

# Broccoli

Revised 2008

## Thermal Properties

	English	Metric
Moisture, %	89.30	--
Protein, %	2.82	--
Fat, %	0.37	--
Carbohydrate, %	6.64	--
Fiber, %	2.60	--
Ash, %	0.87	--
Specific Heat Above Freezing	0.96 Btu/lb*°F	4.01 kJ/(kg*K)
Specific Heat Below Freezing	0.43 Btu/lb*°F	1.82 kJ/(kg*K)
Latent Heat of Fusion	130 Btu/lb	303 kJ/kg

## Storage Conditions

	Fresh	Frozen
Temperature	32°F (0°C)	0 to -10°F (-18 to -23.3°C)
Relative Humidity	98-100%	Vapor proof packaging
Storage Period	2 to 3 weeks	10 to 15 months
Highest Freezing Point	30.9°F (-0.6°C)	

Italian or sprouting broccoli is highly perishable and is usually stored for only brief periods as needed for orderly marketing. Good salable condition, fresh green color, and the vitamin C content are maintained best at 32°F (0°C). If in good condition and stored with adequate air circulation and spacing between containers to avoid heating, broccoli should keep satisfactorily up to 3 weeks at 32°F (0°C). Longer storage or storage at higher temperatures is undesirable because the heads and leaves wilt and turn yellow, florets (buds) may drop off, and tissues soften. Large differences in storage potential have been noted among broccoli cultivars. Any opening of flower buds indicates end of shelf life.

Traditional methods for field packing broccoli included packing in waxed cartons and then cooled by palletized liquid icing. The ice-water slurry provided cooling, and the ice remaining after water drainage (about equal to the broccoli weight) provided protection during distribution. However, package icing of broccoli is only necessary if it is not possible to maintain the proper temperature and humidity conditions.

In recent years, the cost to transport the ice has led to greater use of "iceless broccoli" packs in which hydro-cooling or rapid forced-air cooling are used. Perforated plastic liners or bags help reduce water loss and maintain freshness. Thorough precooling of iceless broccoli to less than 34°F (1°C) is critical because broccoli is one of the highest heat producers of all vegetables.

Some shelf life extension can be achieved by controlled atmosphere (CA) storage. Atmospheres of 1-2% O<sub>2</sub> and/or 5 to 10% CO<sub>2</sub> allow broccoli green color, flavor, and appearance to remain in excellent condition for at least 4 weeks if the broccoli is held between 32 and 36°F (0 and 2°C). If CO<sub>2</sub> is between 8 and 10%, results are almost as good with near normal O<sub>2</sub> (21%) as with low O<sub>2</sub>. This also avoids the potential risk of strong off-odor development with the low O<sub>2</sub> atmosphere. For 3 weeks or less in storage, there is no need for CA if the temperature is kept near 32°F (0°C).

Storage in 10% CO<sub>2</sub>-enriched air may also be beneficial to broccoli for processing. It has a marked tenderizing effect on heads and stems, and this is evident after cooking. Modified atmosphere (MA) consumer packaging is gaining some acceptance. These packages have a beneficial gas mixture inserted and a gas-permeable membrane as part of the film overwrap. Good refrigeration of these consumer packs of broccoli florets is still essential.

Broccoli is extremely sensitive to exposure to ethylene, which causes yellowing and floret opening. Broccoli must never be stored with fruits that produce substantial quantities of ethylene, especially apples, pears and peaches.

Diseases of broccoli closely resemble those of cauliflower. Bacterial Soft Rot causes most of the spoilage. Other decays reported on broccoli are downy and powdery mildews and *Alternaria* leaf spots. Brown Heart, commonly called internal browning, is a physiological defect, and is probably due to boron deficiency.

## **Freezing**

Broccoli may be blanched in hot water or steam before freezing. However, steam blanching will improve color, retain solids, and improve product recovery.

Most commercial broccoli is packed into 8 oz. to 3 lb. (0.2 to 1.4 kg) cartons, boil-in bags, or poly-bags, then blast frozen on trays or contact plate frozen. If packed in bulk, it is preferable to individually quick freeze by fluidized bed technique before packing in 20 to 60 lb. (9 to 27 kg) cartons or tote bins. Although quality is improved with more rapid freezing, cryogenic immersion freezing is not necessary.

Frozen broccoli loses its brilliant green color rather rapidly when stored at temperatures above 0°F (-18°C). The chlorophyll changes to a brownish color. If stored below 0°F (-18°C), good quality is maintained for 10 months and, if stored at -10°F (-23°C), for 1 year and longer.

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