INJURY ASSESSMENT IN CITRUS PACKING OPERATIONS

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Physical injury to citrus fruit, either during harvesting or packing is one of the major causes of losses in fresh fruit operations. Injuries caused by rough handling provide sites for spores of some decay causing organisms to develop, resulting in fruit decay. The importance of careful handling and packing cannot be overly stressed as a means of ensuring good keeping quality in-transit, during sales and eventually in the hands of the consumer. This also means maximum profitability to growers and packers of citrus fruit because of increased packout and reduced price adjustments. It is, therefore, important that physical injuries caused by abrasion, dropping or shearing of fruit during harvesting, and packing be minimized to assure good keeping quality during transit, retail marketing and storage in the consumer's home. The key to reducing physical injury is careful assessment of harvesting, handling and packing operations and taking necessary steps to ameliorate those conditions which can lead to fruit injury.

Several methods of injury detection have been proposed (Grierson 1958; Parker et al. 1984; Peleg 1985). In this presentation, discussion will be limited to two procedures, namely, predicting oil spotting before harvest and physical injury detection in the packinghouse using 2,3,5-triphenyl-2H-tetrazolium chloride(TTC).

Prediction of Physical Injury During Harvesting

Oil spotting, also known as Oleocellosis, is one of the most common problems encountered by fresh citrus packers, especially with early season fruit. Navel oranges and lemons are notorious for their excessive susceptibility to oil spotting when harvested in wet conditions created by rain, overhead irrigation, dew or fog (McCornack 1971). Oleo is caused by release of peel oil from oil glands resulting in the formation of green or brown spots depending on fruit color. Increased water content of fruit following rain, irigation or in foggy conditions causes the fruit to become turgid and the oil glands to protude, thus becoming more susceptible to rupture.

Determination of pressure needed for oil release from the rind has been recommended as a measure of potential mechanical injury and oil spotting during harvesting of navel oranges and lemons (Wardowski et al. 1976). A spring-loaded pressure tester (also called Penetrometer), with a 5/16 inch cylindrical tip (Figure 6) is pressed against the fruit surface until peel oil is released onto a small piece of absorbent tissue placed near the penetrometer tip.

If lemon peel oil is released from the rind with 3 lbs of pressure or less, harvesting could lead to severe physical damage and poor fruit appearance. If oil release occurs between 3 and 7 lbs pressure, extreme care must be exercised during harvest to avoid excessive damage. Normal harvesting

can be carried out if the force required for rupture of oil glands exceeds 7 lbs.

A pressure tester Model FT011 (0-11 lbs), recommended for citrus fruit, can be obtained from HESCO, P. O. Box K, Waverly, FL 33877 or from McCormick Fruit Tech., 6111-A Englewood Avenue, Yakima, Washington 98908-2341 (Figure 6).

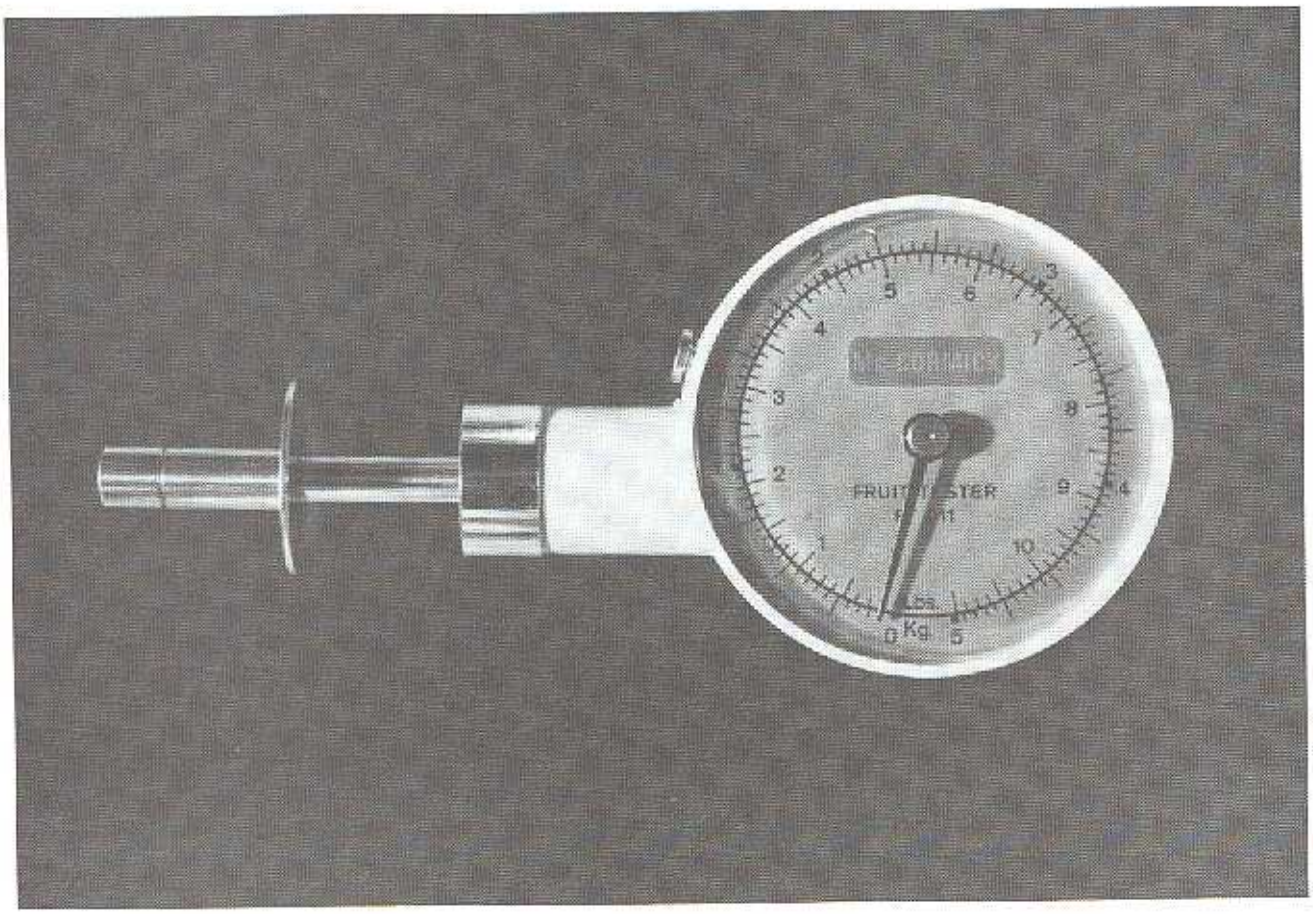

Figure 6. Fruit pressure tester. EFFEGI, Alfonsine, Italy.

Physical Injury Assessment in Citrus Packinghouses

Numerous methods have been used to evaluate the effects of various packing operations and machinery on injury to citrus fruit. These include measuring CO_2 production (Parker et al. 1984), weight loss (Peleg 1985) and staining of injured tissue with reagents or dyes (Grierson 1958; Ismail and Miller 1988; McCornack 1971, 1978; Roistacher et al. 1956). A more recent method of damage evaluation involves the use of an instrumented sphere to measure forces encountered by fruit on the packing line (Miller and Ismail 1988). Currently the procedure which is easiest to use and interpret for assessing physical injury in a Florida fresh packinghouse is that using 2,3,4-triphenyl-2H-tetrazolium chloride (TTC).

TTC is a water soluble powder which becomes insoluble and turns bright red when it comes in contact with freshly exposed (injured) tissue. Thus, cuts and scratches on citrus fruit can become visible to the naked eye and its extent can be evaluated at room temperature without use of instruments or measuring equipment. The method was first developed by Roistacher et al. (1956) and was later adapted by McCornack (1978). We have also tested it repeatedly in evaluation of harvesting and packing of Robinson tangerines at Haines City Citrus Growers Association. It is routinely used by Sunkist Growers, Inc. to evaluate equipment used in California citrus packinghouses.

Procedure for Evaluation of Packinghouse Equipment for Physical Injury to Citrus Fruit Using TTC

1. Purchase TTC from Aldrich Chemical Co., Inc., 940 West Saint Paul Avenue, Milwaukee, Wisconsin 53233 or from your packinghouse chemical supplier.
2. Prepare 0.5% TTC solution by placing 19 grams of the powder (approximately 13 level teaspoonfuls) in a clean plastic gallon jug. Add a quart of tap water and shake until the powder is dissolved. Fill the jug with water. Exercise caution in handling the chemical by wearing rubber gloves and avoid breathing of dust.
3. Collect samples of 6-24 grapefruit, oranges, or tangerines off the packinghouse line where physical damage is likely to occur. This may be before and after dumping, before and after washing, after drying, fungicide application, waxing, etc. You may collect one sample from each location for cursory surveying or three samples per location for a more accurate statistical evaluation of results.
4. Clean unwashed fruit gently with a rag or a sponge.
5. Place fruit in a dish pan and pour TTC solution. Keep fruit submerged for 30 minutes.
6. Pour TTC solution back into the jug and refill the dishpan with clean tap water. Again keep fruit submerged for 5 minutes.

7. Place fruit in a brown paper bag overnight, or a minimum of 8 hours. Label each bag with sample location or number.
8. Examine fruit for amount of stained spots, cuts, scratch marks or bruises and divide them into sound, slight, moderate and severely injured categories.
9. Calculate percentage of fruit in each category of injury.
10. Use these values to determine locations where most of the damage is taking place and make any necessary changes or adjustments to the packinghouse line.

Packinghouse Changes to Reduce Fruit Injury

The following are some of the changes which will reduce physical injury to fruit in the packinghouse (Miller and Ismail 1988).

1. Avoid overfilling of incoming pallet boxes and facilitate fruit movement after dumping.
2. Maximize trash elimination through use of sloping belt or use of a metal rod spaced section.
3. Use pregraders to clip off stems from fruit after dumping, and remove rots and splits.
4. Check and remove any stems or twigs caught on the line several times daily.
5. Optimize brushing time and brush speed. Brush speeds over 120 rpm for washers and 100 rpm for

fungicide and wax applicators should be carefully reviewed for benefit vs damage to fruit.

6. Eliminate brushes with stiff bristles and use wipeout devices. Fruit with brush damage (tiny scratches on the surface of the flavedo) are more susceptible to chemical burn or excess heat and will lose weight during marketing.
7. Condition new brushes before the start of the season, particularly those used on tangerine packing lines. A plywood sheet lightly touching the rotating brushes for 1 to 2 hours is effective in conditioning new brushes. Prewetting of fruit prior to brushing also helps reduce brushing damage. Also, installation of new brushes may be delayed until a midseason break when the fruit peel is more mature.
8. Insure that fruit deliveries from roller conveyors are equipped with ejector slats on the drive shafts, and deliveries from slat conveyors are equipped with spinner rolls.
9. Minimize fruit drop and right angle turns and improve fruit flow.
10. Reduce friction between fruit and shears through design and material selection.
11. Eliminate or minimize fruit rubbing against the sides of drying tunnels or other conveyors.

12. Avoid overfilling of cartons.

Finally, use the TTC injury detection test at least twice a year on various segments of your packinghouse machinery, especially when new or delicate fruit are about to be packed. Results of each test should be filed for future reference.

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