



## **Frozen Concentrated Orange Juice From Florida Oranges<sup>1</sup>**

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FCOJ — Frozen Concentrated Orange Juice is the star of the Florida citrus industry. This product, which was developed in 1945-46, requires 80% of the annual Florida orange crop to meet the consumer demand. During the 1979-80 season, 173 million boxes (7.8 million tons) of Florida oranges were used to make FCOJ. This is more than 30 pounds of juice per person in the United States.

### **WHY IS FCOJ SO POPULAR?**

There are a number of reasons FCOJ is so popular. It is very convenient and time saving compared to squeezing juice at home. It readily pours when thawed and easily reconstitutes with water. The temperature of the frozen FCOJ causes the reconstituted juice to be pleasantly cool immediately.

Most of the success of FCOJ is probably due to its good juice flavor. Lack of flavor was a problem that had to be overcome in the development of FCOJ. In the concentration process, parts of the orange responsible for good flavor are lost when water is evaporated. The discovery that fresh orange juice flavor could be restored by adding a small percentage of unconcentrated fresh juice was the basis for the success of FCOJ.

In 1948, U.S. patent No. 2,453,109 was issued to Florida researchers for the process to manufacture FCOJ with the addition of approximately 10 percent fresh juice to the final product.

When FCOJ is prepared from fresh juice there is very little loss of nutritional value. For example, 98% of the Vitamin C, the most abundant vitamin in fresh orange juice, is retained in FCOJ. This is a loss of only 2% in the process of juice extraction, juice concentration and freezing.

### **ORANGES TO FCOJ — HOW FCOJ IS MADE**

FCOJ is produced from oranges in approximately 35 Florida citrus processing plants (see Figure 1). The mechanical extractors used to obtain juice from the fruit are amazingly efficient and remove the juice from 400 to 700 oranges per minute. The processing plants have very large capacities with some plants processing more than 100,000 boxes of oranges per day. This is 517,000 gallons of orange juice per day — a year's supply of FCOJ for 17,000 people.

### **STEPS IN THE FCOJ PROCESS**

1. A fruit sample is tested for quality before the oranges are approved by state authorities for processing.
2. Fruit is cleaned and washed.
3. Orange oil is recovered from the peel of the fruit.
4. Juice is extracted from the fruit. Approximately 50% of the fruit weight is juice, the remainder is peel, pulp and seeds.

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5. Juice is screened to remove pieces of seeds and large particles of pulp.
6. Juice is heated to inactivate the natural enzymes present in the juice. If not inactivated these enzymes cause loss of quality.
7. Juice is concentrated in a high vacuum evaporator. Water in the juice is evaporated and the juice sugars and solids are concentrated. The juice soluble solids (Brix) in the fresh juice are approximately 12%. In the concentrate the Brix is increased to approximately 65%.
8. The concentrate is frozen and stored until needed.
9. Fresh juice is mixed with frozen concentrate. The final consumer product has 41.8% juice sugars Brix. When mixed with 3 volumes of water the reconstituted juice is 11.8 °Brix, approximately the same as the fresh juice.

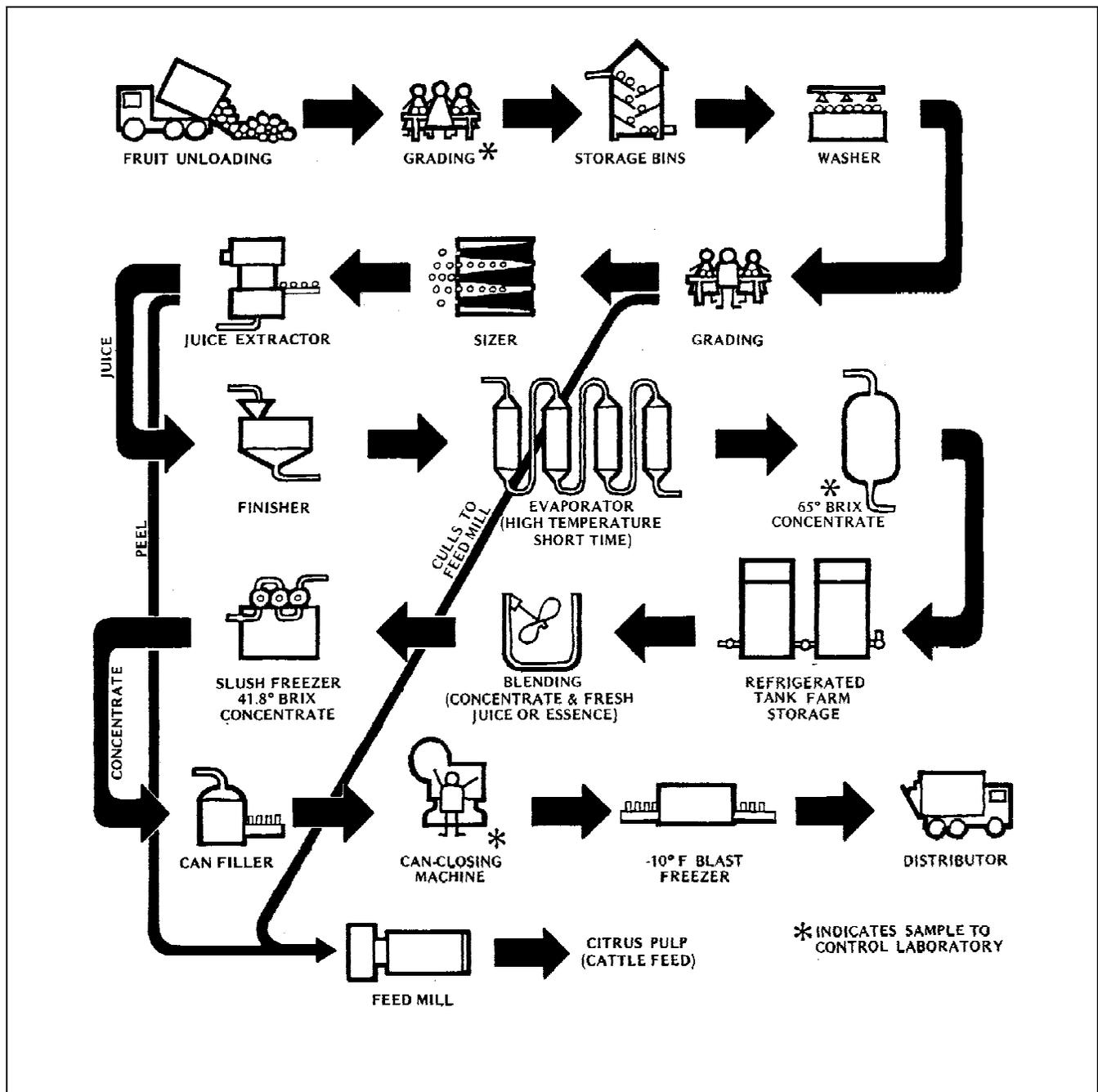
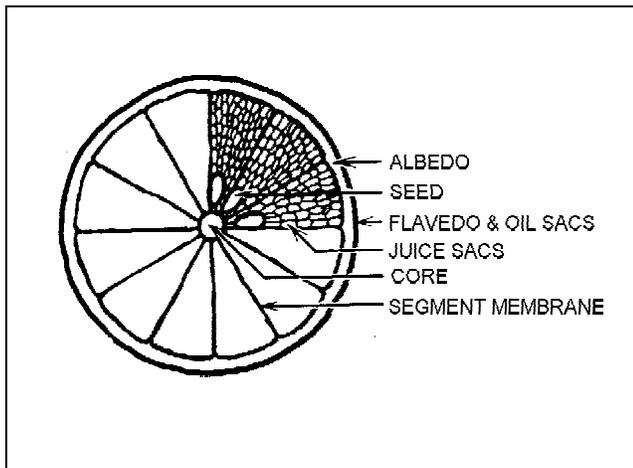


Figure 1. Steps in the production of frozen concentrated orange juice.

A cross section of an orange is presented in Figure 2.



**Figure 2.** Cross section of an orange.

The peel which consists of the flavedo and albedo provides useful products. Sacs in the flavedo provide peel oil (citrus essential oil) which is used in flavors and perfumes. In small amounts citrus oil adds desirable flavor to orange juice, however, too much oil gives a bitter taste to the juice. After removing the peel oil, the remainder of the peel, seed, and segment membranes are dried to produce a nutritious cattle feed.

### MAINTAINING FCOJ QUALITY

To insure the FCOJ produced in Florida is of the highest quality, three agencies directly regulate the industry. These are the Florida Department of Citrus, the Florida Department of Agriculture and Consumer Services, and the U.S. Department of Agriculture.

### FRESH FRUIT INSPECTION

Assuring that oranges processed for FCOJ meet the requirements for quality is the responsibility of the Florida Department of Agriculture and Consumer Services, Fruit and Vegetable Inspection Division, Winter Haven, Florida. From each truckload of oranges that is delivered to the citrus plant a sample of oranges is taken, the fruit is juiced and the juice evaluated for maturity requirements of °Brix, Acid, Ratio, and percent juice content.

**°Brix** (total soluble solids) — As used in the citrus industry this is a measure of the total soluble solids in the juice or concentrate. These soluble solids are primarily sugars; sucrose, fructose, and glucose. Citric

acid and minerals in the juice also contribute to the soluble solids. Brix is reported as "degrees Brix" and is equivalent to percentage. For example, a juice which is 12 degrees Brix has 12% total soluble solids.

**Acid** (titratable acidity) — a measure of total acid present in a juice. The predominant acid naturally occurring in orange juice is citric acid. There are small amounts of malic acid and tartaric acid present. The amount of acid present in the juice is reported as percent citric acid.

**Ratio** (Brix/Acid Ratio) — The Ratio or °Brix/Acid Ratio is determined by simple division. For example: if the °Brix is 12 degrees and the citric acid value is 1.0 percent, the Ratio would be 12.

$$\frac{12\text{Brix}}{1.0\text{Acid}} = 12\text{Ratio}$$

If another juice had a °Brix of 12 and an acid value of 0.8 percent, the ratio would be 15.

$$\frac{12\text{Brix}}{0.8\text{Acid}} = 15\text{Ratio}$$

The Ratio cannot be less than 12.5 nor more than 19.5. This balance between sugars and acid, sweet and tart, is an important measure of juice flavor quality and maturity.

### FCOJ INSPECTION

The U.S. Department of Agriculture standard for Grade A flavor must be met for all FCOJ packaged in Florida for sale in the United States. The following requirements apply:

### PRODUCT DESCRIPTION

Frozen concentrated orange juice (or frozen orange juice concentrate) is the product defined in the standards of identity (21 CFR 27.109) issued under regulations of the Federal Food, Drug, and Cosmetic Act.

- (a) Without sweetener. The Brix value of the finished concentrate is not less than 41.8 degrees and shall be such that when reconstituted according to directions, the reconstituted juice tests not less than 11.8 degrees Brix.

(b) "U.S. Grade A" (or "U.S. Fancy") is the quality of frozen concentrated orange juice that reconstitutes properly and of which the reconstituted juice:

- (1) has an appearance similar to that of fresh orange juice;
- (2) has a very good color;
- (3) is practically free from defects;
- (4) possesses a very good flavor; and
- (5) scores not less than 90 points when scored in accordance with scoring system outlined in this subpart.

(c) Factors rated by score points. The relative importance of each factor which is scored is expressed numerically on a scale of 100. The maximum number of points that may be given such factors are:

<u>Factors</u>	<u>Points</u>
Color .....	40
Defects .....	20
Flavor .....	<u>40</u>
Total Score .....	100

The U.S.D.A. has inspectors at each processing plant who must be present any time fruit is being processed. The inspectors continually evaluate the FCOJ being produced to assure it meets Grade A standards. The inspectors also have the responsibility of seeing that all the equipment and facilities used in processing are maintained in a sanitary condition.

**FLORIDA DEPARTMENT OF CITRUS**

The Florida Department of Citrus is empowered to make rules and regulations regarding the operation of citrus processing plants and the products, such as FCOJ, that they produce. The department has adopted regulations for FCOJ which are more stringent than required by the U.S. Department of Agriculture. These regulations serve to make the Florida FCOJ the highest quality product available to the consumer.