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Evaluation of Ethanol and Sulfur Dioxide Pad Effects on Quality Parameters of Stored Table Grapes

OKAN ÖZKAYA*, OMUR DUNDAR and AHMET ERHAN ÖZDEMIR†
Department of Horticulture, Faculty of Agriculture, Cukurova University
01330-Balcali, Adana, Turkey
Tel: (90)(532)4383839; E-mail: okanozkaya@yahoo.com

Postharvest loses of table grapes are mainly caused berry decay or desiccation of stem and pedicels. It can be slow down or stop these problems by generator pads containing metabisulfite salt, then packing of the fruits in polyethylene liners. Metabisulfite salts are the compounds which slow release SO_2 by the humidity. However, high levels can result in fruit damage or some allergies on human health. Red globe grape variety that has increased growing trend recently, in Mediterranean region was used in this studies. Bunches were sorted after harvest and divided for three treatment as (a) Packed into 0.05 mm thickness plastic film (b) Forced air cooled, packed into 0.05 mm thickness plastic film and sodium metabisulfate paper pads were placed on top of the bunches (c) Bunches were dipped 35 % ethanol solutions + 2 % citric acid concentration for 1 min, packed into 0.05 mm thickness plastic film. After all these treatments bunches that packed into plastic film were arranged in carton boxes and stored at 0 ºC, 85-90 % RH for 4 month. This study showed that Red Globe grape variety can be stored successfully up to 4 month.

Key Words: *Vitis vinifera*, Sulfur dioxide pad, Ethanol, Bunch decay, Storage.

INTRODUCTION

Table grape is one of the most important crops produced in the Mediterranean region. The major postharvest problems of table grapes are desiccation, bruising and decay, so decay being directly related to bruising.

The gray mold rot caused by *B. cinerea* is the most important diseases of grape and can cause heavy losses during storage[1-3]. *B. cinerea* can not be sufficiently controlled by cooling alone because it can be proliferate by mycelial growth from berry to berry and has ability to develop at low temperatures[4].

†Department of Horticulture, Faculty of Agriculture, Mustafa Kemal University, Alahan, Hatay, Turkey.

The most common and worldwide method to control postharvest decay of grapes is to fumigate the fruit with sulfur dioxide in combination with rapid precooling after harvest or to fumigate packed fruit in polyethylene-lined boxes with continuous release SO_2 generator pads[5,6]. However, SO_2 is highly toxic and can causes injuries to rachis and berries and may give sulfureous flavour to the fruit[7]. Moreover, SO_2 residues are dangerous to people allergic to sulfites.

These problems have encouraged lot of researches that can be alternative techniques to SO_2 for preventing decay in table grapes such as controlled atmospheres[8-12], ethanol or combination with heat[13-20] and biological applications[21,22]. However, there are not clear results about the alternatives methods in term of long storage period.

The aim of this work was to use the suitable ethanol dose based on previous works with additional additive of citric acid in order to observe stem and pedicel desiccation, SO_2 genarator pads, control alone to observe gray mold development and evaluate effect of these treatments on berry quality for long term storage.

EXPERIMENTAL

This study was conducted in Horticulture Department of Agriculture Faculty in Cukurova University. Crimson Seedless and Black Pearl grapes were harvested from Unifrutti Company vineyard located in Tarsus, Mediterranean region of Turkey. The grapes were used immediately on the day of harvest.

Bunches were sorted after harvest and divided for three treatment as (a) Packed into 0.05 mm thickness plastic film (Control), (b) Forced air cooled, packed into 0.05 mm thickness plastic film and sodium metabisulfate paper pads were placed on top of the bunches (SMP) (c) Bunches were dipped 35 % ethanol solutions + 2 % citric acid concentration (v/v) for 1 min, dried for 0.5 h and packed into 0.05 mm thickness plastic film (ECA) and stored for 4 months at 0 ºC, > 90 RH. Four replicates were treated and each replicate consisting 5 to 6 kg of grapes.

Total decay was determined by weighing the decayed berries and getting the decay ratio (%) based per kg cluster.

Weighing fruit at the start of experiment and at various intervals determined weight loss during storage. Juice from a berry was squeezed from the grape and total soluble solids (TSS; % determined with a hand-held refractometre. (Atago, ATC1, Japan). The titrable acidity (TA) determined by titration of juice (5 mL) with 0.1 N sodium hydroxide with pH meter endpoint 8.10 (expressed as gram of tartaric acid per 100 g juice) and the pH of juice was measured with a pH meter (Schott, CG840, Germany).

Ethanol contents of the dipped grapes were measured with the method of Lichter *et al.*[19]. Measurements were done by a gas chromatography (Shimadzu 14B), with flame ionization detector (GC-FID) at 180 ºC, equipped with stainless steel column and the final amount was calculated against standard solutions under the same conditions (nl g^{-1} h^{-1}).

Taste panel were done consisted of 3 individuals who evaluated[23] taste according to hedonic scale of 1-9.

An analysis of variance was applied to the results of each experiment and mean values were separated by student multiple range test $p < 0.05$.

RESULTS AND DISCUSSION

Decay control of Crimson seedless and Black pearl grapes were managed by both ECA and SMP after four months storage at 0 ºC, > 90 RH (Fig. 1). Immersion of Crimson seedles grapes in ECA showed 1.72 % total decay after four months whereas SMP showed 3.57 and 8.67 % was found in control grapes. Similar results were obtained on Black pearl grapes. Percentages of decayed fruits were 1.72 % in ECA, 3.37 % in SMP and 8.67 % in Control (Fig. 2). Dipping grapes in ECA significantly controlled postharvest decay development of table grapes after long term storage, the germination of spores of *B. cineria* inhibited by immersion in 35 % ECA solution. Several studies showed that ethanol or SMP were reduced the decay comparing the control on table grapes or other fruits[18,19].

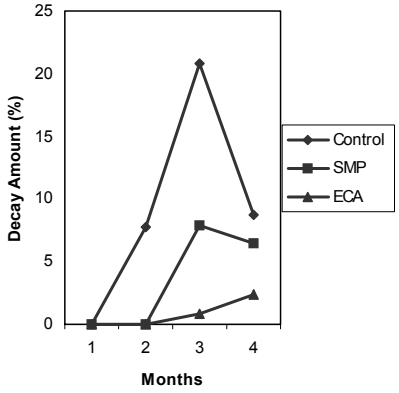

Fig. 1

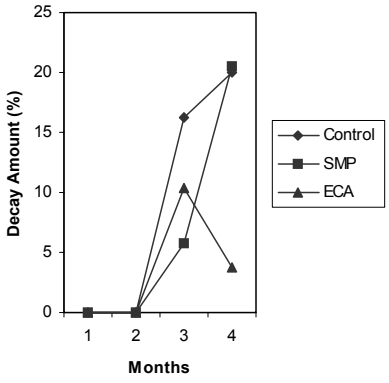

Fig. 2

Figs. 1 and 2. Influence of different postharvest treatments on decay (%) of Crimson seedless (1) and Black pearl (2) grape varieties during storage

The quality of Crimson seedless and Black pearl grapes after postharvest SMP, ECA and followed by 4 months storage at 1 ºC are shown in Tables 1 and 2, respectively. The loss in weight of Black pearl grapes were varies depending on treatments. ECA (7.22 %) and control (6.19 %) weight losses were higher than the SMP (4.06 %) treatment. Weight loss of Crimson seedless grapes during storage after treatment of ECA (7.77 %) was significantly higher than that of the SMP (5.69 %) and control (5.49 %). The loss in weight of both grape varieties was due to high ethanol concentration. Ethanol dips may affect berry wax structure and weight losses may occur more than other treatments. The present work corroborates with previous studies[24].

TABLE-1
INFLUENCE OF DIFFERENT POSTHARVEST TREATMENTS ON QUALITY PARAMETERS OF BLACK PEARL GRAPES

Storage time (months)	Treatments	Weight loss (%)	Tartaric acid (%)	pH	TSS (%)	Taste panel (1-9)
0			0.41	3.81	20.66 ab	9 a
1	Control	2.19	0.36	4.13	18.86 ab	9 a
	SMP	0.85	0.39	4.00	21.40 a	9 a
	ECA	2.64	0.39	4.06	19.53 ab	9 a
2	Control	5.54	0.43	3.77	19.80 ab	9 a
	SMP	4.01	0.41	3.80	19.47 ab	9 a
	ECA	6.22	0.41	3.72	19.87 ab	9 a
3	Control	8.51	0.43	3.94	20.40 ab	7.33 b
	SMP	5.20	0.41	3.96	20.13 ab	8.33 ab
	ECA	8.27	0.42	3.85	19.40 ab	8 ab
4	Control	8.55	0.41	3.74	17.73 b	4.33 c
	SMP	6.20	0.38	3.82	20.00 ab	5.33 c
	ECA	11.74	0.44	3.78	19.83 ab	5 c
Mean Values	Control	6.19 a*	0.41*	3.88*	19.49 b*	7.73 b*
	SMP	4.06 b	0.41	3.88	20.33 a	8.13 a
	ECA	7.22 a	0.42	3.84	19.86 ab	8.00 a

*Mean separation by Duncan's multiple range test. Values followed by different letters within a column are significantly different at the 0.05 level.

According to the present results, total soluble solids average was 20.66 % at the beginning of the storage where as it was found 19.18 % at the end of storage period of Black pearl grapes. However, total soluble solids average of Crimson seedless grapes were not affected by storage time. It was 20.46 % at the harvest time and showed slight increase with average of 20.93 % at the end of 4 months. It is known that berries can be in different maturation period in the cluster. So this may cause differentiation of total

TABLE-2
INFLUENCE OF DIFFERENT POSTHARVEST TREATMENTS ON QUALITY PARAMETERS OF CRIMSON SEEDLESS GRAPES

Storage time (months)	Treatments	Weight loss (%)	Tartaric acid (%)	pH	TSS (%)	Taste panel (1-9)
0			0.50	3.94	20.46	9.00
1	Control	3.09	0.43	4.06	20.33	9.00
	SMP	2.63	0.43	4.09	20.26	9.00
	ECA	4.05	0.45	4.03	20.20	9.00
2	Control	4.48	0.42	3.92	20.40	7.66
	SMP	4.61	0.51	3.90	20.80	8.00
	ECA	5.69	0.50	3.83	20.26	8.00
3	Control	6.57	0.49	4.04	20.60	6.66
	SMP	6.40	0.50	4.06	20.93	7.66
	ECA	9.53	0.55	3.89	20.60	7.66
4	Control	7.81	0.46	3.80	20.20	4.66
	SMP	9.13	0.49	3.81	20.93	4.66
	ECA	11.82	0.50	3.81	21.66	5.33
Mean Values	Control	5.49 b*	0.46*	3.95*	20.40*	7.40 b*
	SMP	5.69 b	0.49	3.96	20.68	7.80 a
	ECA	7.77 a	0.50	3.90	20.64	7.66 ab

*Mean separation by Duncan's multiple range tests. Values followed by different letters within a column are significantly different at the 0.05 level.

soluble solids during storage. The results showed that although there are some differentiations of total soluble solids in storage time and treatments, total soluble solids were prevented during storage period.

The titrable acidity and pH of both cultivars was not affected by the postharvest treatments statistically. However, some differences were found during storage period (Tables 1 and 2). ECA and SMP treatments were kept acidity at the end of the storage time almost the same with the zero time of the storage (Tables 1 and 2). These changes are not important practically and since moisture of the stored products decreases during the storage period consequently titrable acidity and soluble solid amount of the stored product may increase[25].

Taste panel of both grape varieties declined slightly but remained good until 3rd month of storage. The eating qualities of grapes were judged excellent until 3rd month storage of Black pearl and 2nd month storage of Crimson seedless varieties. SMA and ECA were judged the excellent after 4 months storage whereas control clusters were under average (Tables 1 and 2).

Ethanol residues of immersed clusters were detected during storage and given in Table-3. As soon as after immersion the samples were analyzed. The amounts of the ethanol residues were increased during the storage period in both cultivars. It can be said that increase in ethanol concentration is caused by respiration. However, detected amounts were not important levels to cause any health problems in human health. The ethanol level was 28.47 g l^{-1} h^{-1} in Black pearl grapes and 22.34 g l^{-1} h^{-1} in Crimson seedless grapes in the beginning. These levels were increased during the first two months and then decreased to 59.12 and 53.50 g l^{-1} h^{-1} levels at the end of storage period.

TABLE-3
INFLUENCE OF ETHANOL IMMERSION ON ETHANOL RESIDUES OF BLACK PEARL AND CRIMSON SEEDLESS GRAPES DURING STORAGE (g l^{-1} h^{-1})

	Beginning	1	2	3	4	Mean
Black Pearl	28.47	79.09	84.34	64.80	59.12	63.16 b
Crimson seedless	223.34	91.95	88.24	73.64	53.50	65.93 a

Mean separation by Duncan's multiple range tests. Values followed by different letters within a column are significantly different at the 0.05 level.

Ethanol is a cheap and well studied natural substance present in many food products. It should pose a minimal ingestion hazard to human beings because of its low mammalian toxicity[18].

In conclusion, we recommend the use of sulfur generator pads for long term of storage whereas ethanol immersions for limited time of storage like 1 or 2 months. Since table grapes mostly packaged in the vineyard after harvest posthrvest wet applications are limited. Because of this limitation preharvest ethanol sprays and other preharvest immersion techniques should also be checked for future experiment. Moreover since gray mold is the most important decay in grapes it is important point to control the drying after immersion and supply the hygiene of the environment.

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