Spinach

Revised 2018

Thermal Properties

	English	Metric
Moisture, %	91.58	--
Protein, %	2.86	--
Fat, %	0.35	--
Carbohydrate, %	3.50	--
Fiber, %	2.70	--
Ash, %	1.72	--
Specific Heat Above Freezing	0.96 Btu/lb*°F	4.02 kJ/(kg*K)
Specific Heat Below Freezing	0.42 Btu/lb*°F	1.75 kJ/(kg*K)
Latent Heat of Fusion	132 Btu/lb	306 kJ/kg

Storage Conditions

	Temperature		Storage Period	Relative Humidity or Packaging	Freezing Point
	°F	°C			
Cooler Storage	32	0	2 weeks	95 to 100%	31.3°F (-0.4°C)
CA Storage	32	0	2 to 3 weeks	5% O_2 plus 5% CO_2	31.3°F (-0.4°C)
Frozen	0 -10	-17.8 -23.3	1 year 2 years	Vapor-tight packaging	
Canned	60 45	15.6 7.2	6 to 12 months 1 year +		

Raw Spinach

Spinach is very perishable and usually is not stored long in the fresh state. The storage temperature should be as close to 32°F (0°C) as possible; spinach deteriorates rapidly at higher temperatures, discoloring to a yellow color. Hydrocooling and vacuum cooling are the pre-cooling methods most frequently used for spinach. Crushed ice can be placed in the center of containers of bunched spinach, followed by top icing, to remove field heat and absorb the heat of respiration.

Most spinach for fresh market is trimmed, washed, and packaged in perforated plastic bags. After bagging, the consumer units are packed for distribution in corrugated cartons and are vacuum cooled. Prepackaged spinach should be stored at 32°F (0°C) to reduce damage-induced bacterial

growth. At that temperature, shelf life is 1 to 2 weeks. Spinach stored at 41°F (5°C) has a shelf life of only about 1 week.

A controlled atmosphere (CA) of 5% carbon dioxide plus 5% oxygen at 41°F (5°C) may be beneficial in retarding yellowing and maintaining quality of spinach about a week longer than by refrigeration alone. Atmospheres with higher CO_2 concentrations may cause darkening and breakdown of the spinach. Lower O_2 atmospheres may cause off-odors. Trimmed and washed spinach leaves may be placed into modified atmosphere packages (MAP) designed to maintain 1 to 3% O_2 plus 8 to 10% CO_2.

Diseases & Disorders

Bacterial Soft Rot	Water-soaked, muddy green or greasy, with diseased tissues rapidly becoming wet and mushy, with a putrid odor. **Control:** Careful handling to avoid injuries, which become sites for infection, and prompt cooling to below 36°F (2.2°C). Wash and hydrocooler water must contain 50 to 100 ppm chlorine with the pH adjusted to 7.0 to control bacterial soft rot.
Downy Mildew	Irregular pale-yellow areas, possibly enlarging, water-soaked and brown, with downy gray mold on lower surface of leaves and with secondary decay invasion. **Control:** Resistant varieties, crop rotation. No warehouse controls. Do not store or ship diseased spinach.
White Rust	Numerous small blister-like pustules on lower leaf surface, accompanied by slight yellowing of adjacent leaf area, affecting both surfaces. **Control:** Field sanitization. No warehouse controls.

Freezing

Water blanching is usually preferred, as it is more uniform and will remove some of the bitter flavor. Blanching at 200 to 210°F (93.3 to 98.9°C) for 1 to 2 minutes is adequate. The spinach should then be immediately cooled in cold water.

Spinach is packed as whole cut leaf as well as chopped (0.25 x 0.25 inches, or 6 x 6 mm) product. Spinach is filled in retail packages or institutional sized packages before freezing in plate freezers. There is also individually quick frozen (IQF) spinach for industrial re-use operations or for packaging in polybags.

Well cleaned and adequately blanched spinach is somewhat less stable, with regard to flavor, than other green vegetables. One year of storage at 0°F (-17.8°C) is probably near the limit of market shelf life, and lower temperature is advisable for long-term storage. Marketability of about 2 years would be expected at a product temperature of -10°F (-23.3°C).

WFLO is indebted to Dr. Jeff Brecht, Horticultural Sciences Department, University of Florida, for the review and revision of this topic.