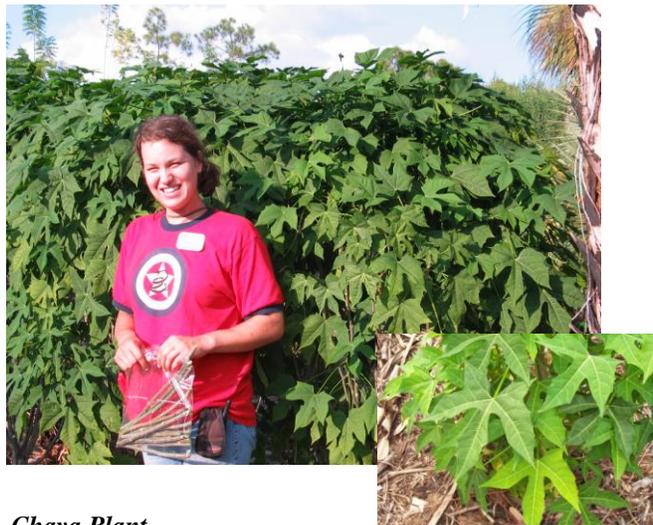


CHAYA

By Dawn Berkelaar

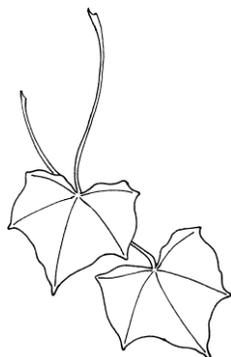
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Chaya Plant
Photo by Martin Price

Close-up of chaya leaves
Photo by Martin Price

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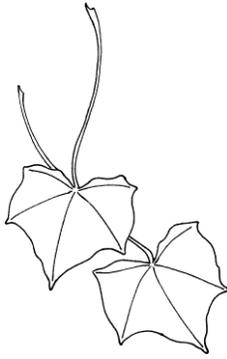
INTRODUCTION

Dr. Martin Price, co-founder of ECHO and former head of ECHO's Agricultural Resources Department, has said, "I would consider chaya to be one of the five most important underutilized food plants ECHO distributes. I give it this rank because of its ability to thrive in both arid and rainy regions, its little need for care or extra fertility, its lack of insect or disease pests, its high production per square foot, and the exceptional nutritional value of its cooked leaves."

Frank Martin, Ruth Ruberte, and Laura Meitzner agreed; in their book *Edible Leaves of the Tropics*, they wrote, "As a year-round source of high-quality food in a wide range of conditions, it is one of the most important edible-leaved plants for the tropics."

And in an article in *Economic Botany* 56(4), "The Ethnobotany of Chaya," Jeffrey Ross-Ibarra and Alvaro Molina-Cruz concluded, "Its high nutritive value, ease of propagation, productivity, tolerance of poor growth conditions, and resistance to pests and disease all make chaya a valuable potential crop that could benefit peoples of many different regions."

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DESCRIPTION

Chaya (*Cnidoscolus aconitifolius*)¹, sometimes called the spinach tree, is a fast-growing perennial shrub native to Mexico that produces lots of attractive, large, dark green leaves. It can grow well on a wide range of soils in both hot, rainy climates and areas with occasional drought. It grows easily and quickly, especially at higher temperatures, and new leaves grow quickly after harvesting. The amount of leaves per square foot of garden space is impressive (see photos). Leaves have lower moisture content than most other green leafy plants like spinach or lettuce.

Young leaves and the thick, tender stem tips are cut and boiled as “spinach”. Leaves do not have a strong or distinct taste, but tend to take on flavors from whatever seasonings are added. Perhaps the most noticeable difference from many kinds of cooked leaves is that chaya leaves have a “dense” feel to them. Chaya is exceptionally high in protein, calcium, iron, and vitamin A. It lacks pest problems and is unlikely to become weedy, because it very rarely sets seed and is generally propagated only by cuttings. (ECHO has grown chaya for 25 years and only one plant produced a few seeds one year. They germinated readily and showed high variability in traits. Though the parent was a special variety from Belize that did not have stinging hairs, most of the seedlings had what appeared to be large and even branched stinging hairs. Our best variety today came from one of those seedlings and is completely free of stinging hairs.)

Botanical Description. Chaya shrubs often grow to 3 m (10 ft) in height, and 2 m (6.5 ft) in width. Ross-Ibarra and Molina-Cruz commented that chaya can grow up to five or six meters, but is typically cut to less than two meters. Branches may break easily if the plant is too tall. The leaves are palmately cut into 3-5 lobes. Stem tips are broad and blunt, up to 2.5 cm (1 in) in diameter, and may be very succulent. The flowers (male and female) are borne in long peduncled cymes. Seed pods and seeds are extremely rare. The leaves contain variable amounts of a cyanide-producing toxin, a glycoside of hydrocyanic acid. When leaves are boiled, the toxin is released as a gas that dissipates safely into the air, leaving the cooked portion safe for eating.

Cultivated Varieties. According to Ross-Ibarra and Molina-Cruz, the four main cultivated varieties of chaya are ‘Estrella,’ ‘Picuda,’ ‘Chayamansa’ and ‘Redonda.’ Within a single variety, local people differentiate between ‘chaya pica’ (with spines or stinging hairs) and ‘chaya mansa’ (spineless). The authors commented, “Surprisingly, when this difference is recognized, chaya pica is unanimously thought to be better tasting than its unarmed counterpart.” The stinging hairs on chaya pica are very irritating during harvest, but disappear when leaves are cooked. Wear gloves or put your hand in a sock to harvest the leaves of a stinging plant. ECHO distributes only cuttings from a non-stinging plant that we obtained from Belize in the late 1980s, or from its one

¹ For years we referred to chaya by the scientific name *Cnidoscolus chayamansa*. However, we since learned from Mr. Jeffrey Ross-Ibarra at the University of Georgia that the scientific name of chaya has been changed to *Cnidoscolus aconitifolius* ssp. *aconitifolius*. This latter subspecies contains many wild varieties and four main cultivated varieties of chaya, including the cultivar ‘chayamansa’ (see Appendix 1). There are significant differences in levels of cyanogenic glycosides among cultivated varieties. Differences in distribution suggest that the varieties also differ in environmental preferences. In “The Ethnobotany of Chaya” (see Introduction), Ross-Ibarra and Molina-Cruz shared evidence suggesting that chaya originated and was domesticated in the Yucatán, and that it only recently spread elsewhere.

progeny (see above). If only the stinging sort is present in your area, you might wish to introduce this non-stinging one.

Chaya is closely related to *Manihot* species (e.g. cassava) and *Jatropha* species.

USES

Chaya has been used for food since pre-Columbian times, and is still eaten regularly, especially in Central America and southern Mexico.

Leaves should be cut into pieces and boiled or fried for at least five minutes before they are eaten, because of the presence of hydrocyanic glycosides in the leaves (brief stir-frying is not adequate cooking). Dr. Frank Martin tells us that cooking quickly removes the cyanide. The word “cyanide” may needlessly scare people. Most people, including scientists, that Dr. Martin Price has talked to in areas where chaya is used seem unaware or unconcerned that leaves contain cyanide-producing substances. We have even heard of people who blend raw chaya and fruit juice or water into drinks, with apparently no ill effects. Perhaps the blending (which ruptures cell walls) is enough to dissipate the cyanide. Ross-Ibarra and Molina-Cruz mentioned a raw chaya drink (blended raw chaya leaves mixed in sugar water with fruits such as lemons and pineapple) but also stated, “Most people consume cooked chaya leaves, and the leaves are only rarely eaten raw as fresh greens.” They commented that blending reduces the HCN content only if “blended leaves sit for several hours.”

Tender stem tips are cut and leaves picked for use as needed, and are used immediately or stored a few days in a household refrigerator. When harvesting from chaya plants with stinging hairs, use gloves or plastic bags on the hands as protection. Alternatively, cut the leaf petioles with scissors and let the leaves fall into your basket. Cooking for 10 to 20 minutes eliminates irritant hairs.

Leaves, and even petioles and stems, can be dried and ground to make a storable product. Although the drying helps reduce HCN content, this powder should still be cooked before consumption. The entire plant can be ground and fed fresh or dried as animal feed (for more on this, see the later section “Other Uses of Chaya”).

Chaya has also been used as a medicinal plant. Usually cooked leaves are eaten, or teas or infusions are made from the leaves. Although many medicinal claims have been made for chaya, it is mostly used for diabetes and kidney problems. Ross-Ibarra and Molina-Cruz tell of a survey from 1991, done in the state of Morelos (Mexico), in which 85 people were interviewed. 60 used chaya for kidney trouble (e.g. leaves blended in a shake); 21 for diabetes (to lower blood sugar); 10 for ulcers, blood pressure and scorpion bites; and four for other purposes.

NUTRITION INFORMATION

Chaya out-performs most other green leafy vegetables nutritionally (Table 1). The leaves are very high in protein, calcium, iron, carotene and vitamins A, B and C. The amino acids in chaya are well balanced, which is important for those who have a diet low in protein and for children and pregnant or nursing mothers.

Vitamin C ends up in the cooking water when chaya is cooked, but if one drinks the broth in addition to eating the leaves, 25 grams of chaya leaves can meet an adult’s daily requirement for

vitamin C (Ross-Ibarra and Molina-Cruz). The HCN boils off as a gas, so the broth is fine to drink.

Table 1: Comparison of nutritional composition of leaves of chaya (Cnidoscolus aconitifolius McVaughn) and spinach (Spinacia oleraceae L.) per 100 g fresh weight.

Component	Chaya	Spinach ^z
Water (%)	85.3	90.7
Protein (%)	5.7	3.2
Fat (%)	0.4	0.3
Crude Fiber (%)	1.9	0.9
Total CHO (%)	4.2	3.8
Ash (%)	2.2	1.8
Calcium (mg/100g)	199.4	101.3
Phosphorus (mg/100g)	39.0	30.0
Potassium (mg/100g)	217.2	146.5
Iron (mg/100g)	11.4	5.7
Ascorbic acid (mg/100g)	164.7	48.1
Carotenoids (mg/100g)	0.085	0.014
Average nutritive value ^y	14.94	6.38

^zData for spinach obtained from the USDA (1984).

^yAverage nutritive value according to Grubben empirical formula (1978).

From: Kuti, J.O. and E.S. Torres. 1996. Potential nutritional and health benefits of tree spinach. p. 516-520. In: J. Janick (ed.), Progress in new crops. ASHS Press, Arlington, VA.

PRODUCTION REQUIREMENTS

Chaya is tropical in origin and grows best during hot weather. During the subtropical winter in Florida when temperate vegetables thrive, chaya plants are essentially dormant and leaves are rather unappealing. Chaya's need for water is moderate. Once well established, plants can stand a great deal of drought or months of excess water, as long as there is good drainage and roots are not in water-logged soil. Because its site of origin (Mexico) has seasons both of long droughts and of hot, humid rainy weather, it has outstanding resistance to pests and diseases under both sets of conditions. In Florida, we at ECHO have grown chaya for over 21 years and never had a problem with disease or insects. However, during our cool, subtropical winter it essentially goes dormant. Any pests at this stage are just ignored.

Since seeds are rarely produced, chaya is propagated from cuttings (Figure 1). Large, somewhat woody cuttings of 15 to 60 cm (6 to 24 in) are cut and planted upright or angled in moist but not waterlogged soil. Cuttings can often survive over a month without planting, but rot quickly if they become damp. It is advisable to water new chaya cuttings infrequently until they are well rooted. Once established, chaya is insect and disease resistant, and grows vigorously with little attention. The quantity and quality of foliage for use as vegetable can be increased with heavy fertilization, regular watering and pruning.



Figure 1: Chaya cuttings. Photo by Martin Price.

Charlie Forst, who for years was Appropriate Technology specialist here at ECHO, pointed out that for maximum production of tender leaves and 4- to 6-inch new shoots, you should pollard chaya (i.e. cut back the larger limbs and upper canopy to about 4 feet) rather than coppicing it (cutting back the whole plant, including the stem, to around 18 inches). For maximum leaf production, harvest leaves every 2 to 3 months (Ross-Ibarra and Molina-Cruz).

EXPERIENCES WITH CHAYA FROM OUR NETWORK

We asked for feedback from our network in July of 2001. Several people wrote to us during the following year, sharing their experiences with chaya.

Kenya

Kristin Davis wrote, “As an agricultural missionary in Kenya, I knew that many people in the arid north would eat more greens if they could just get them to grow. Greens such as cabbage, collards and spinach are not drought-resistant and are attacked by insects when grown in dry areas. I requested chaya cuttings from ECHO because I thought it would stand a better chance of

growing in these drier areas, providing year-round greens for the people.



“It was six weeks' time from shipping to when the cuttings arrived in Kenya. Despite their long journey, they still looked in good shape, and I planted them in pots. Later they were transplanted in three locations in northern Kenya: Kokwo Toto, Kurungu and Kalacha.

Figure 2: Ruth Andersen in front of the chaya plant at Kurungu.

“The cutting at Kokwo Toto was later dug up and replanted, and then totally defoliated by goats browsing on the leaves. It recovered a second time and is now growing nicely, but is periodically defoliated by the local people who take the leaves to eat. The Kalacha cutting was planted in the far north of Kenya, at an oasis in the salty Chalbi desert. It remained stunted despite regular watering. It was later moved to a place that received more water and is doing really well.

“The cuttings at Kurungu have fared the best (Figure 2). The original cuttings are now two big shrubs, about eight feet high. Missionaries and others passing through have taken many cuttings, and the local people recently took more cuttings and planted them in their gardens. About half of the cuttings have taken off. Roughly two-thirds of the people like to eat the chaya. None is being sold yet in the local market. Collards (‘Sukuma wiki’; *Brassica oleracea*) in the same garden are being totally devastated by bugs, but the bugs do not bother the chaya.

“The local Samburu people in Kurungu use chaya a lot.”

Belize

Nancy Harper, working in Belize with Systems of Sustainability, wrote, “We have used chaya for the last ten years as our principal and preferred year-round source of greens. It tolerates lack of care, quite a bit of shade or full sun, and invasion by weeds. Few pests bother it, it is highly resistant to just about everything, and it produces a prodigious amount of leaves, even in the dry season, if given a little compost and mulch.

“After a few years, if not mulched or given compost, chaya can begin to die out, especially during prolonged drought. I believe it is a [viral disease] carried by an insect. As soon as I see these insects on the underside of the leaves and note the fading, sickly leaves, I take cuttings from the healthiest-looking plants and replant them in good soil with compost and mulch. This **only** happens when plants are heavily cropped, underfed, and dry.

We have used chaya for the last ten years as our principal and preferred year-round source of greens.

“Besides compost and/or mulch, chaya enjoys wood ash (in our acid soil) and dilute urine... We can grow a lot of other greens, especially in the cooler months, but chaya never fails. Plant lots, everywhere you have space!

Even our cats love chaya.”

James Golden, working in Belize, wrote to us about chaya with stinging hairs. “For years, the only chaya trees here had stinging nettle on the bottom side of the leaves and on the tender shoots. When the stinging nettle came in contact with the skin, it really stung and itched. If you were to place one of the leaves on the tender part of your forearm, it would set you on fire for hours. [However,] even with the stinging nettle on the bottom of the leaves, poor people here grow it and eat it. They always handled the chaya by the stem that is between the leaf and the shoot. They were careful not to let the bottom side of the leaf come in contact with the skin. When it is boiled, it no longer stings like nettle.”

James Golden added that a new variety of chaya without the stinging hairs was introduced into the area of Belize where he lives and works. He demonstrated to many people in the area that

this chaya didn't sting, by placing the bottom side of the chaya leaf on his arm and witnessing the amazed expression of his neighbors!

The Philippines

Carlos Echavez, Executive Director of Bol-anon Foundation in the Philippines, wrote the following: “We requested planting materials of this plant years ago. It is vigorously growing but we only use it for mulching material and as a living fence instead of eating it. People are afraid to eat it considering that its cousin plant—the cassava—can cause poisoning. Can you give us more advice on this to avoid poisoning?” We were happy to do so!

Hawaii

Jay Ram wrote to us from Hawaii. “We have been propagating chaya in Hawaii and spreading it throughout the Pacific area for a number of years. We have observed the following:

“The ‘spineless’ variety of chaya has been a persistent and vigorous perennial which thrives in high rainfall areas of 150-230 inches per year. No diseases have been noted. However, if an older plant is coppiced [cut back] too close to the ground, the entire plant can succumb to what probably is a fungal or bacterial rot, which enters through the wounds. Some of our plants have been continuously coppiced for 12 years, and are still vigorous. Coppicing seems to work best when the new cut is made just above the previous one, which makes the plant height eventually higher. If the new shoots are not consumed and [are] allowed to grow, [we need to coppice] every 2-3 months in this high rainfall climate, as growth is very rapid. Plants will grow to 8 to 10 feet [2.4 to 3 m] in that amount of time. Note that this rate of growth is without any external inputs of nutrients or anything else. Growth is also rapid in the winter season when temperatures are somewhat lower. Thus in this climate, aside from being a good food source, the plant is a great biomass producer as well. We also grow the chaya variety that has spines, for germplasm purposes [i.e. for genetic diversity]. It may be somewhat more vigorous than the ‘spineless’ variety.” [Ed: They are actually stinging hairs, rather than ‘spines.’]

“Interestingly, a wild variety of chaya (with stinging hairs and narrower leaves) was introduced to Hawaii some decades ago by the government as an alternative perennial vegetable. It never became popular (no doubt due to the stinging hairs), but can still be seen growing wild in the form of trees in some places.

Some years ago, we introduced chaya to the Marshall Islands, Federated States of Micronesia, and Fiji, where it was well-received. Farmers in Fiji were so pleased with this vegetable that they somehow disseminated it on their own (probably through family) to areas of Vanuatu, where it is now established. I suppose that is the ultimate positive reinforcement for someone involved in development work who enjoys introducing new species into different regions.”

Zambia

Tim Bootsma with CRWRC-Zambia wrote to us about how chaya grew in Eastern Province, Zambia. “We received the chaya cuttings in January, 2000. They all arrived safely. They were potted and all six cuttings grew well. Two got eaten by my dog, though; she liked to dig in flower pots. By March the [rest of the] plants were ready to plant out.

“In Zambia we have a four-and-a-half month rainy season that begins in mid-November and goes till the end of March. Then we get no rain until the following November. Our chaya plants were ready for transplanting in March, just at the end of the rains.

“Three plants survived the transplanting and early care. These three were planted in three different locations. One was way up on a dry hill, the second toward the high end of a gardening area (where water is close to the surface), and [the third] in a wetlands/lowland area. They all grew well until this past rainy season, when the one in the lowland got waterlogged and died. The other two did better, with much more vigorous growth on the one grown in the garden area in reach of more soil moisture.

“The one in the high area kept getting attacked by local chickens. At times it was plucked bare, with no leaves left but just a stem. It struggled, but it survived.

“One year after they were planted, the two remaining plants are about 6 feet tall... The two chaya plants are still teaching us new things. One plant is flowering, and we want to see if it will produce seed. [Ed: Our chaya flowers almost continually but only one plant produced seed one year.] The facilitator who has taken over the care of the chaya also wants to monitor it a bit longer to see when will be the best time to harvest the leaves. They have noticed that at some times the leaves are softer than others. The chaya is still being monitored to see how much trimming and cutting and abuse it can take. One of the two plants was accidentally chopped down by an eager person trying to clean up the garden. Since then it has started [sending up new shoots].

“Chaya was cooked up and eaten by our volunteer agriculture promoters—13 people in all. They all liked it very much and want to grow it in their gardens this year.

“After the initial introduction, it looks like chaya could spread fast in this area. Farmers like the taste. It is quite a conversation piece. When farmers come, they often ask about what this plant is. It sparks a lot of curiosity. Until now, however, it has not been openly promoted. . . .Thanks for your help in sending us chaya. We hope and pray that chaya may soon be spread through Eastern Province!”

We asked for more information in 2006, but the Bootsmas now work in a different area of Zambia. Since their move, Tim remembered hearing about a disease like powdery mildew that affected the plants, but he had not heard about the chaya since.

Bolivia

Grant Kaufmann wrote from Villamontes, Tarisa, Bolivia, “Dear ECHO, in response to your question about chaya in *EDN*: We have subsequently started chaya at two locations in Bolivia: 1) Santa Rosa, 17 S latitude, tropical wet/dry (three-month dry season), 1500 mm [60 in] precipitation, 300 m [1000 ft] elevation and 2) the Chaco, 21 S latitude, subtropical dry (six-month dry season), 600 mm [24 in] precipitation, 600 m [2000 ft] elevation.

“The cuttings were hard to start at Santa Rosa because of fungus problems but once established the plants did well. In the Chaco the cuttings took well and had good first season growth. The plants frosted off at ground level but quickly regrew with the first rains.

“In neither location could we persuade people to eat the leaves, as “greens” are not a normal part of their diet. We “gringos” (foreigners) enjoy them, however—especially the women, who consider the local diet seriously short of green vegetables.”

Tanzania

John de Wolff, Dar es Salaam, Tanzania, wrote, “Concerning your question on chaya, I received in the past cuttings. Cultivation is easy and I have a nice stand. During a drought of six months it lost most of its leaves but now after some rains it has resprouted very well. A very easy crop to grow and I have not yet seen any diseases or pests.

“Because of my warning that unboiled leaves are poisonous, people did not take it...I am eating it but my family does not consider it as nice as the normal amaranth species here.”

Brazil

Marsha Hanzi at the Instituto de Permacultura da Bahia, Brazil, wrote, “I brought chaya stakes back from an ECHO conference some years ago, and I now have enough to give away as many as people want. It has adapted to our garden in tropical Northeast Brazil, and also to the drylands, when planted in the vegetable gardens there. It is always a bit puny the first year, but takes off after adapting to the new site.

Chaya has the great advantage of being immune to leafcutter ants.

“It really does better in the dry season than in the wet, and gives better planting results in drier weather. (In the wet season the cuttings tend to rot.) This is fine, as we have a lot of semi-wild leaves for the wet season, but very few for the dry.”

She added, “Chaya has the great advantage of being immune to leafcutter ants...it is totally pest-free, slow to establish but extremely resistant when well-rooted...We have spread it all over the place, in both humid climates and in the drylands, where it does well in the vegetable gardens as a green fence.” [ECHO would like to learn if others have noticed it to be unbothered by leafcutter ants.]

Later, Marsha wrote, “Chaya continues to spread and take hold here—even people who don’t normally like vegetables like it. It has done well in the drylands gardens, and is into the fourth generation now. It is really a fantastic plant!”

Nicaragua

John Freeman works in Nicaragua. He wrote, “Your chaya is doing very well...Sadly, the recent hurricane floods wiped out certain seed stocks we had...but the chaya lives on as it was firmly rooted and they all are over eight feet tall.

“About half the folks hate it, but others love it. I plan to work on drying chaya leaves to be added to soup, as (it) may taste different and be accepted by all. The traditional dish is a sort of rice and

meat soup called “luk-luk” in the Miskito language. It could use some vegetables, so I hope to introduce chaya leaves as an addition.”

Dominican Republic

Deborah Kuiken in the Dominican Republic wrote, “We are very excited about the chaya. As a Peace Corps volunteer in a very dry and poor village, I believe chaya has great potential to improve nutrition here. Our agricultural trainer, Robert Crowley, took some chaya cuttings to Bani (where he lives). The cuttings will be transplanted at a nutrition center for mothers with malnourished children.”

Bahamas



Chaya also has done well on Cat Island in the Bahamas, where the ground is mostly limestone, resulting in very difficult growing conditions for plants (see Figure 3). It was prepared and eaten at an orphanage and Mission Home on Cat Island. Danny Blank commented, “Chaya was one of the few things that grew so well. Insects were voracious on most things they cultivated, so this perennial green was their faithful weekly standby.”

Figure 3: Chaya growing on Cat Island in the Bahamas. Note the arid, rocky terrain. Photo by Lindsay Cameron.

Indonesia

Andy Bell wrote, “In 1998(?) I requested chaya sticks to be mailed to Indonesia. They arrived wrapped in paper and still moist. I planted the sticks directly in our yard in West Java. Two of the sticks slowly began to bud and put out leaves. One of the plants was in the front of the house, one in the back. The one in the back that received fuller sun grew tremendously. Over the five years of its life, it would reach heights of three meters with over 30 productive stems and branches. While we did have some curling at times, particularly on new leaves, it never suffered from any ill health that I could observe. About two times each year I trimmed it back, almost to the ground, simply because it had grown so big. In the end, the trunk had reached the diameter equivalent to a coffee can. The one in the front had fewer leaves, I believe because it received extra shade.

“Popularity: The local Sundanese people are famous for eating leaves. It is said that all you need for a Sundanese person is to provide hot sauce on a banana leaf and release them out to the fields and forest, as they enjoy much of what grows naturally. They call this lalab. One of the most

common (if not the most common) "vegetables" among the farmers I live with is boiled cassava leaves. These are readily available and easy to prepare. Sometimes they are cooked with coconut milk and lemon grass.

"I believe the Sundanese preference for picking rather than growing food makes cassava leaves, "daun singkong," so popular. They don't have to mess with it, as they just go out and pick it and it is available in all seasons. I believe this is one factor that also makes chaya so popular. It is very similar to cassava leaves, though less bitter. The Sundanese understand you can't eat it raw, as it is similar to cassava in this way. So, culturally, they are already used to this type of plant.

"Distribution: Basically, I have passed out cuttings wherever I have gone or to whomever has visited. We eat the chaya leaves about two or three times per month, and serve it to guests so they will ask for it and we can send it home. I am aware that it is now distributed across Java and to Lombok Island and I believe some on Sumatra just through me. I am aware that others are now sharing it as well. I would guess now there are over 1000 plants in the country, maybe three or four times that. I have never met an Indonesian that had seen it before. In about 30 to 40% of the cases of my sharing a bundle of stalks with someone, I will receive an unsolicited response that it has thrived and they eat it regularly. I have found that it seems to grow better and faster in more sandy soil as compared to high clay soil. It definitely seems to be bushier when regularly cut back. Soil fertility doesn't seem to affect it too much. It can rot if planted in high rain season.

Guatemala

Jorge Lupitou R. wrote to us from Guatemala. "Here [chaya] also goes by the name "chatate," but unfortunately its consumption is not common. At home we add it constantly to our rice that they may cook together, and in tamales it is delicious. Too bad the cyanogenic glycosides won't permit the use of raw juice, for chaya juice could be the ideal supplier of chlorophyll, protein, etc."

RECIPES

Some of our readers wrote to let us know how they or people in their area typically prepare and serve chaya. Perhaps these ideas will inspire experimentation by others!

Nancy Harper, Belize:

- Central Americans usually fry the leaves with eggs and tomatoes. I prefer to boil them first to be sure to remove HCN.
- The cooking water is a delicious tea, warm or cold, and is very good for high blood pressure.
- The boiled leaves can be drained (and squeezed if you want to remove all the water) and served like spinach, or fried with oil, salt, onions and garlic. Peanut meal or peanut butter is a very good addition, as are mustard, soy sauce or miso.
- The leaves are also good cooked in coconut milk with ground foods like potatoes and yams or breadfruit.
- Our favorite sandwich is to spread peanut butter on a warm cassava and flour tortilla, pile on the cooked chaya, and roll it up like a burrito. The cooked leaves can also be put in any kind of tortilla or bread dough. All children will eat bread or tortillas and can thus get their greens at the same time.

- Chaya can be used in any recipe that calls for cooked spinach, including lasagna and even pizza!
- The stem tips are very delicious, boiled and peeled. You can cut about 4 to 6 inches, depending on growing conditions. Remove the tough, longitudinal fibers after cooking.

Marsha Hanzi, Brazil:

- We eat it here as kale is eaten: cut into paper-fine strips, and stir-fried with garlic and ginger. [It needs to be cooked] longer than kale because it is more fibrous. I imagine that the very very fine cutting helps to dissipate the acid. It is delicious this way. Sometimes chaya is blanched before it is stir-fried.

SuZann Beverly, Kurungu, Kenya:

- People cut up the leaves, add water, bring it to a boil, pour out the water, add fat, fry slightly and add it to their ugali [corn meal] mix. The Samburu people have no onions and spices to speak of, so they don't use it separately like other people would.
- At Kokwo Toto, the Pokot people cook chaya like sukuma wiki (collards), fried with onion in a little bit of oil.

From ECHO's book *Amaranth to Zai Holes*:

- Young leaves are used to wrap tamales or are eaten with the thick terminal stems cooked as greens.
- Leaves are flavorful when cooked with ham, onion, salt and pepper, or with salt and vinegar.

From "The ethnobotany of chaya," *Economic Botany* 56(4):

- People sometimes drink the broth.
- Leaves are combined with vegetables and meat in stews.
- Boiled chaya is combined with ground roasted pumpkin seeds, cooked tomato and chili in a corn tortilla.
- "The most famous chaya dish is probably *Dzotobilchay*, consisting of diced chaya leaves mixed with *nixtamalized* corn dough, covered with sauce or vegetables and diced eggs, then wrapped in banana leaves or other chaya leaves, and cooked to make a tamale."
- Brazos de la Reina: chaya leaves are rolled in corn dough, then steamed and served with tomato and squash seeds.
- Chaya leaves are boiled, then fried and mixed with eggs, onions and tomatoes.

OTHER USES FOR CHAYA

Animal Feed

Marsha Hanzi wrote, "It is...interesting to note that [chaya] is excellent chicken fodder, and can be used in permanent chicken forage systems, cutting whole branches for them to eat. We have observed that access to greens increases egg-production. [Ed: Access to greens also makes yolks a darker yellow]."

“David Kennedy (Leaf for Life) also points out that it is excellent as a source of dried leaf meal [as a nutritional supplement]. It could be an excellent addition to animal feed in the dried form as well.”

ECHO has been asked in the past about the value of chaya as an animal feed. Because of its great nutritional value, exceptional drought tolerance, and productivity, chaya would seem a logical choice for animal feed, in addition to its primary use as a vegetable for people. However, we wondered about the effect of the hydrocyanic glycosides, since animals would eat uncooked leaves.²

Regarding the use of dehydrated chaya leaves as a feed ingredient for pigs, Dr. Ricardo Bressani, retired head of the Institute of Nutrition for Central America and Panama, commented, “Usually, pigs consume leaves that are edible, but I have not seen pigs consume chaya (which is often found as part of fences in rural areas), probably due to the toxins it contains. On the other hand, if it is processed and dried, it may be part of the feed, since antiphenological factors are partially or totally destroyed.”

Dr. Bressani directed us to the article "Chemical composition of chaya leaf meal (CLM) and availability of its amino acids to chicks" (*Anim. Feed Sci. Tech.*, 30: 155-162). Chaya leaves were cut, air dried, and ground to produce CLM, which can be stored in airtight containers. The study found that CLM was high in calcium, iron, and had a moderately high availability of amino acids (which make up proteins), comparable to many tropical legume leaves [though chaya is not a legume]. Overall availability [digestion and absorption of nutrients] was 84%, but CLM was low in the sulfur-bearing amino acids cystine (66.7%) and methionine (69.9%). The body uses sulfur in the process of detoxifying cyanide, and samples of CLM did contain hydrocyanic glycosides.

Cassava leaves, which are often dried and stored in Brazil (for use in soups) also contain hydrocyanic glycosides that produce hydrocyanic acid (HCN) when fresh uncooked leaves are eaten or pulverized. We asked David Kennedy with Leaf for Life for his perspective on using dried cassava leaves as a food. He commented that HCN is really a fairly common toxin in food, but that acute [severe, sudden onset] HCN poisoning is quite rare. “Chronic toxicity (also quite rare) has been reported mainly where there is a great dependence on cassava and a very low protein intake. Damage to the nervous system and especially the optic nerve can be caused by chronic exposure to HCN. Low consumption of proteins, especially sulfur-bearing amino acids, cigarette smoking, and air pollution all intensify the body's negative reaction to HCN.

"People are currently eating cassava leaves [which also can produce HCN] as a vegetable in much of Africa, and parts of Asia and Latin America. I think the question is not *whether* to eat cassava leaves [and chaya], but rather *how* to. Encouraging the use of low-HCN varieties is critical to this effort. A grinding technique that ruptures cell walls will dramatically increase the rate and total amount of HCN that disperses into the air. It is important that the leaves be ground when fresh, and quite well pulped, not just shredded. The loss of HCN is very dramatic then during drying."

David Kennedy sent us a Ministry of Agriculture publication from Brazil which showed a lot of variation among leaves of cassava varieties in HCN content based on variety and drying method (in the shade or an oven), but all varieties showed greater drops in HCN content with increased

² Read *EDN* 53-1 for more information. Here we have summarized that article.

pulping. Leaves of the six varieties tested ranged from 48-123 ppm dried whole, 20-78 ppm when shredded, and 7-36 ppm when pulped.

We cannot say for certain that these data for cassava can be applied to chaya, but they may help you decide how these leaves may be used in animal feeds. Several years ago we tested the HCN content of fresh chaya from ECHO's farm and found an HCN content of between 30 and 50 ppm on a fresh weight basis. Drying the leaves to any extent would almost certainly reduce HCN content, and cutting them first would be even better. If you decide to use significant amounts of chaya, you can be totally safe by boiling the leaves for a few minutes before feeding it to the pigs. Start with small amounts, and let ECHO know the results if you use CLM in your feed mixes.

Chaya definitely has potential as a source of cheap protein in poultry diets, although no optimal levels of inclusion are available at this point. (As a guideline, poultry specialist Dr. John Bishop recommends that a chicken's diet consist of no more than 5-10% leaf meal on a dry weight basis, since leaves are high in fiber with low digestibility.)

Leaf Protein Concentrate

After publication of an article about chaya in *ECHO Development Notes*, we were asked if chaya could be used to make leaf protein concentrate (LPC)³. LPC is made by blending or pounding leaves, mixing with water, and heating the mixture so that the protein clumps together at the surface. Since the process of making LPC does not include boiling for longer than a few seconds, might the cyanide-containing compounds end up in the LPC? Or have most of those compounds been discarded when the liquid is discarded?

We tested for levels of cyanide in fresh chaya leaves, LPC, whey, and fiber (the latter two are byproducts when making LPC). Fresh ground chaya leaves from a plant on ECHO's farm contained between 30 and 50 ppm of cyanide on a fresh weight basis [ppm stands for 'parts per million'; another way of saying it is 30 to 50 mg of cyanide per kg of leaves]. LPC contained 10 ppm, or 10 mg of cyanide per kg of wet LPC.

The body of a normal adult with adequate protein in his or her diet can detoxify up to 10 mg of cyanide per day with no harmful effects. A person is extremely unlikely to eat one kg of LPC in a day, especially since people do not tend to eat pure LPC. It is usually used as an ingredient in a dish (pasta, for example). In recipes from the *Leaf Protein Concentrate Manual*, LPC generally makes up one-fourth or less (sometimes much less) of the total ingredients (by volume). For example, pasta can be made from one cup of LPC per six or seven cups of flour (plus a teaspoon of salt).

In many plants a substance that is in itself not harmful (e.g. a cyanogenic compound) is confined within one compartment and an enzyme that can act on that substance to produce a toxic chemical (e.g. HCN) is confined within a separate compartment. When an animal (e.g. an insect) chews the leaf, the compartments are broken and the enzyme encounters the chemical, releasing the toxic part in the animal's stomach. This protects the plant from predators, whether they be insects, cattle or a person. Though we do not know if that is the case with chaya, it seems likely. If so, grinding the leaves in the process of making LPC would provide opportunity for much of

³ For more information about LPC, see *EDN* 78-6 and 80-4.

the HCN to be released in the mixing bowl instead of the stomach and then to dissipate harmlessly into the air.

Mulch

Marsha Hanzi wrote that chaya is “also an excellent mulch material for vegetable gardens, when planted in hedges. The high mineral and nitrogen content really favors demanding vegetables.”

CUTTINGS FROM ECHO

Cuttings of *C. aconitifolius* can be obtained from ECHO. If you request chaya from ECHO, we will send several cuttings wrapped in paper. Cuttings can survive for several weeks in the mail. Trim any blackened areas on the ends. Be sure to put the correct end in the ground, so the leaf scars look like smiles, not frowns. Chaya (especially a new cutting) prefers good drainage, but can survive some water logging. Since leaves are larger and more tender when grown in partial shade, many people like to plant chaya near a tree that provides light shade. Avoid contact with the irritating white, sticky sap when harvesting. Harvest often enough so the new shoots stay within arm's reach, or coppice the whole plant and allow for regrowth. You will quickly have sufficient stems to share.

If you are working in development and would like to try chaya, send your name, organization's name and address. We will send cuttings to you. **ECHO only sends virus-free cuttings** from virus-free plants. [A large percentage of plants (at ECHO and elsewhere) contain the common cassava mosaic virus (CCMV). This is NOT the same as the common cassava virus that can devastate cassava crops in Africa! We know of no published studies indicating that CCMV can jump from chaya to other crops. A study we read indicated that around 70% of chaya trees sampled in the Yucatán (believed to be the center of origin of chaya) carried CCMV. Chaya (presumably with CCMV) has been grown on ECHO's farm for twenty years, but to our knowledge our cassava plants remain virus-free.]

APPENDIX 1

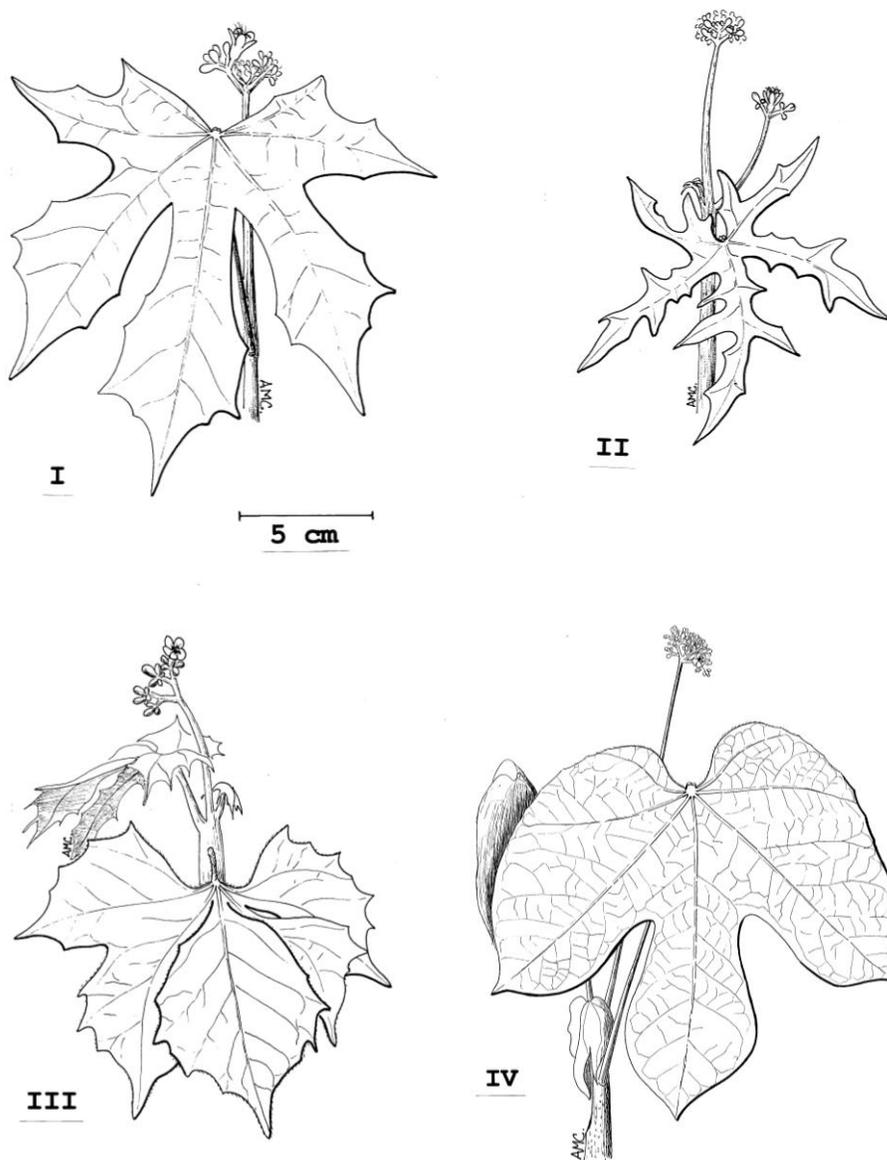


Figure 1: Diagrams of the four cultivated varieties of chaya. I. 'Estrella' II. 'Picuda' III. 'Chayamansa' IV. 'Redonda.' Diagrams by Dr. Alvaro Molina-Cruz. Reprinted by permission from *Economic Botany*, 56(4): 350-365, Jeffrey Ross-Ibarra and Alvaro Molina-Cruz, Copyright 2002, The New York Botanical Garden, Bronx, New York.