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Storage of New Seedless Grape Cultivar with Sulfur Dioxide Generators

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Abstract. *Two new University of Arkansas table grape cultivars, Reliance (25% Vitis vinifera L. x 75% Vitis labrusca L.) and Saturn (78% Vitis vinifera L. x 22% Vitis labrusca L.), were stored for seven and 10 weeks at 2°C in corrugated cardboard shipping containers with five packing treatments (slow, dual, and quick-release SO_2 generators and lined and unlined controls). The SO_2 treatments consisted of placing grapes in shipping containers lined with unvented polyethylene bags, laying commercially available SO_2 generators on top of the grapes, and closing the bag. The lined control had a closed polyethylene bag surrounding the grapes but no SO_2 while the unlined control had neither SO_2 nor polyethylene bag. Reliance grapes had higher percentages of decay and shatter than Saturn grapes. Grapes stored with SO_2 generators had less decay than the controls. The unlined control had more than four times the percentage weight loss of any other treatment. Flavor was similar among all treatments. The SO_2 generators had no effect on color. Grapes that were wrapped and stored with no SO_2 had the greatest amount of berry shatter. Grapes stored with the dual-release SO_2 generators had less shatterthan with the slow-release SO_2 generators. Stem appearance was maintained by the slow-release and dual-release treatments. The use of SO_2 generators had no effect on percentage soluble solids or pH.*

In recent years, new cultivar releases from the grape breeding program at the University of Arkansas have resulted in fresh market grapes comparable in quality to table grapes from other sources. In order for these grapes to compete in the market, harvested grapes must retain their high quality for at least 10 weeks.

Storage life of grapes has been increased through use of SO_2 and low temperature storage (1,2,5,6,7,8, 9,10,11). The ability of such storage to impede decay and deterioration has been reviewed by Ginsburg et al. (3) and Harvey and Uota (4).

The objective of this study was to determine the influence of SO_2 generators on the storage quality on Reliance and Saturn grapes, both newly released University of Arkansas cultivars.

Materials and Methods

This study employed a 2 x 5 x 2 factorial experimental design comprised of two cultivars (Reliance and Saturn), five packing treatments involving three types of SO_2 generators (quick release, slow release, and dual release), and two controls (closed polyethylene bag with no SO_2 generator and no polyethylene bag with no SO_2 generator), and two storage periods (7 and 10 weeks at 2°C). Each treatment was repeated twice.

The SO_2 generators (UVAS - duality Packaging, NIPO Chilena S.A.C., Santiago, Chile - originally made in California) consist of one to three sheets of heat-sealed craft paper impregnated with or containing an SO_2 generating powder. The sheets generate and release SO_2 when exposed to the high humidity generated inside the closed polyethylene bag. The quick-release generators quickly release SO_2 and continue for 10 to 20 days. The slow-release generators release SO_2 in four to five days and continue for six to eight weeks. The dual release generators quickly release SO_2 and continue to release SO_2 for eight to 12 weeks.

Reliance and Saturn grapes were hand-picked at optimum fresh market maturity from the University of Arkansas Fruit Substation, Clarksville, Arkansas, and held overnight at 2°C. Grape clusters of each cultivar were placed into individual 0.95-L cardboard cartons; moldy or damaged fruit was removed before weighing. Carton weights averaged 500 g. The cartons (12/container) were placed inside 5.7-L grape shipping containers made of corrugated cardboard and lined with polyethylene bags. Two SO_2 generators were placed side by side on top of the grapes, and the bags were closed with twist-ties. Sulfur dioxide measurements in the bag atmosphere were taken with a Matheson® - Kitagawa toxic gas detector Model 8014-400A (Matheson Safety Products, E. Rutherford, NJ) using type 103 SD detector tubes initially (20 hours after pads were placed and bags closed) and after seven and 10 weeks storage.

Carton weights were taken initially and after each storage period to determine weight loss. Berry shatter was determined by holding clusters by the basal end and gently shaking in a uniform manner. The fallen berries were counted and divided by the total number of berries per cluster and multiplied by 100 to get percentage shatter. Percentage decay was determined by counting the number of berries containing any visible sign of mold, dividing by the total number of berries per cluster, and multiplying by 100.

Raw product quality was determined from a 200-g sample of grapes blended for 10 seconds in a laboratory blender and strained through coarse cheese cloth. Percentage soluble solids was measured on an OA®'Mark 11 Abbe refractometer (Scientific Instruments, Buffalo, NY). The pH of the juice was determined with a combination electrode standardized with

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pH 4.0 and 7.0 buffers. Titratable acidity was determined by diluting a 5-mL juice sample with 125 to 150 mL of deionized water and titrating to pH 8.2 with 0.1 N NaOH and expressed as percentage tartaric acid.

Sensory panels were conducted initially and after each storage period by 10 trained panelists to determine color, turgidity, shrivel, stem appearance, flavor, and overall quality. Panel ratings were based on a 1 to 10 point scale with 10 being excellent, below 5 being unacceptable, and 1 being totally unacceptable. The grapes were placed on two 23-cm white plastic plates for each treatment. One plate, containing individual berries free from visible mold, was used for rating flavor. The second plate contained three clusters which had been shaken in a uniform manner to allow for shatter evaluation and for rating the remaining variables. Fluorescent lights (GE® chroma 50 lamps) were used to illuminate the sensory evaluation room. Two replications of five samples were presented at each setting. Statistical analysis was performed after averaging the panelist scores. Duncan's multiple range test was used to separate means at the 5% level of significance using the Statistical Analysis System (SAS®, SAS Institute Inc., Box 8000, Cary, NC 27511).

Results and Discussion

More free SO_2 was measured inside the liners of Saturn grapes than inside the liners of Reliance grapes (Table 1). The dual-release generators produced more free SO_2 than the quick-release generators, which produced more free SO_2 than the slow-release generators. By the seven- and 10-week storage periods, the level of free SO_2 had dropped by half that of the initial storage level. No SO_2 was detected with the quick-release treatment by seven weeks for either cultivar (data not shown).

Reliance had a higher percentage of decay than Saturn grapes (Table 1). Grapes with a polyethylene liner, but no SO_2 had more decay than the grapes without a liner, probably because of the humid environment and lack of SO_2. All three SO_2 generators inhibited decay compared to the controls.

Using a liner increases the humidity and the potential for spoilage. However, liners are necessary to prevent excessive moisture loss during extended storage and to retain the sulfur dioxide when using SO_2 generators. The percentage weight loss of the unlined treatment was several times that of the lined treatments (Table 1).

Reliance had 34% more shatter than Saturn (Table 1). Berry shatter was lower in grapes stored with dual release generators than with slow-release SO_2 generators or controls. All three SO_2 generators controlled shatter significantly when compared with the lined control.

The use of SO_2 generators had no effect on percentage soluble solids or pH (Table 1). Reliance grapes had a lower pH and a higher percentage soluble solids and tartaric acid content than Saturn.

Color degraded during storage although it remained acceptable by the final storage period (Table 2). The SO_2 generators had no effect on color as determined by the sensory panel. SO_2 damage (bleaching) was noticed on only a few berries. This damage was noticeable only upon close inspection near the pedicle of berries that were partially detached from the rachis during packing.

Table 1. The main effects of cultivars, S02 generators, and storage on quality of Reliance and Saturn table grapes.

Effects	Soluble solids (%)	pH	Acidity (% tartaric)	SO_2 (ppm)	Weight loss (%)	Shatter (%)	Decay (%)
Cultivar							
Reliance	22.8a[1]	3.71 b	0.55a	4b	0.8a	27.9a	13.8a
Saturn	21.6b	3.91 a	0.48b	6a	0.8a	20.8b	7.7b
Treatment							
SO_2 generators							
Slow	22.3a	3.82a	0.51ab	4c	0.6b	25.6b	9.5bc
Dual	22.2a	3.80a	0.50b	13a	0 3b	6.9c	4.1 c
Quick	22.3a	3.81 a	0.52ab	7b	0.2b	16.4bc	8.1 be
Controls							
Lined	21.8a	3.78a	0.52ab	0d	0.2b	49.0a	19.1 a
Unlined	22.3a	3.84a	0.53a	0d	2.7a	24.1b	13.0a
Storage (weeks)							
0	22.1 a	3.83a	0.53a	7a	0.0b	1.0c	0.0c
7 at 2° C	22.4a	3.83a	0.52a	3b	1.1 a	28.8b	11.3b
10 at 2°C	22.1 a	3.77b	0.49b	4b	1.3a	43.3a	21.0a

[1]Means of main effects separated by Duncan's multiple range test at the 5% level.

Table 2. The main effects of cultivar, SO_2 generators, and storage on sensory quality of Reliance and Saturn table grapes.

Main Effects[1]	Color	Turgidity	Shrivel	Stem appearance	Flavor	Overall quality
Cultivar						
Reliance	7.6a[2]	8.7a	9.3a	6.0a	8.5a	7.5a
Saturn	7.7a	7.9b	7.8b	6.4a	7.5a	7.1a
Treatment						
SO_2 generators						
Slow	7.5a	8.3ab	8.5b	6.8a	8.1ab	7.6ab
Dual	8.2a	8.7a	9.2a	7.2a	8.4a	8.2a
Quick	7.7a	8.5ab	8.7ab	6.1b	8.0ab	7.3bc
Controls						
Lined	7.5a	8.2bc	8.4b	5.4c	7.8ab	6.7c
Unlined	7.3a	7.8c	7.8c	5.8bc	7.7b	6.9c
Storage (weeks)						
0	8.6a	9.5a	10.0a	9.0a	9.1 a	8.8a
7 at 2°C	7.5b	8.1 b	8.1 b	4.8b	8.3b	7.2b
10 at 2°C	6.9b	7.3c	7.5b	4.9b	6.7c	6.0c

[1]All scores are based on a 1 to 10 point scale with 10 being excellent, 5 being acceptable, and 1 being totally unacceptable.
[2]Means of main effects separated by Duncan's multiple range test at the 5% level.

The flavor of grapes was similar among all treatments. Only the unlined treatment was significantly inferior to highest rated dual-release generator (Table 2). Flavor degraded during storage, but remained acceptable throughout the storage period.

Reliance grapes were more turgid and shriveled less than Saturn grapes (Table 2). Shrivel was controlled best with the lined treatments. Grapes from the dual release treatment had less shrivel than those from the slow-release treatment or the controls. No difference in grape turgidity were found among the three SO_2 generators.

Both slow- and dual-release SO_2 generators maintained the best stem appearance. However, after averaging all treatments together, stem appearance was unacceptable after seven weeks at 2°C. The overall quality of Reliance was similar to that of Saturn (Table 2). Overall quality was rated highest for grapes from the dual-release SO_2 treatment although both slow-and dual-release SO_2 treatments were rated higher than the controls.

Conclusions

The data for shatter and decay showed that Reliance did not store as well as Saturn. All three generators were shown to inhibit decay. Also, in lined conditions, all three generators reduced shatter compared to the grapes without SO_2 generators. Since liners are necessary to prevent excessive moisture loss during extended storage, SO_2 generators can be used to provide protection from fruit decay.

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