

Strawberries

Revised 2018

Thermal Properties

	English	Metric
Moisture, %	91.57	--
Protein, %	0.61	--
Fat, %	0.37	--
Carbohydrate, %	7.02	--
Fiber, %	2.30	--
Ash, %	0.43	--
Specific Heat Above Freezing	0.96 Btu/lb*°F	4.00 kJ/(kg*K)
Specific Heat Below Freezing	0.44 Btu/lb*°F	1.84 kJ/(kg*K)
Latent Heat of Fusion	132 Btu/lb	306 kJ/kg

Storage Conditions

	Fresh	Frozen
Temperature	32°F (0°C)	0°F (-17.8°C)
Relative Humidity or Packaging	90 to 95%	Vapor-proof packaging
Postharvest Life	5 to 10 days in air 10 to 21 days in air + 15% CO ₂	18 months with sugar 12 months without sugar
Freezing Point	30.6°F (-0.8°C)	

Fresh Market

Rapid removal of field heat, ideally starting within 2 hours after harvest, is essential for maintenance of fresh market quality; every 1-hour delay in cooling can reduce the percentage of marketable fruits by about 5%. Pallets of strawberries can be cooled by forced-air cooling to 32°F (0°C) in 2 to 3 hours and distributed by refrigerated truck at the same temperature. Storage and transport temperatures must be maintained at 32°F (0°C) with 90 to 95% relative humidity (RH) until the strawberries reach the retail market.

After several days in storage, fresh market strawberries will lose some of their fresh bright color and gloss and begin to shrivel from moisture loss, and subsequent deterioration of fresh strawberry flavor will be evident. Strawberries held at 50°F (10°C) have a life expectancy of only 1/3 that of strawberries held at 32°F (0°C).

Modifying storage atmosphere by increasing CO₂ and reducing O₂ can benefit fresh strawberry shelf life during 3 to 5-day transit periods or short-term storage of up to 3 weeks at 32 to 34°F (0 to 1.1°C). Elevated (15 to 20%) CO₂ atmospheres have been demonstrated to inhibit *Botrytis* and *Rhizopus* decay on fresh strawberries. A CO₂ enriched atmosphere is established around a pallet of strawberries by means of a pallet bag sealed to an air tight base built into the pallet. The pallet bag may contain up to 20% CO₂. Higher concentrations should be avoided because of potential off-color and off-flavor development. Also, O₂ below 2% should be avoided due to potential fermentative off flavor development. Atmospheric modification is a supplement to maintaining optimum ranges of temperature and RH.

Diseases and Injuries

Anthracnose	<p>Fungus produces brown to black, slightly sunken lesions of varying size, but usually on one side of the berry. The rot is shallow and under moist conditions produces salmon colored spores on the surface. This disease is becoming increasingly important throughout the southeast.</p> <p>Control: No specific control measures are known. Storage near 32°F (0°C) will delay disease development.</p>
Gray Mold (Botrytis)	<p>Originates in field, often just under cap (calyx) of berry. Brown, relatively firm rot extends throughout fruit. Later, berries become covered with gray mold growth. Severe nesting may occur. Organism may grow and produce decay at 32°F (0°C). This is the most common of the fruit rots. The disease causes severe losses in the field before harvest and also in storage and transit of the harvested fruit.</p> <p>Control: Careful handling and continuous refrigeration recommended. Field and packinghouse sanitation, rapid forced air cooling to 32°F (0°C), and use of CO₂-enriched atmospheres.</p>
Leather Rot	<p>Affected areas of immature fruit are yellow to light brown at center and shade from this to darker brown to purple or natural red of fully colored fruit. Usually, the tissues are tough and leathery with little or no softening. On fruit on the market, a superficial white mold frequently develops.</p> <p>Control: Field control by mulching. Prompt cooling to 32°F (0°C).</p>
Rhizoctonia Rot	<p>Affected berries are often one-sided. Tissues are dry, spongy, dark brown to black. Usually, a distinct margin between decayed and healthy tissue. Infection most often is on underside of the berry where it touches the soil.</p> <p>Control: Field control by mulching and thorough culling; holding temperature near 32°F (0°C) after prompt cooling.</p>

Rhizopus Rot	<p>Very common during marketing. Berries become soft, very watery or mushy and disintegrate with slight pressure. Later, berries are covered with heavy white to gray fungus growth which contains many black spores.</p> <p>Control: Care in handling. Holding and shipping at temperatures below 40°F (4.4°C). Sanitation in packinghouse, rapid forced air cooling to 32°F (0°C), use of CO₂-enriched atmosphere.</p>
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Pre-Freezing Handling

Strawberries should be harvested, processed, and moved to frozen storage within 12 hours for best quality. However, with some loss of quality, strawberries may still be acceptable for processing after as much as 2 days at 34°F (1°C). Caps are removed during field picking, and strawberries are delivered in plastic crates for processing. In the processing plant, strawberries are washed to remove soil and loose foreign material, size graded if necessary, and sort inspected to remove off color, damaged or otherwise defective fruit. The strawberries may be frozen without further processing or packed with sugar and left whole, or halved, sliced, or pureed, depending on the pack style desired. Sliced strawberries, sweetened by mixing with sugar at a 4 + 1 fruit to sugar ratio, are packed in a 10-oz (284-g) or 16-oz (455-g) rectangular fiber container with metal ends. Sugar syrup can also be added as a packing medium at a 4 + 1 or 5 + 1 fruit to sugar ratio. For individual serving frozen strawberries, the pack ratio must be 11.5+1 fruit to sugar ratio where the packing media is sugar, syrup, ascorbic acid and citric acid, or juice. The packing media must be 5.5 + 1 fruit to sugar ratio where the packing media is 45 degrees Brix syrup and may also be composed of strawberry puree, sugar, ascorbic acid and citric acid.

Freezing

Strawberries are commonly individually quick frozen (IQF) at -25 to -40°F (-32 to -40°C) and usually packaged in 20-pound (9.1 kg) or 30-pound (13.6 kg) containers which are sealed with special care to eliminate air contact with the fruit. The frozen strawberries are subsequently stored at 0 to -10°F (-17.8 to -23°C). Many handlers try for no more than a 12-month storage period of frozen strawberries for economic reasons, since the price can fluctuate from year to year.

Freezing of strawberries packed in sugar or syrup is accomplished in the retail or industrial package within a blast freezer. It is important that the shipping cartons containing retail packages be open palletized to allow adequate air circulation in the freezing process. This is usually accomplished by assuring adequate space between shipping cartons and placement of wood slats between these cartons to assure good air movement.

Not all varieties of strawberries freeze well or display the best appearance when thawed. For advice on what varieties freeze well for any particular area in the U.S., the state's Agricultural Experiment Station or Cooperative Extension Service has the desired information.

Storage

Frozen strawberries lose flavor and color rapidly if held at adverse storage temperatures. At 0°F (-17.8°C), strawberries will maintain quality for 14 to 18 months. At 5°F (-15°C), the quality deterioration is evident in 20 weeks. At 10°F (-12.2°C), quality is lost within 6 weeks.

Retail Market

Storage of frozen strawberry retail packages should be maintained below 0°F (-17.8°C), preferably at -10 to -15°F (-23.3 to -26.1°C). Individually quick frozen (IQF) strawberries may be packed into 1.5-lb (682-g) polyethylene bags directly after freezing or may be repacked from cartons which had been previously frozen by the IQF method.

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