

Pumpkin and Winter Squash

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Scientific Name and Introduction: Three species of the Cucurbitaceae family produce edible fruit that are harvested when physiologically mature. These are pumpkin or acorn squash (*Cucurbita pepo* L.); Winter squash or giant pumpkin (*Cucurbita maxima* Duchesne ex Lam.); and crookneck squash, tropical pumpkin (calabaza), or butternut squash (*Cucurbita moschata* [Duchesne ex Lam.] Duchesne ex Poir.). Mature fruit are harvested in the Fall, and some have the potential to be stored for many months. The distinction between pumpkins and Winter squash is culinary rather than taxonomical. Pumpkins have coarser, stronger flavored flesh and are used for pies. In the U.S. they are also used for decoration as Halloween jack-o-lanterns or for their edible seeds. Winter squash have finer textured and milder flavored flesh. They are cooked and served as vegetables, and are commonly used for 'pumpkin' pies. The *C. moschata* tropical pumpkin or calabaza is a staple food in the American tropics and is prepared in many ways that overlap the above definitions of pumpkin and squash (Daniel, 1995).

Quality Characteristics and Criteria: Pumpkins and Winter squash should be fully mature, with hard rinds and, except for some striped varieties, solid external color. Flesh of good quality pumpkins and Winter squash is bright yellow or orange with fine, moist texture and high solids, sugars, and starch (Cantwell and Suslow, 1998); overmature flesh can become dry and stringy.

Horticultural Maturity Indices: Horticultural maturity coincides with physiological maturity and is recognized externally by corking of the stem (initiation of abscission), loss of rind surface sheen or gloss, groundspot yellowing, and die-back of the tendril nearest to the fruit. The rind should resist thumbnail pressure. Development of intense yellow or orange flesh color (due to synthesis of carotenoids) and accumulation of sugars and solids are indicators of maturity that are highly correlated with sensory quality (Daniel, et al., 1995; Harvey et al., 1997). Delaying harvest is not recommended as it increases occurrence of storage rots (Hawthorne, 1990), and sensory quality improves more in storage than on the plant (Edelstein et al., 1989; Harvey et al., 1997).

Grades, Sizes and Packaging: Grades are U.S. No. 1 and U.S. No. 2 and are based on similar varietal characteristics (shape, texture, and color), maturity, and freedom from damage and decay. There are no standard sizes for pumpkins and Winter squashes, although minimum and maximum weights of individual fruit within packages may be specified. Packages are commonly mesh or burlap bags and one- or two-piece fiberboard cartons containing 23 kg (50 lb); pumpkins and Winter squash are also shipped in 19-kg (42-lb, 1 1/9 bushel) crates and 360- to 410-kg (800 to 900-lb) bulk bin cartons.

Pre-cooling conditions: Room-cooled or loaded directly into refrigerated trucks and containers.

Optimum Storage Conditions: All pumpkins and Winter squashes should be well matured, carefully handled, and free from injury or decay. Pumpkins and Winter squashes are placed on racks, in bulk bins, or in baskets and are often held in ventilated or common storage in production areas. Recommended conditions for storage of pumpkins and Winter squashes are 10 to 13 °C (50 to 55 °F). At higher temperatures of 15 to 20 °C (59 to 68 °F), green varieties will become undesirably yellow and acquire a stringiness of the flesh. Fruit are chilling sensitive (see below). The RH should be 50 to 70%. Higher RH promotes decay while lower RH causes excess weight loss and texture deterioration (Ryall and Lipton, 1979). The fruit surface should be kept dry, and storage rooms should have good air circulation (Holmes,

1951).

Pumpkins generally do not keep as well as hard-shelled Winter squashes. Most cultivars of Winter squash and pumpkins as well as the tropical pumpkins cannot be stored for more than 2 to 3 mo. Acorn-type squashes, such as 'Table Queen,' can be kept 5 to 8 weeks at 10 °C (50 °F). The popular Butternut squash can be kept 2 to 3 mo at 10 °C (50 °F). It is often stored longer, but spoilage and shrinkage increase. Weight loss should be kept below 15% to minimize development of hollow neck (Francis and Thomson, 1965). Turban and Buttercup squashes can be kept 3 mo. Good quality Hubbard squash can be stored 6 mo at 10 to 13 °C (50 to 55 °F) and 70% RH. A 15% loss in weight after 6 mo is about average (Guba, 1950).

Controlled Atmosphere (CA) Considerations: A CA of 1% O₂ + 7% CO₂ was recommended for Buttercup squash (Prange and Harrison, 1993). Reduced O₂ and elevated CO₂ maintained green color, while elevated CO₂ reduced 'white mealy breakdown' and decay was lower in 7% CO₂ than other CA treatments. There were no beneficial effects of 5% O₂ + either 5% or 10% CO₂ on decay of Spaghetti squash (Lin and Saltveit, 1997). Decay was actually greater in CA than air in both cases due to higher RH and was reduced when CaCl₂ was used to absorb moisture. Control of RH is critical in CA storage.

Retail Outlet Display Considerations: Can be displayed in ambient conditions.

Chilling Sensitivity: Both pumpkins and Winter squashes develop chilling injury at < 10 °C (50 °F). Storage at 0 to 4 °C (32 to 39 °F) inhibits yellowing, but causes sunken pits on the fruit surface and loss of flavor. Alternaria rot develops on chilled squashes after removal from storage (McColloch, 1962). Depending on cultivar, chilling injury symptoms develop after 1 mo at 5 °C (41 °F) or several mo at 10 °C (50 °F) (Cantwell and Suslow, 1998).

Ethylene Production and Sensitivity: Pumpkins and Winter squash produce only trace amounts of ethylene, but wounding greatly increases ethylene production (Hyodo et al., 1993). Hubbard squash and other dark-green-skinned squashes should not be stored near apples, as the ethylene from apples may cause the skin to turn orange-yellow (Yeager et al., 1945). Ethylene may also cause stem abscission; especially in less mature fruit (Cantwell and Suslow, 1998).

Respiration Rates:

Temperature	mg CO ₂ kg ⁻¹ h ⁻¹
12 °C	88 to 110 (Buttercup)
25 °C	61 to 121 (Butternut)

To get mL 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 per ton per day or by 61 to get kcal per metric ton per day. Data for Buttercup are from Irving et al. (1997); data for Butternut are from L.L. Morris (unpublished).

Physiological Disorders: Damaged areas on fruit turn brown, detracting from their appearance. Pumpkins and Winter squash are susceptible to water loss at the recommended 50 to 70% RH, but low RH is necessary to minimize decay. Yellowing can be a problem for green Winter squash varieties and is exacerbated by over-maturity, high storage temperatures, and ethylene exposure.

Postharvest Pathology: Decay is the primary cause of storage losses of pumpkins and Winter squash. Numerous fungi cause storage rots including species of *Aspergillus*, *Colletotrichum* (anthracnose), *Didymella*, *Fusarium*, *Mycosphaerella* (black rot), *Rhizopus*, and *Sclerotinia* (Abdel-Rahim, 1988; Arvayo-Ortiz et al., 1994; Guba, 1950; Hawthorne, 1988; Rath et al., 1990; Vigliola, 1993). Alternaria rot develops on chill-damaged fruit (McColloch, 1962). Delaying harvest of Buttercup squash 2 weeks

increased fungal storage rots (Hawthorne, 1990). Infection occurs through wounds and natural openings in the surface. Therefore, careful handling to minimize mechanical damage is recommended to minimize storage rots (Guba, 1950). Less rot will develop in the Hubbard squash if stems are completely removed before storage (Yeager et al., 1945). Hot water at 60 °C (140 °F) for 2 min reduced storage rots (Francis and Thomson, 1965); lower temperatures were not effective (Arvayo-Ortiz et al., 1994; Hawthorne, 1989).

Quarantine Issues: None

Suitability as Fresh-cut Product: Some large Winter squash are cut into sections and seeds removed for retail sale.

Special Considerations: A 10- to 20-day curing period at 24 to 27 °C (75 to 81 °F) before storage can harden the rind of pumpkins and Winter squashes (Gorini and Testoni, 1978). However, in New York, curing for 3 weeks at 27 °C (81 °F) to heal mechanical injuries and to ripen immature specimens proved unnecessary (Platenius et al., 1934; Schales and Isenberg, 1963). Curing Butternut, Hubbard, and Quality squashes was of no value but not harmful, whereas curing Table Queen was detrimental to skin color, texture, and taste (Schales and Isenberg, 1963). Cured Table Queen also decayed more rapidly than non-cured fruit.

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