Handling & Processing Section

Proc. Fla. State Hort. Soc. 113:266-268. 2000.

EFFECTS OF UV-B IRRADIANCE DURATION ON POSTHARVEST QUALITY AND STORABILITY OF HAND-PICKED RABBITEYE BLUEBERRY

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Additional index words. Small fruits, ultraviolet radiation, cold storage postharvest quality.

Abstract. **Fruits of 'Southland' blueberry (*Vaccinium ashie* Reade) were hand-picked at mature-ripe stage to study the benefits of UV-B irradiance on postharvest shelf-life and fruit quality. After precooling, healthy, disease free, uniform fruits were selected and exposed to UV-B irradiance (180 to 310 nm) for 24, 48, and 72 hr under cold conditions. The fruits were then kept at 2-3°C and 90-95% relative humidity for two weeks before determining their quality parameters. Treated fruits were softer, wrinkled and non-marketable compared to non-irradiated berries. UV-B, due to its high energy level, induced damaging effects and did not improve quality or storability of blueberry fruit at any of the above duration.**

Postharvest losses of many perishable fruits including blueberry constitutes a major wastage of produce. These losses required large inputs of labor, materials, and capital to grow. Blueberries are grown commercially in many parts of the United States. Currently, this commodity represents the primary or the secondary source of income for many small and large scale growers. In view of the continuing increase in blueberry production, factors that affect the quality of the fruits are becoming more important. Certain markets require the fruits to be certified free of blueberry insects and pathogens. While the use of methyl bromide fumigation is still the only approved quarantine treatment, the continued use of this chemical is uncertain. Blueberry loose considerable market value due to a variety of postharvest losses (Ceponis and Cappellini, 1979, 1983, 1985; Mainland et al., 1975; Miller et al., 1988).

Research on blueberry storage is rather limited and attempts to extend fruit market acceptability produced encouraging results (Basiouny, 1994, 1996; Basiouny and Woods, 1992; Basiouny and Chen, 1988). Low-dose irradiation using Gamma and UV-C irradiance has been applied to several fruits including Papaya (Miller and McDonald, 1999), sweetpotato (Wu, 1995), Mango (McLauchlan et al., 1990), Citrus (Chalutz et al., 1993) as well as other fruits (Akamine and Moy, 1983; Harm, 1980). UV-B irradiance, however, has been used on blackberry to reduce postharvest losses (Basiouny, 1998) with limited success. The purpose of this research was to investigate the effects of UV-B irradiance on rabbiteye blueberry.

Materials and Methods

Uniform, disease-free rabbiteye blueberries (*Vaccinum ashie* Reade cv. 'Southland') were hand-picked randomly at mature/ripe stage (end of June-early July) from established blueberry bushes grown at Tuskgee Agricultural Experiment Station in Central Alabama. After pre-cooled at 5°C for 12 hr to remove field heat, the fruits were sorted based on uniformity, the degree of color, size and shape. The fruits then divided into three groups of 600 fruits each. Each group was further divided into three replications of 200 fruits in a complete randomized design. Two hundred fruits were selected in the same manner for initial determination used to assess fruit characteristics at harvest.

UV-B irradiance was supplied by two, 4 ft long, Westinghouse FS40 Sun Lamps. UV-B emission was filtered through either 0.005 mm cellulose acetate film for (+) UV-B or 0.005 mm Mylar film for (-) UV-B treatments. Fruits of each replicate were arranged as one layer in a flat glass container, placed 30 cm below UV-B source. The containers of each group were covered with either the cellulose acetate or the mylar films and sealed in a way to allow air, passing through a 3-liter jar of water, to flow in the glass containers to provide 90-95% RH. Fruits of the first, second and third groups were irradiated for 24, 48 and 72 hr, respectively, under cold conditions (1 ± 1°C) then were stored for two weeks under the same conditions.

Random samples from each group were taken after the two week storage period for measurement of fruit quality parameters. Net fruit weight and volume (gain or loss in fruit moisture content) were calculated on a fresh weight bases (g). Fruit firmness (N) was determined by Effegi pentrometer with 3 mm tip, soluble solids content (%SSC), titratable acidity (T.ac), pH and anthocyanin contents (T.Acy.) were determined as described by Basiouny (1998).

Results and Discussion

UV-B irradiation of 'Southland' blueberries for 24, 48 and 72 hours is shown in table 1, 2 and 3. Regardless of the duration of UV-B exposure, maintaining fruits for 2 weeks in cold storage after irradiation resulted in significantly more moisture loss than either initial fruits at harvest or (-)UV-B samples. The losses were 11.11, 15.2 and 51.39% for weight, 11.69, 16.39 and 13.59% for volume in fruits exposed to 24, 48 and 72 hr, respectively (Table 4). There were more losses as the irradiation duration increased. This was due to the fact that UV band (200->300 nm) is a high energy region of the light spectrum. It gives approx. 142 kg Cal/mol. In comparison with the red region (>700 nm) which is considered a low energy region giving only approximately 40 kg Cal/mol. The continuing reduction in weight and volume was also due to fruit respiration after harvest and moisture loss from the surface of the fruit during cold storage.

Due to loss of moisture and the turgidity of the fruit, firmness followed the same pattern as fruit weight and volume (Tables 1-3). The resistance of the fruit to creaking showed

Table 1. Effects of 24 hr of UV-B irradiance on Rabbiteye blueberry fruit quality.[z]

	Initial	(+) UV-B	(-) UV-B
Wt.	59.34[a]	52.72[c]	54.36[b]
Vol.	57.91[a]	50.56[b]	52.02[b]
Firmn	04.98[a]	04.00[c]	04.33[b]
SSC	13.89[c]	15.23[a]	14.12[b]
T. Ac.	01.22[a]	01.00[b]	01.12[a]
S/T. Ac	11.39[c]	15.23[a]	12.61[b]
PH	02.55[a]	02.93[b]	02.67[b]
T. Acy	112.31[a]	106.33[b]	100.11[c]

[z]Average of 3 replications. Mean separation within rows using Duncan Multiple Range Test (5% level).

Table 3. Effects of 72 hr of UV-B irradiance on Rabbiteye blueberry fruit quality[z].

	Initial	(+) UV-B	(-) UV-B
Wt.	59.34[a]	48.61[c]	51.99[b]
Vol.	57.91[a]	50.04[b]	52.11[b]
Firmn	04.98[a]	02.32[c]	03.87[b]
SSC	13.89[c]	14.63[b]	14.22[b]
T. Ac.	01.22[a]	01.10[b]	01.45[a]
S/T. Ac	11.39[c]	13.30[a]	09.81[b]
PH	02.55[a]	02.13[b]	02.11[b]
T. Acy	112.31[a]	87.42[b]	94.32[c]

[z]Average of 3 replications. Mean separation within rows using Duncan Multiple Range Test (5% level).

significant progressive decline parallel to the duration of irradiation exposure. The reduction in firmness, after 2 weeks in cold storage were 19.68, 30.70 and 53.41% for the 24, 48 and 72 hr irradiation periods, respectively. Similar to fruit weight and volume, firmness loss was the highest in fruits irradiated for 72 hr. These fruit lost 53.41% of their firmness (Table 4), which was attributed to moisture losses and the loss of fruit integrity. Excessive moisture losses resulted in shrinkage, softening and shriveling which affected fruit appearance and acceptability. Contrary to previous report by Miller et al. (1994) and a report on blackberry fruits by Basiouny (1998), and despite the irradiation treatment, blueberry fruits showed no signs of fungus infections or fruit decay.

There was a correlation between the decrease in fruit weight, volume, firmness and SSC after 4 weeks in cold storage (Tables 1-3). As the fruit continued to lose its resistance to puncturing, there were significant increases in SSC calculated at 9.65, 11.30 and 5.30% for fruits exposed to 24, 48 and 72 ht, respectively (Table 4). These increases were expected primarily as a result of natural metabolic processes, which occur in the fruit during ripening and the loss of moisture from the fruits. During fruit ripening, there is an inverse relation between SSC and titratable acidity (Ballinger and Kushman, 1970). In this study, it was noticed that there was a slow decrease in T.ac in the fruits exposed for 24 and 48 hr of UV-B irradiance and kept for 4 weeks in cold storage (Tables 1-3). However, for unknown reason, fruits irradiated for 72 hr or in similar fruits received no UV-B treatment had slightly higher T.ac than fruits analyzed at harvest (Tables 3 and 4). The decrease in T.ac was parallel to the increase in pH values of fruit juice. As the irradiation exposure increased, there were similar increases in pH values. The highest pH levels were found in juice from fruits exposed to UV-B for 72 hr (Tables 1-4).

Table 2. Effects of 48 hr of UV-B irradiance on Rabbiteye blueberry fruit quality.[z]

	Initial	(+) UV-B	(-) UV-B
Wt.	59.34[a]	50.32[b]	52.36[b]
Vol.	57.91[a]	48.42[c]	51.02[b]
Firmn	04.98[a]	03.45[c]	04.33[b]
SSC	13.89[c]	15.46[a]	14.73[b]
T. Ac.	01.22[a]	00.98[b]	00.99[b]
S/T. Ac	11.39[c]	15.78[a]	14.88[b]
PH	02.55[a]	02.96[b]	02.81[b]
T. Acy	112.31[a]	96.53[b]	98.31[b]

[z]Average of 3 replications. Mean separation within rows using Duncan Multiple Range Test (5% level).

SSC/T.ac ratios were not consistent. This was mainly due to differences in SSC and T.ac contents of the fruits during storage. This, however, should not imply that high SSC/T.ac ratio necessarily means superior quality, and that a low ratio always indicates inferior quality. In fact, fruits with low ratio may sometimes be far better in quality compared to these with high ones (Basiouny, 1996).

The characteristic color of blueberry is due to the presence of anthocyanin pigments in the epidermal and hypodermal cells of the fruit. T.Acy continued to decrease during 4 weeks in cold storage (Tables 1-4). There was significant T.Acy loss in blueberry fruits irradiated for 72 hr. (22.16%) compared with fruits irradiated for 24 or 48 hr. These were in agreement with previous findings reported by Basiouny (1996). However, they were in contrast with these findings obtained by Ballinger and Kushman (1970) and Ballinger et al. (1972) that could be contributed to cultivar differences.

In general, quality parameters, which contribute to the marketability and acceptability of the fruit were seriously reduced by UV-B irradiance. Loss of external fruit quality was indicative through reduced fruit firmness, increased softness and the total loss of the integrity of the fruits. Internal fruit quality was definitely correlated to external quality. This contributes substantially to the complete loss of appearance and prime condition of the fruit, which spells failure in the supermarket. Treating different fruits with Gamma irradiation or UV-C, which are much more stronger in terms of energy output than UV-B, were damaging to many fruits. The damage varies from discoloration, flesh darkening, and peal scald in mango and papaya (McLauchlan et al., 1990; Miller and McDonald, 1999) to inconsistent results in peaches, apples and sweetpotato (Lu et al., 1991; Steven et al., 1990; Wilson et al., 1997). It was concluded that UV-B should not be used for the duration of 24, 48 and 72 hr to irradiate blueberry fruits to enhance fruit quality and improve their storability.

Table 4. Percent gain or loss in blueberry fruit quality parameters after exposure to 24, 48 or 72 hr of UV-B irradiance and 2 weeks of storage.

	24 hr	48 hr	72 hr
Wt. (-)	11.11	15.2	51.39
Vol. (-)	11.69	16.39	13.59
Firmn (-)	19.68	30.70	53.41
SSC (+)	09.65	11.30	05.30
T. Ac. (-)	18.03	19.67	09.84
S/T. Ac			
PH (+)	15.01	16.08	19.72
T. Acy (-)	05.32	14.05	22.16

Literature Cited

Akamine, E. K. and J. H. Moy. 1983. Delay in postharvest ripening and senescence of fruits. pp. 129-158. *In* E. S. Josephson and M. S. Peterson (eds.). Preservation of food by ionizing radiation. Vol. 111, CRC Press, Boca Raton, FL.

Ballinger, W. and L. Kushman. 1970. Relationship of stage of ripeness to composition and keeping quality of highbush blueberries. J. Amer. Soc. Hort. Sci. 95:239-242.

Ballinger, W., E. Maness, G. Galletta and L. Kushman. 1972. Anthocyanin of ripe fruit of a 'Pink-fruitted' highbush blueberries. *Vaccinium corymbosum* L. J. Amer. Soc. Hort. Sci. 97:381-384.

Basiouny, F. M. 1994. Shelf-life and quality of rabbiteye blueberry fruit in response to preharvest application of CaEDTA, Nutrical and Paclobutrazol. Acta Hort. 368:893-900.

Basiouny, F. M. 1996. Blueberry fruit quality and storability influenced by postharvest application of polyamines and heat treatments. Proc. Fla. State. Hort. Soc. 109:269-272.

Basiouny, F. M. 1998. Effects of UV-B irradiance on storability and quality of blackberry. Proc. Fla. State Hort. Soc. 111:283-285.

Basiouny, F. M. and Y. Chen. 1988. Effects of harvest date, maturity and storage intervals on postharvest quality of rabbiteye blueberry (*Vaccinium ashie* Reade). Proc. Fla. State Hort. Soc. 101:281-284.

Basiouny, F. M. and F. Woods. 1992. Effect of chelated calcium on the shelf-life and quality of blueberry fruits (*Vaccinium ashie* Reade). Proc. Fla. State Hort. Soc. 105:75-78.

Ceponis, M. J. and R. A. Cappellini. 1979. Control of postharvest decays of blueberry fruit by precooling, fungicide, and modified atmospheres. Plant Dis. 63:1049-1053.

Ceponis, M. J. and R. A. Cappellini. 1983. Control of postharvest decays of blueberry, by carbon dioxide-enriched atmospheres. Plant Dis. 67:169-171.

Ceponis, M. J. and R. A. Cappellini. 1985. Reducing decay in fresh blueberries with controlled atmospheres. HortScience 20:228-229.

Chalutz, E., S. C. Droby and M. E. Wisniewski. 1993. UV-induced resistance to postharvest diseases in citrus fruits. J. Phytochem. Phytobiol. 15:367-374.

Harm, W. 1980. Biological effects of ultraviolet radiation. Cambridge Univ. Press. Cambridge.

Lu, J., C. Stevens, V. Khan, M. Kabwe and C. L. Wilson. 1991. The effect of ultraviolet irradiation on shelf-life and ripening of peaches and apples. J. Food Quality 14:299-303.

Mainland, C. M., L. Kusman and W. E. Ballinger. 1975. The effect of mechanical harvesting on yield, quality of fruit, and bush damage of high bush blueberry. J. Amer. Soc. Hort. Sci. 100:129-134.

Mclauchlan, R. L., G. E. Mitchell, G. I. Johnson and P. A. Wills. 1990. Irradiation of Kensington Pride Mangoes. Acta Hort. 269:469-478.

Miller, W. and R. E. McDonald. 1999. Irradiation, stage of maturity at harvest and storage temperature during ripening affect papaya fruit quality. HortScience 34:1112-1115.

Miller, W. R., R. E. McDonald and T. E. Crocker. 1988. Fruit quality of rabbiteye blueberries as influenced by weekly harvests, cultivars and storage duration. HortScience 23:182-184.

Miller, W. R., E. J. Mitcham and R. E. McDonald. 1994. Postharvest storage quality of Gamma-irradiated 'Climax' rabbiteye blueberries. HortScience 29:98-101.

Steven, C., V. Khan, A. Tang and J. Wilson. 1990. The effect of ultraviolet radiation on mold rots and nutrients of stored sweetpotato. J. Food Protect. 53:223-226. [not referred to in text]

Wilson, C., A. El-Ghaouth, B. Upchurch, C. Stevens, V. Khan, S. Dorby and E. Chalutz. 1997. Using an on-line UV-C apparatus to treat harvested fruit for controlling postharvest decay. Hortechnology 7:278-282.

Wu, B. 1995. Carbohydrate metabolism in ultraviolet-light C treated sweetpotatoes. MS Thesis. Tuskegee Univ.

Proc. Fla. State Hort. Soc. 113:268-271. 2000.

DELAYS TO COOLING AND POSTHARVEST QUALITY OF FRESH, FLORIDA BLUEBERRIES

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Additional index words. Quality parameters, firmness, shelf life.

Abstract. **Production of fresh blueberries continues to increase in Florida due to the high price obtained for the early season crop. The fruits are shipped to distant markets in North America and as far away as the Pacific Rim. Following harvest, blueberries are often transported to off-farm facilities for grading, packing and cooling. Growers have become increasingly aware that postharvest quality can be extended if forced-air cooling is applied shortly after harvest. However, delays due to harvest and transport from the field may negate the advantages of such a system. In spring 2000 'Bonita' blueberries (*Vaccinium ashei* Reade), a rabbiteye type, were subjected to delays-to-cooling at 30°C (86°F) of 0, 2, 4, 6 and 8 hr followed by storage for 1 to 4 weeks in clamshells at 2°C (34 °F) and 90% relative humidity (RH) to simulate commercial handling. Fruit quality (appearance, weight loss, firmness, decay and composition) was evaluated weekly during 4 weeks, following transfer to 20°C (68°F) for 24 hr prior to each evaluation. Weight losses were directly proportional to delays-to-cooling and, combined with appearance, seemed to be the best quality parameters to indicate losses in quality. A firmness index obtained through compression of whole fruit based on 1 mm total deformation was more sensitive to detect firmness variation than for deformations of 2 or 3 mm. In general, no quality differences were observed for 'Bonita' blueberries regarding delays-to-cooling effect, but there were significant differences within storage time. Further delay-to-cooling investigations should be carried out for early season, highbush blueberries.**

Florida was ranked seventh in highbush blueberry production in North America with about 2000 acres (800 ha) of cultivated area, and fifth in terms of value (P. Lyrene, pers. comm.; Williamson and Lyrene, 1995). The main appeal for

Florida Agricultural Experiment Station Journal Series No. N-01965.