	0.50 bc	0.53 c	0.72 cd	0.77 b
130/1	0.73 a	0.94 a	1.20 a	1.43 a	1.69 a
5/2	0.62 ab	0.72 ab	1.07 ab	1.27 ab	1.59 a

Means with different letters within the column for the same storage time are significantly different according to Duncan's multiple range test ($P < 0.05$).

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Perlette, 130/1 and 5/2 whereas lowest ratios (below 50 %) in Big Perlon, Mahrabasi and Ribol.

The augmentation in the total defect ratio was also steady on day 8, causing the cultivars/types having a total defect ratio over 50 % except for Hatun Parmagi and Ribol. Besides Hatun Parmagi and Ribol, Big Perlon had significantly lower ratio compared to other cultivars/types. The total defect ratio was 90 % or over 90 % in 5 cultivars/types which were Flame Seedless, Mahrabasi, Patagonia, Perlette and 5/2.

The stable rise in the total defect ratio resulted in 7 cultivars/types (Amasya Beyazi, Flame Seedless, Mahrabasi, Muskule, Patagonia, Perlette and 5/2) attaining a 100 % defect ratio on day 10. Big Perlon, Hatun Parmagi

Table 2 - Quality assessments (measured as defect ratio) of minimally processed table grape cultivars/types on the 2nd day of storage at 4ºC

Cultivar/Type	Defect[z] (%)								Total defects[w]
	Decay[y]	Collapse[y]	Browning[y]	Pr. Soft.[yv]	Splitting[y]	Decay[x]	Collapse[x]	Browning[x]	(%)
Amasya Beyazi	0	0	0	0	0	1.67	3.33	35.00	40.33 ab
Atasari	0	0	0	0	0	0	0	31.67	31.67 abc
Big Perlon	0	0	0	0	0	0	0	11.67	11.67 cde
Bozcaada Cavusu	6.67	0	0	1.67	0	0	0	6.67	15.00 cde
Flame seedless	1.67	0	0	0	0	0	5.00	23.33	30.00 abc
Helwani	0	0	0	0	0	0	0	0	0 e
Hatun Parmagi	1.67	0	0	0	0	0	0	11.67	13.33 cde
Imperatrice	3.33	0	0	0	0	0	1.67	0	5.00 de
Mahrabasi	0	0	0	0	0	0	0	0	0 e
Muskule	0	0	0	0	0	0	0	15.00	15.00 cde
Patagonia	1.67	1.67	0	0	0	0	6.67	0	10.00 cde
Perlette	3.33	0	1.67	0	0	0	0	23.33	28.33 abcd
Regimalazolia	0	0	0	0	0	0	5.00	13.33	18.33 cde
Ribol	0	0	0	0	0	0	0	0	0 e
Trakya Ilkeren	0	0	0	1.67	0	1.67	8.33	8.33	20.00 bcde
130/1	0	0	0	0	0	1.67	0	43.33	45.00 a
5/2	10.00	13.33	13.33	3.33	0	0	0	8.33	48.33 a

[z]Each grape berry was classified by the primary defect; [y]Assessments were made on the berry surface; [x]Assessments were made on the stem end.
[w]Means with different letters within the column are significantly different according to Duncan's multiple range test (P < 0.05); [v]Pr. Soft.: Presence of softening.

Table 3 - Quality assessments (measured as defect ratio) of minimally processed table grape cultivars/types on the 4th day of storage at 4ºC.

Cultivar/Type	Defect[z] (%)								Total defects[w]
	Decay[y]	Collapse[y]	Browning[y]	Pr. Soft.[yv]	Splitting[y]	Decay[x]	Collapse[x]	Browning[x]	(%)
Amasya Beyazi	0	0	0	0	0	1.67	3.33	36.67	41.67 bcde
Atasari	0	0	0	0	1.67	1.67	0	35.00	40.00 bcde
Big Perlon	0	0	0	1.67	0	0	5	13.33	20.00 de
Bozcaada Cavusu	6.67	0	0	3.33	13.33	0	3.33	8.33	35.00 cde
Flame seedless	1.67	0	0	0	0	0	20.00	28.33	50.00 bc
Helwani	0	0	0	0	0	0	6.67	6.67	13.33 e
Hatun Parmagi	1.67	0	0	1.67	0	0	5.00	11.67	20.00 ed
Imperatrice	3.33	0	0	0	10.00	5.00	41.67	1.67	61.67 abc
Mahrabasi	0	0	0	0	0	0	6.67	6.67	13.33 e
Muskule	0	0	0	0	3.33	3.33	25.00	18.33	50.00 bc
Patagonia	1.67	1.67	1.67	0	0	0	15.00	31.67	51.67 bc
Perlette	3.33	0	5.00	0	3.33	1.67	21.67	26.67	61.67 abc
Regimalazolia	0	0	0	0	0	6.67	16.67	23.33	46.67 bcd
Ribol	1.67	0	0	0	0	3.33	13.33	0	18.33 de
Trakya Ilkeren	3.33	0	0	3.33	13.33	1.67	25.00	8.33	55.00 abc
130/1	0	0	0	0	0	1.67	16.67	48.33	66.67 ab
5/2	11.67	15.00	21.67	3.33	0	3.33	15.00	13.33	81.67 a

[z]Each grape berry was classified by the primary defect; [y]Assessments were made on the berry surface; [x]Assessments were made on the stem end; [w]Means with different letters within the column are significantly different according to Duncan's multiple range test (P < 0.05);
[v]Pr. Soft.: Presence of softening.

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Table 4 - Quality assessments (measured as defect ratio) of minimally processed table grape cultivars/types on the 6th day of storage at 4 ºC

Cultivar/Type	Defect[z] (%)								Total defects[w] (%)
	Decay[y]	Collapse[y]	Browning[y]	Pr. Soft.[yv]	Splitting[y]	Decay[x]	Collapse[x]	Browning[x]	
Amasya Beyazi	0	0	0	0	1.67	3.33	23.33	38.33	66.67 ab
Atasari	1.67	0	0	0	8.33	1.67	6.67	40.00	58.34 ab
Big Perlon	0	0	0	1.67	0	1.67	15.00	15.00	33.33 b
Bozcaada Cavusu	10.00	0	0	5.00	15.00	0	3.33	20.00	53.33 ab
Flame seedless	1.67	0	0	0	0	20.00	36.67	28.33	86.37 a
Helwani	0	0	0	0	1.67	0	38.33	10.00	50.00 ab
Hatun Parmagi	1.67	0	0	3.33	0	1.67	15.00	13.33	35.00 b
Imperatrice	3.33	0	0	0	10.00	5.00	46.67	1.67	66.67 ab
Mahrabasi	0	0	0	0	1.67	0	21.67	13.33	36.67 b
Muskule	0	0	0	0	3.33	5.00	28.33	20.00	56.00 ab
Patagonia	1.67	1.67	3.33	3.33	0	0	25.00	31.67	66.67 ab
Perlette	3.33	0	6.67	0	13.33	1.67	31.67	28.33	85.00 a
Regimalazolia	0	0	0	0	3.33	8.33	18.33	26.67	56.67 ab
Ribol	1.67	0	0	0	0	16.67	16.67	0	35.00 b
Trakya Ilkeren	6.67	0	0	3.33	16.67	3.33	28.33	10.00	68.33 ab
130/1	1.67	0	0	0	1.67	1.67	20.00	58.33	83.33 a
5/2	11.67	15.00	20.00	3.33	5.00	3.33	16.67	13.33	88.33 a

[z]Each grape berry was classified by the primary defect; [y]Assessments were made on the berry surface. [x]Assessments were made on the stem end; [w]Means with different letters within the column are significantly different according to Duncan's multiple range test ($P < 0.05$); [v]Pr. Soft.: Presence of softening.

and Ribol similar to the previous day exhibited statistically lower total defect ratios among the cultivars/types.

The cultivars and types showing a 100 % total defect ratio on day 10 apart from Trakya Ilkeren and Flame Seedless have in common with skin color being green or yellow. Additionally, most of the cultivars and types with higher total defect ratios have thin or medium thick skin, indicating that skin characteristics are important factor for choosing table grapes as minimally processed produce. Browning on the berry surface did not cause a significant problem aside from Patagonia, Perlette and 5/2 all of which are with very thin skin and high SSC values, which may the reason for the extensive browning. On the other hand, browning on the stem end posed a serious problem especially white colored cultivar/types. Collapse on the stem end was the second serious problem for these minimally processed table grapes, and did not show a pattern, not affected by berry size, color or skin type, implying that the cap stem attachment to the berry, texture and the other physical characteristics especially detachment force may be responsible for this defect (Deng *et al.*, 2006; Leong *et al.*, 2006). Decay either on the stem end or on the berry surface was also a significant issue that the minimally processed table grapes to face during storage. Decay similar to collapse on the stem end most likely depends on the cultivars/types very own attributes. Most of these minimally processed table grape cultivars and types exhibited splitting on the berry surface without following an order and pattern. The mechanism of the table grape splitting has not been fully understand, however, cultivar, bunch structure, rainfall, irrigation and canopy management has been found be related to this physiological disorder (Leong *et al.*, 2006). Softening and collapse on the berry surface seems to be a non-serious issue since only 7 of these cultivars/types had this defect with not exceeding over 20 % after 10 d. Shriveling development was also schedule to observe during storage, however, not included into the data since no occurrence was recorded at any time of the storage period.

Big Perlon, Hatun Parmagi and Ribol were found be suitable as fresh-cut produce according to the data obtained from the quality analyses. Big Perlon has a pink skin color and very large berry size (5.6 g) without seed; Hatun Parmagi a yellow skin color and a very large berry size (5-6 g) with 2-4 seeds; and Ribol a purple-black skin color and a very large berry size (6-7 g) with 2-3 seeds (Celik, 2006). The cultivars have in common with having large berry size, indicating that table grapes with large berry size are more appropriate for minimal processing.

Chemical analyses: SSC of all the cultivars/types were somewhat lower at the end of the storage period compared to the day 0 values (Table 7). This decrease could be due to physical injuries during processing (Taiz and Zeiger, 1991). The type 5/2 had the highest SSC value on day 0 while Imperatrice lowest SSC value on day 10. The cultivars/types showed different values and patterns in pH whose lowest value was 3.42 (130/1 on day 10) and the highest value was 4.57 (5/2 on day 10). TA in most cultivars/types was either steady or somewhat declined during the storage, ranging from 0.20 % (Regimalozia on day 0) to 0.68 % (Hatun Parmagi on day 0). Similar to SSC, the physical injury during processing could be the reason for this diminutive decrease of TA in some cultivars/types.

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CONCLUSIONS

The defects or quality losses which minimally processed table grapes most likely to face are collapse, browning and decay on the stem end; and splitting and decay on the berry surface. Browning on the stem end was mostly observed in white colored table grapes whereas collapse on the stem end, decay on either stem end or berry surface and splitting did not follow a pattern, implying that the extend of these defects depends on the cultivars and types. However, the cultivars subject to less quality loses Big Perlon, Ribol and Hatun Parmagi have

Table 5 - Quality assessments (measured as defect ratio) of minimally processed table grape cultivars/types on the 8th day of storage at 4 ºC

Cultivar/Type	Defect[z] (%)								Total defects[w] (%)
	Decay[y]	Collapse[y]	Browning[y]	Pr. Soft.[yv]	Splitting[y]	Decay[x]	Collapse[x]	Browning[x]	
Amasya Beyazi	0	0	0	0	3.33	3.33	35.00	43.33	85.00 ab
Atasari	1.67	0	0	0	13.33	1.67	21.67	43.33	81.67 ab
Big Perlon	0	0	0	1.67	0	1.67	33.33	15.00	51.67 cde
Bozcaada Cavusu	10	0	0	5.00	16.67	0	15.00	20.00	66.67 bcde
Flame seedless	1.67	0	0	0	0	25.00	38.33	30.00	95.00 ab
Helwani	0	0	0	0	6.67	0	65.00	13.33	85.00 ab
Hatun Parmagi	1.67	0	0	3.33	0	1.67	28.33	13.33	48.33 de
Imperatrice	3.33	0	0	0	10.00	13.33	48.33	3.33	78.33 abc
Mahrabasi	0	0	0	0	6.67	0	70.00	21.67	98.33 a
Muskule	0	0	0	0	3.33	10.00	40.00	28.33	81.67 ab
Patagonia	1.67	3.33	6.67	3.33	0	0	41.67	35.00	91.67 ab
Perlette	3.33	0	8.33	0	13.33	3.33	33.33	28.33	90.00 ab
Regimalazolia	0	0	0	0	5.00	13.33	21.67	35.00	75.00 abcd
Ribol	1.67	0	0	0	0	16.67	26.67	0	45.00 e
Trakya Ilkeren	10.00	0	0	5.00	18.33	11.67	31.67	11.67	88.33 ab
130/1	1.67	0	0	0	1.67	3.33	21.67	60.00	88.33 ab
5/2	11.67	15.00	23.33	5.00	0	3.33	18.33	13.33	90.00 ab

[z]Each grape berry was classified by the primary defect; [y]Assessments were made on the berry surface; [x]Assessments were made on the stem end; [w]Means with different letters within the column are significantly different according to Duncan's multiple range test ($P < 0.05$); [v]Pr. Soft.: Presence of softening.

Table 6 - Quality assessments (measured as defect ratio) of minimally processed table grape cultivars/types on the 10th day of storage at 4 ºC

Cultivar/Type	Defect[z] (%)								Total defects[w] (%)
	Decay[y]	Collapse[y]	Browning[y]	Pr. Soft.[yv]	Splitting[y]	Decay[x]	Collapse[x]	Browning[x]	
Amasya Beyazi	0	0	0	0	5.00	10.00	40.00	45.00	100.00 a
Atasari	5.00	0	0	1.67	15.00	1.67	23.33	45.00	91.67 ab
Big Perlon	0	0	0	1.67	0	1.67	38.33	16.67	58.33 c
Bozcaada Cavusu	15.00	0	0	5.00	18.33	0	18.33	21.67	78.33 abc
Flame seedless	1.67	0	0	0	0	30.00	38.33	30.00	100.00 a
Helwani	0	0	0	0	6.67	0	73.33	18.33	98.33 a
Hatun Parmagi	1.67	0	0	3.33	0	1.67	35.00	18.33	60.00 c
Imperatrice	6.67	0	0	0	10.00	25.00	50.00	5.00	96.67 ab
Mahrabasi	0	0	0	0	6.67	1.67	70.00	21.67	100.00 a
Muskule	0	0	0	0	5.00	20.00	43.33	31.67	100.00 a
Patagonia	1.67	3.33	6.67	5.00	0	0	46.67	36.67	100.00 a
Perlette	3.33	0	11.67	0	13.33	5.00	36.67	30.00	100.00 a
Regimalazolia	0	0	0	0	6.67	13.33	33.33	36.67	90.00 ab
Ribol	1.67	0	0	8.33	0	16.67	46.67	0	73.33 c
Trakya Ilkeren	13.33	0	0	5.00	20.00	15.00	31.67	15.00	100.00 a
130/1	1.67	0	0	0	1.67	3.33	26.67	61.67	95.00 ab
5/2	11.67	18.33	25.00	5.00	0	6.67	18.33	15.00	100.00 a

[z]Each grape berry was classified by the primary defect; [y]Assessments were made on the berry surface; [x]Assessments were made on the stem end; [w]Means with different letters within the column are significantly different according to Duncan's multiple range test ($P < 0.05$); [v]Pr. Soft.: Presence of softening.

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Table 7 - Means of soluble solids contents (SSC) (%), pH and total titratable acidity (TA) (%) of minimally processed table grape cultivars/types during cold storage at 4 ºC.

Cultivar/Type	SSC			pH			TA		
	Day 0	Day 5	Day 10	Day 0	Day 5	Day 10	Day 0	Day 5	Day 10
Amasya Beyazi	19.67 ± 0.33	19.00 ± 0.58	19.00 ± 0.58	3.94 ± 0.06	4.00 ± 0.05	3.99 ± 0.03	0.40 ± 0.03	0.37 ± 0.03	0.41 ± 0.01
Atasari	17.73 ± 1.27	17.87 ± 0.59	17.40 ± 0.23	3.71 ± 0.13	3.67 ± 0.02	3.71 ± 0.06	0.57 ± 0.07	0.50 ± 0.00	0.52 ± 0.04
Big Perlon	19.87 ± 0.64	18.27 ± 0.18	17.10 ± 0.21	3.73 ± 0.04	3.65 ± 0.33	3.63 ± 0.04	0.43 ± 0.03	0.33 ± 0.03	0.36 ± 0.05
Bozcaada Cavusu	18.87 ± 0.77	18.33 ± 0.18	18.27 ± 0.13	3.84 ± 0.11	3.91 ± 0.01	4.04 ± 0.23	0.30 ± 0.02	0.26 ± 0.02	0.27 ± 0.01
Muskule	17.80 ± 0.60	17.33 ± .35	17.33 ± 0.03	3.69 ± 0.03	3.70 ± 0.01	3.74 ± 0.03	0.30 ± 0.01	0.30 ± 0.05	0.31 ± 0.01
Flame seedless	22.87 ± 0.18	22.67 ± 0.35	22.20 ± 0.69	3.58 ± 0.07	3.67 ± 0.07	3.74 ± 0.01	0.29 ± 0.02	0.27 ± 0.11	0.29 ± 0.00
Helwani	14.73 ± 0.27	14.73 ± 0.18	14.53 ± 0.07	4.11 ± 0.03	4.00 ± 0.12	4.18 ± 0.02	0.46 ± 0.03	0.45 ± 0.01	0.45 ± 0.01
Hatun Parmagi	19.87 ± 0.93	19.53 ± 0.24	19.20 ± 0.12	3.63 ± 0.05	3.59 ± 0.03	3.63 ± 0.03	0.68 ± 0.05	0.64 ± 0.03	0.62 ± 0.02
Imperatrice	15.67 ± 0.18	15.00 ± 0.61	14.07 ± 0.48	3.61 ± 0.01	3.55 ± 0.02	3.69 ± 0.02	0.39 ± 0.01	0.38 ± 0.05	0.33 ± 0.04
Mahrabasi	17.20 ± 0.12	16.93 ± 0.07	16.84 ± 0.50	3.67 ± 0.03	3.52 ± 0.07	3.54 ± 0.03	0.39 ± 0.02	0.39 ± 0.07	0.40 ± 0.00
Perlette	23.07 ± 0.58	21.77 ± 0.43	19.43 ± 0.29	3.96 ± 0.04	3.93 ± 0.11	3.92 ± 0.04	0.41 ± 0.01	0.33 ± 0.02	0.33 ± 0.04
Patagonia	21.27 ± 0.58	21.08 ± 1.20	19.53 ± 0.44	3.70 ± 0.04	3.69 ± 0.16	3.96 ± 0.03	0.36 ± 0.02	0.38 ± 0.07	0.32 ± 0.01
Regimalazolia	23.80 ± 0.92	22.93 ± 0.41	19.97 ± 1.45	4.35 ± 0.03	4.12 ± 0.10	4.16 ± 0.08	0.22 ± 0.01	0.23 ± 0.02	0.25 ± 0.02
Ribol	19.53 ± 0.07	19.62 ± 0.29	18.33 ± 0.71	3.97 ± 0.02	3.92 ± 0.06	4.08 ± 0.03	0.29 ± 0.00	0.29 ± 0.02	0.26 ± 0.01
Trakya Ilkeren	20.07 ± 0.07	19.93 ± 0.07	18.20 ± 0.53	3.78 ± 0.05	3.87 ± 0.04	4.01 ± 0.08	0.32 ± 0.03	0.29 ± 0.01	0.28 ± 0.03
(130/1)	18.27 ± 1.62	17.67 ± 0.29	17.53 ± 0.27	3.44 ± 0.09	3.51 ± 0.09	3.42 ± 0.02	0.63 ± 0.01	0.56 ± 0.01	0.59 ± 0.02
(5/2)	25.00 ± 0.34	24.60 ± 0.60	23.70 ± 0.49	4.57 ± 0.03	4.43 ± 0.33	4.35 ± 0.05	0.29 ± 0.02	0.28 ± 0.02	0.28 ± 0.01

Data are the mean ± SE.

a very large berry size, suggesting that berry size is very important attribute for choosing table grape cultivars as minimally processed produce.

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