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.

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

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Additional index words. sucrose fatty acid esters, low oxygen, modified atmosphere, *Malus domestica*

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.

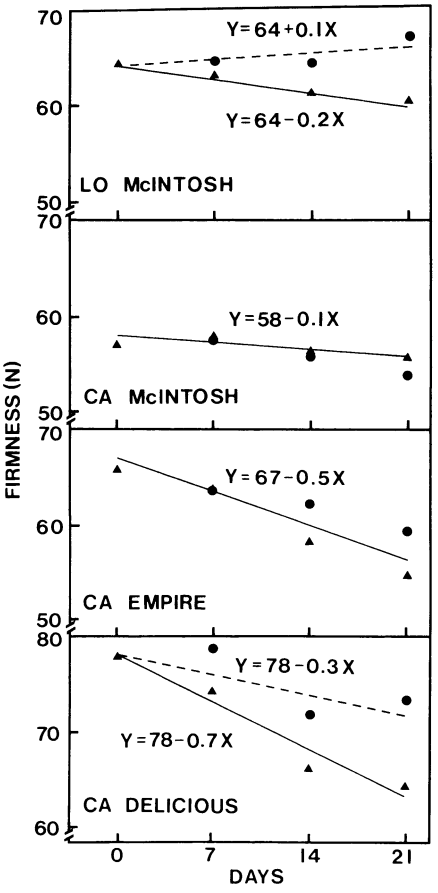

Fig. 1. Changes in firmness of low-oxygen- (LO) and controlled-atmosphere- (CA) stored apples treated with 1% TAL Pro-long poststorage dip (●), as compared to a water-dipped control (▲), and kept at 15°C and 90% to 95% RH for 21 days. Separate regression lines on the same diagram indicate significant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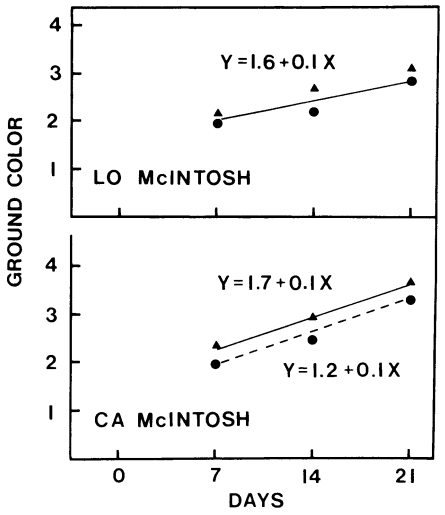

Fig. 2. Changes in ground color ratings of low-oxygen- (LO) and controlled-atmosphere- (CA) stored apples treated with 1% TAL Pro-long poststorage dip (●), as compared to a water-dipped control (▲), and kept at 15°C and 90% to 95% RH for 21 days. Separate regression lines on the same diagram indicate differences (P = 0.01) between coated and uncoated treatments.

Pro-long retarded the softening process of LO 'McIntosh' but did not benefit CA 'McIntosh' apples (Fig. 1). 'McIntosh' apples from LO storage were consistently firmer than 'McIntosh' from CA storage, which is consistent with the results of Lidster et al. (4). Firmness of CA 'McIntosh' apples was 7.2 N less than the firmness of LO 'McIntosh' when measured immediately after storage (i.e., day 0) and did not show a significant decrease during the shelf life study. Blanpied and Dewey (3) indicated that the firmness of 'McIntosh' apples may decrease to a minimum plateau at the end of their CA storage life. The present study indicated that the effectiveness of poststorage Pro-long coating application on 'McIntosh' apples depended on the significance of the residual retention of firmness over the minimum plateau at the time of treatment.

There was a decrease in firmness of CA 'Empire' apples at a rate of 0.5 N/day during the shelf life study (Fig. 1). Application of Pro-long did not influence the maintenance of firmness.

CA 'Delicious' showed a decrease in firmness at a rate of 0.7 N/day during the shelf life evaluation (Fig. 1). Application of Pro-long treatment to CA 'Delicious' reduced the rate of firmness drop significantly to 0.3 N/day.

Ground color of LO 'McIntosh' apples gradually changed from green to yellow during the shelf life studies. Pro-long did not improve the retention of green color of LO-stored 'McIntosh' apples (Fig. 2).

Poststorage Pro-long coating retarded the loss of green ground color of CA 'McIntosh' apples throughout the shelf life period (Fig. 2). However, the rate of the loss of green ground color was not affected by the coating treatment.

Pro-long coating may modify the atmospheric condition inside the fruit (5, 7). The levels of O_2, CO_2, and C_2H_4 inside the fruit depends on the rate of respiration and ripening of the fruit and the gas permeability of the coating material. The physical impediment of gaseous diffusion from a Pro-long-coated banana fruit is caused by stomatal blockage by the coating (2). The effect of Pro-long on the percentage of weight loss of apples (2, 7) indicates the reduction of the transpiration rate is due to the blockage of lenticels by the coating treatment. The oxygen concentration in the internal atmosphere of the coated fruit can reach 1.2% in banana (2) and <5% in 'Cox's Orange Pippin' apples (7) at 20°C for about 48 hr. The rate of softening and ground color loss of the fruit may be depressed in the modified-atmosphere environment. However, only good quality fruit may be treated with Pro-long to extend shelf life.

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Reduction of Bitter Pit of Apples with Phorone

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Additional index words. 2,6-Dimethyl-2,5-heptadien-4-one, physiological disorders, *Malus domestica*, mineral nutrition, Ca

Abstract. **Phorone reduced bitter pit of apples during 4 seasons. The degree of control varied between cultivars and seasons. The study was carried out in 3 Australian states and New Zealand and involved 'Cox's Orange Pippin', 'Golden Delicious', 'Granny Smith', and 'Twenty Ounce'. The apples were held in sealed or unsealed polyethylene bags, and the chemical was placed in small containers among the fruit or was injected into the core. Phorone was as effective in reducing bitter pit as a postharvest dip in 4% (w/w) calcium chloride, but it sometimes induced an off flavor. Chemical names used: 2,6-dimethyl-2-5-heptadien-4-one (phorone).**

Bitter pit (3) is a physiological disorder of apples that may occur on the tree or develop during cold storage. Susceptible fruit contain low levels of Ca in combination with high levels of K or Mg (1, 2, 5). The incidence and severity of bitter pit may be reduced by spraying the fruit during the growing season with a Ca salt (6) or by postharvest treatment of the fruit with calcium chloride (9, 10).

Phorone, a condensation product of acetone, has been reported to produce an effect similar to that of gibberellins when applied to germinating beans (7). It has reduced several physiological disorders of apples: low temperature breakdown (13), core flush (8),

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