College of Tropical Agriculture and Human Resources
University of Hawai'i at Mānoa

Fruits and Nuts
June 2011
F_N-24

Abiu

Ken Love[1] and Robert E. Paull[2]
[1]Hawaii Tropical Fruit Growers, [2]CTAHR Department of Tropical Plant and Soil Sciences

Pouteria caimito Radlk.
Synonyms: *Achras caimito* Benth., *Guapeda caimito* Pierre, *Labatia caimito* Mart., *Lucuma caimito* Roem & Sch., and *Pouteria leucophaea* Baehni
Family: Sapotaceae

This small to medium sized evergreen tree can grow to over 30 feet in height under optimal conditions but usually is kept low to facilitate harvesting. The rough bark is grey to brown and exudes white latex when cut. The glossy leaves are pointed at both ends and tend to cluster at the end of the branch. Flowers occur along branches between the branch tip and trunk, always in leaf axils. Trees are relatively quick to produce fruit, sometimes in as few as two years or as much as 10 years. Environmental factors also play a part in the time it takes to fruit. Fruit development takes up to 3 months, depending on rainfall or irrigation.

When immature, all parts of the fruit contain a sticky white latex, and the cut surface browns rapidly. As the fruit matures, the latex disappears from the pulp and remains only in the peel. The smooth, bright yellow–skinned fruit can be oblong or round and differs in size from 2.5 inches in length to as large 7 inches. The translucent flesh becomes jelly-like, with a pleasant caramel-flavored pulp. The leathery skin can easily be bruised.

Other common names

yellow sapote, yellow star apple, abiu (originally a Tupi Indian word) (English); caimito, caimo, cauje, abiurana, abi, abierio, abio (Brazil); amarilla, madura verde (Colombia); luma, cauje (Ecuador); temare (Venezuela)

Origin

The fruit is said to originate along the headwaters of the Amazon River and found in the wild in Peru, Columbia, Ecuador, Venezuela, and elsewhere in Brazil. The fruit was well known in the pre-Columbian Amazon, where it was considered to be an essential component of Native American home gardens and fruit orchards, a popularity that continued during the colonial period. The USDA first received seeds in 1914. It is not known when the fruit first appeared in Hawai'i. Abiu is well distributed throughout the tropics. Small commercial orchards are occasionally found in northern Peru, Ecuador, Brazil, Colombia, and Venezuela.

Cultivars

The genus *Pouteria* consists of dozens of edible fruits, most of which originated in Brazil. Other species found in Hawai'i include *P. lucuma* (lucumo), *P. viridis* (green sapote), *P. sapote* (mamey), and *P. campechiana* (canistel).

Seedlings of abiu show great variation. Cultivars include 'Z1', 'Z2', 'Z3', 'Gray', 'Inca Gold', 'Cape Oasis', 'Lu', 'Z4', 'T25', and 'T31' (Australia); 'Redondo' and 'Graudo' (Brazil); and 'Ticuna', a selection from the Amazon basin Ticuna Indians.

Environment

The tropical abiu grows best in areas with a year-round

Published by the College of Tropical Agriculture and Human Resources (CTAHR) and issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, under the Director/Dean, Cooperative Extension Service/CTAHR, University of Hawai'i at Mānoa, Honolulu, Hawai'i 96822.

warm, moist climate. Soil should be moist, well mulched and well drained, with a pH from mildly acidic to neutral. The trees will fruit in Hawai'i from 100 to 3000 feet elevation. In tropical South America, trees fruit to 6000 feet. Established trees will withstand short periods of drought, but in dry areas in Hawai'i, or in times of drought, irrigation is required to produce fruit.

Propagation

The short-lived seeds should be planted as soon as possible after collection. Germination generally is within 50 days after planting with a 90 percent success rate. Grafting and other vegetative propagation techniques are often difficult due to copious amounts of latex. Most seeds will produce acceptable but, often, smaller fruit than the parent tree bears. Some Brazilian abiu are relatively true to type when grown from seed.

Culture and management

Younger plants should be protected from wind and require irrigation to become established. Trees can be spaced from 7 x 7 feet to 15 x 20 feet and pruned low to facilitate harvesting. In Brazil, fertilizer at planting time includes manure, lime, super-phosphate, and potassium chloride in the planting hole. On Kona test trees, quarterly applications of a ½ pound of 6.6.6 (NPK) and daily irrigation (1 gallon emitter for 10 minutes per day) are used for consistent yields. In Australia, 2 pounds of NPK of 12.12.17 plus trace elements is used on mature trees every 4 months. As the fruit are susceptible to fruit fly and bird damages, protective wrapping on individual fruit while they are growing is advised.

Pests and diseases found in Hawai'i

Some leaf-eating larvae, twig borers, various scales, aphids, and mealy bugs attack various parts of the tree. The fruit is a host for fruit flies as it ripens.

Aphis gossypii Glover (aphids)
Toxoptera aurantii Boy (aphids)
Bactrocera dorsalis Hendel (fruit fly)
Ceratitis capitata Widemann (fruit fly)
Ceroplastes rubens Maskell (scale insect)
Coccus viridis Green (scale insect)
Cephaleuros virescens Kunze (algae leaf spot)
Colletotrichum gloeosporioides Penz. & Sacc. (fruit spot)
Cylindrocladium pteridis F.A.Wolf (fungus)
Lasiodiplodia theobromae Griff & Maubl. (dieback)

Harvesting and yield

Abiu trees in Hawai'i will produce in 4–6 years. Mature trees 10–12 years old can yield as many as 500 fruits per tree, each weighing 7–10 ounces. Fruit is ready to harvest 3 months after fruit set. Fruit can be harvested half ripe and packed in protective boxes to ensure that the easily bruised skin is not damaged. The tree may fruit multiple times per year depending on rainfall and irrigation. A mature wild tree in Brazil was observed to bear in excess of 1000 fruits. Although vigorous pruning will ensure new growth and production, yield generally starts to decline after 20 years.

Postharvest considerations

Full ripening occurs 1–5 days after harvest, when the fruit pulp and skin loses the sticky latex. Fruit can be stored at 50°F with a shelf life of 7–14 days. At all times during the harvest and postharvest process, the fruit needs to be protected form bruising. There are USDA protocols that allow abiu to be treated with irradiation and sent to the U.S. mainland from Hawai'i.

Packaging, pricing, and marketing

Abiu fruits should be protected from bruising at harvest by placing them directly into padded or protected sections of boxes. Individual fruit can be wrapped in a styrofoam netting for additional protection. Fruits baseball- to softball-size are sold to wholesalers at $2.50 to $3.50 per pound, depending on size. Growers may sell smaller and off-grade fruits at farmers' markets at 50¢ to $2.00 each. Some resort hotel chefs who offer the fruit cut it just before serving rather than pre-cutting it, due to its rapid oxidation and color change.

Flowers occur in leaf axils along branches between the branch tip and trunk.

Nutritive value

Composition of abiu per 100 g edible portion

Proximate (g)	
water	61–81.5
calories	62–95
protein	0.8–2.1
lipid (fat)	0.4–1.6
carbohydrate	14.5–36.3
fibre	0.9–3
ash	0.7–0.9
Minerals (mg)	
calcium	21–96
iron	0.8–1.8
phosphorus	17–45
Vitamins (mg)	
ascorbic acid	11–49
thiamine	0.02–0.04
riboflavin	0.02–0.03
niacin	3.4–1
vitamin A	78 IU
glycerides	22 g
vitamin B	0.2 mg
vitamin B2	0.2 mg
Amino acids (mg per g of nitrogen (N 6.25))	
lysine	316
methionine	178
threonine	219
tryptophan	57

Uses and recipes

Abiu usually is used fresh, sometimes in salads with other fruit. The ripe pulp can be added to sherbets, jams, and yogurt, or dried.

Abiu and Date Sticky Toffee Pudding

Chef Matthew S. Zubrod

2¼ c	pitted dates
1	large abiu's pulp
2 c	water
2 tsp	vanilla extract
2 tsp	baking soda
2 tsp	baking powder
4 c	all-purpose flour
pinch	salt
¼ lb	butter
1½ c	sugar
2	eggs

Boil dates with water. Cool. Remove dates, peel and pit. SAVE water! In mixer, cream butter and sugar. Add eggs, vanilla, salt, and baking powder. Add baking soda to water. Add dates, abiu, and water to butter mixture alternating with flour. Cook in a bread/loaf or cake pan lined with parchment paper at 400 degrees for 16–20 minutes (toothpick test). Allow to cool, then cut into squares. Heat in toffee sauce and serve with vanilla ice cream.

Toffee Sauce

¼ lb	butter
2 c	brown sugar
2 c	cream
1 oz	Knob Creek bourbon

Heat until caramel, mix well.

Abiu and Onion Soup

Chef Matthew S. Zubrod

(serves eight)

2 oz	unsalted butter
5	onions, julienned
2	peeled, diced parsnips
3	abiu fruits' pulp
2 oz	garlic, chopped
⅓ c	cognac
1 qt	duck or chicken stock
1 qt	veal or beef stock
1 tsp	thyme, chopped

Caramelize onions until dark brown in butter. Add garlic, deglace with cognac, add parsnips, thyme, and abiu. Stir and add stocks, and simmer until tender (onions). Season to taste. Gratin with Gruyere cheese and crouton.

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

Janick, Jules, and Robert E. Paull. 2008. The encyclopedia of fruits and nuts. CABI, Wallingford, Oxon, UK. p. 832–835.

Kennard, William C., and Harold F. Winters. 1960. Some fruits and nuts of the tropics. USDA ARS, Misc. Pub. 801.

Popenoe, Wilson. 1920. Manual of tropical and subtropical fruits. Hafner Press. p. 349–350.

Tankard, Glenn. 1987. Tropical fruit, an Australian guide to growing and using exotic fruits. Viking Penguin, Australia.

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

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

Acknowledgments

We thank Dr. Francis Zee and Dr. Bryan Brunner for review and comment on the manuscript, and Dale Evans for editing and layout services. The provision of cost-of-production tables by Dr. Kent Fleming is gratefully acknowledged.

Assumptions: *(Data entries are annual amounts expressed on a per tree basis)*

Fruit tree => ABIU

1.	Average number of bearing trees *(counted)*		5	trees
2.	Yield (*expressed in number of fruit [F] or lbs*)	F	125	fruit / tree
3.	Average wt. (ozs.) / fruit =	6.0	ounces	
4.	Total lbs. harvested/ tree =	46.9	lbs. gross yield	
5.	Marketable yield /tree (%) =	85%	of the gross yield	

To calculate profitability: Enter wage rate & benefits actually paid (or the rates one would to pay if labor were hired.) To calculate cash flow enter nothing. The cash flow result is (except for depreciation considerations) one's taxable income.

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	25%	2.00	10.0	marketable lbs.	19.92	100	18%
2 Retail sales	75%	3.00	29.9	marketable lbs.	89.65	448	82%
Total sales = *Weighted ave. price/lb. =*		*$2.750*	**39.8**	marketable lbs.	109.57	548	100%

Operating Costs: *Enter unit quantities as total per year per tree:*

A. Growing costs:	Units:	$/unit:	¢ /lb. of fruit	$ /tree /yr.:	$ /total crop /yr.	% of gross
1 Fertiliziation		*Sub-totals =>*	*0.20*	*8.00*	*40.00*	7%
Fertilizer (lbs.)	2.0	$2.00	0.100	4.00	20.00	
Labor (min.)	15	$0.27	0.100	4.00	20.00	
2 Irrigation: *Assuming ag water rate =*	*$2.00*	*/1,000 gals.*	*Sub-total=>*	*0.03*	*1.34*	*6.70*	1%
Water (gallons)	3	*$0.002*	*/ 1,000 gals.*	0.000	0.01	0.03	
Labor (min.)	5	$0.27		0.033	1.33	6.67	
3 Pest control:		*Sub-totals =>*	*0.32*	*12.67*	*63.33*	12%
Materials	1.0	$10.00		0.251	10.00	50.00	
Labor (min.)	10	$0.27		0.067	2.67	13.33	
4 Weed control:		*Sub-totals =>*	*0.07*	*2.67*	*13.33*	2%
Chemicals and/or machinery	0.0	$0.00		0.000	0.00	0.00	
Labor (min.)	10	$0.27		0.067	2.67	13.33	
5 Pruning:		*Sub-totals =>*	*0.13*	*5.33*	*26.67*	5%
Machinery	0.0	$0.00		0.000	0.00	0.00	
Labor (min.)	20	$0.27		0.134	5.33	26.67	
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 =	**0.753**	**30.01**	**150.03**	27%

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	25.6	¢/lb.	*25.6*	*12.00*	*60.00*	11%
2a Packing: for wholesale	20.1	¢/lb.	*5.0*	*0.50*	*2.50*	0%
2b Packing: for retail sales	20.1	¢/lb.	*15.1*	*6.01*	*30.03*	5%
3 Delivery to market	10.0	¢/lb.	*10.0*	*3.98*	*19.92*	4%
		Total harvesting costs =	**50.7**	**21.99**	**109.95**	20%
		TOTAL Operating Costs =	**51.4**	**52.00**	**259.99**	47%
		Gross Margin =	**223.6**	**57.57**	**287.86**	52.5%

Break-even analysis:

Given the weighted average price of	$2.750	$/lb. fruit, the mkt. yield required to cover operating costs =	94.5
Given the marketable yield of	39.8	lbs. fruit/ tree, the ave. price req. to cover operating costs =	$1.305

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 =* 46.9 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 havest 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 = 0.8

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 =** **25.6 ¢ / lb.**

Example to illustarate 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 lbs. ÷ 100 minutes = **8 lbs./ min.**

b You would pay pickers $12.00 per hour = 20 ¢ per minute to pick fruit. 12 ÷ 60 = $0.20 or **20¢ per minute**

c Your picking cost / tree is: 20 ¢/min ÷ 8 lbs./ min. = **2.5 ¢/ lb**. per pound of fruit picked

Packing:

1 WHOLESALE: Record the total annual cost for packaging to pack the marketable fruit sold wholesale. **$2.00**

2 Divide this cost by pounds of fruit sold wholesale. (This has been calculated in "Gross Revenue" above) 10.0

Your materials cost in ¢ / lb. = **20.1** **¢ / 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 =** **20.1 ¢ / lb.**

5 RETAIL: Follow the same proceedure (steps 1 to 4 above) to calculate the cost to pack fruit sold retail.

Total cost of retail packaging = **$6.00** Retail sales = 29.9 pounds Materials cost = 20.1 **¢ / lb.**

Extra labor required (minutes): **0** Packing rate = lbs. / minute Labor cost =

Total packing cost per pound of fruit marketed retail = **20.1 ¢ / 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 ÷ 1,200 = $0.08 = 4**¢ / lb.**

d During the year 60 minutes of packing labor was required (beyond the picking labor.) Your average packing rate is: 1200 lbs. ÷ 60 min. = **20 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 ¢/min ÷ 20 lbs./ min. = **1.0 ¢/ 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 ¢/ lb. + 1 ¢ / lb = **9.0 ¢/ lb.** for packing wholesale fruit.

Delivery:

1 Based on your annual records, calucuate 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: **4**

3 Record the total weight of marketable fruit delivered during the year: 39.8

4 Multiply estimated share of mileage times mileage rate & divide by total weight of deliveries: **10.0 ¢ / 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: Oviously, 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 miles driven @ $1.00 / mile = **$480** $480.00 transport cost ÷ 12,000 lbs fruit = $0.04 = **4.0 ¢ / lb.** of fruit delivered