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## Starfruit: A fruit for healthy life

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### Abstract

Starfruit, botanically known as *Averrhoa carambola*, grows in tropical and subtropical regions throughout the world. The Starfruit can be used raw as vegetable and ripe as fruit. The Starfruit is sweet tasting fruit that possesses high nutritional value. From the time immemorial, the whole starfruit tree is used as a traditional medicine. The medicinal properties of Starfruit include anti-inflammatory, analgesic, hypotensive, anthelmintic, anti-oxidant, anti-ulcer, hypocholesterolemic and hypolipidemic, antimicrobial, anti-tumor activities. It is effectively used in diabetes and help to reduce the risk of heart disease and stroke.

The present paper reviews the Introduction, Geographical distribution, history, cultivation, uses, strange facts, side effects, synonyms, botanical description, taxonomical classification, nutritional value, phytochemical constituents, and pharmacological activities along with the current trends in research on starfruit.

**Keywords:** *Averrhoa carambola*, Sterols, Anti-inflammatory, Anti-oxidant

### Introduction <sup>[1, 2]</sup>

An 'Oxalidaceae family' member- *Averrhoa carambola*, well known as Starfruit, is an age old plant. Starfruit, is a star shaped tropical fruit with sweet and sour flavor. The starfruit is about 2 to 6 inches in length. Major two distinct classes of Carambola, the Smaller with sour taste and the Larger with sweet taste. It is vegetatively propagated during the 1940's and 1950's and, later in 1965, and changed the name to 'Golden Star' and distributed for cultivation.

The word *carambola* comes from the Sanskrit word Karmaranga meaning "food appetizer". Traditional medicines are plant derived medicines. According to WHO, more than 80% of developing country's population depends on plant based medicines for their health care needs. Carambola as ripe used as a source of food, eaten out-of-hand, sliced and served in salads, or used as garnish on avocado or seafood. Carambola has many medicinal uses and also contains secondary metabolites which have various biological activities. In addition, the wood of Starfruit is used for construction and furniture.

### Geographical Distribution <sup>[29, 32, 52]</sup>

It is believed to have originated in Ceylon and the Moluccas, but it has been cultivated in Southeast Asia and Malaysia for hundreds of years.

**World scenario:** It is commonly found in Sri Lanka, Southern China, Taiwan, Philippines, Queensland, Australia, Malaysia, Thailand, Israel, Florida, Brazil, Indonesia, in some of the South Pacific islands, particularly Tahiti.

**India scenario:** It is commonly found in warmer parts of India, primarily in the southern states and along the west coast, extending from Kerala up to West Bengal.

### History <sup>[29, 32, 52]</sup>

It is believed that star fruit has originated in either Sri Lanka or the Moluccas (islands of Indonesia) and then relatively new to north and South America. In 1887, it was first introduced to Florida but is viewed as a decorative fruit and has not been planted on a wide scale. In the orient, it is usually called balimbing, belimbing, or belimbing manis (sweet belimbing), to distinguish it from the bilimbi or belimbing asam. In 1935, Star fruit was introduced to the Caribbean islands, Central America, South America, and Hawaii and become very popular there. Today, star fruits are widely growing in Southern China, Taiwan, Philippines, Queensland, Australia, Malaysia, Thailand, Israel, Florida, Brazil, Indonesia, in some of the South Pacific Islands.



Fig 1: Starfruit



Fig 2: Starfruit leaves



Fig 3: Starfruit seeds



Fig 4: Starfruit fruit



Fig 5: Starfruit flowers

#### Cultivation <sup>[12, 13]</sup>.

**Climate:** The carambola should be classed as tropical and subtropical environments because mature trees can tolerate freezing temperatures for short periods and sustain little damage at 27° F (-2.78° C). In an interior valley of Israel, all trees surrendered to the usual hot and dry winds. The carambola needs moisture for best performance and ideally rainfall for its growth. Older trees are more tolerant of frost, but growth stops at 55 to 60 degrees and prolonged exposure to temperatures.

**Altitude:** Starfruit thrives best up to an elevation of 4,000 feet (1,200 m).

**Soil:** Carambola are not too particular as to soil, it grows well on sand, heavy clay or limestone and in rich loam. It prefers a moderately acid soil (pH 5.5 - 6.5) and is sensitive to waterlogging.

#### Propagation

The most important methods for propagation of star fruit is

1. Budding
2. Grafting.

#### Air-layering/ marcotting/ gotee

A healthy one-year old branch acutely positioned is selected from a healthy mother tree. Two rings are cut at 3-4 cm apart around the branch. The bark between the rings is completely removed and the exposed cambium layer is gently scraped off from the wood. The cut is wiped with clean cloth or tissue paper. The edge of the bark towards the shoot is applied with root-promoting hormone (IBA). A ball of moist soil mix (2:1) is placed around the cut and the soil ball is wrapped up in a transparent polythene sheet and secured tightly with string at both ends of the wrapper. After several weeks the roots will develop sufficiently in the soil ball within the polythene wrap. The rooted branch/ branches are cut off from the mother tree at 3-4 cm below the wrap and then kept in hardening area after 6 - 12 months in the nursery are planted out at a spacing of 4 m x 6 m

#### Grafting

**Bud grafting:** Prepare the budding patch on the stem of rootstock at 10-15 cm height above the soil surface. The two vertical cuts are made with this knife separately followed by two horizontal cuts at the top and bottom of the former cuts. The bark in the cut patch or window is carefully removed exposing the wet cambium layer. An identical cut is performed to remove the bud from the scion with the bud carefully centered. While removing the bud patch from the scion slight rotation of the bud patch around the bud stick will assure the "eye" of the bud to remain attached to the bud patch. Carefully place the bud patch with the new bud in the cut patch or window ascertaining complete contact at both the top and bottom of the cut patch or window. Small openings along the sides of the cut patch or window are not important or critical. The newly placed bud patch should be securely tied with budding tape, Para film or wide rubber band. Ensure that the bud is not covered by the budding tape. After 18 - 21 days,

the graft can be checked for its success of grafting which can be easily recognized by the developing bud from the patch. The budding tape or Para film is carefully removed from the graft and the top of the seedling is cut off at 10 cm above the graft. The exposed cut of the stem is applied with melted paraffin or fungicide mix to prevent rotting of the stem. Finally, the bud grafted plants are transplanted into bigger size polyethylene bags and kept the nursery until they are one-year old before planting in the field.

### Wedge Grafting

Firstly, we have to get ready with a rootstock plant of 6-8 months old. The stem of the rootstock is cut at 10-15 cm height from the soil surface. A center cut of 3-5 cm (v-shaped cut) is made through the stem. In the meantime a shoot scion of similar length with the rootstock containing at least 3 buds taken from a very productive and healthy mother plant. The cut end of the shoot must be shaped like a wedge or inverted V-form. This shoot is then inserted into the cut of the rootstock and the graft must be tied firmly with budding tape or elastic band. The grafted seedling is then covered with a translucent polythene cover moistened in the inside with water sprays. The seedling is then kept under a shelter. New buds usually appear 15-20 days later. The plastic cover is then removed and the grafted seedlings are moved to the hardening area for several weeks before they are transplanted into the field.

**Harvesting:** The harvesting of carambola occurs during an eight-month period ranging from June through February depending on the blooming cycle. No tree produces fruit through this entire period, but trees will reach maturity at varying times during the period. In California, the peak of harvest is August through October and December through February. Star fruit is harvested by hand when the fruit develops a yellow color in the grooves of the star shape.

**Irrigation:** The carambola needs moisture for best performance. This means regular watering during the summer months and must be watered even in winter during dry spells.

**Adaption:** *Averrhoa carambola* live in tropical climates, but they have adapted to sub-tropical environments and they can tolerate temperatures as low as 2.78°C for a short period of time.

**Storage** <sup>[10, 11]</sup>. Starfruit generally stored at room temperature for maximum of two to five days. You can also store them in the refrigerator for up to 2 weeks and starfruit can also store in freezer for 10 to 12 months.

**Uses:** <sup>[14-18]</sup>

### General health benefits

- Starfruit contains only 30 calories per fruit plus lots of fiber, it helps to lose weight.
- Flowers of the sweet star fruit are good for treating cough.
- Starfruit is a good source of vitamin B9 (folic acid), which help to reduce the risk of heart disease and stroke.
- Starfruit contain B-complex vitamin, which is essential for hair growth and help in keeping hair strong and healthy.

- Starfruit purifies the blood, helps in getting a glowing skin.

### Medicinal uses

Traditionally Starfruit is used as home remedy for hangovers and sunburns. Starfruit also helps to cure cough, fever, ulcers and sore throats. The leaves of star fruit can be used to treat stomach ulcers and also improves digestion. In India, the ripe fruit is administered to halt hemorrhages and to relieve bleeding hemorrhoids; and the dried fruit or the juice may be taken to counteract fevers.

Pharmacological activities of *Artocarpus heterophyllus* are summarized in Table No.3

### Strange Facts <sup>[20]</sup>.

- When the fruit is cut crosswise, it forms a perfect star.
- Star fruits do not need to be peeled or seeded – they can be eaten whole.
- Two varieties of star fruit are grown – tart and sweet.
- Early English travelers called the star fruit the “cucumber tree” when discovering the plant in Asia

### Side Effects, Contraindications and Precautions <sup>[6-9]</sup>.

- The patient facing kidney problem is recommended not to eat star fruit.
- If any patient had an incidence of stones, it is recommended to steer clear of this fruit.
- People with renal failure or uremic patient should completely avoid it.
- Consumption by those with kidney failure can produce hiccups, vomiting, nausea, and mental confusion.
- Star fruit consumption causes fatal problem.

### Synonyms of *Averrhoa carambola* <sup>[21, 22]</sup>.

- |              |   |                               |
|--------------|---|-------------------------------|
| • Sanskrit   | : | Karmaranga                    |
| • English    | : | Starfruit, Chinese gooseberry |
| • Hindi      | : | Kamrakh, Karmal               |
| • Bengali    | : | Kamranga                      |
| • Assamese   | : | Kordoi/ rohdoi                |
| • Gujarati   | : | Kamrakh                       |
| • Marathi    | : | Karambal                      |
| • Telugu     | : | Ambanankaya                   |
| • Tamil      | : | Thambaratham/Tamarattai       |
| • Malayalam  | : | Caturappuli                   |
| • Sinhala    | : | Kamaranga                     |
| • Filipino   | : | Balimbing, sarnate            |
| • Indonesian | : | Belimbing                     |
| • Malay      | : | Belimbing                     |

### Botanical Description of *Averrhoa carambola* <sup>[1, 29, 32, 33]</sup>

- Fruit type Tropical
- Edible part Fruit
- Shape of fruit Oval with 5 grooves
- Fruits per tree(annual) 200 pound
- Texture Crisp
- Taste Sweet

**Taxonomical Classification of *Averrhoa carambola*** [27-29, 20, 31, 35].

- Scientific Name : *Averrhoa carambola*
- Kingdom : Plantae
- Subkingdom : Tracheobionta -Vascular plants
- Superdivision : Spermatophyta
- Division : Magnoliophyta–Flowering plants
- Class : Magnoliopsida – Dicotyledons
- Subclass : Rosidae
- Order : Geraniales
- Family : Oxalidaceae–Wood-Sorrel family
- Genus : *Averrhoa* Adans. – *averrhoa*
- Species : *Averrhoa carambola* L. – *carambola*

**Table 1:** Nutritional Value of *Averrhoa carambola* [25, 26].

Nutrients	Value per 100 mg
Calories	35.7
Water	92%
Cholesterol	0 mg
Moisture	89000-91000 mg
Protein	380 mg
Fat	80 mg
Carbohydrate	9380 mg
Fiber	0.80-0.90
<b>Minerals</b>	
Calcium	4.4-6.0 mg
Phosphorous	15.5-21.0 mg
Iron	0.32-16.5 mg
Ash	0.26-0.40 mg
Magnesium	10 mg
Potassium	133 mg
Sodium	2000 mg
<b>Vitamins</b>	
Thiamine	0.03-0.038 mg
Riboflavin	0.019-0.03 mg
Carotene	0.003-0.552 mg
Vitamin C	34 mg
Vitamin A	61 IU
Ascorbic acid	26.0-53.1 mg
Niacin	0.294-0.38 mg

**Table 2:** Phytoconstituents of *Averrhoa carambola* [3-5, 40-42].

Sr.	Phytoconstituents	Plant Part
1	Saponins, Alkaloids, Flavonoids	Fruit
2	Proanthocyanidins, epicatechin, Gallic acid in gallotannin	Fruit
3	Sterols- $\beta$ sit sterol, campesterol, lupeol and isofucosterol	Fruit
4	Fatty acid- Palmitic, oleic, linoleic and linolenic acid	Fruit
5	Minerals- Iron, Calcium, Phosphorous	Edible portion of Fruit
6	Flavones- Apigenin-6-C- $\beta$ -L-fucopyranoside and apigenin-6-C- $\beta$ -1-fucopyranoside	Fruit
7	Anisaldehyde, 5-hydroxymethyl-2-furfural, Gallic acid and dihydroabscissic alcohol	Stem and bark
8	Lignins- Benzyl-1-O- $\beta$ -D-glucopyranoside, (+)-5'-methoxysolariciresinol 3 $\alpha$ -O- $\beta$ -D-glucopyranoside	Roots
9	Tannins	Fruit
10	Glycosides- 3,5-dimethoxy-4-hydroxyphenyl 1-O- $\beta$ -apiofuranosyl (1" $\rightarrow$ 6')-O- $\beta$ -D-glucopyranoside, (2S)-2-O- $\beta$ -D-glucopyranosyl-2-hydroxyphenylacetic acid	Roots

**Table 3:** Pharmacological Activities of *Averrhoa carambola*

Sr. No	Pharmacological activity	Plant part	Extracts	Reference
1.	Anti-inflammatory	Stem	Aqueous extract	43,44,45
2.	Analgesic	Fruit	Fruit extract	46
3.	Hypotensive	Leaves	Aqueous extract	49
4.	Anthelmintic	Leaves	Aqueous extract	47
5.	Anti-oxidant	Fruit	Juice and residue extract	34,37
6.	Anti-ulcer	Leaves	Water alcohol extract	48
7.	Hypocholesterolaemic and hypolipidemic	pomace	Water insoluble fiber rich fraction (WIFF)	50
8.	Antimicrobial	Stem	Stem extract	3
9.	Anti-tumor	Stem	Aqueous extract	51

**Conclusion**

*Averrhoa carambola* is an excellent plant due to its multifaceted medicinal properties like anti-inflammatory, analgesic, hypotensive, anthelmintic, antioxidant, anti-ulcer, Hypocholesterolaemic and hypolipidemic, antimicrobial and also show the anti-tumor activity. In addition *Averrhoa carambola* food value with numerous culinary uses. The wood of the tree is also used to make furniture and also used in construction. So we can conclude that starfruit is a health boon to the mankind.

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