FINAL REPORT

Project title: Reducing Storage Disorders with Natural Plant Oils

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Objectives: As an alternative or adjunct to present chemical treatments, to study the efficacy of vegetable oil emulsions on ‘d’Anjou’ and ‘Bartlett’ pears in storage trials of commercial scale.

Storage disorders and fruit decay are two major issues that affect profitability of the fruit industry. Scald (including superficial scald and senescent scald) and internal browning (including senescent breakdown, core browning, and flesh browning) are the major physiological disorders that develop after prolonged regular storage. Although postharvest fruit decay often occurs after months in storage, the innoculum is often present when fruit are placed in storage. Gray mold (*Botrytis cinerea*) and blue mold *(Penicillium expansum*) are the main decay causing pathogens in the Pacific Northwest.

Currently, no effective measures are available to control senescent scald or internal browning except fruit maturity and temperature management. Ethoxyquin or oiled papers without ethoxyquin are used to assist in the prevention of superficial scald, whereas fungicides are the primary tools in controlling fruit decay during storage. With chemical or fungicide dependency, however, there is no immunity from the constant challenges of 1) induced or natural pathogen resistance; 2) tightened regulations from foreign markets; or 3) increasing regulatory pressure stemming from consumer advocacy groups regarding chemical use in food or food products. Development of chemical alternatives that are effective and environmentally friendly would be highly beneficial to the fruit industry.

Early in 1919, Brooks *et al*. reported that fruit wrapped with tissue paper containing 15% mineral oil developed less scald after cold storage. Although this method is quite effective, and still in use in Washington, Oregon, and California, it was abandoned by many countries after the commercialization of DPA and ethoxyquin. Since the early 90s, the effects of surface oil treatments on fruit quality and storage disorders have been studied. Scott *et al*. (1995) in Australia showed that wiping fruit with both vegetable oil (canola, caster, palm, peanut, and sunflower) and petroleum oil effectively reduced scald development in 'Granny Smith'. Curry (2000) found that scald was reduced in ‘d'Anjou' pears, 'Red Delicious' and 'Granny Smith' apples when fruit were wiped with wheat germ oil. The practical application of wiping fruit with plant oils, however, is limited because: 1) it is hard to get uniform coverage; 2) additional machinery may be required in the packing houses thereby adding cost; 3) its inhibition on scald is time dependent and does not meet requirements for practical usage; and 4) the application method may increase greasiness on the fruit surface which is undesirable.

Instead of wiping fruit with oil, Ju *et al*. in 1990 (personal communications) and Curry in 1992 used oil emulsions to treat fruit and effectively controlled scald in apples. Oils from corn, soybean, peanut, cottonseed, and linseed are equally effective, and the formulation developed by Ju *et al*., is stable, and leaves no greasiness on fruit surface either at application or after storage. The fungicidal property of

edible plant oils, on the other hand, has not been well studied and the few reports available are contradictory. In one report, both canola and soybean oil at 1% were effective in controlling apple powdery mildew (*Podosphaera leucotrica*), but had no effect on brown rot of peaches (Northover and Schneider, 1991, 1993) or black knot (*Piosporina morbosa*) on leaves of plum and cherry. Duan *et al*., (personal communication) on the other hand showed that edible plant oils at 5 to 10% were effective in reducing decay severity (not % incidence) caused by gray mold (*B. cinerea*), blue mold (*P. expansum*) and bitter rot (*Glomerella cingulata*) in apples and pears.
Data from initial trials in our laboratory (Ju and Curry, 2000) suggest that treatment of 'd'Anjou' and 'Bartlett' pears with natural oil emulsion formulations: 1) inhibited ethylene production and respiration, and delayed fruit ripening and senescence; 2) prevented superficial scald in ‘d'Anjou' and senescent scald in 'Bartlett'; 3) controlled core breakdown in 'Bartlett'; and 4) reduced decay severity (not % incidence) of gray mold and blue mold. Fruit treated with oil emulsions were firmer, greener, had higher levels of titratable acidity and showed no scald or internal browning after 3 months for 'Bartlett' or 8 months for 'd'Anjou'. Initial observations also suggest oil treatment reduces fruit shrivel during prolonged storage.

REFERENCES

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Significant findings: The final experiment to be evaluated was conducted at Stemilt Growers in September 2000 using the small scale whole-bin drenching facility. The treatments included 1) untreated control, 2) 2.5 % oil, 3) 5% oil, 4) 5% oil + SOPP, and 5) Ethoxyquin (2700 ppm) + SOPP. Although both oil treatments reduced scald similar to that of ethoxyquin, the addition of SOPP to the oil did not reduce the incidence of decay over that of ethoxyquin alone. Severity of decay was reduced with oil treatment commensurate with delay in ripening. The main problem with bin drenching with this facility was that of coverage. Fruit within the top 1/3 of the bin was covered adequately and scald was well controlled. Below this, scald began to increase. Fruit in the bottom 1/3 of the bin had about 25% more scald that that in the top 1/3, but still about 50% less than the

untreated control. In the future, proposed commercial treatments using bin drenching should be made with sufficient flow and for sufficient time to provide adequate coverage.

Results and discussion: Experiments were conducted in 2000 to test the applicability of vegetable oil emulsions in commercial warehouses at the following locations: Washington Fruit in Yakima, OSU Hood River Research and Extension Station and Stemilt Corporation in Wenatchee.

At Washington Fruit, 'Bartlett' used for canning was treated with 2.5% oil, and 5% oil on August 23 and stored in regular storage at 29.5 F and in CA (1.5% O_2 and 1% CO_2) at 29.5 F.

Each treatment contained 4 bin replications. Fruit in regular storage were moved to a ripening area November 10 and evaluated November 17. Control fruit were fully ripe and very susceptible to bruising, whereas 2.5% oil treated fruit were ripe but were light green or yellow and firmer with higher acidity. Fruit treated with 5% oil were unripe, green, relatively firmer and had the highest acidity of all the treatments. Oil treatment did not control decay but reduced spread of decay compared with control. Washing the oil-treated fruit with tap water removed traces of emulsion residue, but did not have a significant effect on fruit ripening.

In the bin, fruit contact points showed greasy spots at removal from storage due to more oil accumulation. The accumulation of oil in those areas, however, did not cause any phytotoxiccity or localized changes in ripening behavior either at removal or after ripening which was our major concern about oil-treated fruit stored loosely in the bin. Washing with tap water was effective in removing excess emulsion and no apparent spotting was observed on the fruit surface.

Fruit in CA were removed on November 7. Three boxes of fruit from each bin were taken to Wenatchee and stored at 32 F. Fruit quality was evaluated upon removal from CA on November 10. Control fruit started to lose color, firmness and acidity after 2.5 months in CA. No difference was found between 2.5% and 5% oil treatment and both maintained similar firmness and color at harvest. Acidity decreased slightly but was significantly higher than the control fruit. Another set of fruit were moved to a ripening room on November 7 and evaluated a week later. Fruit treated with 2.5% oil ripened normally with a slight delay in green color loss but with higher firmness and acidity. Fruit treated with 5% oil failed to ripen after 7 days at 20 F. These fruit were green, firm, and had higher acidity than both other treatments. Decay was also reduced. Fruit in Wenatchee will be kept at 34 F for another 2 months.

These results indicate 'Bartlett' pear can be drenched with vegetable oil emulsion without causing deleterious effects. When treated with 2.5% emulsion, fruit ripen normally and maintain better quality after 2 or 3 month in regular storage or after 3 or 4 months in CA storage. When treated with 5% emulsion, fruit should be stored longer to ripen normally - results of fruit quality after 6 months storage (CA + RA) will be presented in February. This offers additional possibilities for the warehouses. Fruit could be drenched at harvest and stored loosely in bins to extend time available for packing high quality fruit. In addition, although oil treatment does not inhibit decay, it reduces development and spread by delaying fruit ripening. Our preliminary trials in the laboratory indicate that when the emulsion is combined with TBZ most of the decay should be controlled. Treated fruit designated for the fresh market have the additional benefit of less scuffling on the packing line due to the delayed ripening and reduced water loss which causes shrinkage and stretching of the epidermis over the stone cell clusters. Also, by packing later, decay infected fruit can be removed thus saving the cost of repacking should decay blossom in boxes instead of bins.

In Hood River, both 'Bartlett' and 'd'Anjou' were drenched with 2.5% and 5% oil emulsion, or line sprayed with 5% or 10% oil emulsion on September 13. Drenched fruit were stored in bins and line sprayed fruit were stored in cardboard boxes in the storage facility at MCREC. Treatments were further subdivided to include either wrapped with plain paper or unwrapped. Untreated fruit served as control. Each treatment contained 3 bins of fruit, and fruit were stored in regular storage.

Fruit samples were taken to Wenatchee on December 4 and stored at 32 F. Fruit quality evaluation will begin in January, 2001. According to preliminary observations, similar results to those observed at Washington Fruit are anticipated. Interestingly, fruit treated by line spray looked and felt greasy at the time of treatment due to evaporation of water in the formulation during the drying process, leaving emulsion residue on the fruit surface. During storage, however, the oil was absorbed by the fruit cuticle and greasiness was barely noticed after 3 months in storage. The fruit wrapped with paper looked even better because the paper absorbed the excess emulsion on the fruit surface.

Budget:
Project duration: 2000 - 2001

Original budget request:

Year	2000	2001
Total	34,500	39,500

Publications:

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