



Soursop

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Annona muricata L.
Family: Annonaceae

This tropical, hearty, small evergreen tree produces the largest fruit in the Annonaceae family. The tree can reach heights of 30 feet and tolerates a wide variety of soils, although it produces best in well drained, sandy soil with a pH of 5–6.5. Low branching and bushy, with upturned limbs keeping the tree slender, it does not tolerate cold and is susceptible to strong winds. The tree will grow at sea level, if protected from salt spray and irrigated, and will thrive to upwards of 3000 ft elevation in the tropics. Orchards often have windbreaks to protect plantings. The tree grows quickly, often producing its first crop within 3–5 years from seeding. The fruit is heart-shaped to oval, ranging in size from a few inches to over 1 foot in length. Often the fruit is lopsided, possibly due to poor pollination. The fruit is reported to weigh as much as 15 pounds, although the current Guinness Book of Records from Hawai'i is 8.14 pounds, with a circumference of 24 inches and length of 11.5 inches. The white fruit segments surround the fruit core and have a pleasant sub-acid flavor. Most segments are seedless, although those that are fertile have a smooth black seed up to an inch in length. The seeds and bark are considered toxic and contain a number of compounds and potentially poisonous alkaloids such as anonaine, muricine, and hydrocyanic acid.



These can cause severe eye inflammation problems. Some types are considered fibreless and are preferred.

Other common names

The name soursop is derived from the Dutch *zuurzak* meaning sour sack; *guayabano* (Philippines); *guanabana* (Spanish speaking countries); *corossol epineux* (French); *sirsak* (Indonesian); *graviola* (Brazil); *soursop* and *prickly custard apple* (English); *thurian thet*, *thurian-khaek*, *rian-nam* (Thailand), *mang cau xiem* (Vietnamese); *anona de puntitas*, *anona de broquel*

(Argentina); *mundla* (India); *durian belanda*, *durian maki* (Malaysia).

Origin

The soursop originated in the lowlands of Central America. It was first described by Spanish historian Gonzalo Fernández de Oviedo y Valdés in 1526 and was spread around the world by the Spanish explorers. The fruit may have come to Hawai'i with Don Francisco de Paula Marin in the late 1700s with its close relative *cherimoya* (*Annona cherimoya*). The fruit was not reported in Florida until 1879. The fruit is now commercially cultivated throughout the tropical Americas and is found in small family orchards in Southeast Asia, Philippines, India, Hawai'i, and other Pacific islands.

Cultivars

Different growing locations report the fruit, sweet and sour (Indonesia and Philippines), or sweet, sub-acid, and acid (Puerto Rico). Having no fiber or a reduced amount of fiber in the flesh is the most desired characteristic. Puerto Rico cataloged 14 types. Popular cultivars include 'Morada' (Brazil), 'Cuban Fibreless' (Australia), 'Sirsak Ratu' (Java), and 'Bennett', a blue-green skinned type introduced to Florida in 1920. There are no named cultivars in Hawai'i, and seedling trees have a wide range of characteristics.

Environment

Soursop is the most drought-tolerant of the annonas and prefers well-drained soils, although it will tolerate a wide range of Hawai'i's volcanic soils. The tree is highly susceptible to frost and winds. The shallow root system benefits greatly from copious mulching. High temperatures from 80°F to 90°F and low (30%) relative humidity can cause pollination problems, whereas a lower temperature (in the 70s with 80% relative humidity) improves pollination. Seeds can be planted in the field and later topworked if needed. In Hawai'i, soursop is used as a rootstock for cherimoya. The trees are often planted between larger mango, avocado, and macadamia trees.

Propagation

Although usually propagated by seed, better fibreless varieties can be grafted. Airlayering is possible, but the success rate is considered marginal. If planted within 30 days of harvest, 90 percent of the seeds are viable and germinate in 15–30 days. Some seeds will stay viable up to 6 months. Seeds should be washed before planting. Soursop is usually grafted onto other soursop, as well as pond apple (*Annona glabra*).

Culture and management

In production orchards, trees have been planted from 8 x 8 ft to 20 x 25 ft, at the discretion of the grower, for an average of 100 trees per acre. The trees will drop leaves in times of drought. Quarterly fertilization with 10-10-10 NPK at ½ pound per year for the first year, 1 pound the second year, and 3 pounds for every year thereafter gives excellent results. A South Kona orchard used organic 6-6-6 with drip irrigation (10 minutes in the early morning, 3 days per week, from 1.2 gallon-per-hour emitters) to produce excellent results and consistent year-round production. Water stress should be prevented.



Early-stage flowers

Once shaped, the tree requires little pruning other than cutting out dead or poorly placed branches. This should be done after harvest. Trees can be topped at about 6 feet, causing fruit production on lateral branches to facilitate harvesting.

Pests and diseases

Diseases reported in Hawai'i include anthracnose (*Colletotrichum gloeosporioides*) bacterial wilt (*Pseudomonas* spp.) black canker (*Phomopsis anonacearum*) diplodia rot (*Botryodiplodia* spp.) corky rot (*Cylindrocladium colhounii*)

Insect pests reported in Hawai'i include cerconota moth (*Cerconota anonella*) leaf miner (*Leucoptera* sp.) seed borer (*Bephrata maculicollis*) caterpillars (*Thecla* sp. and *Oiketicus kubeyi*) scale insect (*Conchaspis angraeci*) coccid (*Pseudococcus filamentosus*) Oriental fruit fly (*Bactrocera dorsalis*) melon fly (*Bactrocera cucurbitae*) Mediterranean fruit fly (*Ceratitidis capitata*)

Harvesting and yield

The unripe dark green fruit is covered with an inedible skin with soft spines. Harvest takes place when the color lightens and changes to a slightly yellowish-green. The

spines soften and the fruit appears bloated, with segment margins becoming smooth and less noticeable. Generally it takes 4 or 5 days for the fruit to fully ripen after picking, when the skin yields to slight pressure. In most growing locations, trees usually produce two dozen fruits per year, each sometimes weighing up to 5 or more pounds. Trees at lower elevations in Hawai'i can produce 70 smaller fruit per year, especially under irrigation, which also enables the tree to flower and produce year-round at most elevations. Soursop yields in Hawai'i have been observed at approximately 95 pounds on 4-year-old trees and about double that on 6-year-old trees. An established field can yield up to 16,000 pounds per acre. Yields reported from elsewhere are approximately half of those reported in Hawai'i.

Postharvest considerations

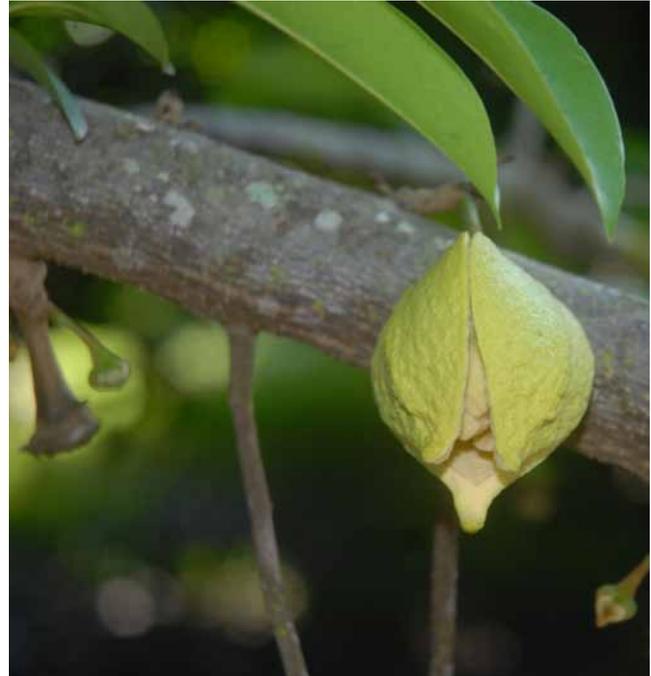
Once harvested, the fruit softens in 4–7 days and has a shelf life of another 3–5 days. The optimal edible stage is 6–7 days after harvest. The fruit's tender skin needs to be handled with great care. An average fruit will yield 62–85 percent edible portion, depending on genetic and environmental influences.

Commercial operations add water to the pulp to reduce the viscosity sugar to 15% and citric acid to adjust the pH to 3.7. Frequently the pulp is frozen or sterilized to be used later in desserts, syrups, soups, and a wide variety of value-added products. Pulp can also be frozen without any additives.

There are commercial plantings in the Philippines, Mexico, the Caribbean, and South America. Soursop pulp and juice are available from South America and Mexico.

Packaging, pricing, and marketing

Soursop is sold retail as individual fruits at farmers' markets throughout Hawai'i. Farmers often sell direct to neighborhood grocery and health food stores. A few wholesalers will purchase fruits, usually for sale to chefs and sometimes stores. Soursop sales have been slow to develop in Hawai'i as ethnic populations known to consume the fruit usually have their own trees. Only in recent years have resort hotel chefs started to experiment with the fruit and use it in a broader range of culinary creations. Growers package similar-sized fruits for delivery to wholesalers at from \$2.00 to \$3.50 per pound. A few growers sell by weight at farmers' markets, but most sell by size, S, M, L, and XL, for \$1, \$2, \$3, and



A later-stage flower

\$5.00 each. Fruit is seldom sold retail with any packaging, although on occasion Styrofoam netting is used to protect fruit from bruising, especially in commercial sales. Further education about soursop to chefs and consumers is indicated to increase markets and sales.

Nutritive value

Per 100 grams of edible portion

<i>Proximate (g)</i>	
water	80.1–82.8
energy (kcal)	61.3–71
(kJ)	247
protein	0.69–1
lipid (fat)	0.39–0.97
carbohydrate	14.6–18.23
fiber	0.79–0.95
ash	0.58–60
<i>Minerals (mg)</i>	
calcium	9–10.3
iron	0.64–0.82
magnesium	22
phosphorus	27.7–29
potassium	20
sodium	22

Vitamins (mg)

ascorbic acid	16.4–29.6
thiamine	0.07–0.11
riboflavin	0.05–0.12
niacin	1.28–1.52
vitamin A	0

Uses and Recipes

Uses include eating fresh or processed into juice, pulp, ice cream, mousse, jelly, soufflé, and sorbet. Cakes are made in Indonesia and candy in the Philippines, where young fruit is also used as a vegetable. In the Caribbean, strained pulp milk and sugar is a popular drink, as is juice mixed with wine or brandy.

Recipes courtesy of Chef Jamon Harper,
Orchid Fairmont

Soursop Punch/Soup

3 c	soursop puree
2 c	milk
1 c	heavy cream
2 c	simple syrup 1:1
1 tsp	nutmeg (optional)

Combine all ingredients in a hand blender. Serve over ice as a refreshing drink, or add fresh tropical fruit and use as a soup.

White Chocolate-Soursop Mousse

14 oz	white chocolate Couverture
1 c	soursop puree
¾ oz	powdered gelatin
4 oz	egg yolks + 3 oz. granulated sugar
¾ c	heavy cream
5 oz	egg whites + 3 oz. granulated sugar

Melt white chocolate and set aside to cool. Bloom gelatin by sprinkling over soursop puree. Whip yolks and sugar until it reaches ribbon stage. Whip heavy cream to soft peaks. Whip whites and sugar to medium peaks. Heat soursop/gelatin mixture until gelatin is melted. Combine chocolate and soursop. Fold in yolk mixture, followed by egg whites. Fold in whipped cream; deposit mousse into desired molds and chill.

Cost of production

It is essential that growers determine their own cost of production for each crop in each growing location. Including *all* the variables in figuring your cost to produce a specific crop is key to farm sustainability. A few of the operating (or “variable”) costs include fertilizer, weed control, pest control, pruning, irrigation, harvesting, marketing, and operations overhead. Ownership (or “fixed”) costs also need to be taken into account. For detailed information on the various types of cost, see “The economics of cacao production in Kona” (www.ctahr.hawaii.edu/oc/freepubs/pdf/AB-17.pdf).

The cost-of-production spreadsheet on the following pages can be downloaded as a Microsoft Excel file from www.ctahr.hawaii.edu/oc/freepubs/spreads/6fruits.xls.

Selected references

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- Verheij, E.W.M., and R.E. Coronel. 1992. Plant resources of Southeast Asia, 2: Edible fruits and nuts. PROSEA Foundation, Bogor Indonesia. p. 75–78.

Internet resources

- Fruits of warm climates, by Julia F. Morton
www.hort.purdue.edu/newcrop/morton/index.html
- Montoso Gardens
www.montosogardens.com
- Plant Resources of Southeast Asia
www.prosea.lipi.go.id
- International Tropical Fruit Network
www.itfnet.org

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Assumptions: (Data entries are annual amounts expressed on a per tree basis)			Fruit tree =>	SOURSOP		
1. Average number of bearing trees (counted)	4	trees	To calculate <u>profitability</u> : Enter wage rate & benefits actually paid (or the rates one would pay if labor were hired.) To calculate <u>cash flow</u> enter nothing. The cash flow result is (except for depreciation considerations) one's taxable income.			
2. Yield (expressed in number of fruit [F] or lbs)	F	50			fruit / tree	
3. Average wt. (ozs.) / fruit =	56.0	ounces				
4. Total lbs. harvested/ tree =	175.0	lbs. gross yield				
5. Marketable yield /tree (%) =	75%	of the gross yield				
					6. Wage rate (\$/hr.) =	\$12.00
					7. Benefits (FICA, etc.) (%) =	33.3%

Gross Revenue:	% of total	\$/lb.	Lbs./tree/yr.	\$/tree /yr.:	\$/total crop /yr.	% of gross
1 Wholesale sales	40%	2.50	52.5 marketable lbs.	131.25	525	29%
2 Retail sales	60%	4.00	78.8 marketable lbs.	315.00	1,260	71%
Total sales =	<i>Weighted ave. price/lb. = \$3.400</i>		131.3 marketable lbs.	446.25	1,785	100%

Operating Costs:		<i>Enter unit quantities as total per year per tree:</i>					
A. Growing costs:	Units:	\$/unit:	¢ /lb. of fruit	\$/tree /yr.:	\$/total crop /yr.	% of gross	
1 Fertilization	Sub-totals =>			0.06	8.00	32.00	2%
Fertilizer (lbs.)	2.0	\$2.00	0.030	4.00	16.00		
Labor (min.)	15	\$0.27	0.030	4.00	16.00		
2 Irrigation: <i>Assuming ag water rate =</i>	\$2.00	<i>/1,000 gals.</i>	Sub-total=>	0.01	1.34	5.35	0%
Water (gallons)	2	<i>\$0.002 / 1,000 gals.</i>	0.000	0.00	0.02		
Labor (min.)	5	\$0.27	0.010	1.33	5.33		
3 Pest control:	Sub-totals =>			0.02	2.67	10.67	1%
Materials	0.0	\$0.00	0.000	0.00	0.00		
Labor (min.)	10	\$0.27	0.020	2.67	10.67		
4 Weed control:	Sub-totals =>			0.02	2.67	10.67	1%
Chemicals and/or machinery	0.0	\$0.00	0.000	0.00	0.00		
Labor (min.)	10	\$0.27	0.020	2.67	10.67		
5 Pruning:	Sub-totals =>			0.06	8.00	32.00	2%
Machinery	0.0	\$0.00	0.000	0.00	0.00		
Labor (min.)	30	\$0.27	0.061	8.00	32.00		
6 Other:	Sub-totals =>			0.00	0.00	0.00	0%
Materials and/or machinery	0.0	0.00	0.000	0.00	0.00		
Labor (min.)	0	\$0.27	0.000	0.00	0.00		
Total growing costs =				0.173	22.67	90.69	5%

Enter picking costs based on gross yield and packing and delivery costs based on marketable yield.

B. Harvesting costs:	Average cents per pound	¢ /lb. of fruit	\$/tree /yr.:	\$/enterprise /yr.	% of gross	
1 Picking	6.9	¢/lb.	6.9	12.08	48.30	3%
2a Packing: for wholesale	14.9	¢/lb.	6.0	3.13	12.52	1%
2b Packing: for retail sales	14.9	¢/lb.	8.9	11.73	46.94	3%
3 Delivery to market	9.1	¢/lb.	9.1	11.94	47.78	3%
Total harvesting costs =			24.9	35.75	143.01	8%
TOTAL Operating Costs =			25.1	58.42	233.70	13%

Break-even analysis:	Gross Margin =	314.9	387.83	1,551.30	86.9%
Given the weighted average price of \$3.400 \$/lb. fruit, the mkt. yield required to cover operating costs =					68.7
Given the marketable yield of 131.3 lbs. fruit/ tree, the ave. price req. to cover operating costs =					\$0.445

How to calculate your harvesting costs expressed as ¢ / lb:

Picking: Assume picking labor wage rate = **\$12.00** /hour

- 1 Weigh all of the fruit picked in one harvest year & average it out for one tree. Ave. gross yield / tree = 175.0 lbs./year
(Important: The picked fruit yield recorded here is the gross yield and not the marketable yield.)
- 2 Record how many minutes on average it takes you to pick all of the fruit on one tree. 60 minutes
(Note: You will probably harvest the tree a number of times during the season. We need the time it takes for the whole crop year.)
- 3 Divide the ave. gross yield /tree by the ave. time taken to pick. Your average picking rate in pounds per minute = 2.9
- 4 Divide the hourly wage rate for pickers by 60 minutes.. This will give you the cents per minute wage rate = 20.0
- 5 Divide this wage rate, in ¢ / min. (result from step 4 above), by the ave. picking rate (in lbs./ min.) (from step 3 above.)

The result is your **cost (in ¢ / lb.) to pick a tree's annual gross yield of fruit** = 6.9 ¢ / lb.

Example to illustrate the process:

- a In one year you picked 1,600 fruit with a total weight of 800 pounds in 1 hour 20 min = 100 minutes. Your average picking rate is:
 $800 \text{ lbs.} \div 100 \text{ minutes} = 8 \text{ lbs./ min.}$
- b You would pay pickers \$12.00 per hour = 20 ¢ per minute to pick fruit. $12 \div 60 = \$0.20$ or **20¢ per minute**
- c Your picking cost / tree is: $20 \text{ ¢/min} \div 8 \text{ lbs./ min.} = 2.5 \text{ ¢/ lb.}$ per pound of fruit picked

Packing:

- 1 WHOLESALE: Record the total annual cost for packaging to pack the marketable fruit sold wholesale. \$7.80
 - 2 Divide this cost by pounds of fruit sold wholesale. (This has been calculated in "Gross Revenue" above) 52.5
Your materials cost in ¢ / lb. = **14.9 ¢ / lb.**
 - 3 If more labor (in addition to the picking labor) is required to pack, calculate its cost in ¢ / lb. as above.
Extra labor required (minutes): 0 Packing rate = lbs. / minute Labor cost =
 - 4 Add these 2 costs together to obtain the **total packing cost per pound of fruit marketed wholesale** = 14.9 ¢ / lb.
 - 5 RETAIL: Follow the same procedure (steps 1 to 4 above) to calculate the cost to pack fruit sold retail.
Total cost of retail packaging = \$11.70 Retail sales = 78.8 pounds Materials cost = 14.9 ¢ / lb.
Extra labor required (minutes): 0 Packing rate = lbs. / minute Labor cost =
- Total packing cost per pound of fruit marketed retail** = 14.9 ¢ / lb.

Example:

- a In one year you picked 1,600 pounds of fruit, of which 75% was marketable, that is, 1,200 pounds.
- b During the year you used 24 boxes (@ \$2 each) to ship 1,200 pounds of fruit to the wholesale market.
- c Divide the packaging cost (\$48) by the amount of marketable fruit. This will give you the materials cost / lb. of fruit:
 $\$48.00 \div 1,200 = \$0.08 = 4 \text{ ¢ / lb.}$
- d During the year 60 minutes of packing labor was required (beyond the picking labor.) Your average packing rate is:
 $1200 \text{ lbs.} \div 60 \text{ min.} = 20 \text{ lbs. / min.}$
- e You would pay packers \$12.00 per hour (= 20 ¢ per minute) to pack fruit. Your annual packing labor cost /tree is:
 $20 \text{ ¢/min} \div 20 \text{ lbs./ min.} = 1.0 \text{ ¢ / lb.}$
- f Add the annual material cost (step c) and labor cost (step e) to obtain your total packing cost / lb. of marketed fruit.
 $8 \text{ ¢ / lb.} + 1 \text{ ¢ / lb} = 9.0 \text{ ¢ / lb.}$ for packing wholesale fruit.

Delivery:

- 1 Based on your annual records, calculate your average cost / mile for vehicle & driver to haul boxes: \$1.00
- 2 Record the total delivery mileage for one year & estimate a portion to allocate to delivering this crop: 12
- 3 Record the total weight of marketable fruit delivered during the year: 131.3
- 4 Multiply estimated share of mileage times mileage rate & divide by total weight of deliveries: 9.1 ¢ / lb.

Example:

- a You have 10 trees that yield an average of 1,200 lbs of marketable fruit = 12,000 lbs.
- b During the year you made 24 deliveries carrying 500 lbs of fruit averaging 20 miles round trip.
- c The cost for your vehicle and driver's time averages about \$1.00 per mile driven.
Note: Obviously, the average delivery cost / lb. of all fruit marketed, unlike the picking and packing costs per pound of fruit, will vary widely for different growers, depending on their location relative to their markets.
 $480 \text{ miles driven @ } \$1.00 / \text{mile} = \$480$ $\$480.00 \text{ transport cost} \div 12,000 \text{ lbs fruit} = \$0.04 = 4.0 \text{ ¢ / lb.}$ of fruit delivered