**College of Tropical Agriculture
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Rollinia

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Rollinia deliciosa Safford
Rollinia mucosa (Jacq.) Baill
Family: Annonaceae

Rollinia is a fast-growing tropical tree that can reach heights of 50 feet and thrives from 300 to 3000 feet elevation in Hawai'i, as long as it receives enough water. It will grow in a wide variety of deep soils and can gain as much as 10 feet in height per year. The tree will not tolerate cold or extended periods of drought. Under ideal conditions, the tree can fruit as early as 2½ years from the time of planting. The fruit is highly inconsistent in shape and size. It turns from green to yellow when ripe. The somewhat fragile skin contains milky-white, pyramidal shaped carpels usually containing black seeds that average half an inch in length.

Limited commercial planting means that most sales occur at small markets and farm stands. The fruit is rapidly gaining popularity as an income source for smallholder farmers in Brazil. In Hawai'i, the fruit can be found at many farmers' markets and health food stores and is rapidly gaining favor with chefs and larger groceries featuring locally grown produce.

Various references list *Rollinia mucosa* (Jacq.) Baill and *Rollinia deliciosa* Safford as two species, while many others list them as synonyms.

Other common names
biriba de Pernambuco, fruta da condessa, jaca de pobre, araticu, araticum, araticum pitaya (Brazil); mulato (Colombia); rinon or rinon de monte (Venezuela); anona babosa, zambo (Mexico); anon cimarron, corosol, cachiman, cashina, candongo anon de monte, articum, condessa, graviola-brava; wild sweetsop, wild sugar apple (English)

Origin
Rollinia is thought to have originated in northern Brazil along the banks of the Amazon. It is also found in its natural state in Guiana, southern Mexico, Peru, and northern Argentina. Seeds from Brazil were sent to Florida and the Philippines in the early 1900s. The first written record of rollinia in Hawai'i was not until the mid 1930s, although it may have existed earlier on the homesteads of Filipino immigrants. It is now found growing in most tropical locations and is rapidly becoming a favorite with tropical fruit aficionados.

Cultivars
Currently there are no known breeding programs, although the fruit offers opportunities for breeding and selection. A few known cultivars include 'Regard' in the Philippines, 'Prolific' in Florida, and 'Liso' in Brazil. Fruits of a type called biriba do Alto Solimoes, developed by the Indians living along the Solimoes river in Brazil, can weigh as much as 9 pounds.

Other fruiting *Rollinia* species found mostly in Brazil include *R. sericea, R. sylvatica, R. salicifolia, R. rugulosa,* and *R. emarginata.*

Environment

This strictly tropical tree needs warm, most soils in hot, humid climates. It thrives with regular year-round irrigation or in areas where rainfall is equally distributed throughout the year. It does not tolerate cold.

The tree grows best in deep, rich, organic soil and benefits form copious amounts of mulch as long as there is good drainage, but it tolerates poorer and highly acidic soils as long as there is sufficient water.

Propagation

Rollinia is often propagated from seed, which should be planted as soon as possible after harvest. Preferably take seeds from trees that bear regularly with superior fruit. Germination takes about a month and averages 80 percent success. Air-layering and grafting are possible.

Culture and management

Water is the most crucial element when growing rollina for home or commercial production. A tree at 400-foot elevation was irrigated 15 minutes per day from a 1 gallon per hour bubbler emitter, this produced good softball sized or larger fruit year around. The tree remained healthy and flushed until the irrigation was turned off and the tree went into rapid dieback with multiple dead branches. In three months, the unirrigated tree was barely surviving until irrigation was restored, dead wood was removed and NPK 6-6-6 applied. The tree was again thriving within 2 months. The rapid growing tree needs to be pruned regularly to facilitate harvesting as well as for removal of dead wood. It's also advisable to trim extremely long branches as the weight of multiple fruits can cause the branch to break. There are no nutritional studies specifically for Rollina but growers in Brazil as well as Hawai'i usually follow guidelines established for cherimoya, quarterly applications of NPK 6-6-6 or NPK 10-10-10 of up to three pounds per year for mature trees. It is advisable to have a soil analysis to determine needs of micronutrients.

Pests and diseases

There are many problems that could potentially affect commercial Rollinia growing in Hawai'i although few have been observed on healthy well cared for trees.

Moth larva (*Lepidopterene*) can attack maturing fruit. A borer (*Cratosomus bombina*) burrows into the bark and trunk causing branch death. Once pruned, these branches should be burned or disposed of and not left

Rollinia flowers

in the field. White flies (*Aleurodyscus cocois*) and mealy bugs (*Pseudococcus brevipes* and *Aspidiotus destructor*) are found on leaves. *Cercospora* leaf spot occurs and *Glomerella cingulata* causes stem dieback and fruit rot.

Harvesting and yield

Trees at lower elevations in Hawai'i can be found with flowers and all stages of fruit the year around. At higher elevations, between 1000 and 3000 feet, the tree usually sets fruit in the fall, depending on rainfall and irrigation. In Brazil, rollinia trees average 35 to 55 fruits per year but can bear as many as 150 fruits per year on 15-year old trees. South Kona trees produced from 25 to 100 fruits per year.

Commercial fruit is generally harvested when it starts to soften and turn yellow. Care in handling is highly recommended, as the fruit protuberances and skin will blacken considerably when touched.

Postharvest considerations

There are no formal postharvest studies but observations in Hawai'i indicate that once harvested, the fruit will fully ripen in 5 to 8 days. As with many other *Annonaceae*, the fruit will have a short, less than 1 week, shelf life. Once the fruit skin turns fully black, the pulp color and viscosity changes to a clear mucous hence the botanic name, *R. mucosa*. At this stage, the fruit remains edible for only 1 or 2 days before fermentation begins.

Packaging, pricing, and marketing

Rollinia should be harvested and packaged with great care. Hawai'i growers usually use copious amounts of newspaper or bubble wrap to cushion the fruit for transport. Sold at farmers markets, health food stores and small groceries, Rollinia's rapid increase in popularity and high value has made it highly sought after by the store produce managers.

Smaller fruit are sometimes wrapped and sold in Styrofoam netting.

At all markets, fruit is either sold by size or by weight, from $1.00 for a small fruit to upwards of $7.00 for an extra large size. This is about twice the price of cherimoya and soursop. By weight, the fruit wholesales for $3.50 to $5.00 per pound. Chefs are just beginning to work with the fruit by creating a myriad of sauces, ice creams, flans and other culinary creations. They are clamouring for more fruit. Clearly rollina has a good potential for Hawai'i growers.

Nutritive value

Composition of edible flesh per 100 g

Proximate (%)

water	77.2
energy (kcal)	80
protein	2.8
lipid (fat)	0.2
carbohydrate	19.1
fibre	1.3
ash	0.7

Minerals (mg)

calcium	24
iron	1.2
phosphorus	26

Vitamins (mg)

ascorbic acid	33
niacin	0.5

Culinary and other uses

The fruit, often described as having a caramel or lemon-custard-pudding flavor, is usually eaten out of hand. It is often juiced in Brazil and sometimes blended with milk for a drink. It has also been made into wine.

Rollina Soufflé
Marg Love

14 oz	rollina puree
1 tsp	coconut extract
1 c	heavy cream
½ c	powdered sugar
2 tbsp	sifted flour
4	extra large eggs, room temperature, separated
2 tbsp	granulated sugar

Reduce 14 oz of rollina puree in a heavy saucepan over low heat and stirring constantly until it is reduced to 10 oz. Remove from heat, stir in coconut extract, and set aside in a cool place. Preheat oven to 350 degrees and lightly butter bottom and sides of soufflé dish. Place 1 cup of heavy cream in saucepan and bring to boil while continually whisking. Remove from heat and set aside. In a medium-sized bowl, mix flour and powdered sugar, then add egg yolks and mix until thick. Drizzle in hot cream, then add mixture back into the same saucepan and cook until it just thickens (less than 5 minutes). Once thickened, place mixture into a bowl and add the rollinia puree. In a separate bowl, beat egg whites to soft peaks, then add granulated sugar and beat until peaks are firm. Gently fold egg whites into rollina mixture, then pour into a soufflé dish. Place filled soufflé dish inside a larger pan filled with hot water that reaches up to half the sides of the soufflé dish. Bake on the middle shelf of oven for 40 minutes at 350 degrees. Carefully remove and serve immediately.

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. 68–70.

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

Lorenzi, Harri. 1998. Brazilian trees (vol. 2). Instituto Plantarum de Estudos da Flora Ltda. p. 31–32.

Lorenzi, Harri, et al. 2006. Brazilian fruits and cultivated exotics. Instituto Plantarum de Estudos da Flora Ltda. p. 52–57.

Silva, Silvestre, and Helena Tassara. 2003. Frutas no Brasil. Editara Editora Ltda. Brazil [in Portuguese]. p. 54–55.

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

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

1.	Average number of bearing trees *(counted)*	**2**	trees	*To calculate profitability: Enter wage rate & benefits actually paid (or the rates*
2.	Yield *(expressed in number of fruit [F] or lbs)*	P **45**	**lbs. / tree**	*one would to pay if labor were hired.) To calculate cash flow enter nothing.*
3.	Average wt. (ozs.) / fruit =	**20.0**	ounces	*The cash flow result is (except for depreciation considerations) one's taxable income.*
4.	Total lbs. harvested/ tree =	45.0	lbs. gross yield	6. Wage rate ($/hr.) = **$12.00**
5.	Marketable yield /tree (%) =	**100%**	of the gross yield	7. Benefits (FICA, etc.) (%) = **33.3%**

Gross Revenue:

		% of total	$/lb:	Lbs./tree/yr.		$ /tree /yr.:	$ /total crop /yr.	% of gross
1	Wholesale sales	**15%**	**3.00**	6.8	*marketable lbs.*	20.25	41	*8%*
2	Retail sales	85%	**6.45**	38.3	*marketable lbs.*	246.71	493	*92%*
	Total sales =	*Weighted ave. price/lb. = $5.933*		**45.0**	*marketable lbs.*	266.96	534	*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 =>	*0.09*	*4.27*	*8.53*	*2%*
	Fertilizer (lbs.)	**2.0**	**$0.80**		0.036	1.60	3.20	
	Labor (min.)	**10**	$0.27		0.059	2.67	5.33	
2	Irrigation: *Assuming ag water rate =*	*$2.00*	*/1,000 gals.*	Sub-total=>	*0.03*	*1.34*	*2.67*	*1%*
	Water (gallons)	**1**	$0.002	/ 1,000 gals.	0.000	0.00	0.00	
	Labor (min.)	**5**	$0.27		0.030	1.33	2.67	
3	Pest control:			Sub-totals =>	*0.06*	*2.67*	*5.33*	*1%*
	Materials	**0.0**	**$0.00**		0.000	0.00	0.00	
	Labor (min.)	**10**	$0.27		0.059	2.67	5.33	
4	Weed control:			Sub-totals =>	*0.03*	*1.33*	*2.67*	*0%*
	Chemicals and/or machinery	**0.0**	**$0.00**		0.000	0.00	0.00	
	Labor (min.)	**5**	$0.27		0.030	1.33	2.67	
5	Pruning:			Sub-totals =>	*0.09*	*4.00*	*8.00*	*1%*
	Machinery	**0.0**	**$0.00**		0.000	0.00	0.00	
	Labor (min.)	**15**	$0.27		0.089	4.00	8.00	
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 =		**0.302**	**13.60**	**27.21**	**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	**20.0**	¢/lb.	*20.0*	*9.00*	*18.00*	*3%*
2a	Packing: for wholesale	**11.6**	¢/lb.	*2.0*	*0.14*	*0.27*	**0%**
2b	Packing: for retai sales	**12.4**	¢/lb.	*12.0*	*4.74*	*9.49*	*2%*
3	Delivery to market	**11.1**	¢/lb.	*11.1*	*5.00*	*9.99*	*2%*
		Total harvesting costs =		**43.1**	**18.74**	**37.48**	**7%**
		TOTAL Operating Costs =		**43.4**	**32.34**	**64.68**	**12%**

Break-even analysis: **Gross Margin =**   **549.8**   **234.62**   **469.24**   **87.9%**

Given the weighted average price of	$5.933	$/lb. fruit, the mkt. yield required to cover operating costs =	**10.9**
Given the marketable yield of	45.0	lbs. fruit/ tree, the ave. price req. to cover operating costs =	**$0.719**

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 =*   45.0   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.   **45** 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 =   1.0

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 =**   **20.0** ¢ / 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.   **$0.78**

2 Divide this cost by pounds of fruit sold wholesale. (This has been calculated in "Gross Revenue" above)   6.8

   Your materials cost in ¢ / lb. =   **11.6**   ¢ / 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 =**   **11.6** ¢ / 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 = **$4.75**   Retail sales =   38.3 pounds   Materials cost =   12.4   ¢ / lb.

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

   Total packing cost per pound of fruit marketed retail =   **12.4** ¢ / 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: **5**

3 Record the total weight of marketable fruit delivered during the year: 45.0

4 Multiply estimated share of mileage times mileage rate & divide by total weight of deliveries: **11.1** ¢ / 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: 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