

STUDIES ON MATURATION AND STORABILITY OF SUPERIOR TABLE GRAPES

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(Manuscript received 7 February 2007)

Abstract

This investigation was carried out during two successive seasons (2003 & 2004) at Hort. Res. Ins. Giza, Egypt. Samples were taken at weekly intervals from the second week of May until fruit reached maturity stage. Samples for storage studies were picked in the early morning and packed into 24 carton boxes lined with perforated polyethylene bags with or without (control) SO₂ generating sheets and stored at room temperature for 14 & 18 days and at 0°C for 70 & 84 days during the first and the second seasons, respectively.

Bunch weight, berry weight, juice percentage, total soluble solids contents and total soluble solids / total acidity ratio of Superior table grape increased gradually and significantly with the increasing of fruit age. On the other side berry firmness and total acidity contents decreased significantly with the increasing of berry age. Berry color of Superior grape changed directly from dark green to light or yellowish green with the increasing of fruit age.

Superior table grape could be considered as mature during the second week of June after fifty five days from full setting (the Dormex treatment is necessary), and berry firmness was nearly about (42 g /cm²) and juice percentage reached about 62 % and then total soluble solids was more than 14.8 % and total acidity was less than 0.75 % and total soluble solids / total acidity ratio was more than 20: 1.

Fumigation with SO₂ generators and low storage temperature significantly reduced all parameters that cause decreasing the storage life of grapes. This study confirmed that Superior grape is able to be stored only 7 days at room temperature without SO₂ generators and 13 days with SO₂ generators. While this period increased to more than one month without SO₂ generators or 63 to 70 days at 0°C.

INTRODUCTION

Grape is one of the most important and favorable fruit crops in Egypt. The planted area in 2005 reached 160005 feddan, while the productive area reached 144624 feddan producing 1391749 ton according to Horticulture General Administration, M.O.A.

One of the most promising new cultivars planted in Egypt is Superior as an early variety of seedless and uncolored berries. However, there is a lack of available knowledge for Egyptian producers about its handling and storage.

Mohamed (1994), reported that, bunch weight, berry weight and size, juice percentage, total soluble solid, and total soluble solids / total acidity ratio increased continuously while total acidity and berry firmness decreased during the developmental stages of grapes. Same trends were reported by Walker *et. al.* (2001) Mohamed and Hassan (2003) and Frank *et al.* (2005).

Grapes could be harvested near to full maturity as possible, unlike many other fruits, grapes don't ripe after harvest and they should be picked only after they reach the optimum stage of maturity with the most favorable appearance, flavor, taste, and texture, [(Mohamed (1994), Mohamed and Hassan (2003)]. Also the last authors added that, to determine fruit maturity, non individual physical and chemical constituents could be taken as a single indicator for maturity in Early Superior grapes, but most of them together may contribute to be a proper index.

Chikkasubbanna *et. al.* (1991) reported that, TSS/Acid ratio could be used as an index of maturity. On contrast, Mohamed (1994) mentioned that, total soluble solids /total acidity ratio could not be used as an individual indicator for maturity stage in grapes. Also he added that, the proper indices to define maturity stage in grapes were total soluble solids and total acidity contents. Same results were obtained by Uhlig (1998), and Mohamed and Hassan (2003).

Mohamed (1994) mentioned that, total soluble solids /total acidity ratio could not be used as an indicator for maturity stage in grapes. Also they added that, the proper indices to define maturity stage in grapes were total soluble solids and total acidity contents. Same results were obtained by Mohamed and Hassan (2003).

Mohamed (1994) reported that, weight loss, decay, shatter, total spoilage, total soluble solids contents of grapes and total soluble solid /total acidity ratio increased while berry firmness, general bunch appearance and total acidity decreased with prolonging the storage period. The same results were reported by Walker *et. al.* (2001), Mohamed and Hassan (2003), and Frank *et. al.* (2005).

Juice percentage of table grape decreased with prolonging the storage period, [Babalar (1998), and Mohamed and Hassan (2003)].

Total soluble solid contents of grapes and total soluble solid /total acidity ratio increased while total acidity decreased during storage, Hussien *et. al.* (1998) and Mohamed and Hassan (2003).

It has been reported that, sulfur dioxide post harvest fumigation reduced weight loss, decay, shatter and total spoilage incidence in table grapes during storage, [Baneh *et. al.* (1999), Ahmed and El-Rayes (2001), and Franck *et. al.* (2005)].

Mohamed (1994) and Mohamed and Hassan (2003) mentioned that, post harvest fumigation with sulfur dioxide significantly reduced the softening rate of Flame Seedless, Ruby Seedless and Early Superior table grapes during storage.

Baneh *et al.* (1999), found that, stem drying and browning was reduced in Banaty grapes when using SO₂ generators pad during storage the stem remained green and relatively fresh. The same results were mentioned by Mohamed and Hassan (2003). On contrast, Castro *et al.* (1998) reported that, the SO₂ generating pads had no effect on cluster appearance or stem browning.

Mohamed (1994) and Mohamed and Hassan (2003) mentioned that, fumigation with SO₂ significantly reduced TSS in fumigated grapes. Moreover fumigation with SO₂ had no obvious effect on total acidity. On the other side Cenci and Ferreira (1996) and Yigiang *et al.* (1998) mentioned that, post harvest treatment with SO₂ had no effect on TSS or total acidity contents of grapes during storage.

Many researchers noted that, grapes stored at low temperature had a long storage period and less decay, weight loss, shatter incidence compared with grapes stored at room temperature. Fruit quality and storability of grapes increased as the storage temperature decreased. The most causing losses (decay, shatter, and water loss) and deterioration of grapes were inhibited at low storage temperature [Mohamed (1994), Munoz *et al.* (2000) and Mohamed and Hassan (2003)]. Also the last authors added that, low storage temperature decreased the deterioration rate of bunch freshness and berry firmness but had no effect on juice percentage.

This investigation was carried out to determine the Superior fruits properties during berry development and maturation and storability, either stored at room temperature or at 0°C with or without SO₂ post harvest treatments.

MATERIALS AND METHODS

This investigation was carried out during two successive seasons (2003 & 2004) at Hort. Res. Inst. Gizza, Egypt. Fruits were picked from a private farm at Cairo Alex. desert road. The Vines were 5 years old, planted on a space of 1.5 x 3 m in sandy soil, trained according to cane pruning and applying drip irrigation system.

During the first week of May, vines were selected to be the source of samples during maturity indices study. Samples were taken at weekly intervals from the second week of May (nearly one month before harvest). During pre harvest study, all fruit quality parameters, such as bunch weight average, berry weight average, berry color and firmness, juice percentage, total soluble solid contents and total acidity contents, were measured and tabulated. Furthermore, three cluster samples were left under room temperature for 5 days at every harvest date. Fruit samples were tested at the

third and fifth day for bunch weight loss percentage, bunch conditions, berry firmness, TSS, total acidity and TSS / total acidity ratio to determine maturity stage.

When fruit reached maturity stage, samples for storage study were taken. Fruits were picked in the early morning and directly transported to the laboratory were packed into 24 carton box (2Kg / box) lined with perforated polyethylene (40 μ , 400 walls / m², 1hall = 0.5cm) with SO₂ generators sheet (12 boxes) or without SO₂ generators (control 12 boxes). All treatments were stored at room temperature for 14 & 18 days and at 0°C for 84 & 98 days during the first and the second seasons, respectively. Fruits stored at room temperature were tested two times per week, while fruits stored at low temperature (0°C) were tested at 14 day intervals for all fruit physical and chemical parameters.

The determination procedures were as follow:

- 1- Bunch weight average, five bunches were weighted and the average of bunch was calculated.
- 2- Berry weight (and size average) was determined by weighting three single replicates, each consists of sixteen berries taken from the whole bunches to find the average of the individual berry.
- 3- Peel color changes during growth and storage was estimated by a Hunter colorimeter type (Dp-9000) for the estimation of "L", "a" and "b" values and to evaluate color values as hue angle as described by McGuire, 1992 and Voss, 1992.
- 4- Berry firmness was estimated in 15 berries by Ibra texture analyzer instrument using a penetrating cylinder of 1 mm of diameter to a constant distance 1 mm inside the skin of berry and by a constant speed 2 mm per second and the peak of resistance was recorded per gram.
- 5- Bunch freshness was calculated as the average of stem color, stems dryness and berry appearance, and was estimated as follow:

The property	Degree			
	1	2	3	4
Stem color	Green	L. brown	Little green	Brown
Stem dryness	Plump	50% Dry	Dry	Very dry
Berry appearance	Excellent	Good	Acceptable	Poor

- 6- Juice Percentage was determined by weighting three single replicates, each consists of sixteen berries taken randomly from the whole bunches. The Juice percentage was calculated according to the following equation: - Juice percentage = Juice Weight * 100 / Berry Weight.

- 7- Percentage of total soluble solids (T.S.S. %) of the flesh was estimated by a'bbe digital refractometer, according to A.O.A.C., 1980.
- 8- Acidity percentage of the flesh was determined as tartaric acid by titration with a solution of 0.1 N., Na Oh, according to A.O.A.C., 1980.
- 9- Weight loss percentage was calculated as the difference between fruit weight at the start of storage and fruit weight at the inspection date.
- 10- Decay percentage, all decayed fruits were calculated and expressed as decay percentage.
- 11- Shatter percentage, all shattered berries were calculated and expressed as shatter percentage.
- 12- Total spoilage percentage was calculated as the sum of the last three parameters (weight loss, decay and shatter percentages).
- 13- Statistical analysis, all data were subjected to analysis of variance as a complete randomized design for the pre harvest studies and as two factorial experiments in random complete design and all means were compared by the less significant differences as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

I-Maturity indices:-

I-A - Physical characteristics:

According to the results illustrated in Table (1) and Figure (1) it is obvious that, Bunch weight, berry weight and juice percentage significantly increased gradually till reached the maximum at harvest during the first and the second seasons.

On Contrast berry firmness of Superior table grapes significantly decreased with the increasing of berry age in the two seasons. Furthermore, berry color, represented as hue angel, of Superior table grape changed directly from dark green (hue angel is more than 115) to light or yellowish green with the increasing of fruit age during the first season, while this trend was not clear during the second season.

Bunch weight of Superior table grape reached the average values of 700 g during the two seasons. While Berry weight of Superior reached an average of 4.1 g during the two seasons. On the other side, juice percentage content of Superior reached the average values of 63.2. Moreover, berry firmness at the harvest date reached average 41 g / cm.

These results are in harmony with those obtained by Mohamed (1994) and Mohamed and Hassan (2003). They reported that, bunch weight, berry weight and juice percentage significantly increased gradually till reached the maximum before harvest.

These results are in accordance with the finding of Mohamed (1994), and Mohamed and Hassan (2003). Also they demonstrated that, berry firmness decreased with advanced of age fruit.

Furthermore, these results are in agreement with that reported by Mohamed (1994) who reported that berry color of Flam seedless and Ruby seedless grapes and Crimson seedless grapes changed directly from green to red.

I-B- Chemical characteristics:

Results illustrated in Table (1) and Figure (1) show that, total soluble solids contents of Superior table grape and TSS / acid ratio significantly increased gradually with the increasing of fruit age while total acidity contents significantly decreased gradually with the increasing of fruit age during the two seasons.

Total soluble solids contents of Superior fruits reached the values of 14.8 % and total acidity contents reached the average values of 0.74 % during the two seasons. On the other hand, total soluble solids / acid ratio in Superior grape reached the average values of 20.0: 1 during the two seasons.

These results are in line with those obtained by Mohamed (1994), Walker *et. al.* (2001) and Mohamed and Hassan (2003). They found that, total soluble solids contents of table grape and total soluble solids / total acidity ratio significantly increased gradually while total acidity contents of table grape significantly decreased gradually with the advanced age of fruit.

I-C- Determination of maturity stage:

From the changes of the physical and chemical properties of Superior table grape during shelf life at different developmental growth stages (table 2) we can conclude that, because bunch weight, berry weight, juice percentage and berry firmness varied widely from year to another, it was not able to be used as an individual indicator to maturity stage of Superior grape. On the contrary total soluble solids, total acidity and total soluble solids / total acidity ratio were nearly the same during the two seasons. So we can demonstrate that, Superior table grape could be considered as mature during the second week of June and after 55 days after fruit set, (the Dormex treatment is necessary) while berry firmness was nearly about (42 g /cm²) and juice percentage reached nearly 62 % and then total soluble solids was more than 14.8 % and total acidity was less than 0.75 % and total soluble solids / total acidity ratio was more than 20: 1.

Table 1. Development of physical properties of Superior table grapes during growing seasons (2003) & (2004).

Properties	Age (days)	34	41	48	55	LSD
	Season					
Bunch weight	2003	536.3	616.5	571.5	678.8	136.6
	2004	469.5	573.3	569.5	739.4	78.43
Berry weight	2003	3.10	3.53	3.90	4.13	0.34
	2004	2.23	2.95	3.40	4.21	0.25
Berry firmness	2003	48.27	45.47	43.13	40.60	8.16
	2004	54.47	55.33	42.33	41.07	12.59
Hue angle	2003	115.7	112.9	115.7	110.1	3.66
	2004	109.8	109.7	112.8	112.6	3.03
Juice %	2003	61.63	65.23	65.45	67.27	6.65
	2004	46.70	59.20	54.30	58.80	8.12
TSS %	2003	12.73	13.10	14.17	14.67	1.31
	2004	8.43	10.67	13.13	14.90	1.36
T. Acidity %	2003	1.38	1.04	0.88	0.75	0.15
	2004	1.84	1.11	0.89	0.73	0.17
TSS / Acidity ratio	2003	9.25	12.63	16.18	19.57	1.28
	2004	4.59	9.68	14.86	20.54	2.03

Table 2. Changes of berry physical and chemical properties of Superior table grapes during maturation in 2003 and 2004 seasons.

Age (days) Season	Weight loss %		Bunch condition		Berry firmness		T.S.S		T. Acidity		TSS / Acid ratio	
	First	Second	First	Second	First	Second	First	Second	First	Second	First	Second
27	0		Good		51.33		9.27		1.76		5.30	
	23.48		Good		39.12		9.91		1.82		5.45	
	36.72		Shrinkage		32.6		10.87		1.93		5.65	
34	0	0	Good	Good	48.27	54.47	12.73	8.43	1.38	1.84	9.25	4.59
	13.39	27.34	Good	Shrinkage	40.47	20.8	12.17	8.2	1.04	6.88	11.7	4.36
	17.04	40.69	Shrinkage	Shrinkage	30.47	25.29	13.23	8.17	0.95	5.36	13.93	4.39
41	0	0	Good	Good	45.47	55.33	13.10	10.67	1.04	1.11	12.63	9.68
	8.27	11.51	Good	Good	28.0	23.2	13.13	11.03	0.80	3.46	16.41	11.61
	16.39	21.17	Shrinkage	Shrinkage	20.87	24.93	14.43	12.2	0.81	1.95	17.81	12.71
48	0	0	Good	Good	43.13	42.33	14.17	13.13	0.88	0.89	16.18	14.86
	7.08	9.48	Good	Good	36	38.33	14.47	13.4	0.80	0.79	18.09	16.96
	11.45	12.80	Good	Good	28	29.2	14.5	13.83	0.79	0.79	18.47	17.51
55	0	0	Good	Good	40.60	41.07	14.67	14.90	0.75	0.73	19.57	20.54

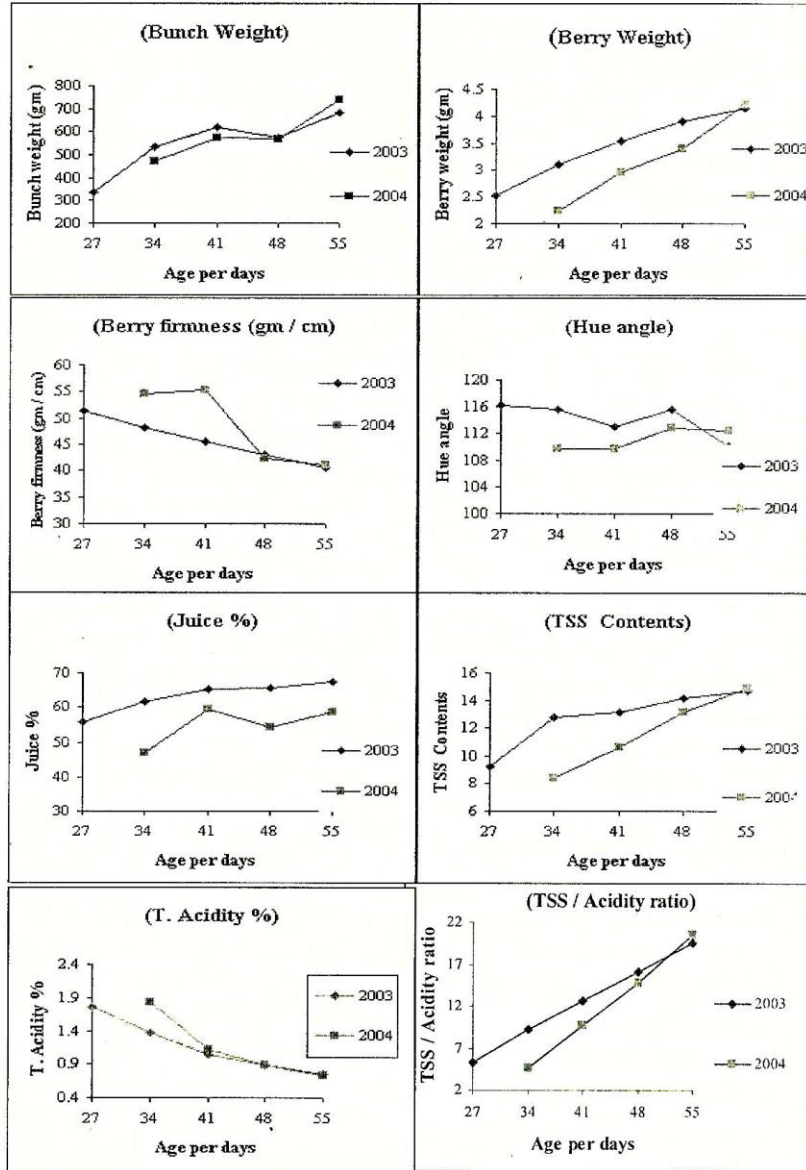


Figure 1. Changes of Physical and Chemical properties of Superior grapes during growth and maturation in the two seasons (2003 and 2004).

These results are in agreement with those obtained by Mohamed (1994), Uhlig (1998), and Mohamed and Hassan (2003). They reported that the proper indices to define maturity stage in grapes were total soluble solids and total acidity contents. On contrast, these results disagree with those mentioned by Chikkasubbanna *et. al.* (1991) who mentioned that TSS/Acid ratio could be used as an index of maturity stage of grape.

II - Storage studies:-

II – A- Weight loss, decay, shatter and total spoilage percentage:

Results presented in Tables (3, 4, 5 & 6) and Figures (2 & 3) clearly indicated that, weight loss, decay, shatter and total spoilage percentage of Superior significantly increased gradually with prolonging the storage period during the two seasons either stored at room temperature or at 0°C temperature. Also these results illustrated that, post harvest fumigation with SO₂ significantly reduced weight loss, decay, shatter and total spoilage incidence of grapes during storage.

Also it appears from the last mentioned results that, cold storage significantly decreased weight loss, decay, shatter and total spoilage incidence of Superior grapes and increased its storability during the two seasons.

Superior table grape fumigated with SO₂ and stored for 14 and 18 days at room temperature had total spoilage of 26.3 % and 25.83 % compared with 77.62 and 89.72 % in untreated grapes with SO₂ during the first and the second season respectively. While when grapes was fumigated and stored at 0°C for 70 and 84 days, total spoilage reached 20.0 % and 20.73 % compared with 62.3% and 99.16 % for unfumigated table grape during the first and the second seasons respectively.

These results are in accordance with those obtained by Mohamed (1994), Babalar *et. al.* (1998), Castro *et. al.* (1998), Baneh *et. al.* (1999), Walker *et. al.* (2001), Mohamed and Hassan (2003), and Frank (2005). They mentioned that weight loss, decay, shatter and total spoilage percentage significantly increased gradually with prolonging the storage period.

Also these results are in harmony with those obtained by Mohamed (1994), Cenci and Ferreira (1996), Baneh *et. al.* (1999), Munoz *et. al.* (2000), Ahmed and El-Rayes (2001), Mohamed and Hassan (2003), and Frank *et. al.* (2005). They reported that, table grape fumigation with SO₂ significantly decreased weight loss, decay, shatter and total spoilage incidence during storage of grape.

Table 3. Effect of fumigation with SO₂ on weight loss percentage of Superior table grapes during storage at room temperature and at 0°C in 2003 & 2004.

Storage at room temperature							Storage at 0°C						
Storage period in days	1st season (2003)			2nd season (2004)			Storage period in days	1st season (2003)			2nd season (2004)		
	No SO ₂	SO ₂	Means	No SO ₂	SO ₂	Means		No SO ₂	SO ₂	Means	No SO ₂	SO ₂	Means
0	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00
4	1.11	0.50	0.81	1.23	0.67	0.95	14	0.93	0.43	0.68	1.40	0.43	0.92
7	3.63	1.20	2.42	2.98	1.37	2.17	28	2.03	0.93	1.48	3.73	0.80	2.27
11	7.30	3.03	5.17	5.07	3.53	4.30	42	3.17	1.57	2.37	6.97	2.32	4.64
14	12.23	4.87	8.55	7.18	5.03	6.11	56	5.83	2.40	4.12	8.97	3.83	6.40
18				9.40	6.47	7.93	70	8.43	3.63	6.03	11.47	5.57	8.52
							84			--	12.83	6.60	9.72
Means	4.86	1.92	--	4.31	2.84	--	Means	3.40	1.49	--	6.48	2.79	--
LSD at 5% level													
Factor	Tre.	S.P.	Inter	Tre.	S.P.	Inter		Tre.	S.P.	Inter	Tre.	S.P.	Inter
LSD values	0.60	0.95	1.34	0.37	0.64	0.91		0.49	0.84	1.19	0.62	1.15	1.63
Tre = Treatment			S.P. = Storage period			Inter = Interaction			N.S = No significant				

Table 4. Effect of fumigation with SO₂ on decay percentage of Superior table grapes during storage at room temperature and at 0°C in 2003 & 2004.

Storage at room temperature							Storage at 0°C						
Storage period in days	1st season (2003)			2nd season (2004)			Storage period in days	1st season (2003)			2nd season (2004)		
	No SO ₂	SO ₂	Means	No SO ₂	SO ₂	Means		No SO ₂	SO ₂	Means	No SO ₂	SO ₂	Means
0	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00
4	0.99	0.27	0.63	1.00	0.44	0.72	14	0.00	0.13	0.07	0.30	0.10	0.20
7	7.27	0.63	3.95	5.87	1.17	3.52	28	0.80	0.57	0.68	1.23	0.33	0.78
11	24.73	2.97	13.85	15.47	3.07	9.27	42	5.47	1.97	3.72	5.43	1.15	3.29
14	39.49	5.07	22.28	36.57	5.73	21.15	56	23.33	4.81	14.07	10.20	1.67	5.93
18				65.03	13.67	39.35	70	46.50	12.53	29.52	25.80	3.63	14.72
							84			--	74.63	10.03	42.33
Means	14.50	1.79	--	20.66	4.01	--	Means	12.68	3.34	--	16.80	2.42	--
LSD at 5% level													
Factor	Tre.	S.P.	Inter	Tre.	S.P.	Inter		Tre.	S.P.	Inter	Tre.	S.P.	Inter
LSD values	3.39	5.36	7.58	1.92	3.32	4.69		2.08	3.60	5.10	1.51	2.82	3.98
Tre = Treatment			S.P. = Storage period			Inter = Interaction			N.S = No significant				

Table 5. Effect of fumigation with SO₂ on shatter percentage of Superior table grapes during storage at room temperature and at 0°C in 2003 & 2004.

Storage at room temperature							Storage at 0°C						
Storage period in days	1st season (2003)			2nd season (2004)			Storage period in days	1st season (2003)			2nd season (2004)		
	No So ₂	SO ₂	Means	No So ₂	SO ₂	Means		No So ₂	SO ₂	Means	No So ₂	SO ₂	Means
0	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00
4	1.07	0.77	0.92	1.33	0.53	0.93	14	0.70	0.53	0.62	0.86	0.57	0.71
7	5.97	2.70	4.33	4.83	2.13	3.48	28	1.50	1.10	1.30	1.69	1.10	1.40
11	10.53	5.33	7.93	6.50	3.53	5.02	42	2.40	1.59	2.00	2.43	1.57	2.00
14	25.90	16.37	21.13	9.37	4.60	6.98	56	4.40	2.48	3.44	4.23	2.43	3.33
18				15.29	5.70	10.50	70	7.37	3.83	5.60	7.90	3.17	5.53
							84			--	11.70	4.10	7.90
Means	8.69	5.03	-----	6.22	2.75	-----	Means	2.73	1.59	-----	4.12	1.85	-----
LSD at 5% level							LSD at 5% level						
Factor	Tre.	S.P.	Inter	Tre.	S.P.	Inter		Tre.	S.P.	Inter	Tre.	S.P.	Inter
LSD values	1.92	3.04	4.30	1.10	1.91	2.70		0.32	0.56	0.79	0.39	0.74	1.04
Tre = Treatment			S.P. = Storage period			Inter = Interaction			N.S = No significant				

Table 6. Effect of fumigation with SO₂ on total Spoilage percentage of Superior table grapes during storage at room temperature and at 0°C in 2003 & 2004.

Storage at room temperature							Storage at 0°C						
Storage period in days	1st season (2003)			2nd season (2004)			Storage period in days	1st season (2003)			2nd season (2004)		
	No So ₂	SO ₂	Means	No So ₂	SO ₂	Means		No So ₂	SO ₂	Means	No So ₂	SO ₂	Means
0	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00
4	3.16	1.54	2.35	3.57	1.64	2.61	14	1.63	1.10	1.37	2.56	1.10	1.83
7	16.87	4.53	10.70	13.68	4.67	9.17	28	4.33	2.60	3.47	6.66	2.23	4.45
11	42.57	11.33	26.95	27.03	10.13	18.58	42	11.03	5.13	8.08	14.83	5.03	9.93
14	77.62	26.30	51.96	53.12	15.37	34.24	56	33.57	9.69	21.63	23.40	7.93	15.67
18				89.72	25.83	57.78	70	62.30	20.00	41.15	45.17	12.37	28.77
							84			--	99.16	20.73	59.95
Means	28.04	8.74	-----	31.19	9.61	-----	Means	18.81	6.42	-----	27.40	7.06	-----
LSD at 5% level							LSD at 5% level						
Factor	Tre.	S.P.	Inter	Tre.	S.P.	Inter		Tre.	S.P.	Inter	Tre.	S.P.	Inter
LSD values	2.97	4.69	6.64	2.60	4.50	6.37		2.42	4.20	5.94	1.88	3.51	4.96
Tre = Treatment			S.P. = Storage period			Inter = Interaction			N.S = No significant				

Furthermore, these results are in agreement with those demonstrated by Mohamed (1994), Munoz *et. al.* (2000) and Mohamed and Hassan (2003). They demonstrated that, low storage temperature decreased weight loss, decay, shatter and total spoilage incidence of table grape during storage.

II-b - Berry firmness, General bunch appearance and Juice percentage:

Results presented in Tables (7, 8 & 9) and Figures (2 & 3) clearly indicated that, berry firmness, bunch freshness and juice percentage of Superior table grape significantly decreased with prolonged storage during the two seasons.

Results also indicated that, fumigation of grapes with SO₂ significantly reduced the softening rate of berry firmness and the deterioration rate of bunch freshness during storage compared with untreated fruits either stored at room temperature or at low storage temperature. On the other hand, fumigation with SO₂ had no effect on grape juice percentage during storage.

Superior table grape fumigated with SO₂ and stored at room temperature for 14 and 18 days had berry firmness of 35.4 g / cm² and 35.73 g / cm compared with the values 25.37 g/cm² and 28.27 g/cm² for untreated grapes with SO₂ during the first and the second season respectively. While when grapes was fumigated and stored at 0°C for 70 and 84 days berry firmness reached the values of 33.33 and 32.20 gm/cm² compared with 25.0 and 22.40 g/cm² for grapes stored without fumigation during the first and the second season respectively.

These results are in accordance with those demonstrated by Mohamed (1994), Walker (2001), and Mohamed and Hassan (2003). They reported that, grape berry firmness and juice percentage decreased gradually while bunch freshness deteriorated with prolonged storage period.

Also these results are in harmony with those obtained by Mohamed (1994), Baneh *et. al.* (1999), Mohamed (2002) and Mohamed and Hassan (2003). They demonstrated that, SO₂ post harvest treatment of grapes reduced berry softening rate and bunch freshness deterioration during storage.

Furthermore, these results are in agreement with those obtained by Mohamed and Hassan (2003), they reported that, post harvest fumigation with SO₂ had no effect on juice percentage contents of grape during storage.

Table 7. Effect of fumigation with SO₂ on berry firmness of Superior table grapes during storage at room temperature and at 0°C in 2003 & 2004.

Storage at room temperature							Storage at 0°C						
Storage period in days	1st season (2003)			2nd season (2004)			Storage period in days	1st season (2003)			2nd season (2004)		
	No So ₂	SO ₂	Means	No So ₂	SO ₂	Means		No So ₂	SO ₂	Means	No So ₂	SO ₂	Means
0	40.60	40.60	40.60	41.07	41.07	41.07	0	40.60	40.60	40.60	41.07	41.07	41.07
4	40.53	41.73	41.13	38.87	41.20	40.03	14	36.07	40.07	38.07	38.47	40.60	39.53
7	35.53	40.00	37.77	36.33	41.20	38.77	28	37.27	42.13	39.70	36.53	42.40	39.47
11	29.73	36.27	33.00	34.53	38.33	36.43	42	31.07	40.60	35.83	36.67	38.93	37.80
14	25.37	35.40	30.38	33.80	39.20	36.50	56	29.33	35.27	32.30	35.40	36.67	36.03
18				28.27	35.73	32.00	70	25.00	33.33	29.17	31.67	35.20	33.43
							84			--	22.40	32.20	27.30
Means	34.35	38.80	-----	35.48	39.46	-----	Means	33.22	38.67	-----	34.60	38.15	-----
LSD at 5% level													
Factor	Tre.	S.P.	Inter	Tre.	S.P.	Inter		Tre.	S.P.	Inter	Tre.	S.P.	Inter
LSD values	3.07	4.85	6.86	2.33	4.04	5.72		2.45	4.25	6.00	1.64	3.06	4.33
Tre = Treatment			S.P.= Storage period			Inter = Interaction			N.S = No significant				

Table 8. Effect of fumigation with SO₂ on bunch appearance of Superior table grapes during storage at room temperature and at 0°C in 2003 & 2004.

Storage at room temperature							Storage at 0°C						
Storage period in days	1st season (2003)			2nd season (2004)			Storage period in days	1st season (2003)			2nd season (2004)		
	No So ₂	SO ₂	Means	No So ₂	SO ₂	Means		No So ₂	SO ₂	Means	No So ₂	SO ₂	Means
0	1.00	1.00	1.00	1.00	1.00	1.00	0	1.00	1.00	1.00	1.00	1.00	1.00
4	1.67	1.00	1.33	1.22	1.00	1.11	14	1.44	1.00	1.22	1.00	1.00	1.00
7	2.11	1.00	1.56	2.11	1.00	1.56	28	2.22	1.00	1.61	1.56	1.00	1.28
11	3.00	1.78	2.39	2.56	1.22	1.89	42	2.78	1.11	1.94	2.56	1.11	1.83
14	4.00	2.78	3.39	3.22	2.00	2.61	56	3.78	2.00	2.89	3.44	1.44	2.44
18				4.00	3.00	3.50	70	4.00	2.67	3.33	4.00	2.22	3.11
							84				4.00	2.89	3.44
Means	2.36	1.51	-----	2.35	1.54	-----	Means	2.54	1.46	-----	2.51	1.52	---
LSD at 5% level													
Factor	Tre.	S.P.	Inter	Tre.	S.P.	Inter		Tre.	S.P.	Inter	Tre.	S.P.	Inter
LSD values	0.18	0.29	0.40	0.14	0.25	0.35		0.18	0.32	0.45	0.21	0.38	0.55

Table 9. Effect of fumigation with SO₂ on juice percentage of Superior table grapes during storage at room temperature and at 0°C in 2003 & 2004.

Storage at room temperature							Storage at 0°C						
Storage period in days	1st season (2003)			2nd season (2004)			Storage period in days	1st season (2003)			2nd season (2004)		
	No So ₂	SO ₂	Means	No So ₂	SO ₂	Means		No So ₂	SO ₂	Means	No So ₂	SO ₂	Means
0	67.27	67.27	67.27	58.82	58.82	58.82	0	67.27	67.27	67.27	58.82	58.82	
4	68.30	69.50	68.90	57.20	60.23	58.72	14	64.34	65.47	64.90	57.63	59.13	
7	68.63	68.37	68.50	55.97	57.37	56.67	28	63.53	66.30	64.92	58.07	59.10	
11	58.15	67.87	63.01	50.07	56.20	53.13	42	60.77	60.50	60.63	55.87	56.17	
14	49.89	65.77	57.83	47.40	54.06	50.73	56	58.97	61.50	60.23	56.10	58.30	
18				45.85	51.97	48.91	70	55.55	60.28	57.92	54.76	56.73	
							84				50.73	55.67	
Means	62.45	67.75	-----	52.55	56.44	-----	Means	61.74	63.55	-----	56.00	57.99	
LSD at 5% level													
Factor	Tre.	S.P.	Inter	Tre.	S.P.	Inter		Tre.	S.P.	Inter	Tre.	S.P.	Inter
LSD values	N.S	5.35	7.81	N.S	3.52	5.22		N.S	6.42	9.07	N.S	5.76	8.15
Tre = Treatment			S.P. = Storage period			Inter = Interaction			N.S = No significant				

Table 10. Effect of fumigation with SO₂ on TSS contents of Superior table grapes during storage at room temperature and at 0°C in 2003 & 2004.

Storage at room temperature							Storage at 0°C						
Storage period in days	1st season (2003)			2nd season (2004)			Storage period in days	1st season (2003)			2nd season (2004)		
	No So ₂	SO ₂	Means	No So ₂	SO ₂	Means		No So ₂	SO ₂	Means	No So ₂	SO ₂	Means
0	14.67	14.67	14.67	14.90	14.90	14.90	0	14.67	14.67	14.67	14.90	14.90	
4	14.87	15.03	14.95	15.37	15.53	15.45	14	15.00	15.10	15.05	15.83	15.17	
7	15.03	15.33	15.18	16.63	16.17	16.40	28	16.03	16.87	16.45	16.43	16.13	
11	16.27	15.97	16.12	16.27	16.40	16.33	42	16.93	16.77	16.85	16.37	16.47	
14	14.37	16.47	15.42	15.03	16.43	15.73	56	15.63	16.60	16.12	16.13	16.63	
18				13.87	15.62	14.74	70	15.27	17.00	16.13	15.53	16.03	
							84				15.13	17.23	
Means	15.04	15.49	-----	15.34	15.84	-----	Means	15.59	16.17	-----	15.76	16.08	
LSD at 5% level													
Factor	Tre.	S.P.	Inter	Tre.	S.P.	Inter		Tre.	S.P.	Inter	Tre.	S.P.	Inter
LSD values	0.28	0.45	0.64	0.40	0.69	0.98		0.21	0.37	0.52	0.30	0.55	0.78
Tre = Treatment			S.P. = Storage period			Inter = Interaction			N.S = No significant				

II-C-Total soluble solids, Total acidity and T.S.S / total acidity ratio:

Results illustrated in Tables (10, 11 & 12) and Figures (2 & 3) clearly indicated that, total soluble solids contents and TSS / total acidity ratio of Superior table grapes significantly increased gradually while total acidity contents decreased with prolonging of the storage period in the two seasons.

Results also indicated that, fumigation with SO₂ increased total soluble solids and total acidity during storage. Moreover, total soluble solids / total acidity ratio of Superior table grape fumigated with SO₂ and stored at 0°C was significantly higher than unfumigated grapes. Furthermore post harvest treatments with SO₂ forbid or delayed the inverse point incidence of TSS, total acidity and TSS / total acidity ratio of table grape at the end of the storage period. On the other side, fumigation with SO₂ had no effect on total acidity % during storage at 0°C temperature and TSS / total acidity ratio during storage at room temperature in this study during the two seasons.

These results are in agreement with those founded by Mohamed (1994), and Mohamed and Hassan (2003). They reported that, total soluble solids contents and total soluble solids / total acidity ratio of grapes increased gradually while total acidity contents decreased gradually during storage.

On the contrary, these results disagree with those obtained by Hussien *et al* (1998). They reported that, total soluble solids contents of table grapes decreased while total acidity contents significantly increased gradually with prolonging the storage period.

These results are partially in harmony with those obtained by Cenci and Ferreira (1996) and Mohamed and Hassan (2003). They reported that, SO₂ fumigation had no effect on total soluble solids contents and total soluble solids / total acidity ratio during storage.

Also these results partially agree with those obtained by Yigiang *et al*. (1998). They mentioned that, grape fumigated with SO₂ had total soluble solids / total acidity ratio significantly higher than that of unfumigated grapes.

Also these results disagree with those obtained by Mohamed (1994) who reported that, grape SO₂ fumigation significantly reduced TSS contents of grape during storage.

Table 11. Effect of fumigation with SO₂ on total acidity percentage of Superior table grape grapes during cold storage at room temperature and at 0°C in 2003 & 2004.

Storage at room temperature							Storage at 0°C						
Storage period in days	1st season (2003)			2nd season (2004)			Storage period in days	1st season (2003)			2nd season (2004)		
	No So ₂	SO ₂	Means	No So ₂	SO ₂	Means		No So ₂	SO ₂	Means	No So ₂	SO ₂	Means
0	0.75	0.75	0.75	0.73	0.73	0.73	0	0.75	0.75	0.75	0.73	0.73	0.73
4	0.63	0.68	0.66	0.71	0.73	0.72	14	0.73	0.70	0.71	0.73	0.73	0.73
7	0.55	0.64	0.60	0.68	0.72	0.70	28	0.61	0.70	0.65	0.72	0.71	0.71
11	0.50	0.59	0.54	0.59	0.70	0.65	42	0.54	0.62	0.58	0.66	0.68	0.67
14	0.55	0.55	0.55	0.62	0.70	0.66	56	0.68	0.57	0.63	0.62	0.64	0.63
18				0.68	0.69	0.69	70	0.72	0.55	0.63	0.68	0.64	0.66
							84				0.70	0.62	0.66
Means	0.60	0.64	-----	0.67	0.71	-----	Means	0.55	0.56	-----	0.58	0.60	-----
LSD at 5% level													
Factor	Tre.	S.P.	Inter	Tre.	S.P.	Inter		Tre.	S.P.	Inter	Tre.	S.P.	Inter
LSD values	0.03	0.05	0.08	0.03	0.05	0.08		N.S	0.04	0.05	N.S	0.05	0.08
Tre = Treatment			S.P.= Storage period			Inter = Interaction			N.S = No significant				

Table 12. Effect of fumigation with SO₂ on TSS/ total acidity ratio of Superior table grapes during storage at room temperature and at 0°C in 2003 & 2004.

Storage at room temperature							Storage at 0°C						
Storage period in days	1st season (2003)			2nd season (2004)			Storage period in days	1st season (2003)			2nd season (2004)		
	No So ₂	SO ₂	Means	No So ₂	SO ₂	Means		No So ₂	SO ₂	Means	No So ₂	SO ₂	Means
0	19.57	19.57	19.57	20.54	20.54	20.54	0	19.57	19.57	19.57	20.54	20.54	20.54
4	23.60	22.11	22.85	21.55	21.40	21.47	14	20.74	21.62	21.18	21.69	20.79	21.24
7	27.34	24.15	25.75	24.60	22.56	23.58	28	26.30	24.36	25.33	22.94	22.76	22.85
11	32.74	27.41	30.07	27.48	23.32	25.40	42	31.62	27.17	29.39	25.04	24.14	24.59
14	26.13	29.93	28.03	24.34	23.62	23.98	56	22.92	29.02	25.97	25.91	26.15	26.03
18				20.53	22.54	21.53	70	21.34	31.04	26.19	22.86	25.07	23.96
							84				21.56	27.66	24.61
Means	25.88	24.63	-----	23.17	22.33	-----	Means	23.75	25.46	-----	22.93	23.87	-----
LSD at 5% level													
Factor	Tre.	S.P.	Inter	Tre.	S.P.	Inter		Tre.	S.P.	Inter	Tre.	S.P.	Inter
LSD values	N.S	2.86	4.04	N.S	1.51	2.14		0.84	1.45	2.05	0.76	1.41	2.00
Tre = Treatment			S.P.= Storage period			Inter = Interaction			N.S = No significant				

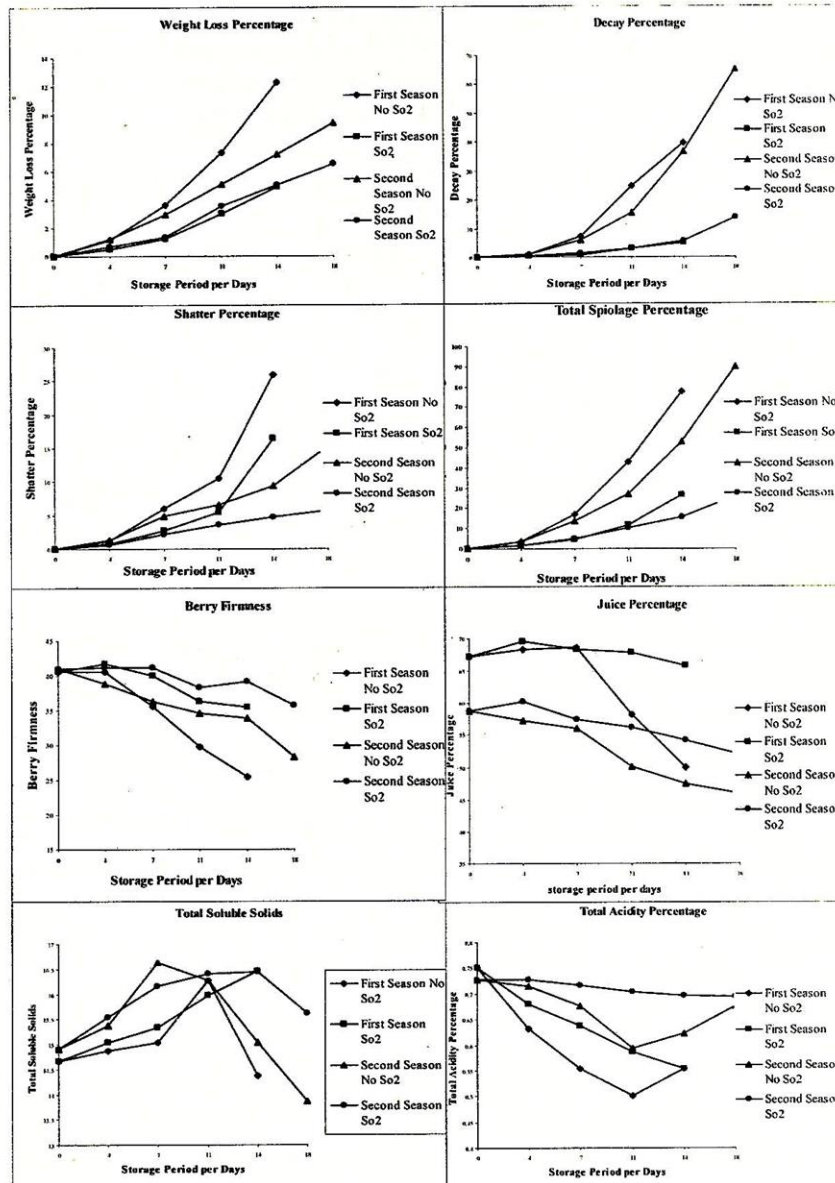


Figure 2. Effect of treatment with sulfur dioxide on properties of Superior grapes during storage at Room temperature in 2003 and 2004.

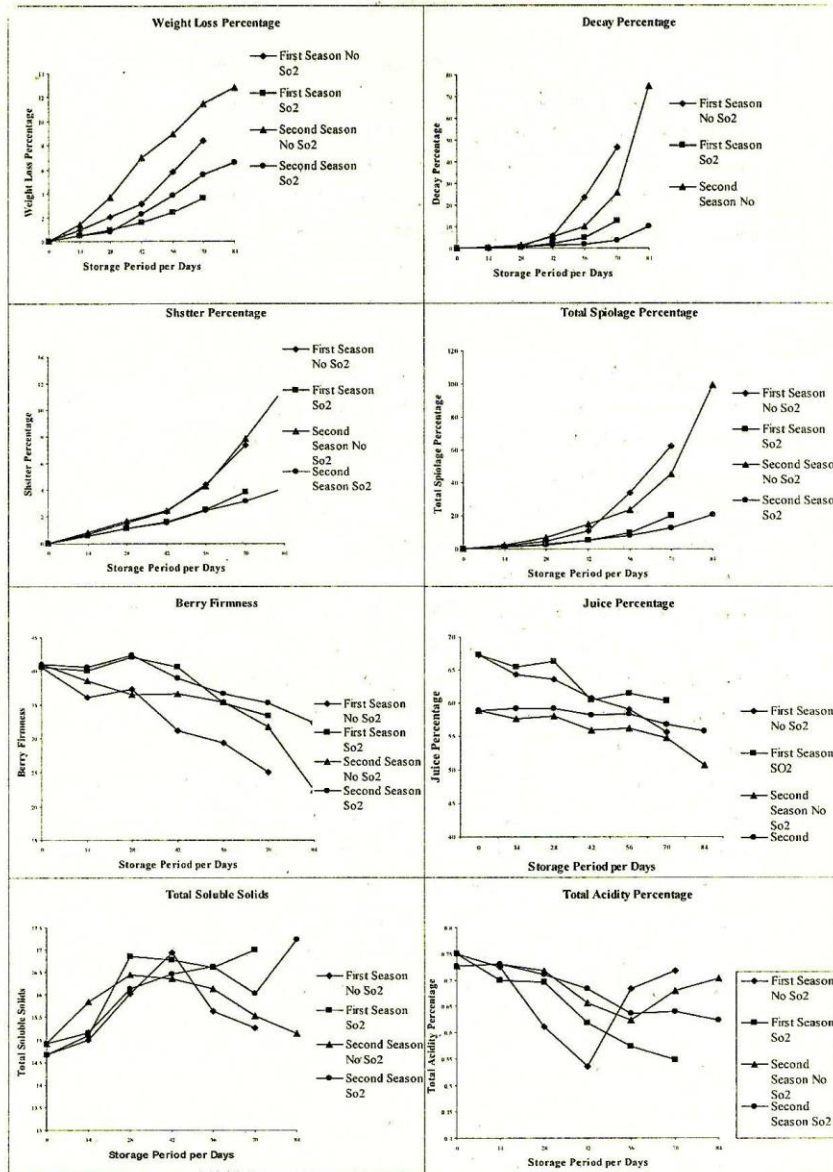


Figure 3. Effect of treatment with sulfur dioxide on properties of Superior grapes during storage at cold temperature (0°C) in 2003 and 2004.

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دراسات على اكتمال النمو والقدرة التخزينية للعنب سوبريور.

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اجرى هذا البحث خلال موسمى ٢٠٠٣ & ٢٠٠٤ بمعهد بحوث البساتين - قسم بحوث تداول الفاكهة. أخذت الثمار أسبوعيا ابتداء من النصف الثانى من شهر مايو وحتى الوصول الى مرحلة اكتمال النمو من مزرعة خاصة بطريق القاهرة الاسكندرية الصحراوي. وعند الوصول الى مرحلة اكتمال النمو اخذت عينات للتخزين حيث فرزت وعبئت فى عبوات كرتون سعة ٢ كجم مع التبطين بالبولي ايثيلين المنقب مع استخدام مولدات ثانى اكسيد الكبريت فى نصف العبوات وتم تخزين الثمار على درجة حرارة الغرفة لمدة ١٤ & ١٨ يوما فى الموسم الاول والثانى على التوالي وعلى درجة الصفر المئوى لمدة ٧٠ & ٨٤ يوما فى الموسم الاول والثانى على التوالي.

يمكن اعتبار الصنف سوبريور مكتمل النمو فى الاسبوع الثانى من شهر يونيو وذلك بعد خمسة و خمسون يوما من اكتمال العقد وعندها تكون نسبة المواد الصلبة الذائبة اكبر من ١٤,٨ % (استخدام كاسرات السكون هنا يكون ضروريا) ونسبة الحموضة الكلية اقل من ٠,٧٥% ونسبة المواد الصلبة الذائبة الى الحموضة اكبر من ٢٠ : ١ وكذلك تكون صلابة الحبات اقل من ٤٢ جرام / سم^٢ وكان اللون اقل من ١١٥ درجة ولما كانت الصفات الطبيعية يمكن ان تتأثر بالعمليات الزراعية فانها ليست على الدوام مناسبة للحكم على وصول ثمار العنب الى مرحلة اكتمال النمو .

ولقد تبين من الدراسة ان استخدام مولدات ثانى اكسيد الكبريت وبالمثل التخزين على درجة حرارة الصفر المئوى من العوامل الهامة فى زيادة القدرة التخزينية للعنب صنف سوبريور. ولقد تبين من الدراسة ان العنب سوبريور يمكن ان يخزن لمدة ٧ او ١٣ يوما على درجة حرارة الغرفة بدون او باستخدام مولدات ثانى اكسيد الكبريت وترتفع هذه الفترة لتصل الى ٣٥ & ٩٠ يوما فى حالة التخزين على درجة الصفر المئوى ودرجة حرارة الغرفة بدون او باستخدام مولدات ثانى اكسيد الكبريت على التوالي.