Proceedings of Pakistan Society for Horticultural Science
2nd International Conference on Horticultural Sciences, February 18-20, 2016
Theme: Production Challenges and Food Security
Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Punjab 38040, Pakistan

Effect of Sulfur Fumigation on Quality and Sulfur Residues in Grape Berries of Kishmish Cultivars Stored at 1°C for 60 Days

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Abstract

Grape berries of Kishmish cultivars were fumigated with sulfur @ 2 g kg^{-1} of fresh fruit for 20, 30, and 40 minutes and stored at 1˚C for 60 days. TSS increased with storage time and it was highest on day 60 of storage and lowest on day 0. Similarly, the weight loss was also increased in storage and it was highest on day 60 of storage. The pH was also increased and it was highest on day 60 of storage. Without washing the grapes berries were not recommended for eating purposes, because the sulfur residues were high and were not permissible for eating. After washing with water, the SO_2 residues reduced greatly and became permissible for eating for 20 and 30 minutes fumigated berries, but it was still not permissible for 40 minutes fumigated berries; which was higher from 350 ppm, which is recommended for eating.

INTRODUCTION

Grapes originated in Asia, most botanists agree, is the home of Vitis vinifera, from which all the cultivated varieties of grapes were derived before the discovery of North America. The grapes belong to the family Vitaceae with 12 genera and about 600 species that are widely distributed in the tropics and subtropics with range extending into the temperate regions Cheema and Jindal (2001). They gave the details about the grapes growing and wine making in Egyptian mosaics of the fourth Dynasty (2440 B.C.) well before the beginning of Christian era grape planted in south Europe. Grape was introduced in India by Muslim invaders around 1300 A.D. The grapes are very important fruit of Balochistan. It is grown on 15,195 hectares and its annual production is 65192 tones. The grapes are grown in districts Quetta, Pishin, Killa Abdullah, and Mastung (Anonymous, 2013-14).

The four hybrid grapes had a pH range from 3.45 to 3.60 in their mature stages Sims and Marris (1987). The TSS increased with maturity of fruit and it is important to determine the quality of fruit Ballinger *et al.* (1978). The pH of grapes fruit has been found to increase with maturation and ripening of fruit Carrol and Marcy (1982).

Marris *et al.* (1986) fumigated grapes with different concentrations of SO_2 to control *Botrytis cenerea.* Their results indicated that 200 ppm of SO_2 stopped the spread of disease but complete control was only obtained with 800 ppm dose. Repeated fumigation (3 times/week) with 200 ppm significantly lower the infection compared with the standard application of 2,500 ppm (1/week). Discoloration, premature browning of stem and increase rate of water loss was observed with the higher concentrations.

Mitchell (1992) mentioned that the grapes have problem of water loss, due to which stem drying occur and botrytis rottening is also a serious problem in grapes storage. If the SO_2 fumigation applied then these problems can be reduced. He has further mentioned that sodium meta bisulfite pads are used in grapes packages, which release the SO_2 and thus control the rottening of grapes. Kochurova (1987) Potassium meta-bi-sulphite tablets (KMBT) packed with grapes transported by rail southern regions of USSR to Moscow. It took about 15 days and at the end weight differences were taken. The original weights and the decay in storage with KMBT was half of that without KMBT.

MATERIAL AND METHODS

The berries of grapes subjected to sulfur fumes at the rate of 2 g kg-1 of fresh fruit for 20, 30, and 40 minutes and one treatment was control i.e., without sulfur fumigation. The fruit was placed in wooden trays (45 x 75 cm) for sulfuring. These trays were then placed in a wooden chamber of size 0.60 x 1.20 x 1.20 meters (W x L x H). The trays were sulfured in this chamber for a fixed time. The chamber was covered with polyethylene sheet to make it airtight. Sulfur at the rate of 2 g kg-1 of fresh fruit in an iron pan was burned on an electric heater. The grapes berries exposed to the sulfur fumes for 20, 30, and 40 minutes. Then the trays were brought in the laboratory and the grapes for each treatment divided into 3 replications each with 4 kilograms. The grapes fruit for fresh storage was stored in cardboard boxes of four kilogram for each treatment, each replication. Thus the 4 boxes for each replication and the total boxes for 3 replications were 12. These boxes were stored in a cold storage for 60 days at 1 ^{0}C. The analysis of sulfur residues was done with the help of Pakistan Council of Scientific and Industrial Research (PCSIR) Laboratories, Quetta. At the PCSIR the samples were analyzed for the sulfur residues by using the method of Skinner (1936). The results provided by the PCSIR were in sulfur ppm. Later on, those results were converted into SO_2 ppm by multiplying the results with 2. The experimental design was a completely randomized design. Data were analyzed using PROC GLM of MSTATC for observation. Means values of parameters were separated according to least significant difference (LSD) test.

RESULTS AND DISCUSSION

significant results were obtained for TSS, weight loss (%), and pH. The TSS was highest on day 60 of storage i.e., 31.33 ^{0}Brix, while it was lowest in the initial on the day 0 i.e., 26.0°Brix (Table 1). These results are supported by Ballinger *et al.* (1978) who reported that the increased in TSS with maturity of fruit and it is most important factor to determine the quality of fruit. The weight loss (%) was highest on day 60 of storage i.e., 14% with comparison to other storage days. The weight loss results are supported by Dick and Labavitch (1989) who reported that 'Bartlett' pears soften in the storage because of the solubilization of pectic polysaccharides which resulted in the weight loss. The pH

also showed an increase with storage time and it was found highest on day 60 i.e., 5.025, while it was low on day 0 and day 20 of storage. The results are supported by Carrol and Marcy (1982) increase in pH was due to ripening of fruit. They said that pH of grapes fruit has been increased with maturation and ripening of grapes fruit.

Significant results for the treatment were found for TSS and weight loss percentage (Table 2). The TSS was highest for 40 minutes fumigated berries i.e., 29.13 ^{0}Brix and there was no significant difference for the 20 and 30 minutes fumigated berries. The increased in TSS increased with fumigation time. The increased in TSS mean increased in the maturity of fruit. These results are again supported by Ballinger *et al.* (1978) they said that the increased in TSS with maturity of fruit and it is most important factor to determine the quality of fruit. The weight loss (%) was highest for 40 minutes fumigated berries i.e., 10.410% and it was low for 30 minutes fumigated berries i.e., 5.264% and for 20 minutes fumigated berries it was 6.804%. It means that sulfur fumigation reduced weight loss, but up to a certain limit of fumigation time after that it caused the fruit injury and decay. Kochurova (1987) supports these results, Potassium meta-bi-sulphite tablets (KMBT) packed with grapes transported by rail southern regions of USSR to Moscow. It took about 15 days and at the end weight differences were taken. The original weights and the decay in storage with KMBT was half of that without KMBT.

Sulfur residues were analyzed in the grape berries after 60 days storage (Table 3). First the berries were analyzed without washing. The sulfur residues were highest for 40 minutes fumigated berries i.e., 1400 ppm and lowest for 30 minutes fumigated berries i.e., 1004 ppm. Then the grapes berries were analyzed after washing with water. The sulfur residues were again found highest for 40 minutes fumigated berries i.e., 510.1 ppm and lowest for 30 minutes fumigated berries i.e., 171.3 ppm. If we compare the sulfur residues of washed and unwashed berries, we can see the reduction in sulfur residues was from 60 to 80% in washed berries than unwashed berries. The permissible SO_2 residues in fruit were 350 ppm (Janjua, 1992). As it is clear from the results that without washing the grapes berries are not recommended for eating purpose. After washing with water, the SO_2 residues reduced greatly and became permissible for eating for 20 and 30 minutes fumigated berries, but it was still not permissible for 40 minutes fumigated berries; which was higher from 350 ppm recommended for eating.

CONCLUSION

Thirty minutes fumigation treatment gives the better results for weight loss and SO_2 residues hence, 30 minutes fumigation treatment is recommended.

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Table 1: TSS, weight loss (%), and pH of sulfur fumigated grapes berries on different storage days by storing at 1°C for 60 days.

Storage time (days)	**TSS (°Brix)**	**Weight loss (%)**	**Ph**
0	26.0 D	0.0 D	4.1 C
20	28.08 C	6.16 C	4.22 C
40	28.92 B	9.79 B	4.56 B
60	31.33 A	14.02 A	5.03 A
LSD (0.05)	*0.67*	*0.95*	*0.13*

Means within column with same capital letter are not different at *P≤0.05*.

Table 2: TSS, and weight loss (%), of sulfur fumigated grapes berries for different treatments by storing at 1°C for 60 days.

Treatment time (minutes)	**TSS**	**Weight loss (%)**
20	28.19 B	6.80 B
30	28.44 B	5.26 C
40	29.13 A	10.41 A
LSD (0.05)	*0.58*	*2.38*

Means within column with same capital letter are not different at *P≤0.05*.

Table 3: Sulfur residues in ppm in grapes berries, after storing at 1°C for 60 days.

Treatment time (minutes)	**SO_2 residues (ppm)**	
	Before washing	**After washing**
20	1024 B	202 B
30	1004 C	171 C
40	1400 A	510 A
LSD (0.05)	*10*	*5*

Means within column with same capital letter are not different at *P≤0.05*.