



# Broccoli

## **Recommendations for Maintaining Postharvest Quality**

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## **Maturity Indices**

Head diameter and compactness; all florets (beads) should be closed

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## **Quality Indices**

Good quality broccoli should have dark or bright green closed florets, and the head should be compact (firm to hand pressure), with a cleanly cut stalk of the required length.

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## **Optimum Temperature and Relative Humidity**

Low temperature is extremely important to achieve adequate shelf-life in broccoli. A temperature of 0°C (32°F) with >95% RH is required to optimize broccoli storage life (21-28 days). Heads stored at 5°C (41°F) can have a storage life of 14 days; storage life at 10°C (50°F) is about 5 days. Broccoli is usually rapidly cooled by liquid-icing the field-packed waxed cartons. Hydrocooling and forced-air cooling also can be used, but temperature management during distribution is more critical than with iced broccoli.

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## Freezing Injury

This may occur if salt is used in the liquid-ice cooling slurry or if noniced broccoli is stored below  $-1^{\circ}\text{C}$  ( $30^{\circ}\text{F}$ ). Frozen and thawed areas on the florets appear very dark and translucent, may turn brown after thawing and are very susceptible to bacterial decay.

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## Rates of Respiration

Broccoli heads have relatively high respiration rates:

Temperature	$0^{\circ}\text{C}$ ( $32^{\circ}\text{F}$ )	$5^{\circ}\text{C}$ ( $41^{\circ}\text{F}$ )	$10^{\circ}\text{C}$ ( $50^{\circ}\text{F}$ )	$15^{\circ}\text{C}$ ( $59^{\circ}\text{F}$ )	$20^{\circ}\text{C}$ ( $68^{\circ}\text{F}$ )
ml $\text{CO}_2$ /kg·hr	10-11	16-18	38-43	80-90	140-160

The respiration rates of florets are slightly more than twice the rates of the intact heads.

To calculate heat of production multiply ml  $\text{CO}_2$ /kg·hr by 440 to get Btu/ton-day or by 122 to get kcal/metric ton-day.

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## Rates of Ethylene Production

Very low,  $<0.1 \mu\text{L}/\text{kg}\cdot\text{h}$  at  $20^{\circ}\text{C}$  ( $68^{\circ}\text{F}$ ).

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## Responses to Ethylene

Broccoli is extremely sensitive to exposure to ethylene. Floret yellowing is the most common symptom. Exposure to 2 ppm ethylene at  $10^{\circ}\text{C}$  ( $50^{\circ}\text{F}$ ) reduces shelf-life by 50%.

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## Responses to Controlled Atmospheres (CA)

Broccoli can be benefitted by 1-2%  $\text{O}_2$  with 5-10%  $\text{CO}_2$  atmospheres at a temperature range of  $0$ - $5^{\circ}\text{C}$  ( $32$ - $41^{\circ}\text{F}$ ). Although under controlled conditions such low  $\text{O}_2$  levels extend shelf-life, temperature fluctuations during commercial handling make this risky as broccoli can easily produce offensive sulfur-containing volatiles. As a result, a high rate of air exchange is recommended in standard marine container shipments of broccoli. Most modified atmosphere packaging for broccoli is designed to maintain both  $\text{O}_2$  and  $\text{CO}_2$  at about 10% to avoid the development of these undesirable off-odor volatiles.

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## Physiological Disorders

Hollow stem is an open area in the stem at the cut surface which may become discolored; growing conditions and variety selection affect development of this disorder.

**Floret (bead) yellowing.** The florets are the most perishable part of the broccoli head; yellowing may be due to overmaturity at harvest, high storage temperatures, and/or exposure to ethylene. Any development of yellow beads ends commercial marketability. Bead yellowing due to senescence should not be confused with the yellow-light green color of areas of florets not exposed to light during growth, sometimes called "marginal yellowing".

**Brown floret (bead).** Is a disorder in which areas of florets do not develop correctly, die and lead to brown discolored areas. This is thought to be caused by plant nutritional imbalances.

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## Physical Injury

Rough handling at harvest can damage the florets and increase decay.

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## Pathological Disorders

**Bacterial decay.** Various soft-rot causing organisms (*Erwinia*, *Pseudomonas*) may affect broccoli shelf-life. Rots due to these organisms are usually associated with physical injury.

**Fungal pathogens.** Although not as common as bacterial rots, gray mold rot (*Botrytis cinerea*) and black mold (*Alternaria* spp.) can infect broccoli heads; this may occur under rainy, very cool growing conditions.

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## Special Considerations

Storage life varies considerably among broccoli cultivars. Shelf-life (appearance of any yellow beads = end of shelf-life) may vary from 12 to >25 days depending on cultivar: Shelf-life of different broccoli cultivars stored at 5°C (41°F), and 95% RH:

**Short** (<20 Days): Baccus, Brigadier, Cruiser, Mariner, Symphony, Zeus

**Moderate** (20 to 25 days): Cascade, Embassy, Emperor, Esquire, Galaxy, Gem, Green Lady, Green Valiant, Hi Caliber, Midori #8, Pinnacle, Sakata #12, Schooner, Southern Comet, Vantage

**Long** (>25 days): Citation, Galaxy, Glacier, Greenbelt, Marathon, Mercedes, Packman, Pirate, Premium Crop, Shogun, Skiff



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