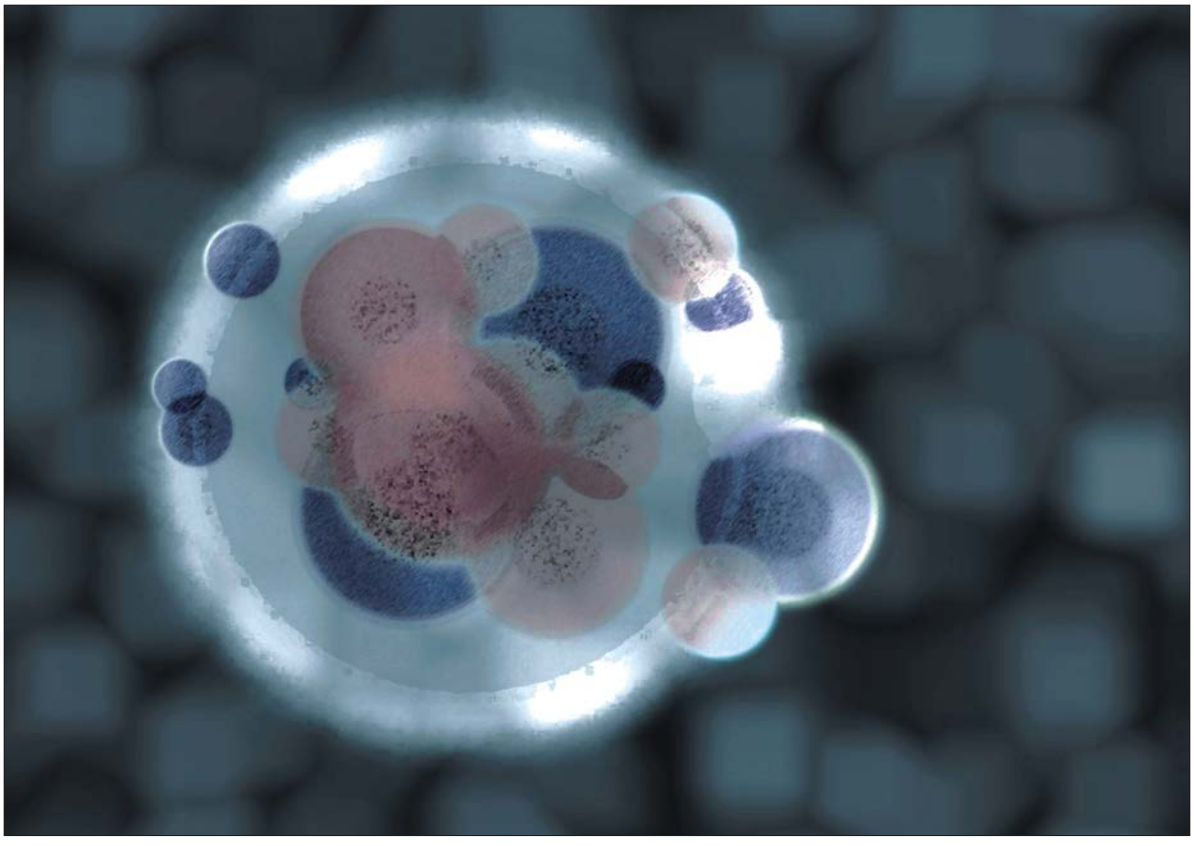

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Quality Properties Changing of Grape During Storage Period

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Abstract: The purposes of this research were to determine quality properties of the stored grape during storage period. In addition, temperatures and relative humidity of polyethylene bags used to place grapes and cold store were measured. Variety name of stored grape was Alphonse Lavalle. Storage temperatures were +3°C. Amount of soluble solid, titratable acidity, maturity index, decaying index and bunch colour were also determined and evaluated during the storage period. Soluble solid, titratable acidity of the stored grapes increased during the storage. If we would only evaluate decaying index for the quality of the grapes there was only one decayed bunch grape. Colour of the bunches was fresh green at the starting of the storage and then changed into matt green during the storage period. Distribution of the temperature and relative humidity in the cold stores and polyethylene bags were. Temperatures of the different places were not uniform in the cold store and were not same as set temperature of the cooling system because of the ventilation. There is only one ventilator to distribute the air and it is not enough for the uniform distribution of the air.

Key words: Cold storage, grape, quality properties

INTRODUCTION

Storage methods used to protect freshness of grapes are chemical protect, controlled atmosphere storage and cold storage. Cooling is the most active method to control maturity of vegetables and fruits in practice. Maturity of vegetables and fruits are the decaying caused by changing of chemical properties of agricultural products. Enzymes can cause chemical changing in organic matters. Chemical reaction is too slow at below 0°C.

Barlinka, Waltham Cross, Alphonse Lavallée, Red Emperor, Almeria, Hanepoot and Raisin Blanc were stored at 0°C in a medium that includes 20 ppm SO_2. Storage periods were 6 months for Berlinka Variety, 2-3 months for Alphonse Lavallée, Hanepoot and Raisin Blanc Variety and 4 months for Almeria Variety[1].

Soluble solid, amount of general acid, weight losses of the stored grapes, moisture content of bunch of grapes, decaying percentage and percentage of fading of grapes were determined during the storage[2].

The quality of table grapes was evaluated by chemical, physical and sensory analysis supplemented with investigation of the occurrence of undesirable microscopic fungi. Dynamics of the changes of evaluated traits was studied during the storage of samples in the storehouse with adjusted atmosphere. Storage affected the change of different parameters in different way as well as the change of the quality of evaluated samples. Sensory traits like taste, scent and texture decreased during storage. The storage reduced also the quality of instrumentally measured physical parameters-fixing ability of grape berries and firmness of grape skin. Based on the results of sensory and microbiological evaluation of the quality, the best pre-requisites for storage in this trial has been demonstrated by the cultivar Guzal Kar. The Cultivar Datchny seemed to be the less suitable for storage (Qualitative properties of stored new breeds of table grapes[3].

In this research; quality criteria of the stored grapes were periodically determined since starting time of the grape storage. In addition, temperatures and relative humidity of polyethylene bags used to place grapes were measure. Grapes were placed in polyethylene bags and then polyethylene bags were placed in the wooden boxes. Wooden boxes were putted in the cold store. Then required measurements such as ambiance temperature, ambiance relative humidity, quality properties of stored grapes were realized for each months.

MATERIALS AND METHODS

Dimensions of cold store were (length x width x height) 4.52 x 1.90 x 2.22 m. The volume of the cold store was 19.07 m^3. The cold store was made of reinforced

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Table 1: Properties of the Alphonse lavallee

Name	Alphonse lavalle
Synonym	Ribier, Enfes, Karatoplak
Principal growing districts	Marmara region, Turkey
Berry size	Very large (7-9 g)
Berry Number of seeds	3-4
Berry skin	Tough
Flavour	Neutral
Shape	Short conical, shouldered
Cluster compactness	Well filled
Cluster size	Large (500-600g)
Maturity time	Early midseason
Commercial use	Table grape

concrete and isolated by using Foamglass. Foamglasses were placed on the walls using an adhesive material produced as variety of asphalt. Then a coverage material formed of steel rush was placed on the wall surface to cover the foamglass. The steel rush material was covered with plaster. Finally ceramics were used to cover the wall. Foamglass was put on the ceiling of the cold store and then both surfaces were covered with cement. The floor of the cold store was covered with foamglass and ceramics. A compressor was located in the corridor. Natural air was used to cool the cold store. A condenser, a condenser ventilator, a fluid hopper and a drier were gathered as a group inside the compressor chassis. An evaporator was put on the ceiling of the cold storage with steel screws. Thermostatic expansion valve was fitted in the evaporator inlet and on the high pressure side of the compressor. A control panel, which includes a thermometer-thermostat, a manometer and a humidity gauge, was placed on the front wall of the cold store. The refrigerant was R404A.

Alphonse Lavallee grape variety was stored in this research. Some properties of this variety are given in Table 1[4].

Grapes were placed in polyethylene bags the size of which was 400 mm in width, 600 mm in length and thickness was 5 mm. The polyethylene bags placed in the wooden boxes. The wooden boxes were used to transport and to store grapes.

In addition, solid generator was put on the bunch of the grapes. The SO_2 solid generator pad contains 97.5% Sodium Meta-bisulphite ($Na_2S_2O_5$) and 2.5% inert ingredients in 24 pockets. There are two sides of the pads. Brown side should be put on the food and the other side, which contains explanations with a different colour, should beat the top[5].

Measurement limits of the temperature sensors ranged between -20°C and +100°C. Accuracy of the temperature sensor was ±1%. Measurement limits of the humidity sensors ranged between 0°C and +95°C. Accuracy of the humidity sensor was ±5%.

Grapes were stored at +3°C in the cold store. Temperature of the cold store was set as 3°C. Water was spread by hand on the floor of the cold store to control humidity for both of them. Temperature was controlled by the cooling system.

Inside temperatures and relative humidity of polyethylene bags and around the wooden boxes of which polyethylene bags were placed in were measured at the same time for each month during storage period. 9 wooden boxes were used to put polyethylene bags used for putting the grapes in. In addition, grapes of 200g were taken for each measurement.

Polyethylene bags were placed in the wooden boxes. 4 temperature and 4 humidity sensors were used to measure temperatures and relative humidity of the different places of the cold store. Three of these sensors were placed in the polyethylene bags and the other was placed in the cold room. The wooden boxes used for measurements were chosen from different level, such as top, middle and bottom Temperature and humidity measurements were done at the same time for polyethylene boxes and the cold room. The results of the temperatures and relative humidity were evaluated by using mean, standard deviation and correlation coefficient. Changing of the temperature and humidity results were given in tables.

Quality properties of the stored grapes were also measured during storage period for each month. These properties were total amount of soluble solid, titratable acidity, maturity index, decaying index and bunch colour[5]. Soluble solid, titratable acidity, maturity index, decaying index and colour index of grape clusters were determined by using following methodology.

Mean, standard deviation (SD) and coefficient of variation were used for evaluation of the results[6,7]. All data were evaluated by using this statistical method except decaying index an colour index of the bunch. Decaying and bunch colour indexes were evaluated by mean, differences between first and last values.

Soluble solid (%): Prepared by chopping fruits into pieces; fruit puree was filtered by using muslin. Then the amount of the soluble solid of the filtered fruit puree were measured as percentage of total with the hand refractometer. This value was corrected due to 20°C[8-10].

Some grape juice was spread drop by drop on the glass of the refractometer. Device was directed to diffuse light. The score, which was placed between light and dark side on the glass, was read from the ocular arranged according to the eyes. Accuracy of this system was 0.1%[11].

Titratable acid: Amount of sample was 10 ml. 20-30 ml pure water was added into sample. Sample was mixed with 0.1 normal NaOH until pH is achieved 8.0. Titratable acidity was calculated by using Eq.1[10,11].

$$A = (S.N.F.E/C) * 100 \quad (1)$$

A: Amount of titratable acidity (g -100 ml^{-1})
S: Amount of NaOH (ml)
N: Normality of NaOH (0.1N)
F: Factor for NaOH
E: Equivalence value of acid (for Tartaric Acid 0.0075 g)
C: Amount of filtered fruit sample (ml)

Determination of the maturity index: Maturity index was calculated by using following equation (Karaçali, 1993);

$$MI = SS/TA \quad (2)$$

M = Maturity index of the grape
SS = Percentage of the soluble solid of the grapes
TA = Percentage of the titratable acidity of the grape

Decaying index: First of all, number of decayed grapes and faded grapes were counted for each bunch. The decaying index was calculated by using Eq.2. Bunches, its number was 9, were used to determine decayed grape for each observation[12].

$$DI = (si+2md+4hi)/10 \quad (3)$$

DI = Decaying Index (Maximum value is 40)
si = Percentage of bunch which includes 1-2 number grapes decayed and bleached
md = Percentage of bunch which includes 3-5 number grapes decayed and bleached
hi = Percentage of bunch which includes more than 5 grapes decayed and bleached

Determination of colour of bunch: Changing of colour in the stem and bunch of grapes were determined by using. The Wilson Horticultural Colour Chart[12]. According to this chart:

0 = Fresh, bright green
1 = Green
2 = Matt green
3 = Green-light brown
4 = Brown
5 = Brown close to dark grey+dried

RESULTS AND DISCUSSION

Temperatures and relative humidity of cold stores: Temperature and relative humidity of the cold stores were given in Table 2 and Table 3, respectively.

The results were measured when the cooling system temperature sensors showed 3°C. The aim of the cooling system is to protect temperature at the same degree for every place of the cold store. According to the temperature results; temperatures changed between 2.6°C and 4.6°C. There was another temperature sensor to set and to measure cold store temperature in the cold stores.

Relative humidity of the cold stores changed between 78.4 and 98.7%. There was not any automatic controlled system to control humidity in these two cold stores. Variability was not too much compared to the temperature.

All results showed that the control of the temperature and humidity require more measurement from different places to get reliable data to protect the product. The temperature of the cold store was set 3°C. But the distribution of the cold store temperature was not at level at different places of the cold store.

Temperatures and relative humidity of polyethylene bags: Temperature change of the polyethylene bags which were used to store grapes were given in Table 4 and Table 5 for two cold stores.

According to the results; inside temperatures of the polyethylene bags changed between 3.3°C and 5.9°C during the storage period. There is no homogeneity for the inside temperatures of the bags and the values were too much than the desired temperatures.

The relative humidity of the polyethylene bags changed between 79.7 and 98.5%. It was acceptable for the storage of the grapes.

Quality properties of the stored grapes: Total soluble solid of stored grapes for the storage period were given in Table 6. When the results were evaluated; Minimum value of the total soluble solid was 14.60% and maximum value was 17.20%. Differences between first and last day was -0,13. Results of the titratable acidity of the stored grape were given in Table 7.

According to the results; Minimum value of the total soluble solid was 0.37% and maximum value was 0.45%. Differences between first and last day was 0.06. Titratable acidity of the stored grapes a little beat increased during the storage

Maturity index was calculated by using these values. Consequently, maturity index showed the same behaviour (Table 8).

Table 2: Changing of temperature (°C) in the cold store

	Temperature measurements (Replications)						
	1	2	3	4	Mean (°C)	SD (°C)	CV (%)
At first day	3.1	4.6	3.3	3.5	3.6	0.7	18.5
1 month later	2.9	3.0	3.6	3.7	3.4	0.4	12.8
2 month later	3.1	3.1	2.6	2.8	2.9	0.2	8.4
Mean (°C)	3.0	3.9	3.2	3.3	3.3		
SD (°C)	0.1	1.1	0.5	0.5	0.3		
CV (%)	3.8	27.5	16.2	14.2	9.2		

Table 3: Changing of relative humidity in the cold store (%)

	Temperature measurements (Replications)						
	1	2	3	4	Mean (°C)	SD (°C)	CV (%)
At first day	85.6	78.4	89.5	91.2	86.2	5.69	6.60
1 month later	97.7	98.6	98.7	95.7	97.7	1.39	1.42
2 month later	93.1	90.7	94.8	92.8	92.9	1.68	1.81
Mean (%)	92.1	89.2	94.3	93.2	92.2		
SD (%)	6.1	10.2	4.6	2.3	4.7		
CV (%)	6.6	11.4	4.9	2.4	5.1		

Table 4: Inside temperature (°C) of the polyethylene grape bags

	Replications					
	1	2	3	Mean (°C)	SD (°C)	CV (%)
At first day	4.2	5.2	5.9	5.10	0.85	16.75
1 month later	3.3	4.6	4.8	4.23	0.81	19.24
2 month later	4.5	4.8	5.4	4.90	0.46	9.35
Mean (°C)	4.00	4.87	5.37	4.74		
SD (°C)	0.62	0.31	0.55	0.45		
CV (%)	15.61	6.28	10.26	9.56		

Table 5: Inside relative humidity (%) of the polyethylene grape bags

	Replications					
	1	2	3	Mean (°C)	SD (°C)	CV (%)
At first day	97.00	79.70	95.70	90.80	9.63	10.61
1 month later	79.50	92.10	92.90	88.17	7.52	8.52
2 month later	92.90	93.00	98.50	94.80	3.20	3.38
Mean (°C)	89.80	88.27	95.70	91.26		
SD (°C)	9.15	7.43	2.80	3.34		
CV (%)	10.19	8.42	2.93	3.66		

Table 6: Amount of the total soluble solid of the stored grape (%)

	Replications					
	1	2	3	Mean	SD	CV
At First day	16.00	16.00	16.00	16.00	0.00	0.00
1 month later	15.30	15.80	14.60	15.23	0.60	3.96
2 months later	17.20	15.40	15.00	15.87	1.17	7.39
Differences (%)	1.20	-0.60	-1.00	-0.13	1.17	
Mean	16.17	15.73	15.20	15.70		
SD	0.96	0.31	0.72	0.41		
CV (%)	5.94	1.94	4.74	2.61		

Table 7: Amount of the titratable acidity (%) of the stored grape

	Replications					
	1	2	3	Mean (%)	SD	CV
At First day	0.39	0.39	0.39	0.39	0.00	0.00
1 month later	0.37	0.40	0.40	0.39	0.02	4.44
2 months later	0.45	0.45	0.45	0.45	0.00	0.00
Differences (%)	0.06	0.06	0.06	0.06	0.00	
Mean (%)	0.40	0.41	0.41	0.41		
SD	0.04	0.03	0.03	0.03		
CV (%)	10.32	7.78	7.78	8.45		

Table 8: Maturity index of the stored grape

	Replications					
	1	2	3	Mean (%)	SD	CV
At First day	41.00	41.00	41.00	41.00	0.00	0.00
1 month later	41.40	39.50	36.50	39.13	2.47	6.31
2 months later	38.20	34.20	33.30	35.23	2.61	7.40
Differences (%)	-2.80	-6.80	-7.70	-5.77	2.61	
Mean (%)	40.20	38.23	36.93	38.46		
SD	1.74	3.57	3.87	2.94		
CV (%)	4.34	9.34	10.47	7.65		

Table 9: Decaying index of the stored grapes

	Decaying Index			
Measurement time	1-2	3-5	>5	Mean
At First day	0	0	0	0
1 month later	0.01	0	0	0.003
2 months later	0.01	0	0	0.003

Table 10: Colour codes of the stored grape bunches

Storage time	Bunch number									
(month)	1	2	3	4	5	6	7	8	9	Number of the bunch sample
At first day	0	0	0	0	0	0	0	0	0	9
	0	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	0	
1 month later	1	1	2	1	1	2	1	2	1	9
	1	1	1	1	1	1	1	1	1	
	1	1	1	1	1	1	1	1	1	
2 months later	2	2	1	2	2	3	3	2	2	9
	1	2	1	2	1	3	2	3	3	
	1	1	2	2	1	1	1	1	1	

Soluble solid and the titratable acidity of the stored grapes increased during the storage. As it is known, when fruits stored moisture of the stored products decreases during the storage period and consequently titratable acidity and soluble solid amount of the stored product increase.

According to the results; Minimum value of the total soluble solid was 33.3 and maksimum value was 41.4. Differences between first and last day was -5.8. Its means situation of the grapes at the first storage day was protected by cold store. Decaying index of the stored grapes was given in Table 9.

According to the results; if the quality of the grapes would be evaluated only from the aspect of decaying index, it could be seen that there was only one bunch including decayed grapes. It is showing that the packaging and storage was good enough to protect the grapes. Changing of the colour of the bunch were given in Table 10.

The colour of the bunch changed from fresh green to matt green during the storage of the grapes. The colour changing of bunches were acceptable.

Product must make respiration to protect their liveliness. The product takes into O_2 and release out Carbon dioxide (CO_2). When a product stored, gas changing was realized by diffusion of gases by the help of intercellular area. Firstly, Oxygen is used for oxidation

of soluble Carbohydrates. The oxidation of soluble Carbohydrates produces Carbon dioxide (CO_2) and water (H_20). Heat is released. Small part of the heat is used for chemical reactions. Most part of this heat distributes around and consequently it causes to heat the product and their surround. Respiration speed of the product gets increased and temperature of the polyethylene bags increase and contrary relative humidity decreases caused to increase transpiration speed[10].

Temperature variation of the cold store was not good because of the ventilation. There should be another ventilator to improve distribution of the cold air in the cold stores.

There are not humidity control systems in the cold stores in Turkey because prize of the humidity controlling systems are too high. In this research, traditional method was used to add water in the air. Three sacks were distributed on the floor and water scattered on these sacks regularly. But the results showed that this method can be accepted to humidify cold stores despite the disadvantages such as irregular distribution.

All results showed that the distribution of the temperatures and relative humidity of the cold store and polyethylene packages used to place grapes were not good but packages of the stored grapes were good and these packages protected the grapes from decaying because grapes were stored in a polyethylene packages with a regulator in the wooden boxes. The distribution of the temperatures and relative humidity may be improved by using perfect ventilation systems. Further research should be carried out and different products should be used to clarify effect of distribution temperature and humidity on the quality properties.

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