

**Title** The impact of packing line processes on gloss development, and the use of gloss as an indicator of coating integrity and quality of 'Red Delicious' apples (*Malus domestica*)

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### **Abstract**

Apples are coated with food grade waxes to maintain and improve quality, such as color and firmness, and to enhance gloss. In this study, a combination of simulated packing line cleaning and wax application processes were used to evaluate their efficiency in cleaning and developing gloss on 'Red Delicious' apples.

Commercially available alkaline and neutral detergents were applied in a pilot packing line while varying the temperature and dwell time in the dump tank (DT) together with the rinse-water pressure and dwell time on the washing brushes (WB) to simulate the cleaning process. A solvent extraction system quantifying surface residue after cleaning was developed to evaluate cleaning efficiency. The alkaline detergent was more effective in acquiring a cleaner surface than the neutral detergent. Increasing the temperature of the DT also resulted in a significantly cleaner surface.

Cleaned fruit were subsequently waxed with commercially available shellac fruit coatings at different viscosities; they were applied and "dried" in different environmental conditions of temperature and relative humidity (RH) to investigate the conditions conducive for gloss development and the maintenance of the quality attributes of weight and firmness. A non-destructive device for measuring gloss on curved surfaces was developed and correlated to the human perception of gloss. The wax viscosity with RH in the drying zone, and the duration of drying significantly affected the gloss. The inability to remove moisture from the apple surface in the drying zone under high RH conditions in the environment decreased the ensuing gloss as a result of dilution and therefore a decrease in the deposition of the coating thickness. Wax with higher viscosity "dried" under lower RH conditions produced significantly higher glossed fruit compared to a lower viscous formulation. Furthermore, the decay of gloss during storage was accompanied by decreasing attributes of weight and firmness as the uniformity and integrity of the wax coating deteriorated. Respiration as influenced by the availability of O<sub>2</sub> was impacted by the barrier properties of the peel and storage temperature. Hand-coated shellac 'Red Delicious' apples were "dried" at 50 °C under two RH conditions of 25 and 60%, and stored at 4, 10 and 20 °C for a month. In this controlled system, it was determined that the drying treatments resulted in

varied coating thickness, surface roughness and gloss. Surface gloss was determined to be directly related to coating thickness, and inversely to surface roughness through the use of micrographs. The transmission of respiratory gases through shellac was studied by bar-coating polyethylene film with different shellac wet thicknesses, 4 and 10  $\mu\text{m}$ . The transmission rate of  $\text{O}_2$  was higher at higher temperatures with a corresponding increase in respiration rate, production of  $\text{CO}_2$  per g of fruit. The increase in respiration rate was accompanied by an increase in the loss of fruit weight. All of these increases were less pronounced in higher glossed fruit. In contrast the internal  $\text{CO}_2$  concentration was higher for the higher glossed fruit. Coated fruit, compared to the uncoated, recorded lower respiration rates with significantly reduced gloss and weight loss.