

Chayote—A Potential Vegetable Crop for Florida¹

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General Description

Chayote (*Sechium edule* (Jacq.) Sw.), known as the vegetable pear, is a nutritious plant with a pale-green, ridged, fleshy fruit with a single seed. This crop originates from Mesoamerica, specifically southern Mexico and Guatemala (Cook 1901; Newstrom 1991; Stephens 2018). Although there is not sufficient archaeological evidence to show the full timeline of chayote cultivation, this plant has been cultivated in Mexico at least since the pre-Columbian era (Fern 2020; Lira Saade 1996). Chayote was introduced to South America and Europe between the eighteenth and nineteenth centuries, and spread to Africa, Asia, and Australia at the same time (Lira Saade 1996). It has been grown in Louisiana since 1898 and popularly across the United States today as Asian and Hispanic populations have grown (Hill 2022; Cadena-Iñiguez et al. 2007; Cook 1901).

Chayote has many common names, including vegetable pear, christophene, mirliton, and mango squash (Stephens 2018). Because chayote is well-adapted to grow in warmer climates, this plant is widely distributed throughout tropical and subtropical regions in Mexico and Central America countries, such as Costa Rica, Cuba, Dominican Republic, and Guatemala (Sheu 2020), and Puerto Rico was one of the origins of this plant (USDA-NRCS 2020). Chayote has been cultivated for many decades in Hawaii and Louisiana and is not considered to be invasive. According to chayote production data, yields exceed 45,000 lb/ac and 66,000 lb/ac in Mexico and Costa Rica, respectively (Lira Saade 1996). Chayote is prolific; one plant can produce 80 to 100 fruits

per season and a yield of 54,000 lb/ac is considered normal (Fern 2020; Valenzuela 2020).

Chayote now has a place in cuisines and cultures throughout the world (Sheu 2020). As one of the first US states to start cultivating chayote (Cook 1901; Stephens 2018), Florida's suitable climate combined with chayote's excellent taste and nutrition indicate that it could be an economically viable crop for commercial production. The intended audience of this article is vegetable growers, Extension agents, certified crop advisors, crop consultants, environmentalists, agricultural policy makers.

Botanical Description

Chayote is a monoecious, perennial, herbaceous, and vigorous climbing vine with large tuberous roots (Lira Saade 2020; Stephens 2018). The stem can grow up to 50 feet (Lira Saade 2020); therefore, trellis support is recommended to help plant growth (Stephens 2018). The leaves have ovate-cordate shapes, measured 3 to 6 inches in length (Lira Saade 1996, 2020). The flowers are small and usually white to greenish white in color (Table 1). Like other plants of the Cucurbitaceae family, chayote develops large and clinging 3-to-5-branched tendrils to support the climbing plant (Lira Saade 1996, 2020).

The chayote fruit grows individually or in pairs rarely (Lira Saade 1996, 2020). The sizes and shapes of fruits vary greatly, with sizes ranging from 1.7 to 10.4 inches long and 1.2 to 7.6 inches wide and shapes including globose, ovoid, ellipsoid, and pyriform (pear-shaped) (Table 1). The fruits

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are usually pear-shaped with smooth and pale-green skin (Figure 1). The pulp of cultivated chayote is pale green or white and has a pleasant taste. The tiny, ovoid seeds are 0.08 to 0.16 inches long (Figure 2).



Figure 1. Pear-shaped chayote fruit (*Sechium edule* (Jacq.) Sw.) with smooth green skin.

Credits: Guodong Liu, UF/IFAS



Figure 2. Chayote fruit (*Sechium edule* (Jacq.) Sw.) sliced open to show the flesh and seed.

Credits: Qingrong Qiu, Hefei, Anhui, China

Propagation and Pollination

The most common way of propagation is by planting the entire chayote fruit (Valenzuela 2020). Some preplanting preparations are recommended, such as weed clearance (Lira Saade 1996, 2020). Fruit can be planted in hills spaced 12 feet apart with its shoot end sloping downward, also avoiding deep planting that may cause fruit rot (Stephens 2018; Valenzuela 2020). Chayote can be planted at any time of the year, but it is recommended to sow the fruits at the

beginning of the rainy season (Lira Saade 2020; Valenzuela 2020). The recommended planting date for Florida cultivation is early spring in north and central Florida and either spring or fall in south (Stephens 2018). A trellis, usually 6 feet tall, which allows people to walk beneath for cultivation, should be placed near the plant for supporting the climbing vine (Stephens 2018).

Although chayote grows as a perennial plant (Stephens 2018), the regular production cycle for this plant is one to three years, and it is recommended to remove plants after the final harvest to prevent the spread of disease (Fern 2020; Lira Saade 1996). Plants may start flowering one to two months after germination, and fruit development takes about 35 days after pollination (Stephens 2018). Chayote is mainly cross-pollinated (Rojas-Sandoval 2020), which is carried out by several bee (*Apis* spp., *Trigona* spp.) and wasp species (*Polybia* spp., *Synoecca* spp., *Parachratus* spp.) (Lira Saade 1996, 2020). Neither pollination method nor number and frequency of pollen transferred to stigma affect the fruit production. However, the absence of pollinators can cause fruit development failure and premature death (Lira Saade 1996).

Growing Conditions

Chayote can be grown in tropical and subtropical areas at elevations of 0 to 6,000 feet above sea level (Rojas-Sandoval 2020; Fern 2020). This plant grows ideally when daytime temperatures are between 66°F to 86°F and nighttime temperatures are higher than 60°F (Fern 2020; Valenzuela 2020). Chayote can tolerate temperatures between 54°F to 104°F, but this frost-sensitive plant will develop unripe fruits and cannot survive at temperatures less than 54°F (Fern 2020). Chayote can grow in full-sun and partially shaded conditions, and 12-hour day length is required for plant flowering (Fern 2020; Valenzuela 2020).

Chayote growth requires high relative humidity between 80% and 85% (Rojas-Sandoval 2020). This plant grows optimally when average annual rainfall is between 30 to 80 inches, but it can tolerate 24 to 100 inches (Fern 2020). Chayote cannot withstand excessive water standing in the root zone; raised beds or hills are often used to ensure good drainage in heavy rainfall areas and seasons (Valenzuela 2020). Irrigation plays a key role in chayote growth, particularly in the dry season, providing the shallow/superficial chayote roots with a high water demand (Lira Saade 1996). Sprinkler irrigation could be a double-edged sword, because it could prevent the infection of the pest red spider mite (*Tetranychus urticae* Koch) but could also impede

pollinators, resulting in flower abscission (LiraSaade 1996; Valenzuela 2020).

Soil and Fertilizer

Chayote grows well in a fertile and well-drained soil (Fern 2020; Valenzuela 2020). Commercial cultivation of chayote in Mexican calcareous soils with high Ca^{2+} and Mg^{2+} concentration shows low fruit productivity and quality (Cadena-Iñiguez et al. 2007). This plant grows best in soils with a pH within the range of 5.5 to 7.0 but tolerates pH from 4.3 to 8.0 (Fern 2020). Organic manure application is crucial for a sustainable chayote production, with a recommendation rate of 150 lb per plant during the growing season (Cadena-Iñiguez et al. 2007). Commercial growers in Brazil and Costa Rica apply fertilizers more frequently, every two months, at 4 to 5 inches away from the plant (Pacheco et al. 1990; Valenzuela 2020).

No recommendation is available for chayote cultivation in Florida. However, chayote growers can follow the recommendations for cucumber production for the time being: target soil pH, 6.0; nitrogen, 150 lb/acre; 100–120, 80, and 0 lb/acre P_2O_5 for low, medium, and high soil P; and 100–120, 80, and 0 lb/acre K_2O for low, medium, and high soil K for Mehlich-3 extraction (Liu et al. 2020). Because Florida soil properties might differ from those in Brazil and Costa Rica, the application rate must be carefully calibrated before cultivation, and a preliminary practice might also be required to avoid overapplication (Pacheco et al. 1990).

Pests and Diseases

One of the most damaging pests, red spider mite (*Tetranychus urticae* Koch), is a mite that poses a great threat to the plant during the dry season and results in yellow leaves and fruit scabs (Cadena-Iñiguez et al. 2007). Some other species of mites, such as *Paraponychus corderoi* and *Eutetranychus banksi*, also cause detrimental effects on chayote plants (Cadena-Iñiguez et al. 2007). Lepidopteran pests (*Diaphania hyalinata* L. and *Diaphania nitidalis* Stoll) make chayote more susceptible to fungal and bacterial diseases by means of perforating the unripe fruits. Hemiptera (*Aphis* spp. and *Bemisia tabaci* Gennadius) can suck sap from leaves and cause dark blemishes on fruits, and coleoptera (*Phyllophaga* spp. and *Diabrotica* spp.) can attack fruits and seedlings (Lira Saade 1996; Valenzuela 2020). Also, nematodes (*Heterodera radicola* (Greef) Müller and *Meloidogyne incognita* (Kofoid and White 1919, Chitwood 1949)) are the main pests that cause root damage in chayote plants (Lira Saade 1996; Valenzuela 2020).

Most of chayote diseases are caused by fungal pathogens such as *Ascochyta phaseolorum* and *Fusarium oxysporum*, which may cause 35 to 40 percent yield loss of commercial production (Cadena-Iñiguez et al. 2007; Lira Saade 2020). These diseases can occur any time in the growth stage, particularly during the rainy season (Lira Saade 1996; Valenzuela 2020). Also, chayote with high nitrogen fertilization rates is shown to be more susceptible to the diseases *Mycovellosiella cucurbiticola* and *Ascochyta phaseolorum* (Valenzuela 2020). Damaged plant tissues can be manually removed to prevent the spread of diseases, but this process is time-consuming. Crop rotation could be another strategy to help reduce the pests and diseases (Lira Saade 1996).

Harvest and Storage

Generally, fruit are selected based on their shape, appearance, color, and freedom from decay and insect feeding (Cadena-Iñiguez et al. 2007). Chayote fruit are ready for harvest approximately 35 days after pollination, when they are 0.5 to 1.0 pound in weight and 4 to 6 inches in diameter (UC Master Gardeners 2020). The fruit are usually harvested in the early morning, when the texture and tissue are more turgid and the lower temperature minimizes cooling (Cadena-Iñiguez et al. 2007). Fruit are classified with different fruit quality requirements according to the intended market, such as export and local retail; these should be harvested separately (Lira Saade 1996).

Fruit should be handled carefully to prevent any kind of physical damage, including cuts and bruises (Valenzuela 2020). To reduce moisture loss, chayote fruit can be wrapped in individual perforated polyethylene bags or waxed paper and stored at 45°F to 55°F with a relative humidity of 80% to 90% (Cadena-Iñiguez et al. 2007; Valenzuela 2020). Fruit may develop chilling injury when the temperature is lower than 45°F and will sprout if stored at ambient temperatures above 78°F (Cadena-Iñiguez et al. 2007; Valenzuela 2020).

Uses

The young and tender leaves are nutritious and can be eaten and cooked like spinach or asparagus. The shoots can be either stewed in soups or stir-fried in dishes (Sheu 2020; Valenzuela 2020). The seeds are one of the most nutritious parts. These seeds are rich in protein with a nutlike flavor; when deep-fried, they taste like french fries (Rojas-Sandoval 2020; Fern 2020).

Although almost every part of chayote is nutritious and edible, this plant is mainly consumed as a fruit vegetable

(Rojas-Sandoval 2020). The fruit, as the most commercially important part of the plant, can be prepared and served differently depending on the flavor (Sheu 2020; Valenzuela 2020). The starchy and crispy fruit are often eaten raw in salad mixes (Sheu 2020), while those with bland flavor are commonly used as food fillers in pastas and sauces (Fern 2020). Chayote fruit can be prepared in many ways, such as but not limited to fried, curried, baked, stewed, casserole, and pickled (Sheu 2020; Stephens 2018; Valenzuela 2020) (Figure 3). The chayote fruit overall is high in vitamin C and calcium as well as all essential amino acids (Table 2, Table 3). Also, the low energy value of this fruit makes it an important dietary food and baby food (Fern 2020; Lira Saade 1996).



Figure 3. Chayote fruit (*Sechium edule* (Jacq.) Sw.) stir-fried with peppers and wood ear mushrooms (*Auricularia auricula-judae* (Bull.) J. Schröt.).

Credits: Jidou Chen, Hefei, Anhui, China

Marketability and Future Outlook

Chayote has been spread throughout tropical and subtropical areas except for South Asia and Africa (Rojas-Sandoval 2020). However, the cultivation practice of chayote is not well-established in the United States, and thus it has only been grown to a limited extent in California, Florida, Hawaii, and Louisiana (Valenzuela 2020). As the highly nutritious and adaptable chayote has been successfully cultivated in Mexico and Central America countries for decades, establishing a set of suitable field management practices is a critical need in order for this crop to become commercially cultivated in Florida.

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Table 1. Summary of several important characteristics of chayote fruits and plants from several Central American countries and Mexico. Data retrieved from Lira Saade (1996).

Fruit	Costa Rica	Guatemala	Honduras/Panama	Mexico
Length (cm)	4.8–26.5	4.9–16.4	7.1–15.9	4.3–25.0
Length (in)	1.9–10.4	1.9–6.5	2.8–6.3	1.7–9.8
Width (cm)	4.7–19.3	4.6–11.6	6.6–10.9	3.0–12.6
Width (in)	1.9–7.6	1.8–4.6	2.6–4.3	1.2–5.0
Thickness (cm)	4.4–11.0	4.3–8.7	6.8–9.9	2.7–10.2
Thickness (in)	1.7–4.3	1.7–3.4	2.7–3.9	1.1–4.0
Weight (g)	58–1207	48–540	299–398	61–1211
Weight (oz)	2.0–42.6	1.7–19.0	10.5–14.0	2.2–42.7
Volume (cm ³)	n.a.	n.a.	n.a.	47–1227
Volume (fl oz)	n.a.	n.a.	n.a.	1.6–41.5
Color	white, light green, dark green	white, light green, dark green	light green, dark green	white, yellow, light green, dark green
Shape	pyriform, subpyriform, ovoid, flattened, spheroid	pyriform, subpyriform, ovoid, flattened, spheroid	pyriform, subpyriform, ovoid, spheroid	elliptic, pyriform, subpyriform, ovoid, obovoid
Spines	absent, few, intermediate, many	absent, few, intermediate, many	few, intermediate, many	absent, few, intermediate, many
Furrows	absent, shallow, intermediate, deep	absent, shallow, intermediate	shallow, intermediate, deep	shallow, intermediate, deep
Ridges	n.a.	n.a.	n.a.	absent, few, intermediate, many
Lenticels	absent, few, intermediate, many	absent, few, intermediate	few, intermediate, many	absent, few, intermediate, many
Texture of pulp	n.a.	n.a.	n.a.	solid, soft
Taste of pulp	n.a.	n.a.	n.a.	simple, sweet, insipid, tasty, salty
Fiber of pulp	n.a.	n.a.	n.a.	absent, few, many
Days to harvest	n.a.	n.a.	n.a.	102–331
Fruits per plant	n.a.	n.a.	n.a.	49–521
n.a.—not available				

Table 2. Nutritive value of chayote (*Sechium edule* (Jacq.) Sw.), fruit, raw. Source: USDA-ARS, National Nutrient Database, available at <https://fdc.nal.usda.gov/fdc-app.html#/food-details/170402/nutrients>.

Name	Amount	Unit
Variables		
Water	94.24	g
Energy	19	kcal
Energy	80	kJ
Protein	0.82	g
Total lipid (fat)	0.13	g
Ash	0.3	g
Carbohydrate, by difference	4.51	g
Fiber, total dietary	1.7	g
Sugars, total including NLEA	1.66	g
Minerals		
Calcium, Ca	17	mg
Copper, Cu	0.123	mg
Iron, Fe	0.34	mg
Magnesium, Mg	12	mg
Manganese, Mn	0.189	mg
Phosphorus, P	18	mg
Potassium, K	125	mg
Selenium, Se	0.2	µg
Sodium, Na	2	mg
Zinc, Zn	0.74	mg
Vitamins		
Vitamin A, IU	0	IU
Vitamin A, RAE	0	µg
Vitamin B-6	0.076	mg
Vitamin B-12	0	µg
Vitamin B-12, added	0	µg
Vitamin C, total ascorbic acid	7.7	mg
Vitamin D (D2 + D3)	0	µg
Vitamin D (D2 + D3), International Units	0	IU
Vitamin E (alpha-tocopherol)	0.12	mg
Vitamin E, added	0	mg
Vitamin K (phylloquinone)	4.1	µg
Folate, total	93	µg
Folic acid	0	µg
Folate, food	93	µg
Folate, DFE	93	µg
Carotene, alpha	0	µg
Carotene, beta	0	µg
Choline, total	9.2	mg
Cryptoxanthin, beta	0	µg
Lycopene	0	µg
Lutein + zeaxanthin	0	µg
Niacin	0.47	mg

Name	Amount	Unit
Pantothenic acid	0.249	mg
Retinol	0	μg
Riboflavin	0.029	mg
Thiamin	0.025	mg
Amino acids		
Alanine	0.051	g
Arginine	0.035	g
Aspartic acid	0.092	g
Glutamic acid	0.125	g
Glycine	0.041	g
Histidine	0.015	g
Isoleucine	0.044	g
Leucine	0.077	g
Lysine	0.039	g
Methionine	0.001	g
Phenylalanine	0.047	g
Proline	0.044	g
Serine	0.047	g
Threonine	0.04	g
Tryptophan	0.011	g
Tyrosine	0.032	g
Valine	0.063	g
Lipids		
Cholesterol	0	mg
Fatty acids, total saturated	0.028	g
Fatty acids, total monounsaturated	0.001	g
Fatty acids, total polyunsaturated	0.057	g
Fatty acids, total trans	0	g
Others		
Alcohol, ethyl	0	g
Caffeine	0	mg
Theobromine	0	mg

Table 3. Nutritive value of chayote (*Sechium edule* (Jacq.) Sw.), fruit, cooked, boiled, drained, with and without salt. Source: USDA-ARS, National Nutrient Database, available at <https://fdc.nal.usda.gov/fdc-app.html#/food-details/169344/nutrients>; <https://fdc.nal.usda.gov/fdc-app.html#/food-details/170403/nutrients>.

Name	Amount (with salt)	Amount (without salt)	Unit
Variables			
Water	93.43	93.43	g
Energy	22	24	kcal
Energy	90	100	kJ
Protein	0.62	0.62	g
Total lipid (fat)	0.48	0.48	g
Ash	0.97	0.38	g
Carbohydrate, by difference	4.5	5.09	g
Fiber, total dietary	2.8	2.8	g
Sugars, total including NLEA	1.89	1.89	g
Minerals			
Calcium, Ca	13	13	mg
Copper, Cu	0.11	0.11	mg
Iron, Fe	0.22	0.22	mg
Magnesium, Mg	12	12	mg
Manganese, Mn	0.169	0.169	mg
Phosphorus, P	29	29	mg
Potassium, K	173	173	mg
Selenium, Se	0.3	0.3	µg
Sodium, Na	237	1	mg
Zinc, Zn	0.31	0.31	mg
Vitamins			
Vitamin A, IU	0	0	IU
Vitamin A, RAE	0	0	µg
Vitamin B-6	0.118	0.118	mg
Vitamin B-12	0	0	µg
Vitamin B-12, added	0	0	µg
Vitamin C, total ascorbic acid	8	8	mg
Vitamin D (D2 + D3)		0	µg
Vitamin D (D2 + D3), International Units		0	IU
Vitamin E (alpha-tocopherol)	0.14	0.14	mg
Vitamin E, added	0	0	mg
Vitamin K (phylloquinone)	4.7	4.7	µg
Folate, total	18	18	µg
Folic acid	0	0	µg
Folate, food	18	18	µg
Folate, DFE	18	18	µg
Carotene, alpha	0	0	µg
Carotene, beta	0	0	µg
Choline, total	10.5	10.5	mg
Cryptoxanthin, beta	0	0	µg
Lycopene	0	0	µg
Lutein + zeaxanthin	0	0	µg

Name	Amount (with salt)	Amount (without salt)	Unit
Niacin	0.42	0.42	mg
Pantothenic acid	0.408	0.408	mg
Retinol	0	0	µg
Riboflavin	0.04	0.04	mg
Thiamin	0.026	0.026	mg
Amino acids			
Alanine	0.038	0.038	g
Arginine	0.026	0.026	g
Aspartic acid	0.069	0.069	g
Glutamic acid	0.094	0.094	g
Glycine	0.031	0.031	g
Histidine	0.011	0.011	g
Isoleucine	0.033	0.033	g
Leucine	0.058	0.058	g
Lysine	0.03	0.03	g
Methionine	0.001	0.001	g
Phenylalanine	0.036	0.036	g
Proline	0.033	0.033	g
Serine	0.035	0.035	g
Threonine	0.031	0.031	g
Tryptophan	0.008	0.008	g
Tyrosine	0.024	0.024	g
Valine	0.047	0.047	g
Lipids			
Cholesterol	0	0	mg
Fatty acids, total saturated	0.031	0	g
Fatty acids, total monounsaturated	0.01	0	g
Fatty acids, total polyunsaturated	0.065	0	g
Fatty acids, total trans	0	0	g
Others			
Alcohol, ethyl	0	0	g
Caffeine	0	0	mg
Theobromine	0	0	mg