

**SP88: SIX MONTHLY REPORT TO PROGRAMME MANAGEMENT COMMITTEE
(FOOD LINK)**

Project Number: CSA 2948

Project Title: INVESTIGATION OF TEXTURAL QUALITY DEVELOPMENT
AND POST-HARVEST SOFTENING OF COX'S ORANGE
PIPPIN APPLES.

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Project Start / Completion dates: 1.4.95 / 31.3.98 **Months since project start:** 36

1. Project objectives:

To establish strategies for enhancing the textural quality of Cox apples by investigating the factors that operate during fruit development which affect the textural characteristics of the fruit at harvest, and which provide for greater firmness retention during storage. To identify biochemical and molecular markers of softening in stored Cox apples in order to provide future opportunities for the use of molecular genetics to improve apple fruit quality and continuity of supply.

2. Milestones for the six month period:

Fruit from two orchards that typically produce very soft or very firm apples were chosen for studies related to post-harvest softening since these were most likely to provide the clearest differences at the biochemical level. These are referred to as 'firm' and 'soft' fruit in the text of the report.

2.1 Complete EELS (electron energy loss spectroscopy) analysis of the cell walls of fruits from the 1997 harvest. More specifically, to determine levels and distribution of calcium and nitrogen in the cell walls of 'soft' and 'firm' fruit.

2.2 Confirm the relationship between fruit firmness and fruit composition for Cox apples grown under different agronomic regimes and continue with field experiments to improve fruit firmness.

2.3 Initiate studies of the relationship between fruit firmness and tissue composition for individual fruits.

2.4 Complete the determination of galactanase activity in apples from the 1997 crop stored under controlled atmosphere (CA) conditions.

2.5 Analysis of cell wall composition, specifically galactan content in 'firm' and 'soft' apples..

3. Research report:

3.1 The EELS analysis revealed that the relative intensity values for calcium were significantly higher in the 'soft' fruit in both middle lamella and primary wall regions. In contrast 'firm' fruit showed significantly higher levels of wall nitrogen. Thus high wall nitrogen was associated with higher firmness at harvest and these fruits remained firmer during CA storage. These data are similar to those obtained for stored apples from the 1996 crop. The nature of the high nitrogen component in the wall is not known, but it could represent wall structural proteins. Determination of hydroxyproline content of walls, a crude measure of wall structural protein content, revealed no differences between orchards. However, the hydroxyproline content was very variable and these analyses are being repeated on larger samples.

3.2 Field experiments planned for 1997 were seriously disrupted due to loss of crop caused by a series of hard frosts. Consequently, no progress could be made to establish a causal link between the nitrogen content and strength of apple cell walls, suggested by EELS analysis. Experiments abandoned in 1997 will be repeated in 1998 as part of a 1-year extension of the project.

Orchard differences in firmness at harvest and during storage were correlated ($r = 0.8$) with cell wall content (alcohol insoluble matter minus starch). Contrary to results obtained for the 1996 crop, thinning resulted in only small increases in cell wall material which corresponded with nil or slight increases in fruit firmness (penetrometer). There was no consistent effect of thinning on compression stiffness modulus, peak stress, work of fracture or maximum force during wedge tests. The lack of response to thinning may relate to the lateness of treatment enforced by the need to assess the extent of frost damage.

3.3 Mechanical tests were carried out in March 1998 on individual apples from the 5 sites involved in the study and from thinned and unthinned trees (3 sites only in 1997). Collation and calculation of the mechanical test data are complete. Samples of cortical tissue are currently being analysed for their cell wall content. When these data are available any relationships between composition, density and mechanical properties of tissues for individual fruits will be determined. Opportunities for including apples from this project in other MAFF-funded work, relating sensory and mechanical properties of different apple cultivars, will be discussed with the University of Reading and Leatherhead Food Research Association.

3.4 The activities of beta-galactanase and beta-galactosidase activity were low throughout the storage period. Galactanase activity in stored fruit was lower than in the 1996 crop but increased in fruit from both orchards during ripening. As in 1996, the levels of activity were significantly greater in the softer apples. The total beta-galactosidase activity showed the same trend as that for galactanase, but there were no significant orchard effects.

3.5 The cell wall compositional analysis is still in progress as agreed on the work plan. Total cell wall hydrolysates from fruit stored in CA for 2 and 5 months have been analysed. There were no significant differences in wall sugar components between the two orchards.

4. Project changes:

None.

5. Publications:

Presentation. D.S. Johnson, C.J. Dover, T.J. Samuelson and K. Pearson. Mechanical properties of apple tissue during fruit development and storage in relation to pre-harvest factors. Workshop on Fruit Quality, Ravensburg-Weingarten, Germany 1-3 July 1996.

Presentation. C.J. Dover and D.S. Johnson. Changes in the mechanical properties of Cox's Orange Pippin apples during development and subsequent CA storage. International Postharvest Science Conference, Taupo, New Zealand, 4-9 August 1996.

Summary of project background, scientific programme and participating organisations sent to Campden and Chorleywood Food Research Association for publication on a web site. January 1998.

Presentation. C.J. Dover. Improving texture of Cox apples. Top Fruit Storage. East Malling Research Association Members' Day, 26 March 1998.

Johnson, D.S., Dover, C.J., Seymour, G.B. and Shakespeare, L. Investigation of textural quality development and post-harvest softening in Cox's Orange Pippin apples. A review of progress with project SP88. APRC News, April 1988.

Seymour, G.B., Huxham, I.M., Jarvis, M.C., Dover, C.J., Shakespeare, L. and Knox, J.P. (1998). EELS imaging of cell wall calcium and nitrogen in relation to changes in apple fruit texture. For submission to Planta (May 1998).

6. Ph.D. students employed:

The view of the supervisors (Dr Graham Seymour of HRI-Wellesbourne and Dr Paul Knox, Centre for Plant Biochemistry and Biotechnology, University of Leeds) is that Ms Shakespeare is performing effectively. The objectives of the project are being met and her work activities are adequate for the purpose of her degree.

7. Exploitation report:

It is appropriate to consider exploitation opportunities and future plans during the final year of the project. Fortunately mechanisms are in place via English Apples and Pears Ltd and the Apple and Pear Research Council for the effective dissemination of information to fruit growers and those involved in the storage and distribution of English fruit. The more practical outcomes of the project will be transferred in this way and via presentations by HRI staff to grower groups and advisory organisations. Approaches are being made to various funding bodies such as BBSRC, Horticulture Link and EU framework V in order to continue the more strategic elements of the work and particularly the biochemical factors that influence cell wall strength and cell separation processes. There is firm industrial backing for this research since it is imperative that UK apples, particularly Cox, can compete on the basis of texture with the best of foreign imports.

