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Averrhoa carambola L. – As an Overview and Pharmacological Activities

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Abstract: *Increasing the understanding of assimilation procedure and the fruitful outcome of the plants on humanoid have become larger variety of utilization of medicinal plants. Long time ago, herbal drugs have been utilized to tackle different disorder, recently they had flattered an object of worldwide significance, with medical value and economic inference. One such plant is Averrhoa carambola, it belongs to Oxalidaceae family. It is habitually well known as 'Kamrakh' and generally, called as 'star fruit'. Due to its distinctive shape. It has been extensively utilized in Ayurveda, also its fruits and leaves are utilized to cure throat, bile, pelt diseases, larva contamination, dysentery, shivering, spewing, itching, piles and overall weakness. It is second-hand as medicines in nations such as India, Philippines, Indonesia, China, Brazil, Thailand for different disorder. Though review pupillages on star fruit plant are previously available, but the current paper is to analysis and assemble all the efficient details on botany as well as phytochemical and pharmacological effects of Averrhoa carambola. Star fruit leaves holding Flavonoids, Apigenin and Quercetin as prospects Anti-inflammatory and Anti-cancer agents.*

Key Words: *Averrhoa carambola, Oxalidaceae, Starfruit, Kamrakh, Pharmacological activities.*

1. INTRODUCTION:

The term carambola is obtained from the Sanskrit term karmaranga. it meaning nutrition savoury". In Malayalam language star fruit is termed as carambola. Once Portuguese grabbed it to America and Africa they are known by their original name. star fruit plant is found in tropic regions including Indonesia. Star leaves have a lot of medicinal benefits. They are useful as anti-inflammatory, laxative diuretic, antidiarrheal, appetite enhancer. They are used as traditionally as medicine to reduce fever and treat eczema. (Moresco HH *et* al.,2012) Star fruit leaves include large scale flavonoids compound like apigenin and quercetin. Star fruit leaves also contain amarin, rutin, saponin and tannin. (Araho D. *et al.*,2005).

2.TAXONOMIC CLASSIFICATION

Kingdom: Plantae
Sub kingdom: Tracheobionta
Super division: Spermatophyta
Division: Magnoliophyta
Class: Magnoliopsida
Subclass: Rosidae
Order: Geraniales
Family: Oxalidaceae
Genus: *Averrhoa Adans.*
Species: *Averrhoa carambola* L.

(According to Bentham and Hooker classification)

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Figure 1: *Averrhoa carambola* L. fruits

Figure 2: *Averrhoa carambola* L. flowers

3. LITERATURE REVIEW:

Nomenclature

- Sanskrit: Karmaranga
- Hindi: Karmal
- English: Chinese gooseberry, star fruit
- Gujarati: Kamrakh
- Marathi: Karambal
- Bengali: Kamranga
- Assamese: Kordoi
- Telugu: Ambanamkaya
- Tamil: Tamarattai
- Sinhala: Kamaranga
- Filipino: saranate
- Malayalam: Caturappuli
- Indonesian: Belimbing
- Malay: Belimbing (Orwa *et al.*,2009)

3.1 Derivation and Dispersal

Averrhoa carambola L. is originally to have derived in Ceylon and Moluccas, but then it has been ploughed in Southeast Asia also Malaysia for centuries. (Morton JF.1987). This perpetual herb is generally grown in Malaysia, Taiwan, Thailand, Israel, Florida, Brazil, Philippines, China, Australia, Indonesia, Bangladesh, in cosy aera of India and other region of the biosphere with the same climatic condition. (Ghani A.2003)

3.2 Plant Description

- **Category**
  Edible Fruits
- **Height**
  9-12 m
- **Spacing**
  4.7 – 6 m
- **Dangerous**
  N/A
- **Sun detection**
  Full sunny
- **Flower Blooming Colour**
  Pink
- **Blooming Time**
  Bloom frequently

- **Herbage**
  Evergreen
- **Other character**
  Require regularly water, always need moist soil.
- **PH of Soil**
  6.1 to 6.5 (moderately tart)
  6.6 to 7.5 (neutral)
  7.6 to 7.8 (moderately basic)
- **Copyright evidence**
  Non evident
- **Propagation technique**
  Through seed, directly sow in outdoor field
  Via grafting
- **Pit collection**
  In the short-term sow, it because seed doesn't store well
- **Components**
  Experiments determine the appearance of flavonoids, alkaloids, saponins and tannins. (Gaurav Singhal *et al.*, 2012)

3.3 Morphology of Plant:

Averrhoa carambola is a small in height, attractive shrub, multistemmed. It is a slow growing evergreen tree species. It has a short trunk with so many branches. Averrhoa carambola generally spreading up to 20-25 ft in diameter. (Morton JF.1987). It has 10m height in rare case, commonly 5-7m of height. It has a bushy shape, rounded, broad branches therefore, its canopy look like crown. At the basal part the diameter reaches up to 15 cm. (Kapoor LD. 1990)

- **Leaves:**
  Leaves are compound, alternate and arranged spirally. It is 15-25 cm long, ovate to ovate-oblong in a shape. The leaves are soft, light green in colour and pubescent. Upper surface is smooth in touch and lower surface are whitish. The leaves are shortly petiolate and imparipinnate. Each twig has 5-11 green pedant leaflets. The leaflets are 2-9 cm long and 1-4.5 cm wide. Those are reacted with the light and become fold together at night. They have sensitive properties. (Morton JF.1987)
- **Flowers:**
  Flowers are produced in the axils of the leaf. It is light purple to dark purple in colour. Flowers are present in tiny clusters and individually cluster is jointed to the bush by red trunk. Flowers are little in size, pedicellate and it is around 6 mm wide. Flowers having 5 petals and sepals. All petals are curve at the ends. (Kapoor LD.1990)

- **Fruits:**
  The fruits are fleshy, having an oblong shape. It has longitudinally 5-6 angle therefore, it is look like star shape and called as 'star fruit'. It is 5 to 15 cm long and up to 9 cm wide. Generally, fruits are green in colour when it is small and unripe, while it turns into yellow colour when it is ripe and mature. The fruits are crunchy and have a brittle surface. when we cut in slice, they are look like star shape. Aroma of the starfruit similar to the Oxalic acid. It is very sour in the taste, sometime mildly sweetish. Fruits are very juicy without fibre and it is light yellow in colour. (Warrier PK and Nair RV, 2002)
- **Seeds:**
  There may be around 12 seeds in one fruit. It is flat, thin, 5 mm long and brown in colour. When seeds are in the fruits, it covered by a gelatinous aril. When seeds are removal from the fruit it was non-viable. Few days after they lose their viability. Star fruit is naturally propagated by developed and mature seeds. (Thomas S *et al.*,2008)

3.4 Ecology

Varieties

There are 2 different categories of *Averrhoa carambola.* The 'smaller', too much sour in taste, highly flavoured with extra oxalic acid. The 'sweeter' in taste, moderately flavoured, quite dry, with less oxalic acid. (Gaurav Singhal *et al.*,2012)

Climate

The *Averrhoa carambola* should be classified as tropical and sub-tropical. For the result that matured trees can be indulge freezing temperatures for short time and survive little harm at 27°F. In Florida, the star fruit tree exists in privileged area such as St. Petersburg on the west coastline and Daytona beach on the east side. In India it is flourishes up to 1,200 m height. These trees required moisture for their best performance and preferably downfall should be equitably evenly distributed in all year. Australia claimed that when annual downfall is 180cm or more than the fruit quality and taste are be best. (Gaurav Singhal *et al.*,2012)

Soil

Averrhoa carambola does not need particular soil, it does well on sand, heavy clay or limestone, however it will grow more quicker and more deeply in ironic soil. It is frequently greensick on sandstone. It requires best effluent. It cannot survive in front of flooding. (Gaurav Singhal *et al*.,2012)

3.5 Propagation Method and Management

Propagation method

We can propagate star fruit plant by seed, budding, grafting onto seedling root stocks and air-layering. Then seedling is transfer into polythene bags and after 6 – 12 months it goes to the nursery then planted outside spacing of 4 x 6 m. (Gaurav Singhal *et al.*,2012)

Tree Management

A baby plant of *Averrhoa carambola* need careful attention because at that stage it is delicate. It is rapidly growing bush therefore, it needs trimming and retreating of surplus fruit at in early stage when tree is become 2–3-year-old then crops are harvested. If trees are 10 years old the yields up to 900 kg/year. (Gaurav Singhal *et al*.,2012)

Germplasm Management

Seed depository behaviour is intermediary. The low-cost safe is 12.3%, further persistence decrease viability. Cold weather harm the seeds. Viability can be present at 5°c for 6 months with partly dried seeds. Mature trees have approximately 15,000 seeds by bark- grafting. (Gaurav Singhal *et al*.,2012)

4. FOOD USES:

Mature carambola is eaten as out of hands, as slice and served as salads or else even utilized as relish material on sea diet. They are utilized in desserts, pastries, lathers and seasonings also. In Malaya, starfruit is frequently cooked with honey and some spices or sometimes with fruits. In China, it also stewed with fishes. In Thailand, the slice of green star fruit use as boil food. Moderately ripen fruits are used as salted, in pickle and also use for make jelly or else other conserves. In China and Taiwan, starfruit slice is utilized in sirup intended for exportation. In Queensland sweet type starfruit are used as a vegetable. Sometime their cross-sections covered with honey and stand for overnight then cook for short time and put into sterilized jars. A dish may be made up of chopped unmature fruits combined with celery, horseradish, vinegar, spices and seasonings. Starfruit liquor is also served as a cold drink. In other country the liquor of star fruits is combined with jelly, honey, lemon extract and hot water to make sharbat. For make jelly it is compulsory use the unripen sweeter type of star fruit and then add commercially available pectin fruit such as green papaya or lemon. The flowers are acidic and it is used as garnishing to salads in java. (Neto MM *et al*.,2003)

4.1 Other Uses

The acidic type of star fruit has been utilized to spotless and refinement steel, particularly brass. They clear stain and corrosion. The juice was utilized as cleaning agent for clothes. Unmature fruits are utilized in dyeing.

Timber: starfruit timber is white in colour becoming reddish in colour with age, medium hard. Their wood has been used for furniture and construction. (Chen LL *et al.*,2005)

4.2 Medicinal Uses

In India, the ripen fruit is used as relieve bleeding to haemorrhoids. Their dry fruits and juice may be used to prevent fever. Star fruit is relieving a "hangover" from over drink of alcohol. The cream made up of star fruit is protect eye infections. Starfruit is approved as a water pill in kidney and bladder complains. They are recommended to have a benefit effect in the therapy of eczema. A decoction of star fruit and leaves are utilized for overcome vomiting. Crushed leaves are used for precaution of chicken-pox, also on ringworm. A concoction of the pits performances as ernmenagogue. It is moderately alcoholic. The residue of pit is utilized to cure asthma and indigestion. The inner bark of star fruit tree is used with sandalwood for irritable heat. The roots are used with sugar are examined an antidote for poison. (Neto MM *et al.*,2003)

4.3 Risks

Carambola hold oxalic acid, which is harmful to people who suffering from kidney failure, kidney stone, under kidney dialysis treatment. If kidney failure consumes the star fruit it can produce hiccups, nausea, vomiting and mental confusion. (Titchenal A & Dobbs J,2003)

5. Phytochemicals :

Phytochemical word comes from the Greek word Phyto, it meaning plant. The chemical compounds which are biologically active, and obtain naturally in plants. it is called "Phytochemicals". Phytochemicals gives health benefits to human being apart from those allocate to macronutrients and micronutrients. (Hasler and Blumberg,1999).

5.1 Significance of Phytochemical

Phytochemicals shield plants from infection and destruction. Phytochemicals give a colour, fragrance, and saviour to the plants. Phytochemicals protect the plant cells against environmental damage such as pollution, water stress, dry spell, UV revelation and pathogenic assault. (Gibson *et.al.*,1998; Mathai,2000).

6. PLANT METABOLITES:

Plant Metabolites remarkably depends on environmental consequence and the elemental aspect. Inside the injury of any inherent conglomeration, metabolite categorization is gradually attracting the situation of the region well liked. Suggestive metabolites are old or successfully written on such subjects as ecosystem interaction likewise in the midst of rising and chemical cluster chemistry and the stress reaction of plant. (Fester, 2015).

6.1 Types of Plant Metabolites

The exact classification of phytochemicals has not been given yet, due to their various forms and composition. Classically, Phytochemicals are classified by their character in plant metabolism. They are mainly divided into two parts (Saxena *et. al.*,2013).

(i) Primary metabolites
(ii) Secondary metabolites

Sugars, amino acids, proteins, chlorophyll etc. are consider as a primary metabolite while some plant chemicals like terpenes, alkaloids, flavonoids, steroids, lignans, phenolics, saponins and glycosides are included in secondary metabolites (Hahn,1998; Ramavat *et al.*,2009).

6.1.1 Primary Metabolites

Molecular moderation within primary metabolite that conclusively gives complex structure and dimensions for protective combination biosynthesis possesses much lesser observation power. Dissimilarity within the amount of malate and being or having particular internal habitation of malate transforming enzyme under stress conditions of the nature recommends a role or part of malate metabolite inner plant protection (Levitt, 1980 and jory schaai *et al.,1995).* There is amalgamation or demeaning primary metabolites which have an incredulous important title role in the metabolism and reproduction of the cells in question. The cue metabolites like as amino acid, nucleic acid and sugars generally. Primary metabolite is a compound which has an especially insignificant role in photosynthesis, breeding and extension and development. (Krishnanandar p. ingle *et al.*,2016).

6.1.2 Secondary Metabolites

A) Flavonoids

Flavonoids are the biggest group of plant chemical and it is also highest studied one. (Dai & Mumper,2010). Flavonoids are complex compounds. They contain two benzene rings. Those benzene rings are separated by a propane unit. Flavonoids are derived from flavones. It is a water-soluble compound (Kaufmann 1999). They are polyphenolic compounds. Flavonoids are universally found in nature. More than 4,000 flavonoids have been approved yet, many flavonoids are come out from the vegetables, fruits, some beverages such as tea, coffee and few fruit drinks also. (Pridham,1960). The flavonoids seem to have an important role in victorious medical therapy of long ago and their use has continued at present. Flavonoids are mostly present in the vascular plants and it take place as aglycones, glycosides, methylated derivatives. Flavonoids having a low molecular weight. Flavonoids comprise the chalcones, flavanols, flavones, isoflavones, flavanones and anthocyanins. (Kaufmann 1999).

B) Tannin

Tannins are naturally water-soluble compound. Tannins are having plentiful phenolic groups and they are capable to stick or give rise to water soluble proteins. Tannins are oftenly found in vascular plants. They are appearing firstly in woody tissues but they can also be built in leaves, flowers and seeds. Plants which have higher amount of tannin are extremely bitter in taste, therefore animals are avoid to eat those plants. Tannins are mainly divided into two groups:

(i)condensed tannins and (ii)hydrolysed tannins. Tannins are useful in medical science such as astringents, against diarrhoea, as diuretics, against stomach infection, duodenal tumours, antiseptic, antioxidant, anti-inflammatory, and also in haemostatic pharmaceuticals. Tannins are used for production of ink as well as production of dyes. Tannins are utilized for purify wine, beer and fruit juices in the food industry. They are also useful as coagulants in rubber production. Tannins are found in various fruit like grapes, blueberry, persimmon, some crops such as corn, sorghum, grass spp., etc. (Giner-Chavez,1996).

C) Alkaloids

Alkaloids are naturally presents in plants, it can be synthesized by a lot of creatures which includes animals, fungi and bacteria. Alkaloids basically made up of heterocyclic compound. Alkaloid term obtains from the alkaline. it was utilized to narrate nitrogen holding base. (Muller-Harvey,1999). Alkaloids were firstly derived from the plant materials in 19th century. It was found that they have contain nitrogen base which made up of salts with acid. Alkaloids are bitter in taste. They are found in vegetable. Therefore, it is called as vegetable alkalis.

Alkaloids are used as painkiller and tonic as cocaine. Alkaloids are having diversity of molecular structure therefore; their logical categorization is difficult. However, they are classified to depending on the type of heterocyclic ring attached in the molecule. Alkaloids are important for the saving and abidance of plant because they make sure their survival opposed to micro-organisms, beetles and herbivores. Alkaloids containing plants are used as dyes, drugs and spices.

Alkaloids are having a lot of pharmacological activities such as antihypertensive activity, antiarrhythrnic effect, antimalarial activity, anticancer activity. These are some examples demonstrating the considerable economic value of this set of herbal fragments. Few Alkaloids have tonic features such as caffein and morphine which are utilized as pain-relieving and quinine which is utilize as an antimalarial drug. (Wink *et al.*,1998).

D) Saponins

Saponins are a category of secondary metabolites. It is found extensively dispersed in the plant kingdom. They are creating a steady foam in aqueous compound like soap, therefore, it called as “saponin”. Synthetically, saponins are include the complex compounds such as glycosylated steroids, triterpenoids, steroid alkaloids. Saponins have a high molecular mass. Saponins are bitter in taste, and sticky in touch. They are toxic for fish as well as other water animal. In ancient time, plants which contain saponins were used as soaps. For instance, soaproot, soapbark, soapnut. (Kaufmann 1999). Saponins physiological function in plants is not yet decided. While some publisher reported their recognition in plants and their various result in animal cells and also in fungi and bacteria. Many saponins have an antimicrobial effect to hold back mould, and to defend plants from beetle attack. Saponins are include membrane permeabilizing effect, immunostimulant, Hypocholesterolaemic activity and anticarcinogenic properties. Saponins are also react as antifungal and antiviral. (Morreissy & Osbourn,1999; Takechi *et.al.*,1999; Traore *et.al.*,2000).

E) Phenols

Phenolic compounds are well known category of secondary metabolites. They have broad pharmacological activities. Phenols are extensively found in the plant kingdom. (Walton *et.al.*,2003). Phenols are divided into main three groups such as flavonoids, phenolic acids and polyphenols. Phenols are marked as the simplest group of natural compounds. Phenols contain hydroxyl groups (-OH) in their structure. -OH, group is connected to an aromatic ring. Phenols take a major role in protection mechanisms. Phenols have particular effect that are advantageous to humans. The antioxidant activity of phenols is main to decide their character as preserving agents opposed to free radical-mediated infection procedure.

F) Terpenoids

Terpenoids are include in secondary metabolites. Terpenoids are set of natural outcomes which obtained from 5 carbon isoprene component. Terpenoids have numerous cyclical compositions. It is different from each other by their functioning groups and cardinal carbon skeletons. Terpenoids can be found in each category of living object, and therefore it is taken into account as the biggest set of ordinary outcomes. Most of the terpenoids are economically fascinating for the reason that their usage as additives and aroma in nourishments and make-up. (Horborne & Tomas-Barberan 1991).

For instance, menthol is significant for the grade of agricultural manufactures like taste of fruits also the aroma of flowers such a linalool. Terpenoids contains different eight isoprene units which may be acyclic such as lycopene, monocyclic such as gamma-carotene and bicyclic such as alpha and beta carotenes. Terpenes is helpful to the plants like they are attract particular insects for pollination. Plants which have higher amount of terpenoids are extremely bitter in taste, therefore they are protected to being eaten by animals. It called antifeedants. In addition, terpenoids are play a major act as growth regulators in plants. Moreover, terpenoids having a medicinal property like antimalarial, antiulcer, anticarcinogenic, diuretic, antimicrobial and anticancer.

7. PHARMACOLOGICAL STUDIES:

Various Pharmacological Activities have been reported in Averrhoa carambola plant in different solvents by different scientists.

Sr. No.	Plant Part	Activity	Solvent	Pathogenic Organism	References
1	Stem	Anti-inflammatory	Butanol, ethyl-acetate, hexene	Carrageenan rat paw	Sripanid kulchai B. *et. al.*,2002
2	Fruit	Analgesic	Acetic acid	Swiss-Albino mice	Ahmed M. *et. al.*,2012
3	Ripe Fruit	Hypoglycemic effect	Alcohol, Water, Dietary Fibers	Male Sprague Dawley rats	Genasekara L. C. A. *et. al.*, 2011
4	Leaves	Anthelmintic	Aqueous, albendazole	Paralysis and death cell	Shah N.A. *et. al.*,2011
5	Leaves	Anti-ulcer	Alcohol, Water	Gastric mucosa injury	Goncalves ST. *et al.*,2006
6	Leaves	Hypotensive	Aqueous	Aorta of rate	Soncini R. *et. al.*,2011
7	Fruit	Hypocholesterolaemic	Water, insoluble fiber	Hamster	Chau CF. *et. al.*,2004
8	Fruit	Hypolipidemic	Water, insoluble fiber	Hamster	Chau CF. *et. al.*,2004
9	Stem	Antibacterial	Methanol	Staphylococcus aureus, Klebsiella sp.	Sripanid kulchai B. *et. al.*,2002
10	Bark	Antimicrobial	Petroleum ether, chloroform, carbon tetra chloride	Bacillus cereus, Megatherium, B. subtilis, Staphylococcus aureus, Escherichia coli, Salmonella typhi, S. Para typhi, Candida albicans, Aspergillus Niger, Pseudomonas aeruginosa	Mia Masum Md. *et. al.*, 2007
11	Stem	Anti-tumor	Alcohol	Liver carcinoma cells	Sripanid kulchai B. *et. al.*,2002
12	Leaves	Antibacterial	Aqueous	All the bacteria	Basanti Majhi, 2019
13	Leaves	Antibacterial	Aqueous	Salmonella typhi	Kunja Bihari Satapathy, 2019
14	Leaves	Antifungal	Methanol	Candida Krusei	Sagar Kumar Mishra,2019
15	Bark	Antimicrobial	Ethanol	Staphylococcus aureus, Staphylococcus saprophyticus, Escherichia coli	Ferreira *et. al.*, 2006

16	Leaves	Antimicrobial	Ethanol	Enterococcus faecalis, Enterococcus aerogenes, Pseudomonas aeruginosa	Ferreira *et.al.*, 2006
17	Fruit	Antimicrobial	Ethanol	Klebsiella pneumonia, Proteus mirabilis, Acinetobacter baumannii	Ferreira *et. al.*, 2006
18	Leaves	Antifungal	Ethyl acetate, DMSO	Candida albicans	Marina Ika Irianti *et. al.*,2021
19	Leaves	Antidiabetic	Acetone, ethyl acetate, Hexene	Cultured L 6 cell lines	Sona Rajashree B.2018
20	Leaves	Antimicrobial	Ethanol	Staphylococcus aureus 6MRSA, Staphylococcus aureus 10 MRSA, Staphylococcus aureus 12 MRSA	Gardete and Tomasz,2014
21	Bark	Antimicrobial	Ethanol	Escherichia coli ATCC25922, Escherichia coli 67ESBL, Enterobacter aerogenes	Prieto *et. al.*,2016
22	Fruit	Antimicrobial	Ethanol	Pseudomonas aeruginosa ATCC27853, Pseudomonas aeruginosa 31 MBL, Acinetobacter baumannii 2 MBL	Costa *et. al.*,2020
23	Fruit	Antimicrobial	Ethanol	Candida albicans, Candida Krusei	K.B. Silva *et. al.*,2020
24	Bark	Antimicrobial	Methanol, Petroleum ether, Carbon tetrachloride, Chloroform, aqueous	Bacillus cereus, B. megaterium, B. subtilis, Sarcina lutea, Vibrio mimicus, V. parahaemolyticus, Saccharomyces cerevaceae, Aspergillus Niger	Md. Masum Mia *et. al.*,2004
25	Bark	Antibacterial	Ethanol	Shigella sonnei, Bacillus subtilis, Vibrio cholera, Salmonella typhi, Bacillus megaterium, Escherichia coli	Joysree Das, Zulon Datta *et. al.*,2013
26	Bark	Anti-infective	p-anisaldehyde, sitosterol	Escherichia coli, fungi	Mia *et. al.*,2007
27	Root	Anti-diabetic	Ethanol, Water	Male Kunming mice	Xiaohui Xu, Tao Liang *et. al.*,2014
28	Leaves	Antioxidant	Ethyl acetate, Hexene, Water	Staphylococcus aureus	Annisa dhanira, Katrin Basah, 2019

Table-1 Review of Different Pharmacological Activities of different plant parts of Averrhoa carambola in various solvents.

8. CONCLUSION :

Averrhoa carambola is one of the Medicinal plants. The Leaves of the plant having different kind of secondary metabolites such as saponins, flavonoids, tannins and alkaloids. Averrhoa carambola plant having various type of pharmacological activities such as Antibacterial, Antifungal, Antitumor, Antiviral, Anticancer, Antidiabetic, Antiulcer and anti-inflammatory. It is use as food material like juice, jelly, curry, jam, and as slice. Their wood is also use as furniture and at construction site. So, *Averrhoa carambola* L. plant has not only medicinal importance but it has also economic importance.

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