Consumer Assessment on Sensory Attributes of Fresh Table Grapes Cv 'Italia' and 'Red Globe' after Long Cold Storage Treatment

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The impact of research that is being carried out into the relationship between food and consumers is progressively reinforced by continuous findings in literature confirming that consumers choose foods basing on their functional cognition and sensory perception, especially when buying fruit and vegetables. Therefore, it is important for table grape producers to be aware of consumers' concerns and preferences both, during the purchasing stage and after, during consumption at home, when experiential attributes have more importance. In both cases, sensory attributes play an important role in determining consumers' purchase behavior of table grape. Table grapes cv 'Italia' and 'Red Globe' are produced in South Italy (Sicily and Apulia) and appreciated by consumers for their superior taste and other intrinsic qualities, both in Italy and in other European countries. Nevertheless, harvested grapes of these cultivars deteriorate rapidly without post-harvest appropriate treatments, especially in terms of fungal rot, rachis browning, berry drop, softening, moisture loss and off-flavor, and this fast deterioration is the main limitation to market acceptance. The objective of this study is to assess consumers preferences in regards to 22 sensory attributes of fresh table grapes cv 'Italia' and 'Red Globe', after a cold storage treatment of 90 days at 1±1 °C and 90±2% RH, combined with low SO2 concentration. Therefore, 'In-store' consumer acceptance tests were performed, on 1000 consumers, in nine cities nearby the main Sicilian areas of table grape production. Consumers were asked to score table grape sensory attributes, using a 9-pt scale, after long storage of 30, 60 and 90d. For this study, the table grapes were harvested from two locations, Canicattì and Naro during the last week of September and treated with SO_2 fumigation, with SSC >14%, for prolonging shelf life. Analysis of scores revealed that consumers preferred cv 'Italia' for its uniform color and no shades of berries and for a balanced tasting sugar/acidity ratio. The cv 'Red Globe' performed good results for crunchy berries and intense berry aroma, detachment of berries and skin tannicity. No difference was observed between the two cultivars for odor descriptors.

1. Introduction

Several studies have been carried out, so far, on table grapes; particularly, recent researches have focused on new methods for extending storage shelf life of cultivars bred in the major producing countries. For this study we observed consumers' preferences in regards to *Vitis vinifera* L. cvs. 'Italia' (white berries) and 'Red Globe' (red berries), that are the most important cultivars in the Italian market, in order to understand if they are still valued by consumers, or if a varietal renewal may be need. Grape growers have a fundamental dual role in the sustainability of the globalized table grape production chain, as primary consumers of cultivars and other agricultural materials (i.e. fertilizers, pesticides and farm machinery), and as suppliers of a grape commodity. This role is unique, because it differs from that of the final consumers who purchase agricultural products by mainly evaluating consumption attributes (Roberts-Nkrumah et al., 2005); contrarily, grape growers consider production attributes as key factors in their cultivar-adoption decision-making. Grape growers may have markedly different cultivar-selection criteria than fruit-selection criteria of consumers. Previous researches have demonstrated that farmers modify their cultivation choices, cultivars and production

methods basing on consumers' preferences, more particularly, their choices are strongly influenced by other external factors (i.e. market preferences) in the agricultural supply chain, such as agrichemical and extension services (Haugerud and Collinson, 1990; Macholdt et al., 2016, Liguori et al. 2015b). Technological developments have made international transactions easier, increasing the profitability for shippers exporting table grapes and making produce available to consumers globally, at affordable prices (Lichter et al., 2008). Technology has advantaged the seasonal differences expanding exports. Communication and information technology, such as electronic technologies, have enabled shippers to track their cargos around the world to monitor quality, reduce risks of liability claims and cut delivery time. Among the major exporters of table grape, Italy is the main European producer and exporter and ranks third in world's export share (12% in 2009-2011) following Chile and the US (Seccia et al., 2015). Under this scenario it may be very crucial to extend shelf life of Italian table grape, stored after harvest, in order to prolong its marketing outside Italy, and be more competitive in the EU and world markets. Therefore, consumer preferences and liking towards table grapes cvs. 'Italia' and 'Red Globe', which are the major production in Southern Italy, and the most appreciated by consumers, should be assessed for understanding the effectiveness of cold storage techniques. Despite it has been widely demonstrated that the identity factors play an important role in food preferences (Allegra et al., 2015; Piazzolla et al., 2016; Chironi et al., 2015), in this study we wanted to observe the preferences of Italian consumers for these two cultivars, which have seeds, unlike the grapes marketed in most countries of the world. More particularly, we want to know if, in those areas in which these two grape varieties are produced, the consumer has kept the old preferences or evolved, by changing their preferences from grapes with seeds, to grapes seedless. That it is important for producers in order to know if a varietal change may be necessary or if these grapes are still appreciated by the consumer, at least in the territory of origin and production. Generally, techniques and methods for prolonging shelf life of fruit after harvest are considered expensive by producers (Cantín et al., 2012). In this study it was experimented a low cost cold-storage technology that may be easily used by grape growers, and consumers' preferences on major quality descriptors were assessed after the cold treatment in order to know the effectiveness of the treatment according consumers (Liguori et al 2015a). A good consumer acceptance may allow table grape to be marketed for a longer period, and thou producers' income could increase of about 30-40%. The objective of this study is to assess consumers preferences in regards to 22 sensory attributes of fresh table grapes cv 'Italia' and 'Red Globe', after a cold storage treatment of 90 days at 1±1 °C and 90±2% RH, combined with low SO_2 concentration.

2. Materials and Methods

This study was conducted on 10-year-old table grapes plants, Vitis vinifera L. cvs. 'Italia' (white berries) and 'Red Globe' (red berries), grown in a commercial vineyard located in the Central Sicily (Southern of Italy) near Agrigento (Naro : 37°18'25.0"N 13°52'11.0"E) in the District named "Uva da tavola di Canicattì PGI" (Reg. CE 2325.1997). Table grapes plants were supported on an overhead arbor 2 m high "Tendone" system, covered with netting and plastic film (LDPE, thickness 170 µm), spaced at 2.5m×2.5m (1600 plant ha^{-1}). The table grapes used for this study were harvested during the last week of September. Grapes collected were clean, visually free of disease or other damages. Uniformity of grape sampling was taken into account. 300 boxes were prepared, by placing about 10kg of table grape in each box made of cardboard internally and plastic externally (Carton Pack, Italy). For this study, sampled grape was treated with SO_2 fumigation and SSC >14%, according to other studies carried out on methods to extend storage life of table grapes (Sortino et al., 2017).

Fresh weight was measured at commercial ripe with an electronic balance (EU-C 2002 RS. Gibertini Milano. Italy); fruit firmness was measured as penetration force required to depress 5 mm into the fruit using a 2 mm-cylinder probe, the results were expressed in Newtons (N). Soluble solids concentration (SCC) was measured with a digital refractometer (Palette PR-32, Atago Co., Ltd. Tokyo, Japan) expressed as % sucrose equivalents. The pH of the juice was registered, and then titratable acidity (TA) was determined in triplicate, from the above juice, by potentiometric titration, with 0.1 N NaOH up to pH 8.1, using 1 mL of diluted juice in 25 mL of distilled H_2O, and results were the mean (SE expressed as g of tartaric acid equivalent per 100 g^{-1} fresh weight (n=25) (Table 1). Due to the fact that sensory attributes play an important role in determining consumers' purchase behavior, for this study it was used a cluster of 22 sensory descriptors ([1]Cluster - General appearance1=badly shaped; 9=well shaped; [2]Cluster - Detachment of berries1=low resistance; 9=high resistance; [3]Cluster - Uniformity of color1= ≥ to 30% defects; 9=all colored; [4]Stalk - Color1=brown; 9=bright green; [5]Stalk – Turgidity 1=shriveled; 9=turgid; [6]Rachis - Presence of rot and/or lesions1=all rotten; 9=all healthy; [7]Stalk -Browning of the peduncle 1=all brown; 9=all green; [8]Berry - Uniformity of color 1= < to 30% colored; 9=all colored; [9]Berry - Presence of shriveling1=all shriveled; 9=all healthy; [10]Berry - Ease of detachment from the pedicel1=low resistance; 9=very resistant; [11]Skin - Browning of the skin1=clearly visible; 9=not visible; [12]Pulp - Browning of the flesh1=clearly visible; 9=not visible; [13]Berry - Crispness   1=low; 9=very crisp [14]Pulp – Consistency 1=deliquescent; 9=very firm; [15]Berry - Intensity of aromatic sensation1=not

very intense; 9=very intense; [16]Pulp - Taste balance (sweet/acid) 1=not balanced; 9=very well balanced; [17]Skin - Thickness1=thick; 9=thin; [18]Skin - Astringency1=astringent; 9=not tannic; [19]Skin - Persistence of skin in mouth1=very persistent; 9= little persistent; [20]Seeds - Perception (sensation of dimensions) 1=unpleasant; 9=not perceptible; [21]Seeds - Hardness (resistance to crushing) 1=very hard; 9=little resistance; [22]Berry Off-flavor intensity 1=not very intense; 9=very intense) related to visual, taste, olfactory indicators (Liguori et al., 2014; 2015b; Crisosto et al., 2002). An *In-store* consumer acceptance test (Crisosto et al., 2010) was conducted on the four times of storage, i.e. at 0 day (after harvest) and after 30 days, 60 days and 90 days, at 1+1°C (Sortino et al., 2017). One thousand (n=1,000) regular or, at least, occasional consumers were surveyed at the major supermarkets of the nine selected cities nearby the main Sicilian areas of table grape production (i.e. Palermo, Catania, Trapani, Agrigento, Caltanissetta, Enna, Ragusa, Siracusa and Messina). According to previous studies (Ingrassia et al., 2017; Sortino et al., 2017) the supermarkets were selected basing on the following variables: 1. Store size (i.e. very large); 2. Social status of users (i.e. all classes); 3. Fruit types (i.e. large variety of fresh fruit). The consumers' sensory test was made during the peak hours before the exit of the supermarket. Target population was selected according to socio-demographic and psychographic marketing variables for consumer stratification. The *Systematic* sampling method was applied for the selection of consumers, as for 'dynamic population' (Rolfe et al., 2006; Sortino et al., 2015, 2016) including a diverse combination of ages and genders and respondents' age equally distributed inside the range. Berries for the tasting were taken from the central part of the cluster. Samples were presented in a white plastic plate and tasted at least 1 h after they were taken out of the cold room (Liguori et al., 2015b). Consumers were asked to score table grape sensory attributes, using a 9-pt hedonic scale (1 = dislike extremely to 9 = like extremely), after long storage i.e. 30, 60 and 90 days (Ma et al., 2016; Liguori et al, 2014). Analysis of Variance (ANOVA) test was performed to investigate significant differences between scores (control and SO_2 treatment) for each time of storage. The method used to discriminate among the means was the Fisher's test at 95% confidence level and p-values lower than 0.05 ($p < 0.05$) were considered significant. Coefficient of variation (CV% = σ/mean*100) was calculated to analyze homogeneity of scores in terms of 'dispersion'. The data were processed using the software SPSS v.21.

3. Results and Discussion

During the entire storage period (90d), the 'Red Globe' grape stored with SO_2 obtained the lowest weight loss (%), that was 2.86%, contrarily the 'Red Globe' stored as CTRL had the highest weight loss, which was 3.97% (Table 1). The mean of total soluble solid content (Table 1) of 'Italia' CTRL grape at 90 days of storage was 16.30% and 14.25% for 'Red Globe' (CTRL). In the experiment the highest soluble solids were obtained for the grapes stored in SO_2 at 90 day (16.50% for cv 'Italia' and 14.61% for cv 'Red Globe'), and the lowest soluble solids were obtained for CTRL grapes. Values of titratable acidity of grapes tested show for cv 'Italia' at harvest a value of 0.319 which decreased to 0.28% at the end of the storage period. During the entire storage, the highest titratable acidity value was obtained for the Red Globe grapes stored at SO_2 (0.35%). Flesh firmness of grapes at harvest was 28.7 N and it decreased to 20.00 kg/cm^2 for cv 'Italia' as CTRL and to 21.6 kg/cm^2 for 'Red Globe' CTRL at the end of storage (Table 1). The effects of both storage periods on flesh firmness were found statistically significant ($p < 0.05$). During the cold storage, the highest flesh firmness was obtained for the 'Red Globe' grapes stored with SO_2 and the lowest value was obtained for the fruit stored as CTRL (20.00 N). At the end of the 90-day of storage, the berries treated with SO_2 were more firm and marketable. Consumer assessment on the table grape cultivars tested was not significantly different between demographic subgroups in our sample (data not shown). The degree of liking of the two cultivars evaluated in the *In-store* test was affected by cultivar and time of storage, however, it is interesting to highlight that there was a significant effect of the SO_2 treatment in both cultivars tested. Mean values of scores given by consumers to cultivar 'Italia' at different times of storage are presented in Table 2 (data are means). Respondents assessing grapes cv 'Italia' at T_2 and T_3 preferred the attributes 'General appearance', Uniformity of color' and 'Taste balance (sweet/acid)'. More particularly, data shown in Table 4 highlight a good effect of the SO_2 treatment for 'General appearance', demonstrated by a reduction of appreciation 0.8 from T_2 to T_3, a reduction of 'Taste balance' of 1.2 and a reduction of 0.7 for 'Cluster Uniformity of color'. Furthermore, if we observe all the other attributes in the group of visual indicators, it is possible to discover other positive effects of the SO_2 treatment for 'Stalk Turgidity' (-0.4 from T_2 to T_3), 'Browning of the peduncle' (CTR values at T_2 is 6.7 and at T_3 is 7.4, values at T_2 is 5.4 and at T_3 is 5.0), 'Uniformity of color of berries' (+0.2 from T_2 to T_3) and 'Browning of the skin' (+0.8). However, with respect to taste and olfactory indicators, it is possible to observe modest reductions of 'Crispness' (-0.5 from T_2 to T_3) and 'Intensity of aromatic sensation' (-0.6). Generally, for all the other descriptors, it is possible to observe a slower decay (since results show a good consumer liking) of treated fruit from T_1 to T_3 comparing to control, according to consumers' assessments.

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Table 1 - Weight, soluble solid concentration (SSC), titratable acidity (TA), and firmness (N), of fruit of table grape cv 'Italia' and 'Red Globe' after 30, 60 and 90 days after harvest, at 1±1 °C and 90±2% RH .

Days		Weight losses (%) Italia	Red	SSC (%) Italia	Red	Titratable acidity % Italia	Red	Firmness (N) Italia	Red
0	SO$_2$	0.0±0.0^d	0.0±0.0^d	14.90±0.11^b	15.30±0.21^a	0.39±0.09^{ns}	0.46±0.05^{ns}	28.7±0.15^a	30.7±0.16^a
	CTRL	0.0±0.0^d	0.0±0.0^d	14.90± 0.21^b	15.30±0.21^a	0.39±0.09	0.46±0.05	28.7±0.15^a	30.7±0.16^a
30	SO$_2$	2.47±0.11^c	2.65±0.14^c	16.20±0.5^{ab}	15.51±0.14^a	0.36±0.05	0.44±0.05	27.6±0.24^a	30.2±0.20^a
	CTRL	3.26±0.15^a	3.09±0.08^a	15.30±0.33^b	15.38±0.18^a	0.34±0.04	0.43±0.02	24.2±0.39^b	26.5±0.57^b
60	SO$_2$	2.88±0.10^b	2.79±0.10^b	16.60±0.18^a	15.00±0.12^a	0.33±0.07	0.42±0.09	27.2±0.25^a	29.0±0.25^a
	CTRL	3.54±0.14^a	3.54±0.14^a	15.90±0.11^b	14.70±0.14^b	0.31±0.06	0.40±0.06	22.8±0.21^c	25.5±0.21^c
90	SO$_2$	2.99±0.13^b	2.86±0.13^b	16.50±0.22^a	14.61±0.17^b	0.30±0.04	0.37±0.04	23.5±0.24^c	23.5±0.24^c
	CTRL	3.77±0.22^a	3.97±0.19^b	16.30±0.19^{ab}	14.25±0.11^b	0.28±0.09	0.35±0.07	20.0±0.16^d	21.6±0.12^d

Means value followed by same letter are not significantly different at P <0.05 (Data are means ± SE; n = 25).

Table 2: Sensory analysis of cv Italia table grape by stage (T0=0, T1=30, T2=60, T3=90 days) and treatment

Descriptors	T$_0$ CTR	SO$_2$	T$_1$ CTR	SO$_2$	T$_2$ CTR	SO$_2$	T$_3$ CTR	SO$_2$
[1]Cluster -General appearance	8.8±1.8	8.7±1.8	8.5±0.9	8.2±0.6	6.1±1.1	7.9±0.8	5.5±0.5	7.1±0.7
[2]Cluster - Detachment of berries	7.5±1.0	7.5±1.5	7.4±0.7	7.7±0.7	6.5±1.0	6.9±1.5	6.6±0.8	6.4±0.3
[3]Cluster - Uniformity of color	7.1±1.0	7.1±1.0	6.9±0.6	6.1±0.6	6.5±1.1	6.9±1.0	5.7±0.7	6.2±0.5
[4]Stalk - Color	8.0±0.5	7.8±0.9	7.1±1.2	7.0±1.1	6.8±0.8	7.0±0.5	3.5±0.8	3.5±0.4
[5]Stalk - Turgidity	8.0±0.7	8.0±0.8	6.8±0.6	6.9±0.6	5.5±0.7	6.7±0.4	4.5 ±0.7	6.3±0.2
[6]Rachis - Presence of rot lesions	1.0±.0.01	1.0±.0.2	4.7±0.8	4.1±0.8	5.9±0.6	4.2±0.4	7.4±0.8	4.9±0.5
[7]Stalk - Browning of the peduncle	1.3±0.0	1.3±0.4	5.4±0.7	4.1±0.7	6.7±1.3	5.4 ±1.5	7.4±0.4	5.0±0.9
[8]Berry - Uniformity of color	7.8±0.5	7.9±0.7	6.0±1.1	6.9±0.5	6.1±0.7	6.5±0.6	5.0±0.2	6.3±0.4
[9]Berry - Presence of shriveling	2.0±0.2	2.0±0.0	2.9±0.3	2.5±0.3	3.2±0.2	2.6±0.2	3.8±0.5	3.1±0.4
[10]Berry - Ease of detachment pedicel	7.2±0.3	7.0±0.5	7.3±0.2	7.0±0.7	7.8±0.3	7.1±0.4	7.5±0.6	7.3±0.7
[11]Skin - Browning of the skin	1.9±0.5	1.9±0.6	3.4±1.1	2.5±1.6	3.9±0.7	2.9±0.7	5.3±0.6	3.7±0.9
[12]Pulp - Browning of the flesh	1.0±1.3	1.0±1.3	2.6±0.6	2.3±0.6	2.5±0.9	2.7±0.7	3.1±0.5	2.7±0.5
[13]Berry - Crispness	8.0±0.8	8.0±0.8	7.0±0.4	7.5±1.0	6.7±0.8	7.4±0.9	5.2±1.1	6.9±0.9
[14]Pulp - Consistency	8.0±0.7	7.9±1.1	6.9±0.5	7.8±0.8	6.2±0.5	7.5±0.3	5.7±0.4	6.0±0.6
[15]Berry - Intensity of aromatic	7.1±0.6	7.1±0.7	7.5±0.4	7.4±0.3	6.5±0.7	6.0±0.9	5.1±0.4	5.4±0.3
[15]Pulp - Taste balance (sweet/acid)	8.0±1.3	8.0±1.5	7.6±1.1	7.6±1.1	8.0±0.7	8.0±0.7	6.6±0.4	6.8±0.5
[17]Skin - Thickness	7.3±1.4	7.3±1.4	7.1±0.7	7.0±0.7	7.0±0.5	7.0±0.5	7.1±0.8	7.2±0.5
[18]Skin - Astringency	3.5±1.5	3.3±1.5	3.5±1.2	3.7±1.5	3.0±0.7	3.0±0.5	2.6±0.4	2.5±0.6
[19]Skin - Persistence of skin in mouth	2.0±0.5	2.0±0.5	5.4±0.8	3.3±0.8	5.2±0.9	3.5±0.9	6.6±0.8	4.8±0.6
[20]Seeds - Perception (dimensions)	5.2±0.3	5.2±0.3	5.5±0.5	5.3±0.5	5.1±0.7	5.0±0.4	5.3±0.5	5.1±0.2
[21]Seeds - Hardness (crushing)	6.0±0.6	6.0±0.4	5.9±0.4	5.9±0.4	6.1±0.7	6.2±0.3	6.3±0.5	6.3±0.4
[22]Berry – Off flavor intensity	1.0±0.0	1.0±0.0	1.0±0.0	1.1±0.1	1.5±0.3	1.2±0.2	1.4±0.4	2.8±0.5

Data concerning consumers' evaluations with regards to table grape 'Red Globe' at different times of cold storage are presented in Table 3. For this cultivar, from T2 to T3, after the SO$_2$ treatment, the best results were noticed, generally, for taste descriptors. Nevertheless, a good acceptance was observed also for 'General appearance' (-0.6 from T2 to T3). More particularly, 'Crispness' acceptance decreased of 0.5 from T$_2$ to T$_3$ and consistency decrease was -1. Also results for olfactory descriptors showed a good behavior, from T$_2$ to T$_3$ since the descriptor 'Intensity of aromatic sensation' decreased, practically, unnoticeably (-0.1), and 'Taste balance (sweet/acid)' decreased of 0.8, demonstrating a satisfactory effect of the SO$_2$ treatment also for this cultivar. However, for the descriptor 'Taste balance (sweet/acid)' results showed that the treatment was more effective for cv 'Red Globe' (7.1) than for 'Italia' (6.6). For both cultivars, consumers perceived a low odor of sulfur at all times of storage for treated grapes. The off-flavor intensity is usually caused by the SO$_2$ treatment, however, only at T$_3$ the off-flavor intensity increased of 1.6 points for cv 'Italia' (2.8 at T$_3$) and 1.1 for cv 'Red Globe' (2.6 at T$_3$). Coefficient of variation indicates modest differences (CV%<10) among respondents with different age for all descriptors, for the two cultivars, therefore it was observed a unitary behavior in respect to each category of descriptors. Additionally, in previous works, seeds had always a significant negative impact on consumer acceptance of fruit (ElBehi et al., 2015; Chironi et al., 2015), nevertheless, in

this study it was possible to advance an in-depth knowledge of Italian consumers' preferences for table grape cv 'Italia' and 'Red Globe' which highlighted different conclusions. In fact, considering that the world industry of table grape produce grapes with seedless berries, our results show that consumers' evaluations of attributes concerning seeds were equal to sufficient or higher. This in line with previous literature, demonstrating that preferences for food attributes are strongly influenced by identity factors (ElBehi et al., 2015; Ma et al.,2016;).

Table 3: Sensory analysis of cv Red Globe table grape by stage (T_0=0, T_1=30, T_2=60, T_3=90 days) and treatment

Descriptors*	T_0		T_1		T_2		T_3	
	CTR	SO$_2$	CTR	SO$_2$	CTR	SO$_2$	CTR	SO$_2$
[1]Cluster -General appearance	8.4±1.1	8.5±1.2	7.9±0.3	7.2±0.6	6.8±1.1	7.5±1.1	5.2±0.9	6.9±0.7
[2]Cluster - Detachment of berries	7.0±0.7	7.0±0.7	7.4±0.7	7.7±0.7	7.2±1.0	7.5±1.5	7.1±0.9	7.0±0.3
[3]Cluster - Uniformity of color	7.0±1.0	7.0±1.0	6.5±0.4	6.3±0.7	6.0±0.3	6.5±0.6	5.3±0.4	5.5±0.3
[4]Stalk - Color	8.2±0.3	8.0±0.5	7.5±1.2	7.8±1.0	6.0±1.3	7.7±0.9	4.7±0.3	5.5±0.2
[5]Stalk -Turgidity	7.4±0.5	7.4±0.5	6.7±0.5	6.9±0.4	6.0±0.3	6.2±0.5	5.5±0.3	6.8±0.2
[6]Rachis-Presence of rot and/or lesions	1.0±.0.5	1.0±.0.2	3.7±0.6	2.5±0.6	4.7±0.6	4.2±0.4	6.3±0.4	4.7±0.6
[7]Stalk - Browning of the peduncle	1.5±0.2	1.6±0.4	3.1±0.3	2.4±0.5	3.7±1.1	2.9 ±0.8	6.2±0.9	4.0±0.5
[8]Berry - Uniformity of color	8.3±0.5	8.2±0.5	6.3±1.7	6.7±0.9	5.3±0.6	6.0±0.8	4.4±0.6	6.0±0.6
[9]Berry - Presence of shriveling	1.0±0.0	1.0±0.0	1.5±0.5	1.5±0.5	2.2±0.4	1.5±0.2	2.5±0.5	2.0±0.5
[10]Berry - Ease of detachment pedicel	7.0±0.3	7.0±0.5	7.5±0.5	7.1±0.7	7.5±0.6	7.4±0.5	7.7±0.4	7.3±0.2
[11]Skin - Browning of the skin	1.0±0.5	1.0±0.6	2.2±0.4	1.5±0.4	3.0±0.5	2.5±0.5	3.5±0.5	3.0±0.3
[12]Pulp - Browning of the flesh	1.0±0.0	1.0±0.0	2.0±0.5	2.0±0.2	2.9±0.4	2.3±0.7	2.6±0.6	2.2±0.5
[13]Berry - Crispness	8.6±0.5	8.5±0.4	7.5±0.7	7.9±0.9	7.1±0.6	8.0±1.2	6.2±0.7	7.5±0.6
[14]Pulp - Consistency	8.5±0.6	8.2±0.5	7.1±0.6	7.9±1.1	6.2±0.5	7.5±0.8	5.5±0.8	6.5±0.8
[15]Berry-Intensity of aromatic sensation	7.4±1.5	7.4±1.5	7.6±1.0	7.4±0.7	6.7±0.4	6.6±0.9	5.6±0.6	6.5±0.4
[16]Pulp - Taste balance (sweet/acid)	7.0±0.7	6.8±0.5	7.9±0.3	7.1±0.7	7.5±0.4	7.9±0.2	7.7±0.6	7.1±0.9
[17]Skin - Thickness	6.5±1.1	6.3±1.5	6.1±0.9	6.0±0.8	6.2±0.6	6.5±0.3	5.7±0.4	6.0±0.7
[18]Skin - Astringency	4.6±0.6	4.9±0.4	3.8±0.4	3.3±1.0	3.3±0.9	3.6±0.4	2.9±0.3	3.1±0.5
[19]Skin - Persistence of skin in mouth	2.0±0.5	2.0±0.5	5.1±0.7	3.6±0.4	5.9±0.9	4.3±0.6	7.0±0.5	4.5±0.7
[20]Seeds - Perception (dimensions)	5.7±0.5	5.7±0.5	5.9±0.3	5.7±0.6	5.4±0.5	5.2±0.7	5.5±0.3	5.6±0.2
[21]Seeds - Hardness (crushing)	4.3±0.7	4.4±0.5	4.9±0.6	4.5±0.4	5.4±0.7	5.2±0.6	5.3±0.8	5.3±0.4
[22]Berry – Off flavor intensity	1.0±0.0	1.0±0.0	1.0±0.0	1.3±0.3	1.2±0.2	1.5.0±0.4	1.1±0.1	2.6±0.3

4. Conclusions

Consumers preferences in regards to the 22 sensory attributes of fresh table grape selected for this study revealed a good acceptance for the two cultivars (cv 'Italia' and cv 'Red Globe'), treated with low SO$_2$ during a cold storage of 90 days at 1±1 °C and 90±2% RH. More particularly, consumers preferred cv 'Italia' for its visual appearance and taste, and cv 'Red Globe' for its crunchiness and intense berry aroma. Good results with no differences between the two cultivars were observed for odor descriptors. Therefore, producers may use this technique of storage to extend shelf life of grape up to three months after harvest and maintain very good sensory attributes to prolong its commercialization. Moreover, these results are very interesting in order to improve the efficiency of Italian production of table grape and of its storage, because SO$_2$ treatment has a lower environmental impact than SO$_2$ generating pads (one and double release SO$_2$ pads) that are special waste, negative for the environment and expensive to dispose. In view of the excellent results of the cold storage both for control and for the treatment with SO$_2$, and considering that consumers liked both cultivars each for its specific sensory characteristics, it would be desirable if table grape growers could use new cultivars with the same sensory characteristics of grape cv 'Italia' and 'Red Globe', but seedless, in order to satisfy the large consumer preference in Europe and worldwide. Future studies should be carried out with the aim to investigate new and better treatments for cold storage of grape.

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