

Fruit Juice, Citrus Juices

Revised 2024

Thermal Properties

	Grapefruit Juice, sweetened		Lemon Juice	
	English	Metric	English	Metric
Moisture, %	87.38	--	92.46	--
Protein, %	0.58	--	0.40	--
Fat, %	0.09	--	0.29	--
Carbohydrate, %	11.13	--	6.48	--
Fiber, %	0.10	--	0.40	--
Ash, %	0.82	--	0.36	--
Specific Heat Above Freezing	0.92 Btu/lb*°F	3.85 kJ/(kg*K)	0.95 Btu/lb*°F	3.99 kJ/(kg*K)
Specific Heat Below Freezing	0.43 Btu/lb*°F	1.78 kJ/(kg*K)	0.41 Btu/lb*°F	1.73 kJ/(kg*K)
Latent Heat of Fusion	126 Btu/lb	292 kJ/kg	133 Btu/lb	309 kJ/kg

	Lime Juice, Unsweetened		Orange Juice	
	English	Metric	English	Metric
Moisture, %	92.52	--	89.01	--
Protein, %	0.25	--	0.59	--
Fat, %	0.23	--	0.14	--
Carbohydrate, %	6.69	--	9.85	--
Fiber, %	0.40	--	0.20	--
Ash, %	0.31	--	0.41	--
Specific Heat Above Freezing	0.95 Btu/lb*°F	3.99 kJ/(kg*K)	0.93 Btu/lb*°F	3.90 kJ/(kg*K)
Specific Heat Below Freezing	0.41 Btu/lb*°F	1.73 kJ/(kg*K)	0.42 Btu/lb*°F	1.76 kJ/(kg*K)
Latent Heat of Fusion	133 Btu/lb	309 kJ/kg	128 Btu/lb	297 kJ/kg

Storage Conditions

	Frozen		Chilled	Canned	Fresh-Squeezed
	Concentrated	Single Strength	Single Strength	Single Strength	Single Strength
Temperature	0°F (-18°C)	0°F (-18°C)	40°F (4.4°C)	30 to 40°F (-1 to 4.5°C)	34 to 40°F (1.1 to 4.4°C)
Relative Humidity				70%	
Storage Period	1 year	1 year	2 months	1 year	2 to 3 weeks

Quality and nutritive loss in frozen concentrated orange juice is negligible, providing it remains at 0°F (-18°C) or below. Some cloud instability in the reconstituted juice may occur if the product has not been adequately heat-treated, and this settling of cloud is objectionable to consumers.

During storage at 0°F (-18°C) or below, the loss in flavor or activity of any residual enzymes is negligible in the product for as long as 5 years. At 5°F (-15°C) the cloud begins to become unstable in about 6 months. At 15°F (-9°C) the quality becomes undesirable in about 20 to 30 days. In addition, the concentrate can become gel-like if enzymes were not previously inactivated by adequate heat treatment. Heat treatment is applied to most citrus products.

High Brix for Further Processing

For bulk concentrated citrus juices stored at about 65° Brix for further processing or blending for later packaging in consumer packs, the following conditions apply: the concentrates can generally be stored for an indefinite period when kept at around 18°F (-9°C) or for 30 to 45 days when kept at 32°F (0°C) with no significant changes in quality factors, if an inert gas such as nitrogen or carbon dioxide is kept filling the headspace in the bulk tank. Such concentrates, stored in bulk "tank farms," are evaporator "pump-out" with no added cutback juice or essence, and only a small amount of peel oil is added for flavor stability during storage. These flavor components are blended with the concentrate upon preparation of the final consumer product to which they are ultimately converted.

Single strength frozen citrus juice, or juice that has not been concentrated, is usually not on the retail market. It is for institutional trade, for making chilled juice blends, or for making chilled juices (which are retailed). Freezing of these retains their original flavor and vitamin C content as well as their nutritional value. They are stable so long as they remain well-frozen; but upon thawing should be treated as chilled juice.

Chilled citrus juices are usually single strength. They are either made from pasteurized juice not from concentrate, or by reconstitution of frozen concentrated juice. They are refrigerated at 50°F (10°C) or below to retain fresh flavor and vitamin C content. Processing techniques for pasteurized juice not from

concentrate are such that a pleasing flavor is retained in the freshly packed product. However, if stored at ambient temperatures in the retail marketing channels, the flavor changes rapidly. If kept refrigerated, this is a premium product and is increasingly popular. There are two types of chilled juice not from concentrate: 1) thermally processed and 2) aseptic packaged. Thermally processed juice undergoes usual pasteurization and cooling. Aseptically packaged product is processed with a minimum of heat exposure, quick chilled, and chemical sterilant of the packages are used. Although both products are stable up to 3 months at 40 to 50°F (4 to 10°C), chilled juices retain higher quality for longer times the nearer to 30°F (-1°C) they are stored.

Reconstituted frozen concentrated orange juice contains some or all of the following flavor fractions: orange peel oil, orange essence, fresh un-concentrated juice, and larger particles of pulp or juice cells, all of which are added prior to reconstitution with water. This reconstituted single strength juice can be sold as a chilled juice described above, or packaged in cans, plastic or glass bottles, or in aseptic cartons under truly sterile conditions and sold as a shelf-stable product with a longer shelf life of 6 to 12 months. The higher the storage temperature and longer the juice is stored, the less the desirable flavor and the less the vitamin C are retained.

Citrus juices packaged in tin cans were the first processed 100% juice products to be widely distributed commercially. The market for these products has decreased steadily in recent years because they are perceived as a lower quality product. Usually, this product is stored at ambient temperature (to prevent moisture condensation which causes tin cans to rust), and this results in a more rapid decrease in flavor. More recently, single-serve juices in aluminum cans have become popular, especially for vending machine and commercial airline use, since they can be stored at cooler temperatures, and thus retain their flavor longer.

Fresh-squeezed or unpasteurized orange juice is a premium quality juice in increasing demand. It must be prepared under strict sanitary conditions and distributed rapidly to adhere to a 2 to 3 week shelf life. The product cannot be frozen at any time and still be labeled as "fresh squeezed" juice.

Packaging

Modern packaging of juice and juice concentrates utilizes some form of aseptic totes. There are several different styles, including stainless steel totes that can be sterilized and reused; reusable plastic totes with disposable aseptic liners; or large (275 to 300 gallons or 1,041 to 1,135 liters) fiberboard disposable totes. It is important to note that none of these container types are designed for frozen use. Freezing and thawing destroys the integrity of the disposable fiberboard totes, and the plastics can become brittle and/or break. Stainless steel totes can burst with freezing due to internal gas pressure. As a result, containers should be stored in either ambient or refrigerated areas using similar storage length as drums under the same conditions. This limits their use to aseptic products. After opening, the items either need to be used immediately or transferred into another container for refreezing and storage.

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