

Carrots

Revised 2018

Thermal Properties

	English	Metric
Moisture, %	88.29	--
Protein, %	0.93	--
Fat, %	0.24	--
Carbohydrate, %	9.58	--
Fiber, %	2.80	--
Ash, %	0.97	--
Specific Heat Above Freezing	0.94 Btu/lb*°F	3.92 kJ/(kg*K)
Specific Heat Below Freezing	0.48 Btu/lb*°F	2.00 kJ/(kg*K)
Latent Heat of Fusion	126 Btu/lb	293 kJ/kg

Storage Conditions

	Fresh		Frozen (sliced or diced)
Temperature	32°F (0°C)		0°F (-17.8°C)
Relative Humidity	Topped	98 to 100%	Vapor-tight packaging
	Bunched	95 to 98%	
Storage Period	Mature topped	5 to 9 months	1 year +
	Immature topped	4 to 6 weeks	
	Bunched	8 to 12 days	
Highest Freezing Point	29.5°F (-1.4°C)		

Fresh carrots that have had the tops removed, commonly called topped, store well in slatted crates or ventilated pallet boxes that allow air circulation to aid removal of field heat and heat of respiration.

Mature topped carrots for processing should keep 5 to 9 months at 32°F (0°C) if promptly cooled to this temperature after harvest. A relative humidity (RH) of 98 to 100% is recommended at 32°F (0°C) to minimize moisture loss, wilting, and decay. Condensation or dripping on the carrots should be avoided as this is conducive to decay development. Therefore, RH should be no more than 95% if storage is above 34°F (1.1°C). Air circulation between crates and pallet boxes is required to remove respiratory

heat, maintain uniform temperatures, and help prevent condensation. Air movement through the crates or pallets is desirable even if the temperature of the air is near 32°F (0°C) and if its RH is 98 to 100%. Storage in plastic film reduces weight loss but may result in increased decay.

Mature carrots are stored in fairly large quantities in winter to await processing. Bruised or damaged carrots should be removed before storage, when possible, as they are particularly susceptible to some storage diseases. Low temperature greatly retards sprouting, which is minimal after 3 months below 40°F (4.4°C), but becomes objectionable after 7 months. With storage at 40 to 50°F (4.4 to 10°C), considerable decay and sprouting may develop within 1 to 3 months.

Most carrots for the fresh market are not fully mature. Prompt cooling, typically hydrocooling with chlorinated (50 ppm, pH 7) water to reduce the root temperature below 41°F (5°C) is critical for successful storage. High RH (98 to 100%) in storage is required to reduce water loss and loss of crispness. If all traces of leaf growth are removed and they are cooled quickly before packaging, immature carrots can be held 4 to 6 weeks at 32°F (0°C) or 2 to 3 weeks at 37 to 41°F (2.8 to 5°C).

Immature carrots are prepackaged in 1- or 2-lb (0.45- or 0.91-kg) perforated polyethylene bags, usually at the shipping point. The 2-lb (0.91-kg) bags are packed into 'Master Bags' of thicker perforated polyethylene or in cartons; therefore, it is very important to cool before packing. In Texas, immature carrots are often stored in 50-lb (22.7-kg) mesh sacks. These sacks should be stacked so that at least one surface of each sack is in contact with top ice, which should be replenished as needed. The top ice provides some refrigeration and retards dehydration.

Bunched carrots with full tops may be stored 8 to 12 days at 32°F (0°C) if in good condition. The condition of the tops (leaves) determines shelf life. The tops should not be tightly packed within crates as they will heat up and quickly turn yellow. Package ice is often used in containers of bunched carrots to help reduce water loss from the tops and thus maintain quality during shipment.

Sometimes carrots become bitter in storage. Bitterness is induced by ethylene produced by apples, pears, and some other fruits and fruit-vegetables or from other sources such as internal combustion engines. Bitterness can be prevented by storing carrots away from products that produce ethylene. Even exposure to low levels (<1 ppm) of ethylene at low temperatures will cause bitterness. Cut carrot segments (with peel) are extremely sensitive to ethylene; immature carrots are more sensitive than mature carrots.

It is not recommended that carrots be stored in controlled atmospheres (CA), since concentrations of less than 3% O₂ and greater than 5% CO₂ promote decay, while less extreme atmospheres show little or no benefit.

Modified atmosphere (MA) packaging of fresh "ready-to-use" peeled and cut or grated carrots in gas permeable polymeric films for consumers is increasing. An atmosphere of 2 to 5% O₂ plus 15 to 20% CO₂ is maintained by the film and helps preserve quality for up to 14 days at 36°F (2.2°C).

Diseases and Injuries

Bacterial Soft Rot	<p>Soft mushy spots, sometimes smelly because of secondary invaders.</p> <p>Control: Careful harvesting and sanitary handling. Avoid bruising and refrigerate promptly. Bacterial soft rot should not be a problem on sound carrots stored at 32°F (0°C).</p>
Black Rot (Alternaria)	<p>Fairly firm, black decay at crowns, sides, and tips.</p> <p>Control: Avoid bruising. Refrigerate promptly.</p>
Fusarium Rot	<p>Shallow, spongy, corky, or scabby areas with sparse white mold development. Usually not important at temperatures below 46°F (7.8°C). Occasionally found on California bunched carrots.</p> <p>Control: Avoid injury of root and store promptly at 32°F (0°C).</p>
Gray Mold Rot	<p>Fairly firm but semi-watery decay, grayish-brown, velvety spore masses.</p> <p>Control: Sanitation. Avoidance of bruises. Refrigerate promptly and maintain 32°F (0°C) temperature. Do not permit roots to be wet during storage.</p>
Rhizoctonia Crown Rot	<p>Affected tissues are brown and soft at the top of the root. This disease is important in a few production areas only.</p> <p>Control: Do not store lots in which disease is known to exist in field. Avoid surface moisture on roots.</p>
Watery Soft Rot	<p>Watery rot with fine, white, "cottony" mold and large, oval, black sclerotia. "Nesting" common.</p> <p>Control: Culling, sanitation, and prompt continuous refrigeration at 32°F (0°C). Carrots from fields affected with watery soft rot should not be stored longer than 30 days.</p>
Freezing Injury	<p>Roots become flabby and discolored brown or black after thawing. On being cut, they show radial cracks in central part, tangential cracks in outer part and have a water soaked appearance if severely frozen.</p> <p>Control: Prevent exposure to temperatures below the highest freezing point of 29.5°F (-1.4°C).</p>

Freezing

Carrots should be steam peeled to remove the skin, which is then washed, brushed, or scraped off. Carrots are also lye peeled in 4% lye. They are then diced or thinly sliced and blanched in boiling water for 3 to 5 minutes, depending on the thickness of the piece. Since carrots are frequently added to other

vegetables for a mixed pack, they are normally IQF frozen in a fluidized bed system. Then, when needed for mixing, they are not in a solid block that requires thawing.

Handling

Carrots in the frozen state are not very sensitive to fluctuations in temperature in the freezing range. If thawed and refrozen, their quality is impaired as they lose some of their firmness.

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