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Fungal and Physiological Breakdown in Six Cranberry Cultivars Following Water Harvesting and Cold Storage

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Abstract. **Six cranberry (*Vaccinium macrocarpon* Ait.) cultivars, (water harvested under New Jersey growing conditions) were evaluated for their suitability for fresh market sale. Fruit were hand-picked and water-reel picked, held in the bog flood water for 0-, 4-, 8-, 12-, and 24-hr periods, and then stored for 12 weeks at 3°C. After an additional 4 days at 21° storage the fruit were evaluated for fungal fruit rot and physiological breakdown (PB). 'Franklin', 'Pilgrim', and 'Stevens' were superior to 'Early Black' and 'Wilcox' as measured by occurrence of rot and PB. Water immersion time had a greater influence on PB than on rot. As time in the water increased, the percentage of fruit manifesting PB increased, with 'Ben Lear' developing the least and 'Early Black' and 'Wilcox' the most PB.**

Water harvesting cranberries for the fresh market is an accepted practice in Wisconsin but not in New Jersey. It has been demonstrated, however, that New Jersey-grown 'Early Black' cranberries, when water-reel picked and stored and handled properly, can maintain salable quality for the traditional Thanksgiving and Christmas marketing season (1, 2). 'Early Black' is the principal cranberry cultivar grown in New Jersey; however, 'Stevens' and 'Ben Lear' are gaining acceptance. The emergence of these and other cranberry cultivars motivated us to evaluate their suitability for the fresh market when the berries are water-reel picked.

Six cranberry cultivars were harvested on 3 separate dates in 1982 and again in 1983 at the Blueberry and Cranberry Research Center, New Jersey Agricultural Experiment Station, Chatsworth. The 3 dates were chosen to sample a given cultivar during its normal picking season. At each harvest, a dry lot of berries was hand-picked (HP) from the same planting in the bog that would be water-reel picked (WRP) the following morning. When WRP commenced, the HP berries were placed in the flooded bog beside, but separated from, the fruit being freed by the water-reel. Samples of HP and WRP fruit were removed during the water-reel operation, which was completed in less than 5 min, and again after the berries had been in the bog water for 4, 8, 12, and 24 hr. Bog water daytime temperatures ranged from 15° to 21°C in the early harvests and from 8° to 13° in the late harvests. Immediately after removal from bog water, berries were washed with tap water to remove plant debris, dried by forced ambient air (30° to 35°), and culled to remove obviously damaged and decaying fruit.

Berry lots of each treatment (cultivar/picking method/water dwell time) were subdivided at each harvest into 4 open-mesh plastic pint (473 ml) containers and placed in 12-pint trays and stored for 12 weeks with air circulation at 3°C. Cranberries were removed from storage and held an additional 4 days at 21° to evaluate their marketability, emphasizing assessment of rots and physiological breakdown. The 4 days at 21° simulated a nonrefrigerated marketing period. HP and WRP berries were compared to evaluate the effect of water-immersion times and mechanical damage on keeping quality of the 6 cranberry cultivars. HP fruit provided a check on the mechanical damage caused by WRP.

Subsamples of rotted berries were surface-sterilized in an aqueous solution of 1.3% sodium hypochlorite for 5 min, and a slice of rotted tissue was cultured on V-8 juice agar medium to isolate the causal organism(s).

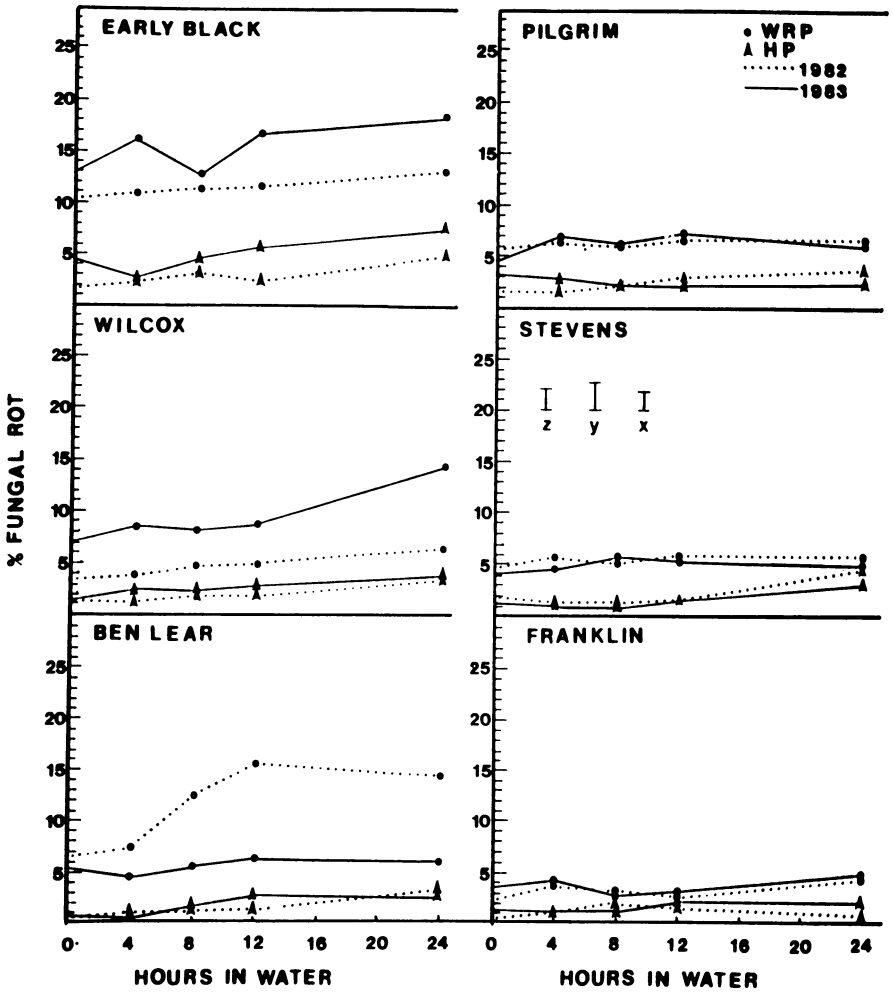

Fig. 1. Percentage of fungal fruit rot in 6 cranberry cultivars water-reel picked (WRP) and hand picked (HP) after 12 weeks of storage at 3°C and a 4-day holding period at 21°. Bars = 2 SE; z = 1982; y = 1983; x = value for comparisons between 1982 and 1983.

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Table 1. Analysis of variance for fungal rot and physiological breakdown in 6 cranberry cultivars as affected by picking method, water immersion time, and year of harvest.

Source of variation	Ds of cf	Mean squares	
		Fungal rot	Physiological breakdown
Y	1	101.5**	1537.3**
C	5	1046.6**	2791.6**
T	4	317.9**	4654.0**
P	1	8751.2**	3487.1**
Y, C	5	294.5**	301.7**
Y, T	4	7.0 NS	29.8 NS
Y, P	1	0.0 NS	778.2**
C, T	20	22.2**	255.2**
C, P	5	447.2**	177.3**
T, P	4	20.4**	0.3 NS
Y, C, T	20	12.8**	88.6**
Y, C, P	5	159.7**	143.8**
Y, T, P	4	9.6*	23.1 NS
C, T, P	20	15.6**	8.9 NS
Y, C, T, P	20	13.3**	14.6 NS
Error	1320	3.4	19.9

[z]Y = year; C = cultivar, T = immersion time; and P = pickling method.
*,**,[NS]Significant at 5%, 1%, and not significant, respectively.

The organisms were identified using descriptions provided by Shear et al. (4).

The data were subjected to an analysis of variance to investigate the effects and interactions of the 4 factors (year, cultivar, immersion time, and picking method) on fungal rot and physiological breakdown. The 3 harvests with 4 pints/harvest provided the yearly replication. Least significant differences were used to determine differences between means.

Significant differences among years, cultivars, water immersion time, and picking method were shown in the statistical analysis (Table 1). Many of the interaction terms were also significant, and they are illustrated in Figs. 1 and 2. Significant differences in fungal fruit rot occurred among the cranberries 'Franklin', 'Pilgrim', and 'Stevens' having less rot than 'Early Black' and 'Wilcox' (Fig. 1). Yearly variation in rot occurred within certain cultivars. For example, the incidence of rotting in 'Ben Lear' did not differ in 1983 from the low levels shown by 'Franklin', 'Pilgrim', and 'Stevens' in both years. In 1982, however, it was substantially greater. The yearly variation indicates that certain cultivars may react to environmental and/or cultural practices in different ways. No detailed data are available for the site used in this experiment; however, since cultural practices were virtually the same for both years, weather or some other environmental factor is a likely cause of yearly variation.

Fungal fruit rot in certain cultivars was related directly to water immersion time. 'Ben Lear', 'Early Black', and 'Wilcox' showed increasing levels of fungal fruit rot the longer fruit were left in the water, whereas little increase occurred in 'Franklin', 'Pilgrim', and 'Stevens'.

The method of harvest influenced rot development in all cultivars. The WRP fruit had more rot than HP fruit and was doubtlessly related to the bruising caused by the beating action of the water-reel. Impact bruising has been demonstrated to increase PB (2, 3).

Black rot, caused by the fungus *Strasseria oxycocci* or *Ceuthospora lunata* was the most prevalent rot. Other rot fungi identified were *Physalospora vaccinii, Sporonema oxycocci, Pestalotia vaccinii, Diaporthe vaccinii, Pullularia sp.* and an unidentified dark gray nonsporulating type.

Water immersion time and method of harvest significantly influenced the development of physiological breakdown (PB), a disorder characterized by a soft and/or rubbery texture and diffusion of the anthocyanin pigment throughout the fruit flesh. Increasing water immersion time significantly increased PB in all cultivars except 'Ben Lear' (Fig. 2). 'Pilgrim', 'Franklin', and 'Ben Lear' had little or no increase in PB with up to 4 hr of immersion. As time in the water increased, the percentage of fruit developing PB increased. 'Ben Lear' developed the least amount and 'Early Black' and 'Wilcox' showed the most PB in the 2 years of the tests. Method of harvest also influenced the level of PB, but to a lesser degree than duration of immersion, especially with 'Pilgrim', 'Franklin', and 'Ben Lear'.

This study shows that the cultivars 'Franklin', 'Pilgrim', and 'Stevens' are significantly better than 'Early Black' as measured by the criteria we used for salability of the fresh product. Less rot and PB developed in 'Franklin', 'Pilgrim', and 'Stevens' when they were immersed for periods longer than 4 hr as compared to 'Early Black'. 'Ben Lear' showed good resistance to PB, but was not consistent in rot resistance.

In addition to selecting water-reel picked

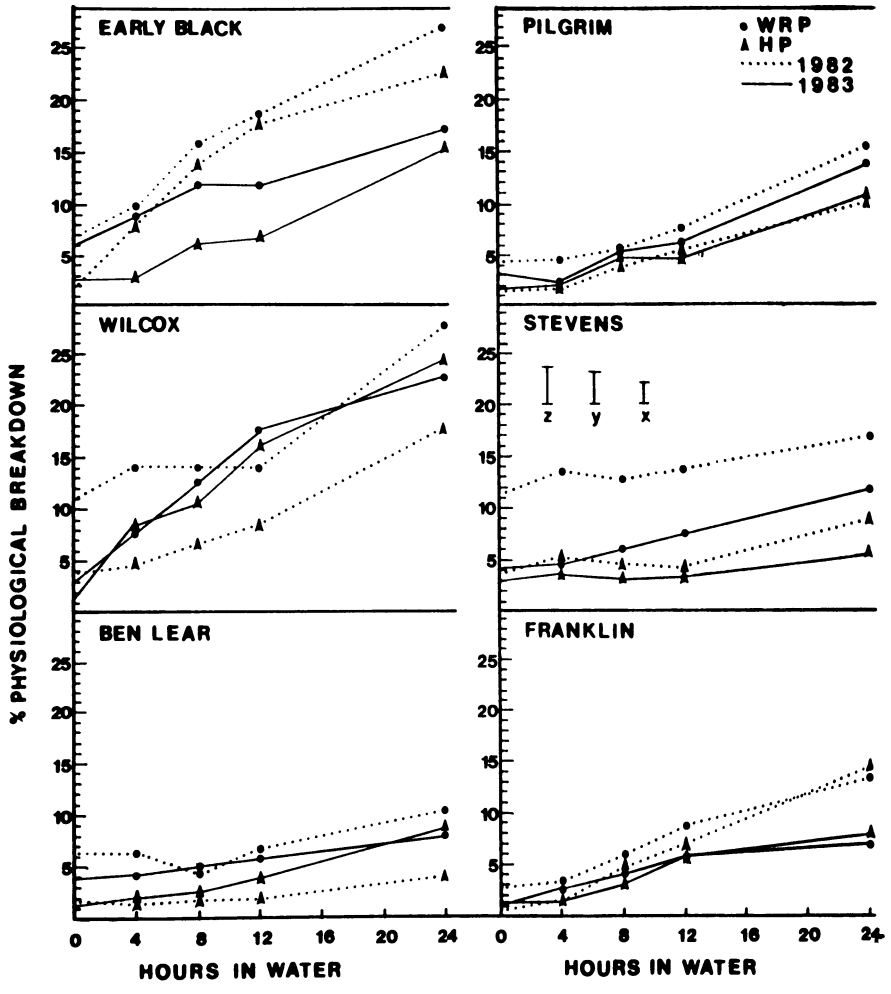

Fig. 2. Percentage of physiological breakdown in 6 cranberry cultivars water reel picked (WRP) and hand picked (HP) after 12 weeks of storage at 3°C and a 4-day holding period at 21°. Bars = 2 SE; z = 1982; y = 1983; x = value for comparisons between 1982 and 1983.

cultivars suitable for sale on the fresh market, the methods used in this research may have application in evaluating advanced selections from a breeding program. It would be desirable to develop fresh market cultivars which could be water-harvested, a method much more economical than mechanical dry picking machines. The difference in cultivars noted in these test suggests that germplasm in 'Franklin' and 'Pilgrim', imparts more resistance to rot and PB than 'Early Black'. The yearly variation in rot and PB in certain cultivars clearly shows the need for more than 2 years of evaluation before a selection is named.

'Franklin', 'Pilgrim', and 'Stevens' in this study have demonstrated better properties than 'Early Black' in suitability for sale on the fresh market when water harvested. If these cultivars are quickly removed from the flood water, rapidly dried, and cold stored, they should prove superior to 'Early Black' in commercial production.

Literature Cited

1. Ceponis, M.J. and A.W. Stretch. 1981. The influence of water immersion times at harvest on physiological breakdown of 'Early Black' cranberries in storage. HortScience 16:60–61.
2. Ceponis, M.J. and A.W. Stretch. 1983. Berry color, water-immersion time, rot, and physiological breakdown of cold-stored cranberry fruits. HortScience 18:484–485.
3. Graham S.O., M.E. Patterson, and B. Allen. 1967. Bruising as a predisposing factor in the decay of stored cranberries. Phytopathology 57:497–501.
4. Shear, C.L., N.E. Stevens, and H.F. Bain 1931. Fungous diseases of the cultivated cranberry. USDA Tech. Bul. 258.

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Poststorage Application of TAL Pro-long on Apples from Controlled Atmosphere Storage

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Abstract. **A poststorage application of TAL Pro-long reduced the softening of low-oxygen- (LO) stored 'McIntosh' and controlled-atmosphere- (CA) stored 'Delicious' apples (*Malus domestica* Borkh) during a 21-day shelf-life period at 15°C and 90% to 95% RH. The treatment did not affect fruit firmness of CA-stored 'McIntosh' or 'Empire' apples but did retard the loss of ground color in 'McIntosh'. No physiological disorder was found in any treated fruit.**

Since the development of modified-atmosphere and controlled-atmosphere (CA) techniques, attempts have been made to develop a material that would coat fruit in such a way that an internal modified atmosphere would develop by natural respiration to concentrations suitable for short-term transportation. In 1981, Lowings and Cutts (5) reported finding a specific coating mixture that is nonphytotoxic, tasteless, odorless, and effective. This coating material is a mixture of sucrose fatty acid esters, sodium carboxymethyl cellulose, and mono- and diglycerides. It is sold under the trade name of TAL Pro-long.

In 1982, the U.S. Food and Drug Administration (FDA) approved the use of sucrose fatty acid esters as a protective coating to retard ripening and spoilage of apples, bananas, and pears (6). The other 2 components of Pro-long are both approved food additives by FDA.

Research on English 'Cox's Orange Pippin' apples has indicated that Pro-long treatment before storage did not reduce detrimental losses in fruit firmness, or weight or changes in yellowing, but did increase the core flush (7). When applied after storage, Pro-long reduced yellowing and loss of firmness and markedly increased internal CO_2 levels during a 21-day simulated marketing period.

Increased interest in this material in Britain (1, 2, 5, 7) has prompted concerns regarding the suitability of this coating material for locally grown apple cultivars. The purpose of this study was to determine the effects of the poststorage application of Pro-long on the shelf life quality of commercially stored CA and low-oxygen (LO) apples in Ontario.

Apples from each of 3 orchards in 1982 were stored for 6 months at a commercial storage operation and treated as follows: a) LO 'McIntosh' (1% O_2 and <1% CO_2); b) CA 'McIntosh' (2.5% O_2 and 2.5% CO_2 the first month, then 2.5% O_2 and 5% CO_2); c) CA 'Empire' (2.5% O_2 and 2.5% CO_2; and d) CA 'Delicious' (2.5% O_2 and 2.5% CO_2). The poststorage coating treatment consisted of a 1% aqueous Pro-long dip for 20 sec.

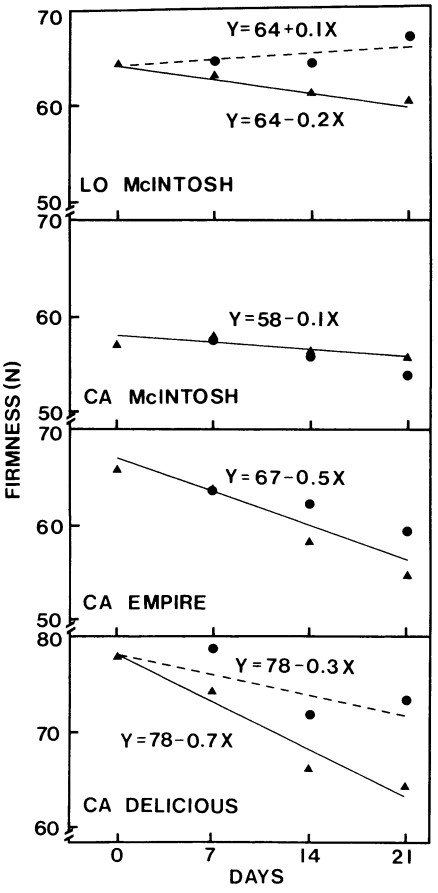

Fig. 1. Changes in firmness of low-oxygen- (LO) and controlled-atmosphere- (CA) stored apples treated with 1% TAL Pro-long poststorage dip (●), as compared to a water-dipped control (▲), and kept at 15°C and 90% to 95% RH for 21 days. Separate regression lines on the same diagram indicate significant differences ($P < 0.01$) between coated and uncoated treatments.

Control samples were dipped in water in a similar manner. Apples then were placed at 15°C and 90% to 95% RH and evaluated for ground color with a color chart (scaled from 1 = green to 8 = yellow) (8); fruit firmness using an Effegi penetrometer (reported in N); and possible disorders after 7, 14, and 21 days. Ground color was recorded only for 'McIntosh' apples. A randomized complete block design with each orchard considered as the block was used for statistical analysis.

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