Orange Fruit Processing

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Commercially Important Orange Varieties

- Valencia most widely grown, late maturing, good for FCOJ
- Pineapple mid season maturing, good fresh & processing qualities
- Hamlin early maturing, beats the freeze
- Pera late maturing, most popular in Brazil

Fruit Quality Factors

- Soluble solids
- Acidity
- Brix/acid ratio
- Juice color
- Low level of bitter compounds
- Good flavor

Juice Categories

- Fresh unpasteurized
- FCOJ
- Chilled orange juice
- Canned orange juice

Fresh Unpasteurized Juice

- Minimal treatment after extraction before packaging and distribution
- Excellent flavor, but shelf life < 3 days
- Must be stored at < 10C, preferably cooler

Preparation for Processing



Frozen Concentrated Orange Juice (FCOJ)

- Developed 1940's
- Initial product had poor flavor & color
- Development of high vacuum, low temperature evaporator improved quality
- Concentrate was added to a small quantity of fresh "cut back" juice to restore flavor & aroma lost during concentration

Frozen Concentrated Orange Juice (FCOJ)

- Original low temperature evaporators have been replaced by:

 A) multi-effect, multi-stage, high temperature, short time evaporators
 B) thermally accelerated short time evaporators (TASTE)
- Volatile aroma & flavors compounds are collected (aqueous essence or essence oil)



Multiple- (two-) effect evaporator



Frozen Concentrated Orange Juice (FCOJ)

- Juices of various origin are concentrated & stored in refrigerated tanks
- Frozen concentrates are blended to achieve desired final product
- Flavor is restored by addition of peel oil & essence
- Blend is packaged & distributed in frozen form

Chilled Orange Juice

- Fresh juice pasteurized, either hot filled or aseptically filled after cooling into sterile containers
- Blending to achieve uniform quality
- FCOJ juice is reconstituted, pasteurized & peel oil added for flavor, then filled into sterile packages

Package Considerations

- Glass deterioration of color, flavor and loss of ascorbic acid
- Plastic containers or plastic lined cartons - orange flavor compounds migrate into the plastic container or container liner

Canned Orange Juice

- Produced by reconstituting FCOJ or blending juices from several varieties
- Steps involved:
 A. Deaeration
 B. Deoiling
 C. Pasteurization
 D. Canning

Juice Deaeration

- Reduces levels of dissolved oxygen
- Reduces flavor deterioration
- Prevents degradation of ascorbic acid
- Reduces frothing during the filling step

Juice Deoiling

- Controls the peel oil level of freshly extracted juices prior to packaging
- Performed under vacuum with the application of mild heat to produce vapors which remove about 90% of the volatile peel oil
- U.S. standards specify an upper limit for peel oil content (limonene)

Juice Pasteurization

- Required to inactivate enzymes and destroy microbial contaminants
- Inactivate PME to stabililize cloud
- Juice is rapidly heated to 92C in tubular or plate heat exchangers and held for 30 sec
- Juice is then pumped into filler tanks and rapidly filled into cans

Juice Canning

- After filling, live steam is injected into the headspace followed by closing of the can
- Cans are inverted to sterilize the inside of the lid and cooled as they are conveyed
- Cans emerge with some residual heat to facilitate drying, thereby preventing rusting
- Plain tinned or enameled cans are typically used to prevent discoloration and loss of ascorbic acid

Processing By-Products

- Orange flavor volatiles aqueous essence, used for flavoring purposes
- Orange peel oils cold pressed oil, used for flavoring purposes
- Water extracted soluble solids (WESOS) or pulp wash - used for beverages
- Waste products animal feed, flavonoids, pectin



Fruit Sections

- Manual sections Cold peel method where the peel & outer membrane is sliced off manually with a knife, or hot peel method where the peel is subjected to steam scalding or hot water immersion
- Sections are separated with knife from the peeled fruit, followed by packing into containers in juice or light syrup

Syrup for Refrigerated Grapefruit Sections

- 12 15 Brix
- Citric acid (0.5 1%)
- Potassium sorbate and sodium benzoate (0.1% each)
- 30 day shelf life when stored at < 40F

Fruit Sections

- New system Vacuum infusion of hot water or pectic enzyme solutions into scored grapefruit peel
- Peel is easily removed and yield of sections is greatly improved
- Sections may be treated with calcium salts & edible coatings to improve quality
- Packaged in modified atmosphere films





Gas and water vapor permeability



Oxygen and carbon dioxide transfer from a fruit



Post-harvest Handling

- The objective: To extend the shelf life of fresh horticultural commodities.
- We must understand the biological and environmental factors involved in deterioration.
- Use Post-harvest technology procedures which will delay senescence and maintain the best possible quality

Post-harvest Handling (Some benefits)

- Standardize/Increase benefits: By sorting, sizing, washing.
- Extend shelf-life: Temperature, relative humidity, gas composition, light, physical damage.
- Provide added value: Fresh-cut, packaging

Flow chart for Post-harvest handling operations

Harvesting Washing **Sorting** Packing Cooling **Storage Transportation** to Retail Stores

Flow chart for Fresh-cut process

Harvesting **Spinning** Washing/cooling Packing Sorting Storage Cooling **Transportation** Cutting to Retail Stores Washing