

Strawberries

Revised 2008

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 (-18°C)
Relative Humidity or Packaging	90-95%	Vapor-proof packaging
Postharvest Life	5-10 days in air 10-21 days in air + 15%CO ₂	14-18 months
Freezing Point	30.6°F (-0.8°C)	

Fresh Market

Rapid removal of field heat immediately 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 2-3 hours and distributed by refrigerated truck at the same temperature. Storage and transport temperatures must be maintained at 32°F (0°C) 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 4-5 day transit periods or short-term storage of up to 3 weeks at 32-34°F (0-1°C). Elevated (15-20%) 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.

Strawberries pre-cooled to 35-38°F (1.7-3.3°C), serviced with "Tectrol Atmosphere" pallet system, and center loaded on refrigerated trucks were removed from the atmosphere treatment on arrival after a 4-5 day transit period. After 3 days, the average loss was 12.9% vs. 20.3% for fruit not treated with CO₂.

In surface transport at 34°F (1°C), a controlled atmosphere of 2% O₂ and 15% CO₂ at 32-45°F (0-7°C) extends storage life and controls decay. Reducing O₂ levels to below 2% and/or increasing CO₂ above 20% may induce off flavors. Atmospheric modification is a supplement to maintaining optimum ranges of temperature and relative humidity.

Retail Market

Sliced strawberries, sweetened by mixing with sugar at a 4+1 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 level.

It is important that the shipping cartons containing the 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. Storage of retail packages should be maintained below 0°F (-18°C), preferably at -10 to -15°F (-23.3°C 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.

Diseases and Injuries

Anthracnose	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. Control: No specific control measures are known. Storage near 32°F (0°C) will delay disease development.
Gray Mold (<i>Botrytis</i>)	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

	<p>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>

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 packed with sugar or whole, halved, sliced, or pureed, depending on the pack style desired.

Freezing

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 (-18°C), strawberries will maintain quality for 14-18 months. At 5°F (-15°C), the quality deterioration is evident in 20 weeks. At 10°F (-12°C), quality is lost within 6 weeks.

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