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RESEARCH PAPER

Reducing the Losses of Three Local Grape Varieties (*Vitis vinifera* L.) by Cool Storage Period.

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A B S T R A C T:

Three local varieties of grapevine (*Vitis vinifera* L. Jnoby, Sulaimana- Rash and Zaitony); were taken from a private vineyard in Sian village, Dinarta, Duhok, Kurdistan region-Iraq after the distinctive signs of maturity appeared for each variety from healthy grapevines of 6-years old which planted at 2×3 m spacing and irrigated by drip irrigation system for study the effect of storage periods (0, 20, 40 and 60 days at 2±1 °C and 83-88% RH) on chemical and physical characteristics plus the loss of grape berries and clusters. The vines received conventional cultivation practices with regular winter and summer pruning, weed and diseases control. Berry shattering, spoilage, weight loss, total loss and rachis condition for the varieties were estimated as a function to storage in this study. Results showed that the maximum berry shattering (1.71%) was recorded in Sulaimana-Rash variety showing a significant difference with Jnoby variety (0.48%). The highest values of percent spoilage and total loss were recorded in variety Zaitony (20.17 and 26.36%) respectively. The maximum weight loss (10.24 %) was recorded in variety Jnoby which was significantly higher than the other two varieties (Sulaimana-Rash and Zaitony). Spoilage percentage, weight loss and total loss significantly increased with increasing storage periods (23.48, 12.13 and 32.83%) respectively. There were significant interaction effects on weight loss and total weight loss percentages among the varieties, the storage periods showed a maximum value was started after 60 days of the beginning of storage (14.33%) in Jnoby variety, while highest total loss (60.25%) was recorded in Zaitony.

KEY WORDS: Table grape, cluster, storage, weight loss, Local variety
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1. INTRODUCTION:

Table grape varieties (*Vitis vinifera* L.) are non-climacteric fruits with a relatively low rate of physiological activity, rapid moisture loss results in rachis (cluster stem) drying and browning, mass loss, berry shatter and wilting (Crisosto et al., 2002), which reduces the visual appeal and price of the product. Preparing storage is needed to extend the marketing period of the horticultural crops because the harvesting season for most of horticultural crops is relatively short. Different storage methods are already in use, one of the common storage methods is air-cooled storage house; cold storage is another type of storing horticultural products.

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Grapes should harvest when they are fully ripe, have the right size and the right color. Chilling injury's occurrence and severity are determined by storage temperature, storage length, and va riety. The cold storage capacity of table grape cultivars varies, ranging from 5 to 10 weeks (Ginsburg, 1965).

The vulnerability of a cultivar to quality problems during cold storage determines its storage potential. A variety's storage potential is determined by its susceptibility to quality defects during cold storage. Physiological problems, fruit rot, and desiccation are examples of these flaws. Decay excluded, berry split and berry abscission are the primary disorders which shorten the storage potential of varieties.

The main quality problems include severe postharvest losses during storage and long distance transport quantitative and quality losses (Lichter *et al*., 2011 and Ngcobo *et al*., 2013). Interdisciplinary studies gained great advances in postharvest technology for long-term storage of table grapes to achieve a better balance between supply and demand in table grape industry. In spite of the financial significance of grapes in Iraq and Kurdistan locale generation has not been coordinated with recharging of promoting forms such as sorting, transportation and capacity. However, there has been recent interest in grape storage although data on storage conditions can only be derived from studies performed outside the country. Therefore, this research aimed to fill a gap in the knowledge by generating primary data on losses and reducing it at critical steps in the supply chain (storage) for three local table grape varieties "Jnoby, Sulaimana-Rash and Zaitony stored at 2± 1 ˚C for different periods.

2. MATERIALS AND METHODS

The clusters of three local varieties of table grape (*Vitis vinifera* L.) cvs 'Jnoby, Sulaimana-Rash and Zaitony' (Table 1) were taken from a private vineyard at Sian village, Dinarta, Duhok, Kurdistan region, after the distinctive signs of maturity appeared for each three variety on August, 11 to 31, 2021. Only uniform commercially ripe clusters those had free from any visible pathogen infection were picked randomly by hand from healthy grapevines of 6-years old which planted at 2×3 m spacing and irrigated by drip irrigation system. The vines received conventional cultivation practice with regular winter and summer pruning, weed and diseases control.

After harvesting, the clusters were manually put in plastic boxes (50 x 30 x 15 cm), and selected to obtain homogeneous batches based on colour, size, free of damage, health and greenish rachises, transported to laboratory of Horticulture Department, College of Agricultural Engineering Sciences, University of Salahaddin-Erbil. On the same day of harvesting, decayed, overripe, wilted injured and damaged berries with dull appearance and/or had quality defects were isolated or removed by a shear. After that, the clusters of each variety were randomly divided into three lots for being used as replicates in different storage periods, plus one additional lot for weight loss determination during storage periods, with three replicates. From each fruit lot, according to total soluble solids% evaluation, it was remained about 9 kg grape berries in each lot. Clusters were packed in white perforated polyethylene bags (with 12 holes of 5 mm diameter), each bag contained 1 kg of grape and represented a replicate. Finally, the bags were stored in cold storage at 2±1 °C and 83-88% RH for 0, 20, 40 and 60 days.

2.1 Statistical analysis

The experiment was carried out according to a Factorial Complete Randomized Design (CRD), including two factors (3 varieties and 4 storage periods) with three replicates. The data was analyzed using the SAS statistical tool (SAS, 2003), and when distinction is made, the means were suitably isolated and mean values were examined using Duncan's Multiple Range Test at P≤0.05 according to (Mead et al., 2017).

Table (1) Cluster and berry characteristics of three grape varieties

Characteristics	Varieties		
	Jnoby	**Sulaimana-Rash**	**Zaitony**
(Clusters)			
Length (cm)	18	20	16
Width (cm)	14.5	15.5	12
Weight (g)	512	530	635
(Berries)			
Length (mm)	22.3	19.5	25.0
Width (mm)	19	19.5	18.3
Weight of 100 berries (g)	434	530	527

Size of 100 berries (cm^3)	380	526	498
No. seeds	1	3	3
Color	Yellow	Medium red	Dark red

2.2 Fruit quality measurements

Evaluation of chemical parameters and other fruit quality attributes were made before storage (0 day) and after (20, 40 and 60 days) of storage. Chemical properties were determined in a sample of juice taken from fifteen berries selected randomly within each replicate, the berries were extracted using a manual juice extractor, then the juice was used for determination of total soluble solids (TSS%). Total sugars% was measured using a digital hand-held refractometer with automated temperature compensation (Atago PAL-3, Tokyo, Japan) and the results were expressed as percentage (Sen and Metin, 2014). Titratable acidity (TA %) was determined by the titration of 10 ml of juice with 0.1 N NaOH until achieving the neutralization of the organic acids to pH 8.2-8.3 The results were expressed as percentage of tartaric acid equivalents (Munoz-Robredo *et al*., 2011). Berry shattering %, berry spoilage %, weight loss %, total loss in weight and stem browning (Rachis condition) were measured after storage of 20, 40 and 60 days (Samra *et al*., 2014 and Khezrzadeh *et al.*, 2013).

2.2.1Shattering%

It was determined by weighting the berries per replicate which loosed from cap stem after moderate shaking and then percent berry shatter was estimated as follows:

$$\text{Shatter \%} = \frac{\text{Weight of berry shatter}}{\text{Initial clusters weight}} \times 100$$

2.2.2 Spoilage%

It was determined by weighting the spoiled berries for each replicate during each storage period and then estimated by using the initial weight of clusters.

$$\text{Berry spoilage\%} = \frac{\text{Weight of spoiled berries}}{\text{Initial clusters weight}} \times 100$$

2.2.3 Weight loss (%)

It was determined according to (Khezrzadeh *et al*., 2013) as follow:

$$\text{Weight loss (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weght}} \times 100$$

2.2.4 Total loss in weight (%)

It was calculated as follow:

$$\text{Total loss in weight} = \frac{(100\text{-weight loss}) * (100\text{- Spoilage})}{100} - 100$$

2.2.5 Rachis condition

After 20, 40 and 60 days of storage, rachis visual quality was evaluated to quantify the symptoms of dehydration, browning for primary and secondary branches, slight occurrence, moderate, severe, and extremely severe browning on a ranked absence of these symptom, slight occurrence, moderate, severe, and extremely severe browning and dehydration (Valverde *et al*., 2005).

Table grape rachis and berry color and appearance were determined after cooling during the cold storage period. Stem browning were evaluated using the following scoring system: healthy = Entire stem including the cap stems (merging point between berries and rachis) green and healthy; slight = only cap stems showing browning; moderate = cap stems and secondary stems showing browning; and severe = cap stems, secondary stems and primary stems completely brown.

3. RESULTS AND DISCUSSION

3.1 Effect of grape cultivars, storage period and their interactions on the chemical characteristics of berry juice:

Table (2) showed that TSS and Total sugar among varieties are not significantly different, while TA was the highest in Jnoby which was (0.36 %).

Table (2) Effect of grape variety on the chemical characteristics of berry juice*.

Varieties	Parameters (%)		
	TSS	TA	Total sugars
Jnoby	17.82 a	0.36 a	16.62 a
Sulaimana-Rash	16.84 a	0.31 b	16.24 a
Zaitony	17.64 a	0.31 a b	16.53 a

*Values within each column followed by the same letter are not significantly different from each other according to Duncan's Multiple Range Test (P≤0.05).

During storage period, each of TSS, TA and Total sugar contents were measured after each storage period; table (3) showed no significant differences between storage periods after 60 days of being stored, indicating that the storage period did not affect the titratable acidity of the fruit.
The effect of the interaction among varieties and storage periods was various as shown in (Table 4). TSS, TA and Total sugar values showed that the interaction between Zaitony variety and 60 days for storage caused an increases in the percentages of TSS and Total sugar (19.67 and 18.70 %) respectively, Rusjan (2010) found increase in sugar contents due to water loss in 'Cardinal' grapes during storage
The statistical differences between the interactions for TA were reached intrusive to the point of significant, in Jnoby variety stored for 0 days it was (0.36 %), which was not significantly difference with the same variety stored for 20 days.

Table (3) Effect of storage periods on the chemical characteristics of berry juice*.

Storage Periods (days)	Parameters %		
	TSS	TA	Total sugars
0	17.43 a	0.32 a	16.46 a
20	17.04 a	0.33 a	16.72 a
40	17.39 a	0.32 a	16.27 a
60	17.88 a	0.31 a	16.76 a

*Values within each column followed by the same letter are not significantly different from each other according to Duncan's Multiple Range Test (P≤0.05).

Maturity of the fruit at harvest is equivalent to that of the fruit when it reaches the consumer, acid concentration generally decreases, grape berries are non-climacteric fruits, meaning that TSS and sugar content did not change once they have been harvested. Acid concentration generally decreases during maturation of most fruits as a result of respiration (Gil, 2012).

Table (4) Effect of interaction between variety and storage periods on the chemical characteristics of berry juice*.

Varieties	Storage Periods (days)	Parameters %		
		TSS	TA	Total sugars
Jnoby	**0**	17.82 bc	0.36 a	16.72 bc
	20	17.80 bc	0.35 a	16.53 bc
	40	17.80 bc	0.33 b	16.60 bc
	60	17.87 bc	0.30 c	16.73 bc
Sulaimana-Rash	**0**	16.27 de	0.32 b	16.10 d
	20	16.67 d	0.34 ab	16.17 d
	40	17.77 bc	0.33 b	17.39 b
	60	18.77 ab	0.33 b	18.13 ab
Zaitony	**0**	17.64 bc	0.31 bc	16.53 bc
	20	17.67 bc	0.29 c	16.47 bc
	40	16.60 d	0.23 d	15.43 d
	60	19.67 a	0.28 c	18.70 a

*Values within each column followed by the same letter are not significantly different from each other according to Duncan's Multiple Range Test at (P≤0.05).

3.2 Effect of grape Varieties, storage period and their interactions on physical characteristics of cluster:

The results obtained in table (5) showed that the minimum berry shattering (0.4%) was recorded in Jnoby variety with the significant difference compared to highest value in Sulaimana-Rash variety (1.71%). The highest percent of spoilage and total loss percentages were recorded in the variety Zaitony (20.17 and 26.36%), respectively. The lowest percent of weight loss was recorded in Sulaimana-Rash and Zaitony variety (7.82, 8.44%) respectively, while the maximum weight loss (10.24%) was recorded in the variety Jnoby which was significantly higher.

Table (5) Effect of grape variety on physical characteristics of cluster*.

Varieties	Parameters				
	Berry shattering %	Spoilage %	Weight Loss %	Total loss %	Rachis condition
Jnoby	0.48 b	2.25 b	10.24 a	15.90 b	Severe
Sulaimana-Rash	1.71 a	6.46 ab	7.82 b	9.86 c	Severe
Zaitony	1.15 ab	20.17 a	8.44 b	26.36 a	Severe

*Values within each column followed by the same letter are not significantly different from each other according to Duncan's Multiple Range Test (P≤0.05).

The results are shown in table (6) indicate that was no statistically significant differences in berry shattering between storage periods, however, there were increases in spoilage percentage, weight loss and total loss with increasing storage periods except in mid storage period for spoilage percent (23.48, 12.13 and 32.83%) respectively. Table (6) shows the average data during three storage periods indicating that there were no negative effects on rachis browning.

Table (6) Effect of storage periods on the physical characteristics of cluster*.

Storage Periods (days)	Parameters				
	Berry Shattering %	Spoilage%	Weight loss %	Total loss %	Rachis condition
20	0.75a	0.65 b	5.46 c	6.06 c	Severe
40	0.85 a	4.77 b	8.93 b	13.23 b	Severe
60	1.74 a	23.48 a	12.13 a	32.83 a	Severe

*Values within each column followed by the same letter are not significantly different from each other according to Duncan's Multiple Range Test (P≤0.05).

In all interactions among varieties and storage periods (Table 7), berry shattering records showed no significant differences, except in the variety Sulaimana-Rash that stored for 60 days (3.78%). Spoilage percentages of all three varieties stored for three storage periods showed no significant interaction effects between varieties and storage periods for all interactions except in Zaitony variety and storage for 60 days (55.55%). There was significant interaction effects on weight loss and total weight loss percentage among varieties and storage periods (Table 7), these interactions showed a maximum value in the variety Jnoby stored for 60 days (14.33%), while the highest total loss percentage (60.25%) was recorded in the variety Zaitony.

Table (7) Effect of interaction between variety and storage periods on the Physical characteristics of cluster*.

Varieties	Storage Periods (days)	Parameters				
		Berry Shattering %	Spoilage %	Weight Loss %	Total Loss %	Rachis condition
Jnoby	20	0.56 b	1.19 b	6.01 ed	7.12 cd	Moderate
	40	0.80 b	7.67 b	10.40 bc	17.24 bc	Severe
	60	0.07b	10.53 b	14.33 a	23.35 b	Slight
Sulaimana-Rash	20	0.50 b	0.29 b	4.46 e	4.74 d	Severe
	40	0.85 b	2.11 b	8.02 cd	9.96 cd	Severe
	60	3.78 a	4.36 b	11.00 b	14.88 bcd	Severe

Zaitony	**20**	1.18 b	0.46 b	5.90 ed	6.33 d	Severe
	40	0.90 b	4.52 b	8.37 bcd	12.50 cd	Severe
	60	1.36 b	55.55 a	11.06 b	60.25a	Severe

*Values within each column followed by the same letter are not significantly different from each other according to Duncan's Multiple Range Test (P≤0.05).

The three table grape varieties which were used in this study are all from the same geographical location, but they are different in many aspects i.e.; seed content, fruit color, sugar level, berry size and many other uncharacterized traits. While traits like fruit color could be readily associated with the genetic makeup of the variety, the propensity of rachis to undergo browning during storage could not be defined as a variety characteristic, simply because until now there was no systematic characterization of rachis browning.

The storage life of table grapes is influenced by the pre-harvest ecological conditions, fruit maturity at harvest and pre-cooling and storage conditions, including the temperature and relative humidity during post-harvest handling (Crisosto and Smilanick, 2004; Sen *et al*., 2012). Weight loss, stem browning, weakening, fracturing, and rot are all signs of grape deterioration during storage (Crisosto *et al*., 2001). Grape degeneration after harvest can be caused by physical, physiological, or pathological reasons in the vineyard (pre-harvest) or after harvest (Zoffoli *et al*., 2009). Table grapes tend to senesce and deteriorate during postharvest handling, which limits their market life (Crisosto and Mitchell, 2002). Weight loss and rachis senescence are signs of quality decline in grape clusters, grape shatter, fruit softening, undesirable color changes in the grape or rachis, and the development of fungal rot (Daudt and Fogaça, 2013).

The shelf-life of berries was measured by counting the number of days the berries stayed in acceptable condition during storage. Moisture loss from the fruits is a severe concern, as it reduces visual quality and adds to the loss of turgor pressure, which leads to softening (Vander-Beng, 1981).

4. CONCLUSIONS

In general, this study showed that interaction between varieties and storage periods did not have a positive effect on reducing rachis browning, except 'Jnoby' which had less browning after storage. Rachis browning corresponds to a postharvest disorder that drastically reduces overall table grape quality. This problem has been associated mainly to water loss, but the possibility of having other factors involved like green pigment degradation and brownish compound synthesis that mask the green tissue is also feasible. Rachis metabolism is an important issue to address to understand the loss of quality post-harvest. As has been shown in the previous study (Lichter *et al*., 2011), prevention of rachis browning by prevention of weight loss was significant and consistent among all varieties during storage, this can be explained by prevention of the additional water loss occurring during cold storage. Susceptibility to postharvest spoilage development is variety dependent, with red varieties tending to be more susceptible than yellow varieties giving similar vineyard management factors and harvest maturity.

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References

DAUDT, C. E., & FOGAÇA, A. O. 2013. Phenolic compounds in Merlot wines from two wine regions of Rio Grande do Sul, Brazil. Food Science and Technology (Campinas), 33(2), pp. 355-361. .

CRISOSTO, C.H.; SMILANICK, J.L.; DOKOOZLIAN, N.K. 2001. Table grapes suffer water loss, stem browning during cooling delays. *Calif. Agric.* 55(1), pp. 38-42.

CRISOSTO, C.H.; GARNER, D.; CRISOSTO, G. 2002.Carbon dioxide-enriched atmospheres during cold storage limit losses from Botrytis but accelerate rachis browning of 'Red Globe' table grapes. *Postharvest Biol. Technol.* 26(2), pp. 181-189.

CRISOSTO, C. H., & MITCHELL, F. G. 2002. Postharvest handling systems: table grapes. In: A. A. Kader (Ed.), Postharvest technology of horticultural crops. Agricultural and Natural Resources Publication, No. 3311, pp. 357-363.

CRISOSTO, C. H., & SMILANICK, J. L. 2004. Grape (Table). In: K. C. Gross, C. Yi Wang & M. Saltveit (Eds.). The commercial storage of fruits, vegetables and florist and nursery stocks. Agricultural Handbook, No. 66, pp. 287-290.

Gil, G. 2012. Fruticultura: Madurez de la fruta y manejo postcosecha: frutas de climas templado y subtropical. 3rd ed. Santiago, Chile. Ediciones UC. 493 pp.

GINSBURG, L. 1965. Recommended storage temperatures, percentage relative humidities and storage life for fruit and vegetables. Decid. Fruit Grower 15, pp. 80-86.

LICHTER, A.; KAPLUNOV, T.; ZUTAHY, Y.; DAUS, A.; ALCHANATIS, V.; OSTROVSKY, V.; LURIE, S. 2011. Physical and visual properties of grape rachis as affected by water vapour pressure deficit. *Postharvest Biol. Technol*. 59, pp. 25–33.

KHEZRZADEH, K.; H. D. BANEH; A.HASSANI; R. ABDULLAHI AND R. SAEDYAN. 2013. Effect of sulfur pads and ammi plant essential oil on storage life of grapevine (*Vitis vinefera*) cv. Rasha. *International Journal of Agriculture and Crop Sciences*. Vol. ,5(20), pp.

MEAD, R., CURNOW, R. N., & HASTED, A. M. 2017. Statistical methods in agriculture and experimental

MUNOZ-ROBREDO, P.; P. ROBLEDO; D. MANRIQUEZ; R. MOLINA AND B. G. DEFILIPPI. 2011. Characterization of sugars and organic acids in commercial varieties of table grapes. *Chilean journal of agricultural research*. vol., 71(3), pp. 451-458.

NGCOBO, M.E.K.; DELELE, M.A.; OPARA, U.L.; MEYER, C.J. 2013. Performance of multipackaging for table grapes based on airflow, cooling rates and fruit quality. J. *Food Eng*.116, pp. 613–621.

Rusjan, D.2010. Impacts of gibberellin (GA3) on sensorial quality and storability of table grape (Vitis vinifera L.) *Acta agriculturae Slovenica* 95 - 2, pp. 163 - 173.

SAMRA, B. N.; M. A. NAGATY AND A. I. FAHMI. 2014. Storage studies on clusters of Taify table grape. *Life Science Journal*. Vol. 11(3), pp. 319-326.

SAS Institute. 2003. Statistical Analysis System Procedures Guice, Ver. 9, 3rd ed. Institute Inc. Cary

SEN, F. AND METIN,KESGIN. 2014. Effect of different covering materials used during the pre-harvest stage on the quality and storage life of 'Sultana Seedless' grapes. *Food Science and Technology*. Vol., 34(4), pp. 787-792.

SEN, F., ALTUN, A., KESGIN, M., & INAN, M. S. 2012. Effect of different shading practices used in the pre-harvest stage on quality and storage life of sultana seedless grapes. J*ournal of Agricultural Science and Technology* B, 2, pp. 1234-1240.

VALVERDE, J.M.; VALERO, D.; MARTÍNEZ ROMERO, D.; GUILLÉN, F.; CASTILLO, S.; SERRANO, M. 2005. Novel edible coating based on aloe vera gel to maintain table grape quality and safety. *J. Agric. Food Chem*. 53, 7807−7813.

VANDER- BENG, L. 1981. The role of humidity, temperature and atmospheric composition in maintaining vegetable quality during storage. ACS Symp. Ser, pp. 170: 95.

ZOFFOLI, J. P., LATORRE, B. A., & NARANJO, P. 2009. Preharvest applications of growth regulators and their effect on postharvest quality of table grapes during cold storage. *Postharvest Biology and Technology*, 51(2), pp. 183-192.