

Cassava

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Scientific Name and Introduction: Cassava (*Manihot esculenta* Crantz) is a woody perennial shrub of the Euphorbiaceae family, and is native to the Amazon region and Central America. It is widely grown throughout the tropics for the starchy root (Rubatsky and Yamaguchi, 1997). Cassava is known as yuca (in Spanish), mandioca (in Portuguese), cassave (in Haitian Creole) and manioc (in French). It is consumed in a wide variety of forms, but only after some form of processing. Cultivars are classified into two groups based on the amounts of hydrogen cyanide present. “Sweet types” contain $< 50 \text{ mg kg}^{-1}$ HCN (fresh weight) and are generally sold as fresh roots, whereas “bitter types” have higher amounts of HCN, but have higher yields and starch content (da Conceição, 1980). These latter types are processed into products including flour (from coarse to fine textured), tapioca starch and fermented starch. In 1998, 158.6 million metric tonnes of cassava was produced, with major producers being, in metric tonnes, Nigeria (30.4), Brazil (19.8), Democratic Republic of the Congo (16.5), Thailand (15.9) and Indonesia (14.7) (FAO, 1999). It is adapted to semi-arid climates and has been a traditional crop for subsistence farmers, although it is increasingly cultivated as an agronomic crop. Most U.S. imports are from Costa Rica (Anon., 1999).

Quality Characteristics and Criteria: Fresh cassava roots are highly perishable under ambient conditions, becoming unmarketable in 3 days or less. However, with proper handling, fresh roots can be stored up to 30 days, permitting export by marine container. The roots should be firm, turgid, fairly straight, and free from mechanical injury, decay, and vascular streaking. The pulp of most common cultivars varies from white to light yellow. Principle causes for loss are vascular streaking, and decay. Extended storage can have two adverse effects on quality: starches are converted to sugars and roots become fibrous, lengthening cooking time (Booth et al., 1976).

Horticultural Maturity Indices: Harvest maturity is based on the root size desired by the market, and ranges from 6 to 18 mo after planting of the stem sections. Sweet types usually grow faster than the bitter types. The main stem is often trimmed to approximately 1 m (39 in) in height a few days before harvest. Plants are manually pulled, or the root zone mechanically undercut to facilitate plant removal, and individual roots cut. Cassava roots are turgid at harvest and must be handled carefully to avoid splitting the periderm.

Grades, Sizes and Packaging: There are no U.S. Grade Standards for cassava. However, shippers should consult with buyers to define quality expectations. For example, root lengths in excess of 30 cm (11.8 in) are undesirable to many importers. Commercially, roots are cleaned by brushing, rinsed in water, surface-dried, and coated with paraffin wax prior to packing in corrugated cartons.

Pre-cooling Conditions: Room cooling is generally sufficient, provided the roots are not held too long at ambient temperatures prior to or after packing.

Optimum Storage Conditions: Cassava is very sensitive to water loss, and methods used to maintain high RH during storage include moist sawdust and plastic films (Booth, 1976). Paraffin wax is applied to roots exported to the U.S. Waxing and holding at 0 to 5 °C (32 to 41 °F) extends shipping time to > 30 days with minimal occurrence of vascular streaking. A water-based carnauba wax maintained postharvest quality equivalent to paraffin wax (Sargent et al., 1995).

Controlled Atmosphere (CA): No commercial-scale recommendations have been reported.

Retail Outlet Display Considerations: Cassava is normally displayed in bulk and should be held in refrigerated display cases.

Chilling Sensitivity: Cassava is chilling sensitive, but it can be stored at 0 to 5 °C (32 to 41 °F) with minimal symptom development.

Ethylene Production and Sensitivity: Cassava roots ('Valencia') stored in air at 25 °C (77 °F) and 98% RH produced about 1.2 $\mu\text{L kg}^{-1} \text{h}^{-1}$ ethylene; however, ethylene production doubled at 65% RH (Aracena, 1993). Ethylene production was 2.1 $\mu\text{L kg}^{-1} \text{h}^{-1}$ for unwaxed roots after 4 days at 25 °C (77 °F) and 1.1 $\mu\text{L kg}^{-1} \text{h}^{-1}$ for roots coated with paraffin wax.

Respiration Rates: After 1 day of storage in air at 25 °C (77 °F) with 98% RH, unwaxed roots respired at a rate of 23 $\mu\text{L CO}_2 \text{ kg}^{-1} \text{h}^{-1}$, whereas those treated with 75 $\mu\text{L L}^{-1}$ ethylene respired 32 $\mu\text{L kg}^{-1} \text{h}^{-1}$. After 4 days under the same conditions, internal CO_2 production was 8 and 11 $\mu\text{L kg}^{-1} \text{h}^{-1}$, while O_2 levels were 9 and 11.5 $\mu\text{L kg}^{-1} \text{h}^{-1}$ for unwaxed and waxed roots, respectively (Aracena, 1993).

Physiological Disorders: Vascular streaking appears as blue or purple spots when the root is cut transversely and is a result of an oxidative process in the vascular bundles. It typically develops at wound sites, such as the apical end where the root is cut at harvest, or under breaks in the peel that can occur during careless handling. Development of vascular streaking is related to the oxidation of scopoletin, a phenolic compound (Wheatley and Schwabe, 1985). Storage of unwaxed cassava roots in 1% O_2 at 25 °C (77 °F) for 3 days significantly reduced vascular streaking over storage in air (Aracena, 1993). Exposure to 75 $\mu\text{L L}^{-1}$ ethylene increased vascular streaking, and ethylene induced by wounding or water-stress may be the immediate cause of vascular streaking.

Postharvest Pathology: There are two major postharvest fungal diseases of cassava. Botryodiplodia rot (*Botryodiplodia theobromae* Pat.) invades the pulp beneath the skin, initially developing white mold that later becomes dark grey (Snowdon, 1992). Fusarium rot (*Fusarium solani*, Mart., Sacc.) also grows on the pulp, causing a brown discoloration. Other pathogens reported by Snowdon (1992) include: Aspergillus rot (*Aspergillus flavus*), bacterial soft rot (*Erwinia caratovora* ssp. *caratovora*), Mucor rot (*Mucor hiemalis*), Phytophthora rot (*Phytophthora cryptogea*), Rhizopus rot (*Rhizopus oryzae*), Sclerotium rot (*Corticium rolfsii*), and Trichoderma rot (*Trichoderma harzianum* Rifai).

Quarantine Issues: There are no restrictions on imports from major the production areas.

Suitability as Fresh-cut Product: There is potential for pre-peeled intact or sliced roots, but shelf-life is currently limited to 2 or 3 days under ideal storage conditions due to vascular streaking.

Special Considerations: None.

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