Oranges and Tangerines

DAN KIMBALL[1]

INTRODUCTION

CITRUS fruits date back as far as 2,200 B.C. when tributes of mandarins and pummelos were presented in the imperial court of Ta Yu in China (Webber, 1967). However, it is believed that citrus originated somewhere on the slopes of the Himalayas in Northeastern India. The citron, lemon, lime, and some mandarins spread south into India and then eastward into Southeast Asia (Nagy et al., 1977). The citron also made its way to Europe and was first mentioned in 310 B.C. by Theophrastus. The sour orange, lemon, and sweet orange followed into Europe centuries apart (Webber, 1967). From Europe, the delicious fruit spread throughout the Mediterranean area and was introduced into the Americas by Columbus. From there, Australia and South Africa borrowed from both American and European horticulture. Over the years, China lost citrus cultivation, which, in recent years, it has regained, bringing the cycle of the propagation of citrus full circle. It is unknown when and where China's neighbor, India, introduced citrus within its borders, but it has developed into a major citrus processing area as well.

Juices and fruit products play a major role in human nutrition and in the food industry around the world. Citrus juices comprise almost 70% of all fruit or vegetable juices consumed in the United States (Nagy and Attaway, 1980). Citrus juices comprise the major portion of the worldwide fruit product market second only to grapes in total production. Every continent, except Antarctica, is endowed with citrus-growing regions. Within the

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citrus juice industry, orange and tangerine products dominate. Asia dominates the mandarin industry with its unique Japanese, Chinese, and Indian species. The terms *mandarin* and *tangerine* are used interchangeably and represent the same species. Some reserve the term *tangerine* for deeper colored fruit. Europe is known for its unique blood oranges; northern Africa and the Middle East for their sugarless and Shamouti citrus; Australia, South Africa, and California for their Navel Oranges; Argentina for its lemons; Texas, Indonesia, and New Zealand for their grapefruit and pummelos; and Florida and Brazil for their orange juice varieties. However, with the advent of high-speed transportation and improved storage technology, citrus products of all types are available to most geographical regions of the world on a year-round basis. Table 9.1 summarizes worldwide citrus production based on U.S. Department of Agriculture statistics (Anon., 1992). Table 9.2 summarizes citrus production and value in the United States based on U.S. Department of Agriculture statistics (Anon., 1992). There was no production for Texas reported in 1991 due to a devastating freeze, and the low production and high values

TABLE 9.1. Preliminary 1991–1992 World Production of Oranges and Tangerines (Agricultural Statistics, 1992, United States Department of Agriculture).

Oranges		Tangerines	
Country	Metric Tons × 1,000	Country	Metric Tons × 1,000
Brazil	13,180	Japan	1,860
United States	8,135	Spain	1,400
Spain	2,490	Brazil	605
Mexico	2,100	Italy	500
Italy	2,000	Turkey	320
Egypt	1,600	United States	308
Turkey	850	Morocco	294
Morocco	790	Egypt	265
Greece	770	Mexico	165
Argentina	750	Israel	97
South Africa	665	Greece	75
Cuba	600	Uruguay	66
Israel	550	Australia	51
Australia	509	Cuba	15
Cyprus	173	Cyprus	10
Uruguay	130		
Gaza Strip	120	Total	6,031
Chile	117		
Japan	38		
Total	35,567		

TABLE 9.2. Preliminary Production and Value of the 1991–1992 Orange and Tangerine Production in the United States (Agricultural Statistics, 1992, United States Department of Agriculture).

	Florida	California	Arizona	Texas	Total	Value ($ mil)	Percent Proc.
Valencias							
boxes × 1,000	56,400	31,000	1,600	10	89,010	—	—
$/box	8.91	4.01	4.42	13.10			
Navels and early fruit							
boxes × 1,000	83,400	35,100	780	20	119,300	—	—
$/box	7.39	9.69	10.88	14.98			
Total oranges							
boxes × 1,000	139,800	66,100	2,380	30	208,310	1,594	73.7
$/box	8.00	7.02	6.54	14.37	7.72		
Tangerines							
boxes × 1,000	2,600	2,400	1,200	—	6,200	104	27.0
$/box	20.77	14.75	12.37	—	17.12		
Tangelos							
boxes × 1,000	2,600	—	—	—	2.600	23	49.7
$/box	9.04	—	—	—	9.04		
Temples (tangors)							
boxes × 1,000	2,350	—	—	—	2,350	20	63.6
$/box	8.55	—	—	—	8.55		

for Texas in the 1991–1992 season reflect the effects of this agricultural disaster. This same freeze severely affected production in Arizona and California in the 1990–1991 season and also affects the 1991–1992 figures.

CITRUS FRUIT CLASSIFICATION

The commonly accepted Swingle and Reece classification of citrus fruits describes two main species of commercial oranges (*Citrus sinensis* (L.) Osbeck, or sweet orange, and *Citrus aurantium* L., or sour or Seville orange) (Swingle and Reece, 1967). It also describes five main tangerine species. Tangerines are often referred to as exotics in the citrus industry due to the great diversity in characteristics exhibited by the fruit. The main five Swingle and Reece species are *Citrus reticulata* Blanco (common tangerines), *Citrus unshiu* Marc. (Satsuma tangerines), *Citrus deliciosa* Tenore (Mediterranean tangerines), *Citrus nobilis* Lourerio (King Tangerines), and *Citrus madurensis* (Lourerio) (Calamondin Tangerines).

The sweet oranges can be further divided into four main varietal groups: common, navel, blood, and acidless or sugar oranges (Hodgson, 1967). The common oranges are the most common, as the name indicates, comprising the largest group of commercial citrus fruits and processed products.

The dominant variety in this group is the Valencia orange. It is believed to have originated in the Azores Islands or Portugal and not in Valencia, Spain, a well-known citrus-growing area. This variety is clearly the main citrus variety grown in all the world. There are several reasons for this. One is that it is a hardy tree that adapts to a wide variety of climates and horticultural conditions. It also possesses an excellent flavor, both as a fresh fruit and as a juice. Citrus juice is the principal citrus product in the world, and the Valencia orange is believed to provide the best orange juice. The orange is very juicy and has a high juice yield when processed. It has a better or deeper color than many varieties, and it contains some, but few, seeds. Its growing season is late, approximately one year from bloom in California and just less than a year in Florida. In tropical countries, fruit growth occurs year-round. Even though the Valencia orange is juicy and, therefore, a messy orange when used as fresh fruit, and though it has seeds, some places, like California and Australia, grow Valencia as a fresh fruit simply because it has a late season. The late season Valencia helps provide a year-round fresh fruit market in navel growing areas. Approximately forty commercial common orange varieties exist, many of which are very similar to the Valencia orange (Kimball, 1991).

The second varietal group of the sweet orange is the navel orange. Navel oranges are characterized by a rudimentary secondary fruit in the apex of the primary fruit, which resembles a human navel. Navel oranges are considered the best fresh fruit orange due to the fact that it is less juicy than the Valencia, is totally seedless, has excellent flavor, and is an early season fruit. Some navel varieties have been bred to mature especially early in order to maximize the benefits of the December Christmas markets. The main variety in this group is the Washington navel, which is the second most popular citrus variety behind the Valencia orange. The Washington navel originated in Riverside, California, and has since spread around the world. The main attraction of the Washington navel orange is that it generates greater profits when sold as fresh fruit than processed oranges. A common practice is to harvest navel or common oranges for available fresh fruit markets and then send culls or extraneous fruit to a juice plant. This maximizes grower returns on their fruit. The disadvantage of navel oranges is that navel oranges develop a delayed bitterness after juicing, which degrades their value as juice products. This disadvantage has been largely overcome by the recent advent of commercial debittering that renders navel, and other bitter citrus varieties, less bitter or nonbitter.

Blood oranges are considered to be the most delicious of all citrus fruit and are found primarily in the Mediterranean area. The main disadvantage of this fruit is that the anthocyanins that provide the deep red color have a tendency to fade during processing and storage. This undesirable muddy color can be removed with treatment of activated charcoal but significant losses of ascorbic acid also occur. High and stable ascorbic acid levels have always been associated with citrus juices and are considered a major source of appeal. Replenishing of lost ascorbic acid is not allowed in most markets, rendering blood orange juice inferior to other major juice varieties.

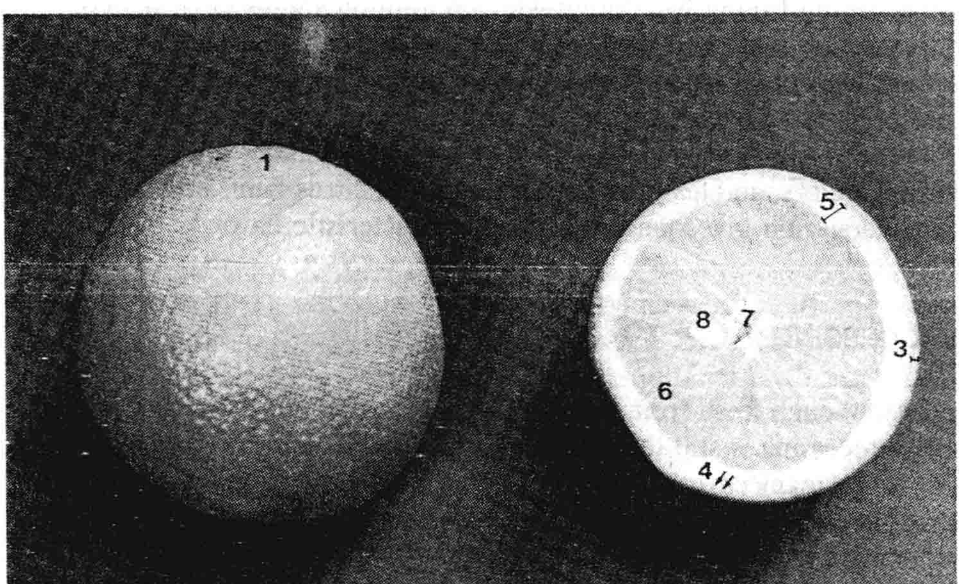
Acidless oranges produce juice very low in acid. Citrus juices generally possess a low enough pH or high enough acid level to prevent the growth of pathogenic microorganisms. In acidless orange juice, the acid level usually is low enough to allow such growth. The excessive sweetness and health risk of processing renders this varietal group, grown mainly in the Mediterranean area, inferior to major juice varieties.

The sour oranges constitute a separate species of citrus fruit but are closely related to the sweet orange species. The Seville orange is probably the dominant variety in this species. It is grown primarily for its peel, which is used in the manufacture of marmalades. The British consider marmalade made from the Seville sour orange to be the best in the marmalade production. The juice by-product from marmalade peel manufacture can be debittered and added to 100% juice products at the 5% level, according to the United States standards of identity for several orange juice products without special declaration.

The common mandarins or tangerines are the largest species among the tangerines. Some of the most common varieties are the Clementine and Dancy tangerines and are characterized by a tighter rind. The Satsuma tangerines dominate the Japanese citrus industry. The Mediterranean tangerines are grown primarily in the Mediterranean basin and contain the broadest distribution of varieties. The King tangerines are the least cold-tolerant and are the largest of the tangerines; however, they are of lesser importance in the citrus industry. Some important hybrids that are most closely associated with the tangerine species are the Minneola tangelo (tangerine x pummelo), the Orlando tangelo, and the Temple tangor (tangerine x orange).

CITRUS FRUIT ANATOMY

Citrus fruits are comprised of an outer flavedo layer that contains the exterior fruit color and sesquiterpene oil sacs that protect the fruit from insects and microorganisms. Just under the flavedo is a white spongy albedo layer (Figure 9.1). Tangerines are characterized by a looser flavedo/albedo layer that makes them easier to peel. This loose rind makes juicing opera-



1 Stem end (proximal)
2 Stylar or blossom end (distal)
3 Flavedo
4 Oil cells
5 Albedo
6 Septum
7 Fruit axis (half hollow)
8 Seed (partially cut)

Figure 9.1 Anatomy of citrus fruit (courtesy of Westfalia Separators).

tions more difficult or messy. Tangerine fruit requires much gentler handling and usually cannot be stored for any length of time prior to processing. In the Orient, however, they take advantage of this by producing canned tangerine sections. The looser rind facilitates easier peeling and sectionizing.

Under this layer are the fruit sections divided by membrane material. Each section contains many vesicles that are elongated and attached to the core or center of the fruit. Within the vesicles are many juice cells. These juice cells are also elongated and attached to the center of the fruit and consist primarily of enlarged vacuoles that contain the juice. The nucleus of these cells and the other organelles are located essentially in the membrane of the expanded juice vacuole. It has been shown that the juice in the vacuole is clear or devoid of cloud material (Bennett, 1987). As the fruit matures, carbohydrates and water from the sap flow of the tree accumulate in the juice vacuole. The mitochondria in the membrane of the juice cell are active during maturation, producing citric acid in the Krebs cycle, which also accumulates in the juice vacuole. This accumulation and subsequent dilution with water and carbohydrate accumulation results in the change in acidity of various juices with maturation. The general trend is for acid to reach high concentrations in early season fruit and then to either be diluted out by fruit growth and dilution and/or citric acid depletion through increased metabolic demand in warmer weather (Kimball, 1984). The combination of water, carbohydrates, organic acids, pulpy textures, cloudy opaqueness, carotenoid and anthocyanin pigments, sesquiterpene oils, and trace flavor components constitute the recognizable flavors, colors, and textures we associate with citrus fruits and their products. Tangeritin gives tangerines their characteristic flavor.

PROCESSING

Even though fresh fruit packing is common and more financially lucrative, processing is still the major treatment of citrus fruit. One reason for this is that many citrus-growing regions cannot grow citrus of sufficient exterior quality to appeal to fresh fruit consumers. Citrus fruit is processed in a number of different ways. Figure 9.2 illustrates a typical juice-processing scheme.

FRUIT UNLOADING

Fruit arrives at the juice plant from either the citrus grove or a packing house. The source of the fruit is important to the processor. Fruit from the field usually contains many leaves and stems that can affect conveying

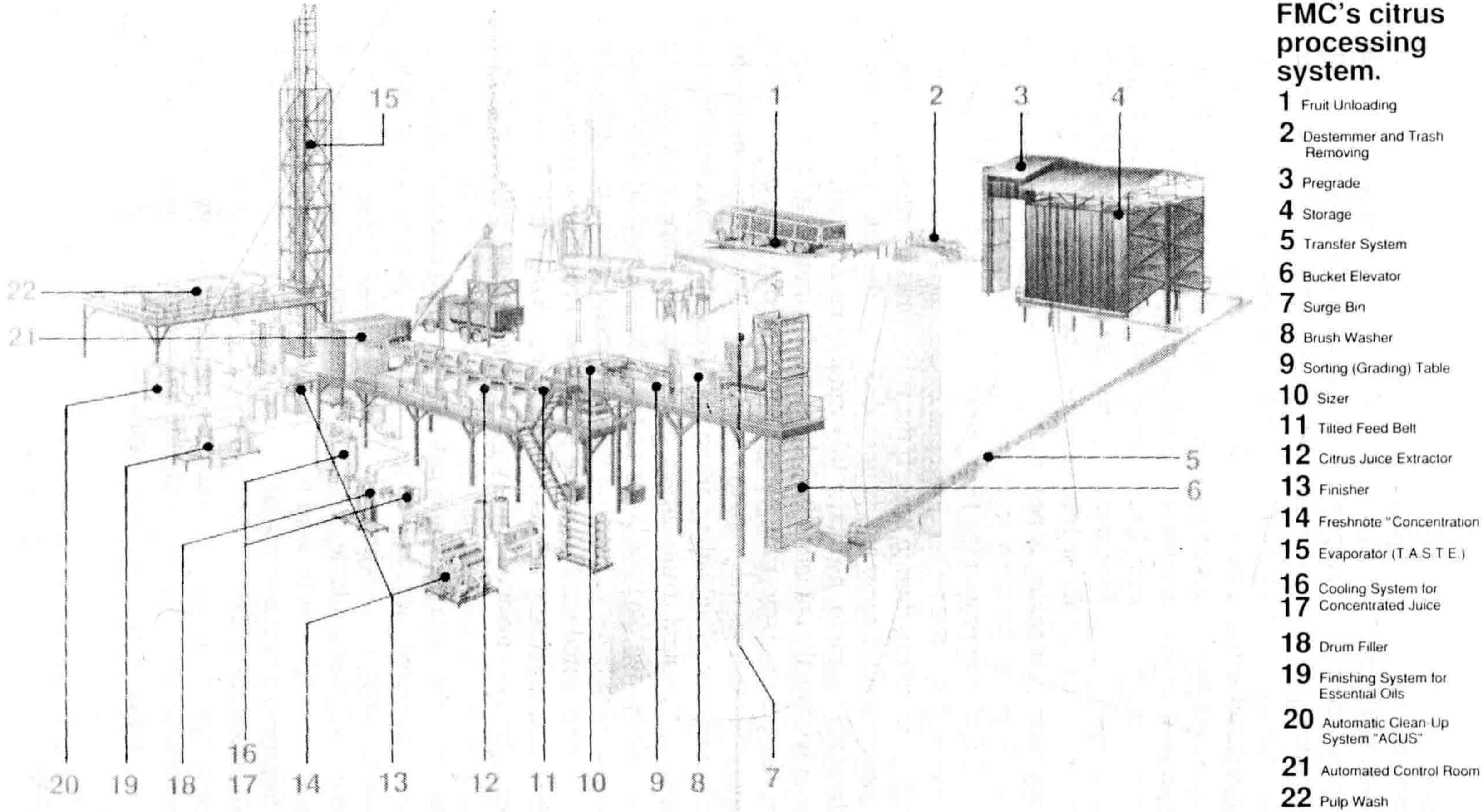


Figure 9.2 Citrus processing general schematic, including fruit unloading, storage, washing, extraction, finishing, and evaporation (courtesy of FMC).

equipment. Such fruit can be passed over a trash or leaf eliminator, such as a slanted tilted belt that allows round fruit to roll down the tilt while conveying nonround trash perpendicularly up the slant into a trash container. Another popular trash eliminator is the spread roller conveyer, which consists of roll bars with sufficient separations between them to allow trash to fall between but retain the larger diameter fruit. Since field run fruit has not been checked for inferior fruit, field run fruit often requires a pregrading during unloading. Fruit coming from a packing house, on the other hand, has already had the trash removed; the fruit most likely has been waxed since packing houses do not like to grade their fruit until it has been waxed; and inferior fruit has mostly been graded out. Thus, no pregrading during unloading is necessary.

Fruit destined for the fresh fruit markets is generally harvested into $4 \times 4 \times 3$ ft bins to protect the fruit; however, fruit destined for juice is usually conveyed by open trailer. Fruit can be unloaded using bin dumpers if the fruit comes to the plant in bins. If the fruit comes in trucks, the truck usually mounts a tilted ramp and is unloaded from the side or rear of the trailer. Instead of a ramp, hydraulic lifts can elevate the trailer.

Fruit can be directly unloaded into the plant for immediate processing, or it can be stored in large fruit storage bins. The use of bins provides a surge supply that enables the plant to run consistently and, thus, more efficiently since the rate of unloading or inbound fruit rarely matches the rate of processing. Inbound fruit surges are common since fruit can be harvested only during daylight hours and is generally packed only in the daytime at packing houses. The fruit to be processed builds up during the day and must be stored until it can be processed. Processing plants often run 24 hr a day, especially during heavy or peak harvesting times of the year. During times of inbound fruit surges beyond the capacity of available fruit storage bins, truck trailers often serve as additional storage. Trailers are parked near the juice plant and unloaded as room becomes available. Field bins can also be used, as well as fruit bins at packing houses; however, there are often times when this additional surge storage capacity is saturated or no longer available. The next logical step is to shop around for other juice plants that can be used to assist the overload. The main drawback of this method is that every juice plant reaches their storage capacity almost simultaneously. Those who have made contractional arrangements to have their fruit processed are taken care of first, and others are left to find other alternatives. The least desirable alternative is to sell the fruit as cattle feed, a market that is always available but less profitable to fruit growers.

FRUIT SAMPLING

One of the important aspects of fruit unloading is the determination of the quality and size of the load. This is done by weighing the trucks on a commercial truck scale before and after unloading. The total weight of the fruit is used to credit the fruit owner. Juice yield and quality are also used in some plants to determine the value of the truckload of fruit. Fruit storage bins usually are designed to hold one truckload of fruit. This aids in sampling problems and general quality monitoring. When running the fruit, however, it is very inefficient to run one truckload of fruit all the way through the plant in order to determine the quality and amount of juice produced. A more efficient system is to run the fruit continuously one storage bin at a time, in order of when the fruit came to the plant (oldest fruit first). This continuous process is the only feasible way to process the fruit; however, it makes it impossible to determine from processing results the quality and amount of juice associated with each individual truckload.

To qualify and quantify the juice products from each truckload of fruit, a 30- to 40-lb random fruit sample is taken from each trailer during unloading. This fruit sample is analyzed for projected juice yield and juice quality. The fruit owner then can be credited for the juice quality and quantity, based on the results of this sampling. There are several ways to collect the sample. One is to collect it by hand. Manual sampling is sometimes suspect as to its randomness and whether or not it is representative of the entire load. Employees often take shortcuts that jeopardize the validity of the sampling. Mechanical samplers are much more objective. The most popular is the Kinsey sampler, which uses an arm to periodically sweep oranges passing over a conveyer during unloading into a sample container. Other mechanical samplers are used, and care should be taken that samples represent the entire load of fruit and not just the beginning, middle, or end.

FRUIT WASHING AND GRADING

The source of the fruit affects the needed fruit preparation prior to juice extraction. Fruit coming directly from the field should have had extraneous leaves and twigs removed from the fruit during unloading. This type of trash can also be eliminated when the fruit is drawn from the bins prior to processing. Often, fruit from the field is just plain dirty and may even contain pesticide residues undesirable to the processed products. Fruit coming from a packing house usually is clean and free from trash and may not need washing at all. However, moist fruit is more easily conveyed. Also, the waxes put on the fruit at the packing house cause the fruit to stick to conveyers. Washing removes some of this wax and allows the fruit to be conveyed more efficiently.

Rotating brushes under a water spray are a common practice for washing fruit just prior to processing. Water may be chlorinated to improve the sanitation of the fruit. In the manufacture of juice products that do not undergo any heat treatment, careful fruit washing becomes imperative to remove excessive microbiological contamination. Fruit washers also often eliminate much of the trash and damaged fruit that had not been previously removed. The best fruit washing system consists of slanted expanded metal under the washer that funnels solid trash into a screw conveyer running under the washer but allows water from the washing to penetrate the expanded metal to a parallel solid metal sheet behind the expanded metal, which funnels the water to a wastewater sump. It is important to separate the solid and liquid debris that falls through a brush roller fruit-washing system. Fruit washing is best done outside the plant due to the fact that the debris has a tendency to attract insects. Washed fruit enters the plant clean and free from extraneous trash, insects, and excessive levels of microorganisms.

Washed fruit then enters the plant and should be immediately graded by hand. Graders are the final check on the quality of the fruit entering the processing area. They look for broken and decayed fruit. The USDA allows 10% or less of the fruit leaving the grading table to be broken and 2% or less of the fruit to have evidence of decay. Discarded fruit is joined with peel wastes and conveyed out of the plant.

JUICE AND OIL EXTRACTION

The extraction of juice from the orange or tangerine is generally done in one of two ways. Even though there are juice extractors that differ somewhat, the FMC cup extractors and the Brown reamers set the standard in juice extraction equipment. Both extractors are widely used and are known to produce high-quality citrus juices.

The FMC juice extractor consists of three to eight upper and lower cups that, when the fruit is placed in the cup, the upper cup comes down and squeezes the fruit down into the lower cup (Figure 9.3). A five-headed FMC extractor can process from 350 to 500 fruit/minute. The upper and lower cups have holes in the center of the cup, with a sharp edge that cuts about a 1-in. diameter hole in the bottom of the fruit, and all of the inside portion of the fruit is forced down into the hole into a perforated pipe. This orifice tube creates a backpressure on the incoming fruit material by a restricted opening in the bottom where the solid portion of the inside portion of the fruit is ejected. This core material is usually discarded out the bottom of the extractor with the peel. The juice is squeezed through the openings in the orifice tube and conveyed through the machine to juice-processing equipment. The outer peel slides through openings in the upper cup and falls out the back and bottom of the machine into a screw conveyer and out of the plant. As the outer peel slides out of the upper cup, it is

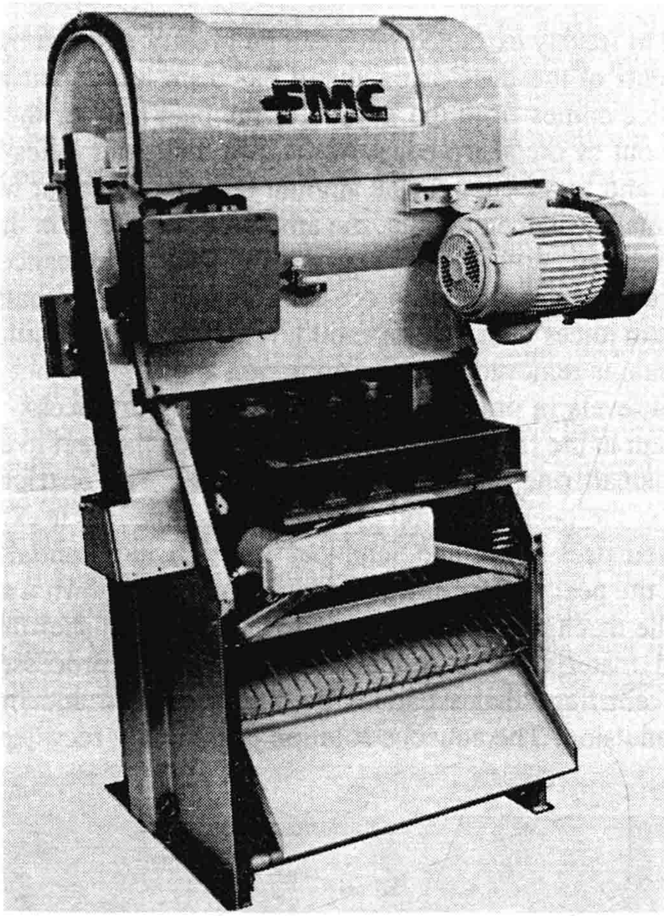


Figure 9.3 FMC citrus juice extractor (courtesy of FMC).

scraped and washed with water to form a slurry consisting of water and the oil extracted from the orange flavedo. This emulsion washes down the front of the machine into a small screw conveyer and is transported to the oil recovery equipment. Thus, in one stroke of the upper cup, the orange or tangerine is separated into the oil emulsion, juice, peel, and core material; the latter two are usually combined (Figure 9.4). See also Figure 10.1 in the next chapter for a more detailed depiction of the FMC citrus juice extractor.

In order for the FMC extractor to function properly, the fruit must be sized prior to entering the extractor in order to match the cup size of the machine. If the fruit is too large for the cup, the upper cup will chop, rather than squeeze, the fruit. If the fruit is too small for the cup, the upper cup will smash, rather than squeeze, the fruit. A typical array of FMC extractors will consist of machines containing various size cups fed by previously sized fruit. Generally, three- to six-cup sizes are adequate for most processing plants. Improper sizing will have a significant effect on juice yield.

Oil levels in freshly extracted juice can be greatly reduced by using low oil components of the FMC extractor. It has been found that most of the oil in the juice comes from the flavedo of the peel plug or the portion of the peel cut out by the sharp edges of the 1-in. diameter holes in the fruit in the upper and lower cups. If the amount of flavedo cut out was reduced by using a smaller diameter cutter, the amount of oil found in the juice can be greatly reduced, up to 50%. This is of greater significance to chilled juice and fresh-squeezed juice processors who would normally produce single-strength juices with excessive oil levels. Excess oil in juice destined for evaporation is removed during evaporation and, thus, is not affected by excessive oil levels in preevaporation, single-strength juices.

The hole cut in the fruit by the upper cup enables the peel to exit the cup through the small ring opening around the cutter. The restricted ring diameter forces the peel to be compressed and scraped as it exits the cup. The expressed peel liquid and scrapings are rich in essential oils originating from the peel and is washed with a water spray down a slanted tray in front of the machine. This "oil slurry" is sent to a finisher that removes excess solid material. The resulting slurry is then processed using a desludging centrifuge that separates the slurry into an aqueous solution and an oil emulsion. The aqueous solution is generally recycled through a

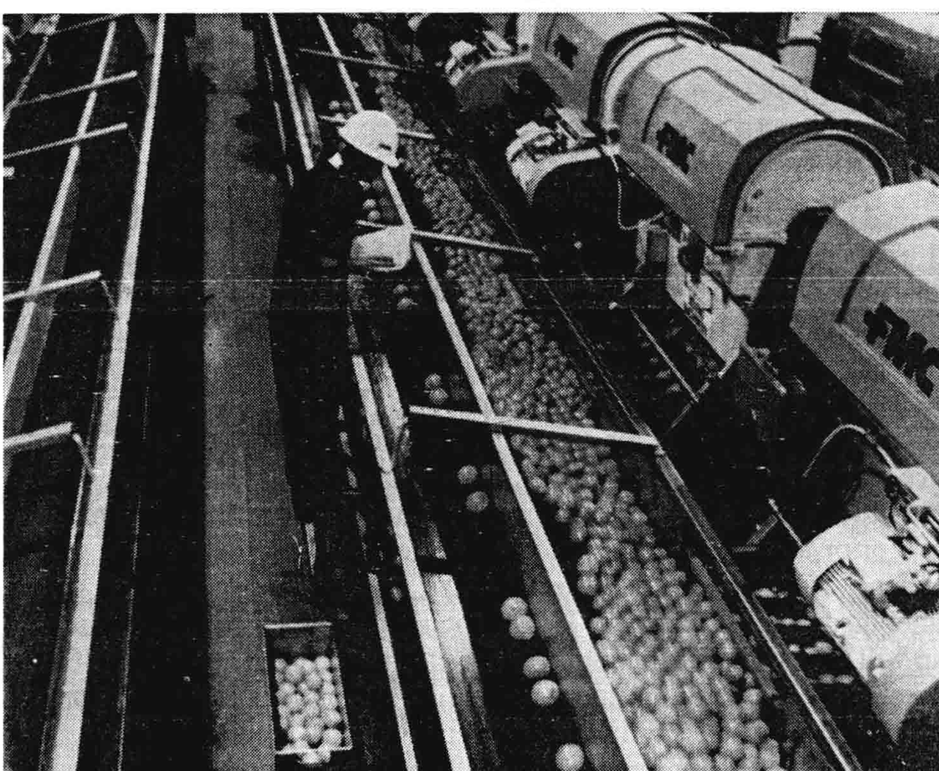


Figure 9.4 FMC citrus juice extractors in operation (courtesy of FMC).

filter to the extractor and is used as a wash water to make additional oil slurry. This way, any trace amount of citrus oil that may remain in the aqueous phase will be recycled and recovered. The oil emulsion exiting the desludger can be processed with enzymes or freezer treatment (winterizing) to aid in breaking the emulsion into a pure oil form. Afterwards, the emulsion is centrifuged in a high-speed polishing centrifuge that separates the emulsion into a viscous opaque material and clear pure citrus oil. The opaque material can be recycled into the polishing centrifuge or the oil emulsion being treated with enzymes or freezer treatment. Oil can also be winterized after production, refiltered or decanted, and repackaged, generally into 55-gal tin-lined drums.

The Brown juice extractor consists of several models that use the same principle (Figure 9.5). The Models 400 and 700 produce juice low in peel oil and of good quality. The Model 700 can process 700 pieces of fruit per minute, while the Model 400 processes about 350 per minute.

The Model 1100 accepts three parallel lines of fruit and can process up to 11 metric tons of fruit per hour (Varsel, 1980). The fruit is washed and sized as with the FMC extractor. Each extractor cuts the fruit in half and then uses a reamer to ream out the inside of the fruit. The juice falls out

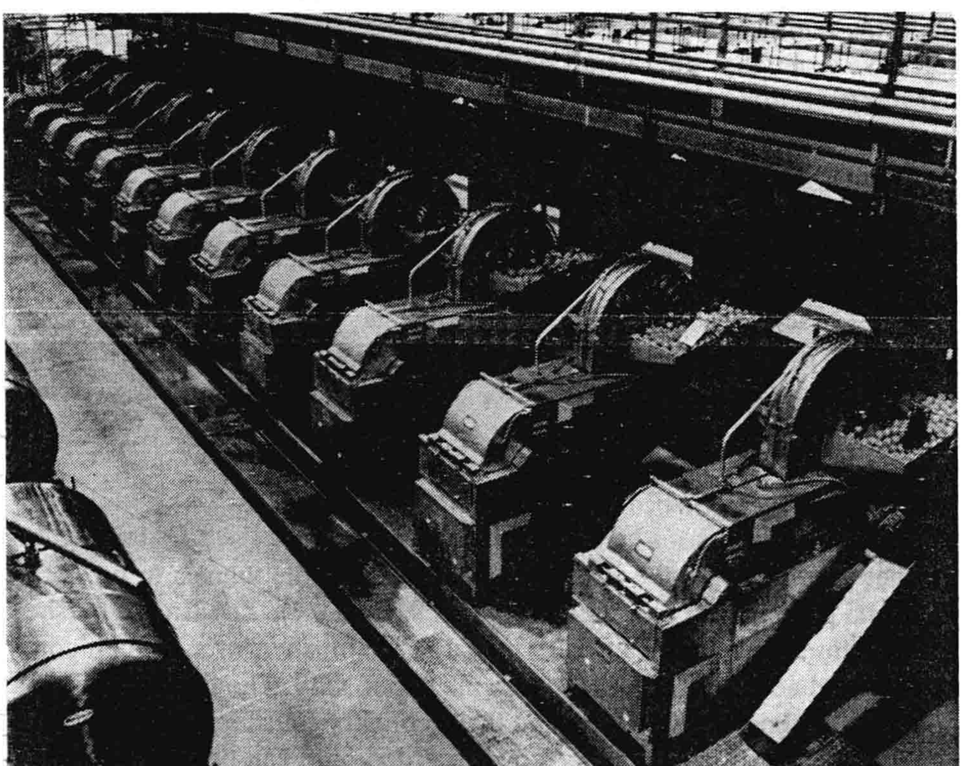


Figure 9.5 Brown citrus juice extractors in operation (courtesy of Brown International).

the bottom and into a trough, and the peel is discarded into a peel screw conveyer. The juice is then conveyed to a primary and secondary finisher to remove pulp prior to evaporation or heat treatment. If oil is to be extracted from the peel, the fruit must be processed by a separate oil extractor prior to juice extraction. A series of blades rupture the flavedo, and the release oils are washed into a slurry conveyer and then proceed through the same oil extraction process mentioned above.

In comparing the two types of extractors, the FMC is considered a more sanitary machine in regards to the juice product. It is common to find peel halves floating in the extracted juice prior to primary finishing using Brown extractors. In Brown extractors, the juice has a greater chance of coming into contact with the outside of the fruit than with FMC extractors. Good fruit washing can overcome much of this disadvantage. Even though Brown provides for a separate oil extraction unit, the FMC oil extraction that occurs simultaneously with juice extraction has been known to be the most efficient method of oil recovery. The Brown oil extractor also produces excellent oil products. Brown extractors run more fruit per unit time than an FMC machine; however, one must look at the cost of machine leasing and manufacturing space in order to determine the true advantage of machine speed. It may be possible that extra FMC machines will enable the same rate of fruit processing at a comparable cost of fewer Brown extractors. Generally, the overall cost of fruit extraction equipment leasing per ton fruit processed per unit time is kept competitive by both manufacturers, and they both should be consulted when designing a juice-processing facility.

PULP AND CORE WASHING

Both extracting systems require primary and secondary finishing prior to entering evaporators. The reason for this is that the solid pulpy material has a tendency to hang up in restricted spaces and adhere to heated surfaces. The FMC uses its orifice tube as a primary finisher followed by an external secondary finisher. The Brown extractor usually employs two external finishers. Both FMC and Brown sell, rather than lease, finishers. The FMC finisher uses a screw press to force the juice and pulp against the finisher screen, while the Brown finisher uses paddle wheels to press the juice and pulp against the screen (Figures 9.6 and 9.7). The Brown finisher has traditionally been regarded as the superior finisher, even though competition and new developments cause the gap to vary. The first finisher has openings of generally 0.040 in. and the secondary finisher has openings of generally 0.020 in. in diameter. The discarded pulp can be heat-treated to deactivate pectinase enzymes, frozen, and used as floating pulp commonly added to citrus juice products (Figure 9.8). The discarded pulp can also be

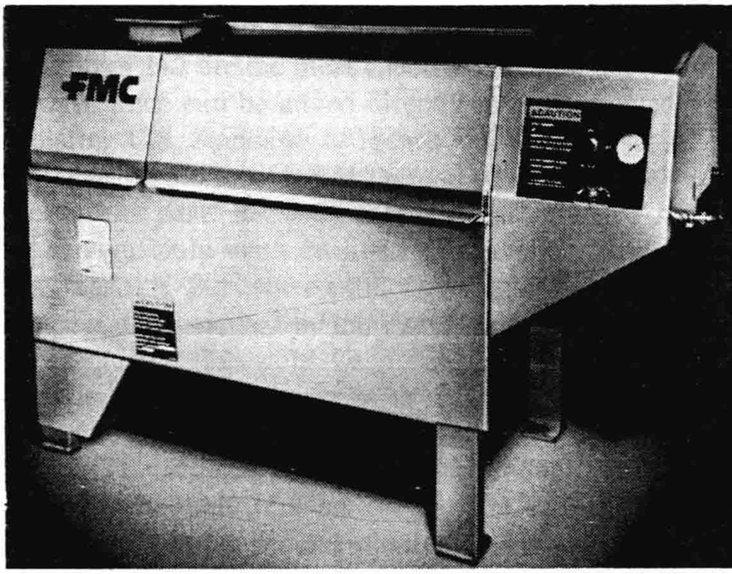


Figure 9.6 An FMC citrus juice screw finisher (courtesy of FMC).

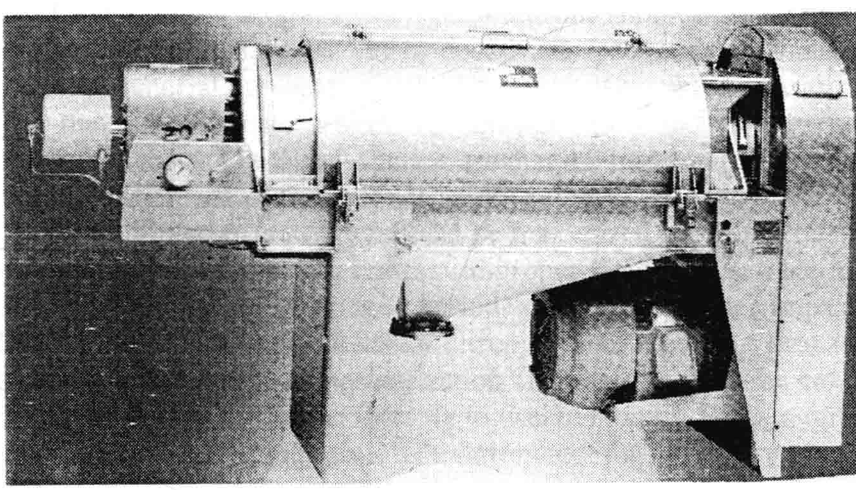


Figure 9.7 A Brown paddle citrus finisher (courtesy of Brown International).