FINAL REPORT
WTFRC Project No.: PR-01-97 **Organization Project No**: ARS 14104

Project Title: Maturity and Storage of Winter Pears

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Objectives:
1. Determine type and time of atmosphere establishment in conjunction with different maturity levels to optimize storage of winter pears.

2. Complete studies presently in progress concerning maturity and storage of 'Bosc' pears and disorder associated with the long-term storage of 'Anjou' pears.

Significant Findings:
1. 'd'Anjou' pears were packed in six commercial paper wraps (dry; 3% oil; 3% oil with copper and ethoxyquin; 6% oil; 6% oil with ethoxyquin; 9% oil). After packing pears were placed in three different (1.5% oxygen & 1% carbon dioxide; 1.5% oxygen & 3% carbon dioxide; 1.5% oxygen & 1% carbon dioxide for 60 days, followed by 4% oxygen for 60 days and then 6% oxygen for 60 days) controlled atmosphere storage conditions. Pears were stored for 120 and 210 days with an additional 30 days in regular atmosphere storage to simulate shipping and handling. Objective quality evaluations were conducted after each storage period and sensory evaluations after 210 days of storage. Paper type influenced both the peel and flesh color of pears before and after ripening, but did not influence firmness, soluble solids or acid content. Sensory ratings of appearance and incidence of disorders were unacceptable for pears stored in the variable atmosphere wrapped in dry or paper containing only 3% oil. **The disorder "Black speck" was present in pears wrapped in paper with 6% oil and stored in an atmosphere of 1.5% oxygen and 1% carbon dioxide.** Pears stored in an atmosphere of 1.5% oxygen and 3% carbon dioxide received acceptable sensory scores regardless of paper type.

2. ‘d’Anjou’ and ‘Bartlett’ pears (*Pyrus communis* L.) were treated with 12% CO_2 for 14 days at -1C and then stored in either regular (RA) or controlled-atmosphere (CA) storage for various periods of time. After each storage period, pears were evaluated for quality attributes. Compared to non-treated fruit, CO_2-treated ‘d’Anjou’ pears from RA storage were firmer, greener, and displayed reduced rot, scald and internal breakdown and better pedicel condition. High CO_2 treatment of ‘Bartlett’ pears prior to RA storage resulted in reduced quality after storage. Pre-storage CO_2 treatment of ‘Bartlett’ pears reduced post-storage firmness and TA and increased incidence of scald, but reduced surface damage during ripening. High CO_2 treatment prior to 120 or 220 days of CA storage had no effect on the post-storage quality of either ‘d’Anjou’ or ‘Bartlett’ fruit.

3. Loss of 'Anjou' pear quality after 90 days of storage (60 days at 1.5% O_2 & <1.0% CO_2; then 30 days at 4% O_2) was apparent in this study. Distinct color changes from green to yellow in the peel and a more yellow flesh, coupled with a loss of firmness, for 'Anjou' pears even after only a short period (30 days) in elevated O_2 was evident. Use of elevated CO_2 (3%), in CA storage, resulted in a greener peel and firmer pears with less change in flesh color, and superior stem condition after 150, or 210 days of storage compared to pears from 1.5% O_2 and <1% CO_2. After controlled atmosphere and an additional 30 days of storage in regular atmosphere, quality differences in 'Anjou' pears from the different atmospheres (1.5% O_2 & <1.0% CO_2; variable O_2; 1.5% O_2 & 3.0% CO_2) were even more manifested. Pears in elevated O_2,

displayed reduced firmness, finish and stem condition and enhanced shrivel. Pears in 3.0% CO_2, compared favorably in all quality considerations with pears from a normal (1.5% O_2 and < 1.0% CO_2) atmosphere. No pithy brown core was evident in 'Anjou' pears regardless of storage atmosphere.

4. 'Anjou' pears were subjected to seven different controlled atmosphere storage practices (1. CA of 2% oxygen and 1% carbon dioxide; 2) Ca for 90 days and then regular air atmosphere for the remainder of the study; 3) cool pears to a uniform -1C and then establish normal CA in <12 hours; 4) warm pears to a uniform 15C and then establish CA in <12 hours; 5) slow oxygen removal from 21 to 2% over a period of 10 days; 6) CA for 90 days, RA for 15 days then back to normal CA; 7) 90 days normal CA then 4% oxygen for 60 days then 8% oxygen for the remainder of the study) and stored at 1C, for 90, 150 and 210 days plus 30 days at regular atmosphere. CA storage treatment conserved pear qualities to a certain extent regardless of storage treatment. **Establishment of CA conditions on warm pears prior to cooling, resulted in reduced firmness, finish and color and increased amount of scald, shrivel and physiological disorders**. Pears held in CA with variable oxygen (2% for 90 days, 4% for 60 days, 8% remainder of storage) resulted in very poor quality pears.

5. 'Anjou' and 'Bosc' pears were harvested one to two days prior to commercial harvest from three orchards in the Wenatchee, Washington growing district. Harvest fruit were treated with 300 ppm ethylene for three days and 20C. Ethylene treatment enhanced yellow color on fruit peel and the reduction of flesh firmness and increased spoilage after 90 days in either regular atmosphere storage or controlled atmosphere storage regardless of cultivar. Ethylene-treated fruit, of both cultivars, stored in CA had a longer storage life than fruit stored in RA. **The safe storage period of ethylene-treated 'Anjou' and 'Bosc' pears was 90 and 45 days, respectively, in RA and 120 and 90 days, respectively, in CA**.

6. 'Bosc' pears were placed in a purge-type controlled atmosphere storage immediately after harvest (<24 hours) and held for 180 days at 1C. Oxygen in all atmosphere as 1.5% and carbon dioxide was 1, 3, or 5%. Pears were evaluated immediately after removal from CA storage and after ripening for an additional 7 days at 21C. **Pears stored in 3% carbon dioxide were firmer, had superior finish, with significantly reduced decay and internal breakdown than pears stored in 1% carbon dioxide.** In 3% carbon dioxide, pears retained the ability to ripen **after** long-term storage. A 10-day delay in atmosphere establishment had little or no influence on the long-term keeping quality or ripening ability of 'Bosc' pears. Firmness, soluble solids content and starch, either alone or together, were good indices of maturity for 'Bosc' pears.

7. 'Gala' apples and 'Bartlett pears were harvested over two crop seasons at different maturities and growing sources then stored in refrigerated storage alone and in controlled atmosphere storage (1% oxygen and 1% carbon dioxide, or 2% oxygen and 3% carbon dioxide). Before and after storage of 45 or 90 days, the juice from the fruit was examined for carbohydrate and acid composition and contents. For 'Gala' apples, the type and length of storage had no significant effect on juice carbohydrate and acid contents compositions, however the time of harvest greatly influenced both parameters. Storage atmosphere did not affect the carbohydrate and acid contents and compositions of 'Bartlett' pear juice, however the source of the fruit and subsequent amount of ripening did appear to significantly cause changes in the same parameters. The carbohydrate and acid compositions and contents of 'Gala' apple juice were within the compositional range for worldwide apple juice. 'Bartlett' pear juice contained significantly greater concentrations of citric acid than shown in previously published studies.

Budget:
Maturity and Storage of Winter Pears
Stephen R Drake
Project Duration: 1999-2001

Year	Year 1 (1999)	Year 2 (2000)	Year 3 (2001)
Total	$18,750	$35,700	$37, 800
Current Year Breakdown			
Salaries[1]	12000	24000	29090
Goods and Services	3000	4000	6000
Benefits	3500	7500	2410
Travel	250	200	300

[1]Salary for temporary technical support.

Project total: $92,250

Publications:

Drake, S.R. and T.A. Eisele. 1999. Carbohydrate and acid contents of Gala apples and Bartlett pears from regular and controlled atmosphere storage. J. Agric. and Food Chem. 47:3181-3184.

Drake, S.R. and R.D. Gix. 1999. Response of 'Anjou' winter pears to commercial controlled atmosphere storage conditions. Proc. Wash. Tree Fruit Postharvest Conf. 15:77-81.

Drake, S.R., B.L. Blaisdell and R.D. Gix. 1999. Influence of temperature and carbon dioxide level on the quality of 'Anjou' pears after 210 days of controlled atmosphere storage. Proc. Wash State Hort. Assoc., #83.

Drake, S.R. 1999. Elevated carbon dioxide storage of 'Bosc' pears. J. Food Qual. 22:417-425.
Shu-shang, MA, P.M. Chen, D.M. Varga and S.R. Drake. 2000. Ethylene capsule promotes early ripening of 'd'Anjou' pears packed in modified atmosphere bags. J. Food Qual. 23:245-259.

Drake, S.R. and P.M. Chen. 2000. Storage quality of ethylene treated 'Anjou' and 'Bosc' winter pears. J. Food Proc. and Pres. 24:379-388.

Drake, S.R., R.D. Gix and C. Coureau. 2001. Quality of 'Anjou' pears after different types of controlled atmosphere storage. J. Food Qual. 24:27-36.

Drake, S.R., D.C. Elfving and R.D. Gix. 2001. The influence of paper wraps on the quality of 'd'Anjou pears after controlled atmosphere storage. HortScience 11:566-570.

Drake, S.R. The influence of paper wraps on the quality and disorders of 'd'Anjou' pears after controlled atmosphere storage. Proc. Washington Tree Fruit Postharvest Conf., March 2001.

Drake, S.R. and D.C. Elfving. Influence of prestorage carbon dioxide treatments on the quality of 'd' Anjou and 'Bartlett' pears. J. Food Proc. and Pres. (Accepted).

Drake, S.R. and R.D. Gix. Quality of 'Anjou' pears from variable oxygen and high carbon dioxide controlled atmosphere storage. J. Food Qual. (Accepted).

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