

## STORAGE CHALLENGES WITH WINTER PEARS

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Winter pears are primarily produced in the Wenatchee and Yakima Districts in Washington, the Mid-Columbia and Medford districts in Oregon, and the Placerville and Santa Clara areas in California. The total production of winter pears including d'Anjou, Bosc, Cornice, Red d'Anjou, and other varieties has increased to 16 million 44-lb packed boxes in 1995 and is estimated to increase to 20 million boxes in 2,000. The increase in production of winter pears has challenged the researchers to improve the handling procedures during harvesting, packaging, storing, transporting, as well as ripening the fruit from the producing sites to the retail markets. The ultimate objective of commercial handling and storage practices for winter pears is to maintain the fruit in a condition acceptable to consumers throughout the marketing season as well as to reduce the cull of fruit during storage and transportation.

D'Anjou pears are the most important variety grown in the Pacific Northwest. In 1995, the total production of d'Anjou pears was 12.8 million packed boxes which were about 80% of total winter pear production. In this report, we discuss the possible causes of the physiological problems (or disorders) of d'Anjou pears associated with improper postharvest handling and storage and the proposed procedures to reduce these physiological problems.

### PHYSIOLOGICAL DISORDERS ASSOCIATED WITH IMPROPER POSTHARVEST HANDLING AND STORAGE

#### *Friction Discoloration (Scuffing Disorder)*

Friction discoloration is one of the most costly problems which remains unsolved in the pear industry. Skin browning occurs after mechanical injury from friction during packing operation and transportation. The symptom of friction discoloration of pear fruit is commonly referred to as "scuffing" or "brush and belt burning". Fruit grown in the cool climate with lower daily hourly temperature are more susceptible to friction discoloration. Immature fruit and fruit with small size are also more vulnerable to this damage. Harvesting fruit at optimum maturity would be the first important step to reduce this type of disorder. Slowing down the speed of the packing line would be another effective measure to reduce scuffing.

#### *Chemical Injury*

When fruit are left in the dump tank with floating salts for too long without thorough rinsing during packing operation, they may be subjected to chemical injury. Another possible cause of chemical injury is wrapping wet fruit with copper-ethoxyquin wrapping paper. The symptom of chemical injury is patched type skin browning of the fruit. Rinsing the fruit thoroughly after elevating from the dump tank and avoiding wrapping wet fruit with copper-ethoxyquin wrapping paper are correct measures to prevent the fruit from chemical injury.

#### *Superficial Scald*

Superficial scald is a symptom of cosmetic surface browning of d'Anjou pears after a period of cold storage. Usually, fruit appear normal in cold storage but develop scald symptom after three

to four days on the shelf at room temperature. Factors that usually increase the severity of the disorder include immaturity, high fruit nitrogen, low fruit calcium, warm preharvest weather, delayed cold storage, high storage temperatures, and high relative humidity in storage. The primary commercial control of superficial scald on d'Anjou pears at present time is a postharvest treatment with the antioxidant, ethoxyquin. The development of superficial scald is due to the oxidation of  $\alpha$ -farnesene to conjugated trienes which cause the death of pear skin tissue. Our current study showed that a CA regime of 0.5% oxygen plus <0.05% carbon dioxide could effectively inhibit the development of superficial scald of d'Anjou pears when the fruit were stored in this regime at 30 °F for no longer than four months. When these low-O<sub>2</sub>-stored fruit were held in air at 30 °F for as long as two months, they developed only minimal incidence of superficial scald on day seven of ripening at 68 °F. These low-O<sub>2</sub>-stored fruit were also free from black speck disorder but with minimal incidence of pithy brown core disorder which might be still commercially acceptable.

### ***Pithy Brown Core***

Pithy brown core affects d'Anjou pears stored in either sealed polyethylene box liners or controlled atmosphere (CA) storage. It is characterized by pithy, brown areas in the core region of the fruit. It may be restricted to brown flecks between the carpels, but it may also encompass the entire core and extend into the surrounding flesh. In some instances the tissues collapse to produce cavities. The affected tissues are dry and pithy, in contrast to the soft, watery texture resulting from core breakdown. The disorder is associated with high concentrations of carbon dioxide in the atmospheres of sealed box liners or CA rooms and is considered to be a form of carbon dioxide injury. It is aggravated by the combination of low oxygen and high carbon dioxide levels. The susceptibility of pears to pithy brown core increases with factors that tend to induce fruit senescence, such as late harvesting, delayed storage, slow cooling, high storage temperatures, and extended storage. Fruit from trees in low vigor and grown in cool seasons are susceptible.

### ***Black Speck***

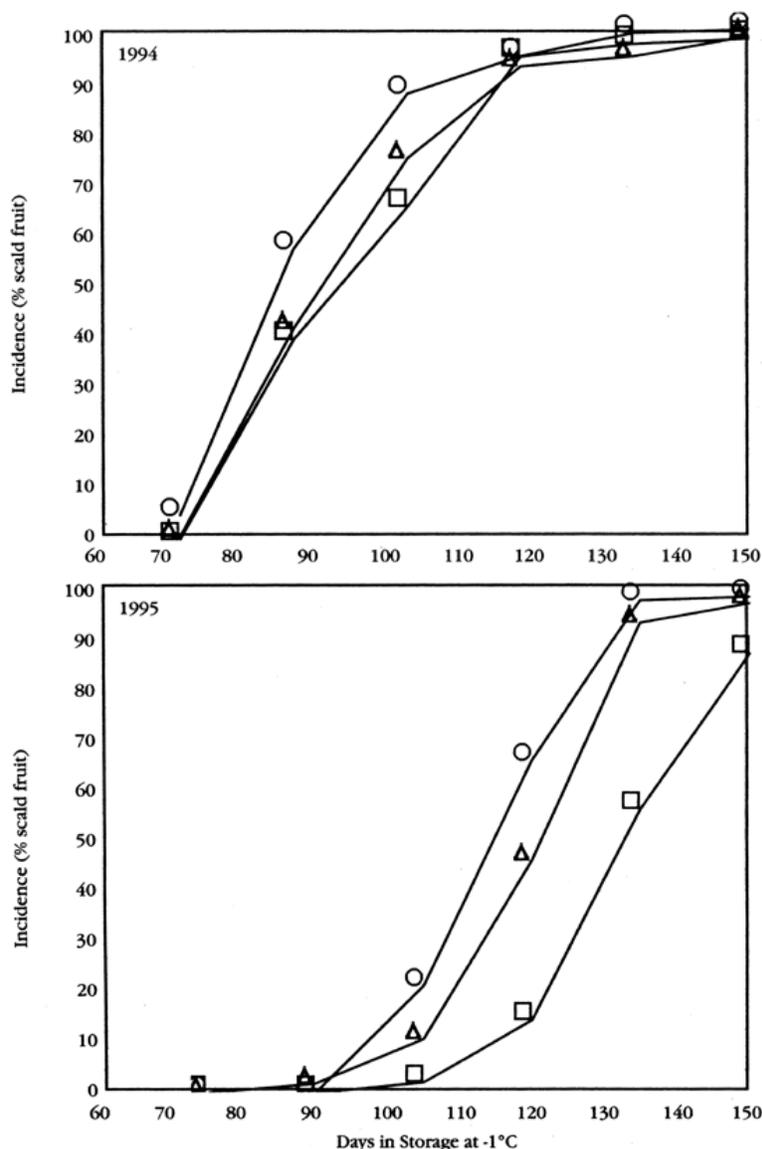
Black speck or skin speckling of d'Anjou pears becomes an economic problem to the pear industry after prolonged CA storage. It is a physiological disorder which may or may not be associated with pithy brown core disorder. The distinct dark brown specks scatter randomly on the skin tissue of affected fruit. The symptom appears on the fruit if they are stored in CA storage with oxygen concentration at 1% or lower for longer than four months. Occasionally, fruit stored in regular CA storage with 1.5% to 2.0% plus 0.8% to 2.0% CO<sub>2</sub>, for seven months or longer may also develop black speck disorder. Fruit predisposed to the unfavorable environment during growth and maturation may be more susceptible to the disorder.

## **PROPOSED HANDLING AND STORAGE PROCEDURES THAT MAY MINIMIZE POSTHARVEST LOSS DUE TO PREVIOUSLY DESCRIBED PHYSIOLOGICAL DISORDERS**

According to Crop reports in 1995 to 1996 season published by Winter Pear Control Committee, 2.5% of total d'Anjou production has been shipped as early as of September 15, 1995, which was about one week after commercial maturity at the lower elevation of Hood River district. As of November 24, 1995, 28% of the total d'Anjou crop was shipped. Some CA- stored fruit were also shipped as early as November 24, 1995, (about 17,000 boxes from the Wenatchee district).

As of December 22, 1995, 42% of total d'Anjou crop was shipped, which included all the fruit stored in the conventional air storage (about 41%) and 1% CA-stored fruit. It is, therefore, reasonable to assume that 60% of the total d'Anjou crop is stored in CA facilities and marketed between early December of each harvesting season to late June of the following year.

Our studies have demonstrated that d'Anjou fruit harvested at optimum maturity with flesh firmness between 14 and 15 pounds will not develop superficial scald until two and a half months of storage in air at 30 °F regardless of growing elevations and other different environmental factors (Figure 1).



**Figure 1.** Development of superficial scald disorder in d'Anjou pears during five months of storage in air at 30 °F in 1994 and 1995. Fruit were harvested at commercial maturity from lower (500-ft elevation), mid (1,250-ft elevation) and upper (2,000-ft elevation) valleys of Hood River district. Incidence of superficial scald disorder was assessed on day seven of ripening at 68 °F after each 0.5-month storage interval.

If fruit are exposed to a cooler growing season such as in the 1995 season, the development of superficial disorder will not occur until three months of air storage at 30 °F (Figure 1). We have also confirmed that fruit stored in 0.5% O<sub>2</sub> plus <0.05% CO<sub>2</sub> at 30 °F for four months or shorter develop only minimal incidence of superficial scald even though these low-O<sub>2</sub>-stored fruit have been held in air storage for as long as two months (Table 1). Based on these results, we propose the following alternative storage and handling procedures of d'Anjou pears that may minimize the previously mentioned physiological disorders.

**Table 1.** Incidence of superficial scald and pithy brown core disorders and levels of farnesene and conjugated trienes in d'Anjou pears after different controlled atmosphere (CA) environments at 30 °F plus seven days ripening at 68 °F.

| CA conditions* | Holding period in air at 30 °F (months) | Superficial scald (% scald fruit) | Pithy brown core (% affected fruit) | $\alpha$ -Farnesene (n moles/cm <sup>2</sup> ) | Conjugated trienes (n moles/cm <sup>2</sup> ) |
|----------------|---|-----------------------------------|-------------------------------------|--|---|
| CA 6           | 1                                       | 0.7 ± 0.9                         | 1.4 ± 1.8                           | 5.2 ± 1.8                                      | 1.0 ± 0.6                                     |
| CA 7           | 1                                       | 9.6 ± 3.1                         | 0.9 ± 1.1                           | 6.3 ± 0.8                                      | 1.8 ± 0.3                                     |
| CA 6           | 2                                       | 6.5 ± 3.9                         | 1.4 ± 1.6                           | 4.4 ± 0.3                                      | 1.8 ± 0.2                                     |
| CA 7           | 2                                       | 87.9 ± 4.0                        | 0.8 ± 0.9                           | 7.0 ± 1.1                                      | 2.6 ± 0.5                                     |

\* CA 6 = 0.5% O<sub>2</sub> (four months) with the CO<sub>2</sub> concentration maintained below 0.05%  
 CA 7 = 0.5% O<sub>2</sub> (three months), 1% O<sub>2</sub> (one month) with the CO<sub>2</sub> concentration maintained below 0.05%  
 All fruit evaluated were free from black speck disorder.

## CA STORAGE AND HANDLING PROCEDURES

1. Harvest 60% of d'Anjou crop at optimum maturity with flesh firmness of 14 to 15 lb into field run bins with bin liner.
2. Load the field run bins into CA rooms and cool the fruit to 30 °F within five days after harvest.
3. After cooling, set bags of hydrated lime on top of bins with a ratio of 2 lb limes per 44 lb of fruit; seal the CA rooms and pull O<sub>2</sub> down to 0.5% within three days after sealing; monitor O<sub>2</sub> and CO<sub>2</sub> levels twice a day to verify that O<sub>2</sub> is between 0.5% and 0.7% and CO<sub>2</sub> is <0.05% throughout the storage period.
4. After three to three and a half months of storage, open one group of CA rooms that contain 15% of total d'Anjou crop; start pre-sizing or packing this proportion fruit within one week after opening each CA room; do not leave the fruit in floatation solution in the dump tank for more than 15 minutes during packing or pre-sizing operation; slow the speed of packing line down to avoid scuffing damage and to ensure thorough rinsing and fungicide application; apply 1,000 ppm ethoxyquin (scald inhibitor) incorporated into pear wax with line sprayer during packing or pre-sizing process; return this proportion of fruit (15%) back to CA storage with O<sub>2</sub> at 2% to 2.5% and CO<sub>2</sub> at 0.8% to 1.0%; market this proportion of fruit between the months of May and June.
5. After three and a half to four months of storage, open another group of CA rooms which contain also 15% of total d'Anjou crop; start pre-sizing or packing this proportion fruit within one week after opening each CA room; do not leave the fruit in floatation solution in the dump tank for more than 15 minutes during packing or pre-sizing operation; slow

the speed of packing line down to avoid scuffing damage and to ensure thorough rinsing and fungicide application; apply 1,000 ppm ethoxyquin (scald inhibitor) incorporated into pear wax with line sprayer during packing or pre-sizing process; return this proportion of fruit (15%) back to CA storage with O<sub>2</sub> at 2% to 2.5% and CO<sub>2</sub> at 0.8% to 1.0%; market this proportion of fruit between the months of March and April.

6. The rest of 30% fruit stored in 0.5 O<sub>2</sub> (plus <0.05 CO<sub>2</sub>) can be also returned to air storage at 30 °F after three to four months of low-O<sub>2</sub> storage; pack these fruit the same as Step 4 or 5, but without ethoxyquin treatment; and market the packed fruit within two months of holding in air at 30 °F. This proportion of fruit (30%) can be marked between January and February.

### **CONVENTIONAL AIR STORAGE AND HANDLING PROCEDURES**

1. Harvest 10% of total d'Anjou crop at optimum maturity with flesh firmness of 14 to 15 lb into field-run bins with bin liners; drench with 1,000 ppm ethoxyquin incorporated into TBZ fungicide solution at labeled concentration; store the treated fruit in air at 30 °F until December 1. Pack the fruit as previously described and market them in the month of December.
2. Harvest 30% of total d'Anjou crop at late maturity with flesh firmness between 13 and 14 lb into field-run bins with bin liner; store the harvested fruit in air at 30 °F; pack the fruit as previously described but without ethoxyquin treatment and market them between the first commercial ordering date and the end of November; pre-condition the packed fruit with or without 100 ppm ethylene before each shipment.