# Cranberry

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## Scientific Name and Introduction

*Vaccinium macrocarpon* Ait., the American cranberry, is a perennial, woody, creeping, evergreen species in the Vacciniaceae (Blueberry) family (Dana 1990). It is native to acid bogs from Newfoundland south to North Carolina and west to Minnesota. It is popular for its tart-flavored red fruit. Canada and the United States produce almost all of the world's commercial crop of cranberries. Between 92 and 95% is processed; the remainder is sold fresh during the autumn and early winter. The major U.S. cranberry-growing States are, in order of production, Wisconsin, Massachusetts, New Jersey, Oregon, and Washington (NASS 2005).

## Quality Characteristics and Criteria

Color intensity, glossiness, uniformity, and freedom from defects are the major quality characteristics for fresh and frozen cranberries (Spayd et al. 1990).

## Horticultural Maturity Indices

Since the amount of red color (anthocyanin content) in the fruit is the major factor determining cranberry crop value, harvesting is timed to achieve the maximum red color without allowing the fruit to become too overmature (Eck 1990). Overmaturity results in physiological breakdown (see *Physiological Disorders*).

## Grades, Sizes, and Packaging

There is only one grade standard for fresh cranberries: U.S. No. 1. Criteria include color (no less than 75% of the fruit surface pink or red), size (minimum diameter of 10.3 mm or 13/32 in), absence of soft or decayed fruit, and freedom from other defects. Fresh cranberries are commonly packed in cartons containing 24 12-oz polybags, or in cartons of 20, 25, or 30 lb (9.0, 11.4, or 13.2 kg) (AMS 1997). Occasionally, 9 2-lb (0.9-kg) and 4 5-lb (2.3-kg) polybag cartons are used for some retail customers, and wood totes may be used for sale of bulk cranberries.

## Precooling Conditions

The storage length can be increased if the fruit are immediately cooled after harvest and packaged just before shipment (Kaufman et al. 1958, Ringel et al. 1959). If cranberries are not at the desired temperature, they can be forced-air cooled (Spayd et al. 1990, Kasmire and Thompson 1992).

## Optimum Storage Conditions

The minimum recommended storage temperature is 2 °C (35.6 °F). The maximum recommended

temperature is 4 to 5 °C (39 to 41 °F) (Hardenburg et al. 1986, Lidster et al. 1988, Spayd et al. 1990, Kader 1997), though there is one recommendation of 7 °C (45 °F) (Kasmire and Thompson 1992). The recommended RH is 90 to 95% (Hardenburg et al. 1986, Spayd et al. 1990, Kader 1997). Some researchers have recommended lower RH in the belief that it may reduce fungal decay: for example, 65 to 70% (Stark et al. 1974), 70 to 75% (Wright et al. 1937), and 80 to 90% (Lidster et al. 1988). Red color can be increased after harvest by holding fruit, especially early harvested fruit, at 7 to 10 °C (45 to 50 °F) for a few weeks rather than at the lower recommended temperatures (Levine et al. 1941). The expected storage life is 2 to 4 mo.

**Controlled Atmosphere (CA) Considerations**

There is no known commercial use of CA in cranberry storage. Some research suggests CA containing various combinations of $O_2$ and $CO_2$ does not extend cranberry storage life compared with ambient air (Anderson et al. 1963, Stark et al. 1969). Conversely, Kader (1992, 1997) suggested that a CA condition of 1 to 2% $O_2$ and 0 to 5% $CO_2$ is beneficial. The maximum $CO_2$ tolerance may be above 5%, as Stark et al. (1969) used 10% $CO_2$ without detrimental effects. In a 2-mo test at 3 °C (37 °F) with 98% RH using 10 CA combinations of 2%, 21%, and 70% $O_2$ with 0%, 15%, and 30% $CO_2$. Gunes and Watkins (2001) concluded that 21% $O_2$ with 30% $CO_2$ was optimal. Cranberries can be held in an anaerobic condition (100% $N_2$) for up to 14 mo at 3.3 °C (38 °F) in low RH (Stark et al. 1974). Such fruit have little decay but a high amount of physiological breakdown, making them unacceptable for fresh or juice use but still acceptable for use in cranberry sauce.

**Retail Outlet Display Considerations**

Water sprinkling or top-icing are not recommended.

**Chilling Sensitivity**

Cranberry is considered to be a chilling sensitive fruit (Wright et al. 1937, Levine et al. 1941, Kader 1992). Storage at temperatures near 0 °C for more than about 4 weeks may result in low-temperature breakdown (Lidster et al. 1988). Chilling injury symptoms include dull appearance, rubbery texture, and increased decay (Mitcham et al. 1999). If fruit are held at 0 °C, intermittent warming to 21 °C (70 °F) for 1 day a month can reduce chilling injury (Hruschka 1970).

**Ethylene Production and Sensitivity**

Cranberry has a low ethylene production rate of 0.1 to 1.0 $\mu L\ kg^{-1}\ h^{-1}$ at 5 °C (41 °F) (Kader 1992, Mitcham et al. 1999). Postharvest treatment of fruit with as little as 10 $\mu L\ L^{-1}$ markedly increases anthocyanin content, which is enhanced further if the fruit are treated in the presence of light (Fudge 1930, Craker 1971). Eck (1990) and Reid (1992) indicate the use of ethephon, a source of ethylene approved in some areas of the United States, which accelerates cranberry maturity and/or red color development. More recently, a 1995 U.S. Environmental Protection Agency “Reregistration Eligibility Decision (RED) on Ethephon” indicates that cranberries have been deleted from ethephon product labels.

## Respiration Rates

Cranberries have a low respiration rate compared to other berry crops, which have a moderate to high rate (Kader 1992).

| Temperature | mg $CO_2$ $kg^{-1}$ $h^{-1}$ |
|---|---|
| 0 °C | 4 |
| 4 to 5 °C | 4 to 5 |
| 10 °C | 8 |
| 15 to 16 °C | — |
| 20 to 21 °C | 11 to 18 |

Data from Hardenburg et al. (1986) and Mitcham et al. (1999).

To get mL $CO_2$ $kg^{-1}$ $h^{-1}$, divide the mg $kg^{-1}$ $h^{-1}$ rate by 2.0 at 0 °C (32 °F), 1.9 at 10 °C (50 °F), and 1.8 at 20 °C (68 °F). To calculate heat production, multiply mg $kg^{-1}$ $h^{-1}$ by 220 to get BTU ton per day or by 61 to get kcal per tonne per day.

## Physiological Disorders

Physiological breakdown of cranberry is manifested by a soft and rubbery condition, dull external appearance, and diffusion of red anthocyanin pigment throughout internal tissues (Ceponis and Stretch 1981). No fungal organisms are associated with this condition. It is correlated with one or more of the following: impact bruising; late-harvested, more intensely colored fruit; and immersion of free berries for 8 h or more in a flooded bog or similar smothering effects where cranberries are held in poorly ventilated conditions (Graham et al. 1967, Patterson et al. 1967, Ceponis and Stretch 1981, Massey et al. 1981). Chilling injury can have the same symptoms.

## Postharvest Pathology

Postharvest cranberry diseases are almost entirely caused by fungi, with the exception of ringspot, which is thought to be a virus-induced disease (Caruso and Ramsdell 1995, Prange and DeEll 1997). Cranberry is not only attacked by several common postharvest fungi but also by a large number of fungi that are unknown on other fruit crops (Caruso and Ramsdell 1995, Prange and DeEll 1997). The principal storage rots, which can be found in all the major cranberry-growing areas, are end rot, black rot, viscid rot, yellow rot, and botryosphaeria fruit rot (Eck 1990, Prange and DeEll 1997). Since the occurrence of these fungi can vary with location and season and some are not easily identified visually, confirmation of the causal organism(s) usually requires extensive culturing and spore examination. Decay may be reduced if storage $O_2$ is below 1%, since there is no decay control at 1% (Anderson et al. 1963), but 100% $N_2$ for 3 weeks at 3 °C (38 °F) reduced the number of pathogenic species and decay compared with air-stored fruit (Lockhart et al. 1971).

## Quarantine Issues

There are no current restrictions for shipments within Canada and the United States. There has

been little, if any, international trade in fresh cranberries. Such future trade may be subjected to quarantine restrictions, depending on the countries involved.

**Suitability as Fresh-Cut Product**

No current potential.

**Special Considerations**

Cranberries can be stored fresh for 2 to 4 mo, depending on season, cultivar, maturity, handling, and storage conditions (Hardenburg et al. 1986). The storage life of cranberries is limited by the development of decay, shrinkage resulting from moisture loss, and physiological breakdown (Lidster et al. 1988). Early-harvested fruit usually have a longer storage potential than late-harvested fruit (Doughty et al. 1967). Physical damage, which can occur during mechanical harvesting or rough hand-harvesting, transport, or mechanical cleaning, sorting, and packing, increases physiological breakdown, postharvest softening, and decay and reduces storage life (Graham et al. 1967, Patterson et al. 1967, Massey et al. 1981). There is more fungal decay and physiological breakdown in water-harvested than in hand-harvested cranberries, especially if cranberries are kept in the water more than 1 h after detachment from the plant (Mitcham et al. 1999; Blake Johnson, 2000, personal communication).

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