The Influence of Breaks in Optimal Storage Conditions on 'Cripps Pink' Apple Physiology and Quality

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Abstract

Apples stored onshore in Australia and New Zealand, are maintained at optimal storage conditions with the aid of low temperatures; controlled atmospheres (CA) and new technologies that retard the production or effect of ethylene (AVG and 1-MCP respectively). These technologies allow distribution of the highest quality apples to local and export markets on a year round basis. However, during distribution, maintenance of optimal storage conditions may be lost due to refrigeration system breakdown, operational constraints or management decisions. This thesis quantifies the influence of commercially realistic breaks in optimal storage conditions (temperature and CA) on fruit physiology and quality, both at the time of the break and in subsequent optimal storage conditions. The 'Cripps Pink' ('Pink Lady™') apple cultivar was chosen for consideration in this thesis because it is a high value cultivar that is of considerable importance to the Australian apple industry.

The knowledge of the behaviour of 'Cripps Pink' apples in coolstorage conditions (in air and CA) was confirmed through comparison of physiological and quality change behaviour of fruit from three harvests collected in this research and those reported recently by other authors. The investigation of the influence of breaks in temperature control during storage in air at 0°C, revealed that preclimacteric apples exposed to a break in temperature control, were advanced towards the establishment of the climacteric. Postclimacteric apple, responded by doubling ethylene production a short time after return to coolstorage. Harvest maturity, timing of break during coolstorage, length of break of temperature control and multiple breaks in temperature control, had little influence on the increase ethylene production response. Quality factors (firmness, background hue angle, and titratable acidity) were all reduced as a result of exposure to warmer temperatures, but on return to coolstorage temperatures rates of loss in these quality factors were not influenced by the increased ethylene production.

Short-term (3-day) breaks in CA while fruit remained at refrigerated temperatures were shown to have no substantial effect on fruit physiology or quality, either during the period of the break in CA or in subsequent CA storage. Breaks in temperature control in combination with breaks in CA were observed to cause a doubling of ethylene production on CA stored apples regardless of being returned to 0°C in air or CA. Those apples that were exposed to a break in temperature control and returned to air storage at refrigerated temperature lost quality (firmness and background hue angle) more rapidly than apples not

exposed to breaks in temperature control and transferred to air storage. This result strengthened the knowledge of the influence of ethylene on changes in apple quality, as found for many other apple cultivars.

The influence of the decision to transport fruit in CA or air atmosphere shipping containers was initially investigated with a laboratory simulation. Physiology (respiration rate and ethylene production) of air shipped fruit was found not only to be more rapid, but more variable between fruit, than for apples shipped in CA. This more rapid and larger variation of possible fruit physiologies, suggests that in addition to losing quality at a faster rate, the variation in the quality of fruit shipped in air will also enlarge during shipment. This hypothesis was confirmed with data pooled from treatments subjected to 0°C and 3°C, simulating the likely temperature variability within a shipping container. Validation of the influence of shipping atmosphere on delivered fruit quality, was conducted in the commercial environment. This trial found that the length of time to ship fruit from Australia and New Zealand to European markets was not sufficient to induce commercially significant differences between 'Cripps Pink' apples shipped in the two atmospheres.

Finally, as ethylene production was influenced by fluctuations in temperature control and subsequently affected quality of apples previously stored in CA, an investigative attempt to model ethylene production in temperature variable scenarios was conducted. Published models of ethylene production in apples were adapted to the variable temperature storage scenario and a new model was proposed. Unfortunately, none of the models investigated were able to predict all of the consistent behaviours of ethylene production observed during the experimental work, indicating that more knowledge of the ethylene production pathway is required, before modelling of ethylene production and subsequently apple quality can be conducted successfully.

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