

Bananas

Revised 2008

Thermal Properties

	English	Metric
Moisture, %	74.26	--
Protein, %	1.03	--
Fat, %	0.48	--
Carbohydrate, %	23.43	--
Fiber, %	2.40	--
Ash, %	0.80	--
Specific Heat Above Freezing	0.85 Btu/lb*°F	3.56 kJ/(kg*K)
Specific Heat Below Freezing	0.48 Btu/lb*°F	2.03 kJ/(kg*K)
Latent Heat of Fusion	107 Btu/lb	248 kJ/kg

Storage Conditions

Temperature	Holding Room:	56 to 58°F (13 to 14°C)
	Ripening Room:	58 to 68°F (14 to 20°C)
Relative Humidity	Green or Turning Fruit:	90-95%
	Ripe Fruit:	85-90%
Atmosphere	2-5% oxygen and 2-5% carbon dioxide can be used to supplement temperature and humidity management during transport and storage. Postharvest life of mature green bananas can be extended by maintaining ethylene concentration below 1 ppm using ethylene scrubbers.	
Storage Period	Mature-green bananas can be stored for up to 4 weeks in ethylene-free air or up to 6 weeks in a controlled atmosphere at 58°F (14°C)	
Highest Freezing Point	30.6°F (-0.5°C)	

Bananas are chilling-sensitive and very specialized methods of handling have been developed for this fruit to avoid exposure to temperatures below 56°F (13°C) even for a few hours.

Most bananas are now removed from the stem in the tropics and hands or clusters are shipped in corrugated boxes with perforated polyethylene liners. Boxing has eliminated many sources of handling damage previously encountered in shipping stems. Green bananas are shipped at a pulp temperature range of 56 to 58°F (13 to 14°C); temperatures below 56°F (13°C) may cause chilling injury within 2 to 24 hours, depending on the cultivar, maturity stage, and temperature (the lower the temperature, the faster chilling injury will occur). Under-skin tissue browning is an early symptom of chilling injury.

Ripening

Bananas are shipped from the tropics in the mature-green stage in specially designed refrigerated vessels or marine containers and upon arrival are usually ripened at temperatures between 58 and 65°F (14 to 18°C) with 90 to 95% relative humidity. Within certain limits, the period required for ripening green fruit can be extended or shortened to meet trade requirements by adjusting the temperature. Under average conditions, ripening may be in as short a time as 4 days with higher temperatures or may be extended to 8 to 10 days with lower temperatures. Ripening room temperatures for bananas are varied frequently as compared to other produce coolers. Automatic temperature controllers or programmers are used in most facilities.

It is recommended that air circulating fans be operated continuously when ripening boxed fruit. This is necessary to insure uniform pulp temperatures throughout the room. Forced-air ripening systems are strongly recommended for new facilities.

Stacking to allow adequate air circulation is essential for uniform ripening of boxed bananas. Ideally boxes should be stacked in rows leaving a 4-inch (100 mm) air channel between adjacent rows.

Many ripening rooms are now being modified to use forced-air ripening, commonly called a Pressurized Ripening System, which provides more uniform temperatures and ethylene concentration throughout the room. In this system, the boxes are palletized in the tropics and are left on the pallets throughout distribution. No hand stacking in ripening rooms to improve circulation is needed. However, the boxes have additional holes to improve circulation of air and ethylene. In the room, pallets are often stacked 2 or 3 tiers high and the top and outside ends of the pallet rows are covered by tarps. The tarps restrict air movement in the room so that it is forced through the banana boxes. The pressurized ripening system uses fans mounted high on the back wall with intakes below that pull air from the room.

The addition of ethylene gas to ripening rooms for 24-48 hours is recommended to stimulate uniform ripening of mature-green bananas, regardless of ripening schedule. A concentration of only 100 ppm (0.01 per cent) ethylene is needed, which is 0.1 cu. ft. of ethylene per 1,000 cu. ft. of room volume. The recommended pulp temperature for gassing boxed bananas is 58-65°F (14-18°C), depending on desired ripening time. Ethylene is explosive in air at a concentration between 2.8 and 28.6%. Carbon dioxide concentration should be kept below 1% to minimize its antagonistic effects on ethylene in inducing banana ripening.

The average highest freezing point of the banana fruit is 30.2°F (-1°C) for mature-green and 26.0°F (-3°C) for ripening fruit. The highest freezing point of the peel is 30.6°F (-0.5°C).

An ammonia concentration of 0.8% causes rather severe injury to bananas. Ammonia fumes are best removed from storage rooms by aeration and washing the contaminated atmosphere with water if this is possible.

Controlled atmosphere transport and/or storage in 2-5% O₂ with 2-5% CO₂ at 58°F (14°C) is also feasible for up to 6 weeks. Bananas stored in controlled atmosphere should be ventilated with fresh air when ripening is desired. Maintaining high humidity (90-95%) during storage is recommended to avoid water loss which leads to brown discoloration of mechanically-damaged areas on the bananas.

As with all produce warehouses, banana ripening rooms should be maintained under a well planned, regularly executed sanitation program.

Diseases and Injuries

Anthracnose	<p>Shallow brown or black spots on stems and skin as fruit ripens, possibly with whitish-hoary appearance and pink spore masses. Eventually, the flesh also decays. Anthracnose differs from simple bruising in that it has pink spores, whitish surface mold and the decay extends into the edible part of the fruit.</p> <p>Control: Handle fruit carefully and keep ripening rooms clean, treating walls and floors with disinfectant. Postharvest hot water treatment can be effective.</p>
Black Rot	<p>The pathogen (<i>Thielaviopsis</i>) is transmitted by the fibrovascular system of the plant from wounds to the fruit and then into the crowns and stem ends of fingers. Produces brownish-black areas in peel at fruit ends. As fruit ripens, skin becomes grayish-black and water soaked. Pulp rarely affected.</p> <p>Control: Paint freshly cut butts of fruit stalks with fungicide or dip in 100 ppm chlorinated water in the tropics.</p>
Chilling Injury	<p>Both green and ripe bananas are susceptible to chilling injury, but green fruit is more susceptible. Chilling is mainly a peel injury in which certain cells are killed. The dead cells darken and give the peel a characteristic smoky or dull-yellow appearance after ripening rather than a bright-yellow color. Ripe fruit, if chilled, develops a dull-brown color when later exposed to higher temperatures and is very susceptible to handling marks. The lowest temperature at which green bananas can safely be held to delay ripening is about 56°F (13°C) pulp temperature. The minimum temperatures causing chilling are not sharply defined and vary with the condition of the fruit, the cultivar, and duration of exposure. A few hours at 50°F (10°C) may cause slight peel dulling, and 12 hours at 45°F (7°C) generally causes enough chilling injury to affect salability of the fruit.</p> <p>Control: Avoid temperatures below 56°F (13°C).</p>

Fruit Spot	<p>Circular, reddish-brown or black spots with a green halo, also has very small rust-colored specks or irregular brown pits, showing up after fruit turns yellow. Seasonal in nature, apparently physiological in character.</p> <p>Control: Cull out medium or heavily spotted fruit. Not due to storage conditions.</p>
Rhizopus Rot	<p>Extensive soft rot of split and broken fruits with rapid development of coarse mold bearing white and black spore cases. Commonly observed in ripening rooms.</p> <p>Control: Handle carefully to avoid skin breaks and bruising.</p>

WFLO is indebted to Dr. Adel Kader, Department of Plant Sciences, University of California at Davis, for the review and revision of this topic.