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 < 10°C, preferably cooler
Preparation for Processing

Washing

Sorting

Fresh

Fungicide/wax

Processed

Extractor
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- Original low temperature evaporators have been replaced by: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)
Concentrating Juices

1. Clarified serum

2. Hyperfiltration

3. Hyperfiltration

Single strength juice

Centrifuge

Pulp discharge as cake or slurry for later reconstitution

3-effect thermal evaporator

2-effect thermal evaporator

Concentrated serum for subsequent reconstitution
Multiple- (two-) effect evaporator

S1  \rightarrow  V1  \rightarrow  F2  \rightarrow  C1  \rightarrow  P1  \rightarrow  S1

F1  \rightarrow  V1  \rightarrow  F2  \rightarrow  C2  \rightarrow  P2  \rightarrow  V2
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 stabilize cloud
- Juice is rapidly heated to 92°C 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
The MAP System

Plastic film
Area
Volume
Permeability $O_2$
Permeability $CO_2$
Thickness

Produce
Weight
Oxygen uptake
$CO_2$ production
Gas and water vapor permeability

- Adsorption
- Diffusion
- Desorption

Film

High concentration → Low concentration

gas flux
Oxygen and carbon dioxide transfer from a fruit

\[ \text{O}_2 \text{e} \rightarrow \text{O}_2 \text{i} \rightarrow \text{CO}_2 \text{i} \rightarrow \text{CO}_2 \text{e} \]
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

1. Harvesting
2. Washing
3. Sorting
4. Packing
5. Cooling
6. Storage
7. Transportation to Retail Stores
Flow chart for Fresh-cut process

Harvesting → Washing/cooling → Sorting → Cooling → Cutting → Washing

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