

Carambola and bilimbi.

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ABSTRACT - Presentation of two fruit species, the carambola (Chinese gooseberry) and the bilimbi, which belong to the genus *Averrhoa*, with special reference to Trinidad and Tobago. The following aspects are discussed: botany, varieties, multiplication techniques and cultural practices. Several physical and chemical characteristics of the fruit varieties studied are shown in three tables.

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RESUME - Présentation de deux espèces fruitières, le carambolier et le bilimbi, appartenant au genre *Averrhoa* avec référence plus particulière à Trinidad et Tobago. Sont abordés les aspects suivants : botanique, variétés, techniques de multiplication et pratiques culturales. Trois tableaux regroupent plusieurs caractéristiques physiques et chimiques des fruits des variétés étudiées.

INTRODUCTION

There are two species of *Averrhoa*, belonging to the family Oxalidaceae and both are found in the tropics. They are *Averrhoa carambola* and *Averrhoa bilimbi*, the carambola and the bilimbi respectively.

The carambola is a tropical fruit locally called five fingers and in other parts of the world, balimbing, belimbing or star fruit. The fruit is waxy in skin texture and deeply ribbed, usually five (six and seven ribs have been seen occasionally). Great variability exists in seedling populations, ranging from unpleasantly sour to semi-sweet to sweet in taste.

The bilimbi, also locally called 'khamrak' or 'kornishore' is somewhat cylindrical with five, broad, rounded, longitudinal lobes. In other parts of the world this fruit is called kamias. When ripe it is juicy and too acidic to be eaten unprocessed.

Carambola is thought to have originated from South East Asia but is now distributed throughout the world and cultivated mainly 30° North and South of the Equator. Some of the major world producers now include Malaysia, Northern Australia (Queensland), Singapore, Taiwan, Hawaii, Florida, Brazil and Guyana.

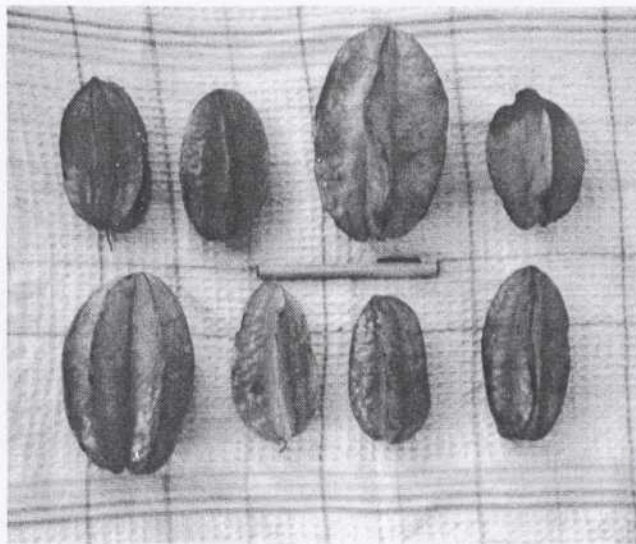
Although these two species of *Averrhoa* have been introduced into Trinidad and Tobago over 100 years ago, today there is only one commercial producing plot of carambola of about 0.4 hectares. This was planted in 1984 at La Vega Estate, Gran Couva by Bert Manhin who collected seed material from Bangkok, Taiwan, Miami, Grenada, Guyana and Cuba. In January 1989 an evaluation was done by Fruits Section, Central Experiment Station (C.E.S.), Centeno on the ninth crop of over 150 trees in the Manhin plot (see Table 1).

BOTANICAL DESCRIPTION

Both species develop into relatively small trees but under good conditions they grow to a height of 6-7 m (20 feet and more). The growth habit is such that, unpruned, they develop rounded, open crowns that can be easily trained to various shapes. The tree is wind resistant, however, for optimal production, a windbreak is necessary.

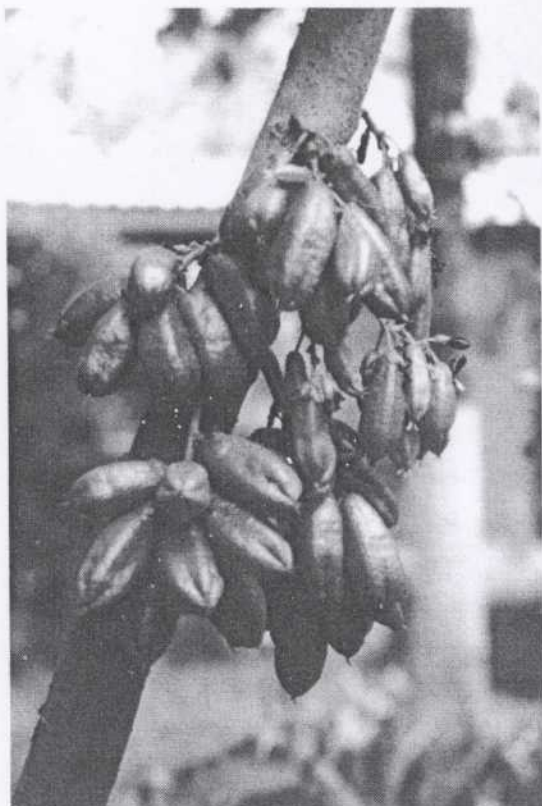
The carambola tree from seedling first flowers after 2 years and comes into full bearing in 4 years. Carambola flowers are borne in small axillary inflorescences. They develop throughout the year on twigs, branches and the trunk of the tree. Mature fruit may be found on the tree at almost anytime. In Trinidad the largest crops of fruit mature during May - June, September - October and December - January. It is not unusual for flowers, immature fruit and mature fruit to occur on the tree simultaneously.

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Variability of the carambola
La Vega Estate.

Bilimbi.



Carambola.

The tree of the bilimbi can be distinguished, from that of the carambola by its larger leaves, however, the requirements of the tree are much the same as those of carambola. Bilimbi flowers are borne mostly on the trunk and thick branches. The bilimbi tree also fruits continuously after the second year of planting with largest crops occurring during January, April and July.

VARIETIES

Differences between carambola are evident especially as to the taste - sweet, semi-sweet and sour. In Trinidad there are no named varieties, all plants are seedling material of sour and sweet types.

In Florida, at present, the 'Arkin' is by far the most common carambola cultivar being planted, with lesser amounts of Golden Star, Fwang Tung and Maha. Some desirable fruit characteristics are large size, good flavour and rounded edges (suitable for packaging). (see Table 2). The

Table 1 - Composition of carambola fruits found in Trinidad and evaluated at the Central Experiment Station in January 1989.

Source of material *	pH	° Brix	Percent Titratable Acidity **	Fruit size	Fruits weight (gms)	Wing edge	Colour at maturity
La Vega Couva (Sweet)	2.1-3.62	5.9-11.8	0.436-0.866	Small, medium and large	58.2-259.5	Firm pointed and slightly rounded	Light yellow, deep yellow, orange
La Vega Couva (Acid)	1.25-2.0	4.9-5.2	1.36-1.38	Medium	181-202	Firm pointed	Light yellow
Guld View (Sweet)	3.42	8.4	0.514	Large	254.1	Slightly	Light yellow
U.W.I (Sweet)	3.25	9.2	0.463	Large	256.3	pointed - do -	Yellow
St. Augustine Nurseries (Semi-sweet)	2.1	7.0	1.123	Small	59.9	- do -	Deep yellow
Trincity (Sweet)	3.31	7.9	0.563	Medium	191.6	- do -	Light yellow
Curepe (Semi-sweet)	2.4	8.0	1.10	Small	71.2	- do -	Yellow
Santa Cruz (Sweet)	3.5	7.8	0.73	Medium	183.5	- do -	Light yellow
Arouca (Semi-sweet)	2.7	8.0	1.05	Small	68.1	- do -	Yellow

* - The above mentioned data was obtained from single trees except the La Vega sweet, acid which came from Manhin plot of approximately 200 tree.

** - Citric acid equivalent.

Table 2 - Characteristics of major carambola cultivars.

Cultivars	Fruit size	Colour	Wing edge	° Brix range	Fruit weight in grams
Arkin (Florida)	Medium	Gold Yellow	Slightly rounded	8.2-11.5	90-200
Fwang Tung	Large	Light Yellow	- do -	9.2-12.6	100-300
Golden Star	Medium	Orange Yellow	- do -	-	113-240
Maha	Medium Large	Pale Lemon	- do -	8.2-11.5	100-200
B10 (Malaysia)	Medium Large	Lemon	Rounded	8.0-11.5	100-300
B16 (Malaysia)	Medium	Orange	Slightly Rounded	9.5-12.0	100-300
Kembangan (Hawaii)	Medium	Lemon Yellow	- do -	9.5-13.0	150-200

Source : C.W. Campbell, 1968 and 1985 - B.I. Watson *et al.*, 1988.

SOIL AND CLIMATE CONDITIONS

major Malaysian cultivar is B10, a sweet type used for the fresh fruit export market.

No differences have been recognised between types of bilimbi, all being very sour and there are no named varieties.

Both species have been observed to grow on a wide range of soil types in Trinidad. Flooding, however, can be most damaging. A well drained soil and or well distributed rainfall is necessary for normal growth and cropping. For

best performance both species should be grown in deep, fertile sandy-loam or clay-loam soil, with plenty of organic matter.

NURSERY PRACTICES.

Propagation by seed.

A well developed seed is used. The seeds are small, about 5 mm, and flattened. They should be cleaned and air dried. Seeds should be stored under cool conditions in air tight containers. They are then sown in nursery boxes or pots, kept under light shade and watered regularly. The carambola seeds usually germinate in 2-3 weeks while bilimbi germinate in 2 weeks. Germination percentage is usually high about 95%. The seedlings are transplanted after 3 weeks to polythene bags containing a potting medium of sand, soil and pen manure in a ratio of 1:1:1. A protective spray of fungicide/insecticide together with a foliar fertilizer is applied every 2 weeks to plants in the nursery. After 3 months the young plants are transplanted to the field.

Most carambola and bilimbi are cross-pollinated which leads to variability in the offspring. Pollination studies in Florida indicate that short style cultivars are self-incompatible and require pollination from long style types. Long style types are self fertile.

Seed material will not always breed true to type. Thus vegetative propagation methods will be of an advantage in maintaining desirable characters.

Vegetative propagation.

Carambola and bilimbi are also propagated vegetatively by grafting, budding and air-layering. Side veneer graftings and air-layering are the most common methods. Shield budding has been recommended in other parts of the world for large scale propagation, while air-layering and inarching are for backyard propagation. There is no record of success for the rooting of stem cuttings, with little success for root cuttings. Chip budding at C.E.S., Centeno, showed a higher degree of success over the side veneer grafting. A chip bud is a shield that has a notch at the lower (proximal) end.

A protocol for propagation through tissue culture is being developed at the University of the West Indies Tissue Culture Laboratory.

CULTURAL PRACTICES.

Land preparation.

Soil type determines the extent of need for land preparation. The loose, free draining soils, do not require land preparation as would the clayey type soils. The land must be ploughed and rotavated to obtain a fine soil tilth. Incorporation of organic manure during tillage is beneficial. A hole is then dug just wide and deep enough to accommodate the ball of soil. The recommended spacing is 6m x 8m. Cambered beds are formed where drainage is a problem.

Irrigation.

Plants should be watered immediately after planting. Supplementary irrigation should be supplied if there is a prolonged dry season. Carambola are water demanding plants. Production is optimum if water is present.

Fertilizers.

To attain a healthy and vigorous growth and to increase fruit production, fertilizers are required. Compost or well decayed farm manure is a good additive. Inorganic fertilizers should also be applied in ring application at about 25-50 g per 3 months (i.e.), 100-200 g per tree per year. The following ratio is recommended.

N	P	K	
2	1	1	(at the young stage) 28 g per 3 months for the first 2 years e.g., (20:10:10).
2	1	2	(at the bearing stage) 25-50 g per 3 months.

Pruning.

Dried or damaged branches should be pruned in carambola. In the case of bilimbi, the trunk and large branches should be kept open by regular pruning of lateral shoots, because flowers and fruits are produced on the large branches.

Weed control.

Weeds can be controlled mechanically, by cutlassing and hoeing and also chemically by using Paraquat at the recommended rate.

Pest and disease control.

The major pest problem in carambola in the leaf-cutting (bachac) ant. No other insect pests or diseases are known to be of sufficient importance to require control measures. However, mealy bugs, mites, aphids and scale insects can cause damage resulting in symptoms such as small fruit, hardening of fruit wall and reddening of leaves. A protective spray of a commonly available insecticide, at recommended dosages can be used. The spray can be applied between the cropping peaks.

In other parts of the world there are pests and diseases that can have disastrous effects on this crop. For example, attack by the Oriental Fruit Fly (*Dacus dorsalis*) causes damage to maturing fruit and a serious leaf-spotting organism (*Cercospora averrhoi*) infects the leaves and fruit of bilimbi. Illegal entry of planting material into Trinidad and Tobago could therefore, pose a threat to the fledgling industry by the introduction of new pests and diseases.

Harvesting and post harvest operations.

Care must be taken at harvesting to prevent injury. Fruits are normally picked by hand or by using a bamboo pole with a basket at the end to catch the fruit. Fruits

are then placed in baskets lined with straw, foam or dried leaves. Individual trees can yield up to 300 kg/tree/annum. However, commercial trees yield on average 250 kg/tree/annum.

Sweet carambola are harvested at the three-quarter-ripe stage for the fruit market while the semi-sweet and sour carambola are harvested full ripe for processing. Bilimbi must be utilized within 24 hours because of a short shelf-life. The shelf-life of both varieties can be prolonged by sun drying for several days.

The most critical aspects of post harvest care are (a) prevention of bruising (b) prevention of moisture loss and (c) pre-cooling. Cling-wrap film over the fruit has proved to be successful in preventing moisture loss. Research has indicated that fruits held at 20°C in cling-wrap film retained a good appearance for at least 1 week. The post harvest life was extended to at least 3 weeks if they were held at 5°C. Fruits stored at 7.2°C held acceptable quality for up to 6 weeks, after which decay sets in rapidly. As soon as carambola fruits are picked they should be pre-cooled (the field heat should be removed by dipping fruits in water), and then refrigerated. This helps to reduce the growth of organisms such as *Colletotrichum* and *Ceratomyces*, which cause post harvest rots.

UTILIZATION AND PROCESSING

Unripe carambolas and bilimbis are used in dyeing and removing iron-rust. Bilimbi may also be used for cleaning brassware. Medicinal uses are attributed to bilimbi. These include mixtures for cough, mumps, rheumatism and pimples. Most notable for the carambola is the use of a leaf infusion for lowering blood pressure.

Carambolas can be eaten as fresh fruit, and made into drinks, processed into candies, relishes and pickles, jams and jellies, and dried preserves. Bilimbis are very sour and are used in wines and pickles.

MARKETING

In Trinidad and Tobago there is now an increasing awareness of the carambola fruit and its nutritional value (Table 3). On the local fresh fruit market, a large sweet carambola costs TT\$0.75 or TT\$ 3.00-4.00/kg (US\$ 1 = TT\$4.25). On the overseas market, wholesale figures range from TT\$16.00/kg to TT\$24.00/kg. Some of the importing countries are England, Holland and Canada while Malaysia and Colombia are the main exporters.

It is estimated that the local market can consume 10,000 kg processed carambola per month. However, present processing is limited to the cottage industry. At Christmas time (1988), preserved fruits were fetching a price of TT\$ 28.00/kg in Trinidad.

Table 3 - Food value of carambola per 100 grams.

Moisture percentage	90.4-94.1
Energy (Kcal)	35.0
Carbohydrate (g)	7.6-8.0
Protein (g)	0.5-0.7
Fat (g)	0.5-0.7
Fiber (g)	1.23
Vitamin C (mg)	35.0
Calcium (mg)	4.0-9.0
Iron (mg)	0.8-2.0
Acids (mg)	0.78
Niacin (mg)	35.0
Vitamin B1 (mg)	0.04
Vitamin B2 (mg)	0.02
Vitamin A (Retinol equivalent)	60

Cultivation of carambolas and bilimbis should increase as more consumers discover the distinctive flavour and versatility of these fruits.

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RESUMEN - Presentación de dos especies frutales, el carambolero y el bilimbi, pertenecientes al género *Averrhoa* con referencia más particular a Trinidad y Tobago. Se abordan los aspectos siguientes: botánica, variedades, técnicas de multiplicación y prácticas de cultivo. Tres cuadros agrupan varias características físicas y químicas de las frutas de las variedades estudiadas.

