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A COMPLETE REVIEW ON THE PHARMACOLOGICAL EVALUATION OF *AVERRHOA CARAMBOLLA* PLANT

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ABSTRACT

Averrhoa carambola L. (Oxalidaceae), commonly known as star fruit bears a great significance in traditional medicine. Traditionally, *A. carambola* was used in epistaxis, spermatorrhea, fever, food poisoning, gastroenteritis, malaria, malarial splenomegaly, oliguria, postpartum edema, sore throat, subcalorism and traumatic injury. Pharmacological investigations on A. carambola have demonstrated anti-inflammatory, antimicrobial, antifungal, antitumor and anti-ulcer activities. In addition, the plant possesses hypocholesterolemic, hypoglycemic, hypotensive, nephrotoxic, neurotoxic, negative inotropic and chronotropic effects. Phytochemical investigations have shown the presence of pharmacological activities and clinical studies on A. carambola.

KEYWORDS: *Averrhoa Carambolla*, pharmaceutical and pharmacological activities.

INTRODUCTION[1-3]

Herbal medicine is the oldest form of healthcare known to mankind. Plants have always been an exemplary source of drugs and many of the currently available drugs have been derived directly or indirectly from them. Herbal medicines have often retained popularity for historical and cultural ingredients and are used primarily for treating mild and chronic ailments. India has an ancient heritage of traditional medicines; Materia Medica of India provides lots of information on the folklore practices and traditional aspects of therapeutically important natural products. Indian materia medica includes about 2000 drugs of natural origin almost all of which are derived from different traditional systems and folklore practices. Out of these drugs derived from traditional system, 400 are of mineral and animal origin while the rest are of the vegetable origin. Natural products and especially those

derived from higher plants have historically played a pivotal role in the discovery of new pharmaceuticals.

India has a rich heritage of traditional medicine and the traditional health care system has been flourishing in many countries. Population in developing countries depends mainly on the indigenous traditional medicine for their primary healthcare needs. In recent years, the use of herbal medicines worldwide has provided an excellent opportunity to India to look for therapeutic lead compounds from an ancient system of therapy, i.e. Ayurveda, which can be utilized for development of new drug. Over 50% of all modern drugs are of natural product origin and they play an important role in drug development programs of the pharmaceutical industry. The World health Organisation (WHO) estimates that about 80% of the population living in the developing countries relies almost exclusively on traditional medicine for their primary healthcare needs. WHO has listed over 21000 plant species used around the world for medicinal purpose. In India, about 2500 plant species belonging to more than 100 genera are being used in indigenous systems of medicine. India ranks 2nd in terms of both quantity and value of the medicinal plants exported. India is one of the 12 mega biodiversity centre of the world with 16 agro-climatic zones. It has about 45000 plant species of which 7000 species identified as medicinal plants. There are about 400 families in the world of the flowering plants, of which at least 315 are represented by India. There are estimated to be around 25000 effective plant based formulations used in folk medicine and known to rural communities in India. It is estimated that there are over 7800 medicinal drug manufacturing units in India which consume about 2000 tones of herbs annually. At the present juncture, the modern conventional healthcare is burdened with great problems of unsafe medicines, chronic diseases, resistant infections, autoimmune disorders and degenerative disorders of ageing despite of great advances. Modern allopathic system has developed many sophisticated and costly diagnostic methodologies which at the times have made it quite exorbitant and beyond the reach of common man. Many modern synthetic drugs may harm more than they help in curing diseases by its serious effects. On contrary, traditional medicines which make use of plants are much more esteemed being more safe without harmful effects and comparatively less expensive than many allopathic medicines.

Undoubtedly, the plant kingdom still holds many species of plants containing substances of medicinal value which have yet to be discovered.

From the centuries, herbal medicines have been used to treat various diseases and now they had become an item of global importance, with both medicinal and economic implications. Selecting the right scientific and systematic approach to biological evaluation of plant products, based on their use in traditional medicine is the key to ideal development of new drugs from plants. One such plant is *Averrhoa carambola* (Oxalidaceae), traditionally known as 'kamrakh' and commonly known as star fruit because of its peculiar shape It has widely been used in Ayurveda, preparations of its fruit and leaves are used to pacify impaired kapha, pitta, skin diseases, pruritis, worm infestations, diarrhea, vomiting, hemorrhoids, intermittent fever, over-perspiration and general debility. It is also used in traditional medicines in countries like India, China, Phillipines, Brazil for various ailments.

Plant Profile[4]

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. In traditional medicine, the fruit was used for treating ailments such as cough, food poisoning, sore throat and malarial splenomegaly, the root for treating arthralgia, chronic headache, epistaxis and spermatorrhea, the leaves for treating boils, colds, gastroenteritis, oliguria, postpartum edema, pyodermas and traumatic injury, while the flowers for treating fever, malaria and subcalorism.

Classification of *Averrhoa Carambolla*[5]

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

Botanical Description of *Averrhoa carambola*[6-7]

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

General health benefits[8-9]

- 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.

Description[10]

Star fruit, Averrhoa carambola (Oxalidaceae) is found in America, Brazil, Australia, South-East Asia including Malaysia, Southern China, Taiwan and India. A. carambola tree (fig-1) usually 3 to 5 m in height and can reach a maximum height of 10 m, with a finely fissured light brown bark and 15 to 20 cm long leaves (fig-2). And the flowers are in pink in color (fig-3). It bears large indehiscent yellowish-green berry fruit of 5 to 8 cm long with a characteristic shape resembling a five pointed star (fig-4), and each cell of the fruit contains five arillate seeds (fig-5).

Fig(1) Starfruit tree

Fig(2) Starfruit's leaves

Fig(3) Starfruit's flower

Fig(4) Starfruit's fruit

Fig(5) Starfruit's seeds

Cultivation.[11-14]

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 27º F (-2.78º 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 stock 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 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 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 2.78ºC for a short period of time.

Storage

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.

Literature Review

Analgesic[15]

Ahmed M. et al (2012) studied the analgesic activity of *Averrhoa carambola* fruit extract by writhing test and radiant heat-tail flick test. It was found that, of *Averrhoa carambola* fruit exhibited significant central and peripheral analgesic activities in acetic acid induced writhing model in Swiss-Albino mice at doses of 200 and 400 mg/kg and showed 37.13% and 42.76% inhibition of writhing respectively. In radiant heat-tail flick test the crude extract product 33.65% and 40.88% elongation of tail flicking time 60 minute after oral doses of 0200 & 400mg/kg body weight respectively.

Hypotensive Activity[16]

Soncini *et al*, (2011) studied the hypotensive effect of the aqueous extract of *A. carambola* and its underlying mechanisms using isolated rat aorta. *In vitro*, the aqueous extract caused a reduction in the Emax response to phenylephrine without a change in sensibility. Furthermore, in a depolarized Ca2+-free medium, the aqueous extract inhibited CaCl2-

induced contractions and caused a concentration-dependent rightward shift of the response curves, suggesting that the aqueous extract inhibited the contractile mechanisms involving extracellular Ca2+ influx. The study concluded the aqueous extract to be hypotensive in nature and suggested the effects to be in part, due to the inhibition of Ca2+, which is in agreement with its uses in traditional medicine.

Hypocholesterolaemic & Hypolipidemic Activity[17-18]

Chau CF. et al (2004) reported that the isolated water-insoluble fiber rich fraction (WIFF) from the pomace of star fruit, showed hypocholestarolaemic & hypolipidamemic activity.Investigation in hemsters showed pronounced cholesterol &lipid lowering affect of WIFF which might be attributed to its ability to enhance the extraction of cholesterol & bile acids via the faeces. It decreased the serum concentration.of triglycerol, liver cholesterol & increased the concentration of total lipids, cholesterol & bile acids in feces.

Anti-Tumour Activity[19]

Li *et al.*, (2012) studied the biotransformation of dihydro-epi-deoxyarteannuin B by using suspension cultured cells *A.carambola*. One novel sesquiterpene, 7α-hydroxy –dihydro – epideoxyarteannuin B, and one known sesquiterpene, 3-α-hydroxydihydro-epideoxyarteannuin B, were obtained upon the addition of dihydro-epi-deoxyarteannuin B. The study concluded that**,** cultured cells of *A.* carambola have the capacity to hydroxylate sesquiterpene compounds in a regio- and stereoselective manner. The inhibitory effects of 7α-hydroxy- dihydro epideox arteannuin B and 3-α-hydroxy-dihydroepideoxyarteannuin B on proliferation of K562 and HeLa cell lines were (59.29 ± 0.99, 84.04 ± 0.27μmol/mL) and (40.63 ± 1.45, 41.54 ± 0.82 μmol/mL), respectively.

Anti-Microbial And Anti-Fungal Activity[20]

Mia *et al*, (2007) isolated two compounds panisaldehyde and β-sitosterol from the bark of *A.*carambola. The petroleum ether, carbon tetrachloride and chloroform fractions of the methanol extract of A.carambola when subjected to antimicrobial screening at 400 μg/disc demonstrated mild inhibition on microbial growth. The average zone of inhibition produced by the petroleum ether, carbon tetrachloride and chloroform soluble fractions were 8-12 mm, 8-12mm, and 8-15 mm, respectively. The petroleum ether extract moderately inhibited the growth of *E. coli* and *S.* dysenteriae having the zone of inhibition of 12 mm each. On the other hand, the chloroform soluble fraction strongly inhibited the growth of *E. coli* with zone of inhibition 15 mm. In the case of fungi, mild inhibitory activity was exhibited by all

extractives. The LC50 values obtained from cytotoxicity evaluation were 0.32, 0.70, 0.06 and 3.14 μg/mL for standard vincristine sulfate, petroleum ether, carbon tetrachloride and chloroform soluble fractions respectively.

Anti-Ulcer[21]

Goncalves ST. *et al* (2006) investigated the anti ulcerogenic potential of *Averrhoa carambola* leaves. In their study, it was reported that the water-alcohol(1:1) extract of *Averrhoa carambola* leaves showed significant, dose dependent anti-ulcer and cytoprotective effects against gastric mucosa injury induced by ethanol-acid method; atdoses of 400,800 and 1200mg/kg, p.o., the protective action was produced at the highest but not at the lowest dose of the extract. As *Averrhoa carambola* extract contains triterpenoids, flavonoids and mucilage which were observed previously, the partial anti-ulcer activity could be due to their effect.

Anthelmintic[22]

Shah N.A. *et al* (2011) carried out the anthelmintic assay as per Ajaiyeoba *et al* with the aqueous extract of *Averrhoa carambola* leaves at various concentrations (10,50,100mg/ml) using albendazole as reference standard at the same concentration to that of the extract. It was found that the leaves of *Averrhoa carambola* displayed a significant anthelmintic activity in dose dependent manner showing the time of paralysis in 10 minutes and death in 16 minutes at 100mg/ml concentration while albendazole at the same concentration exhibited similar effects in 10 & 20 minutes respectively.

Anti-Microbial[23]

It was **Sripanidkulchai *et al.*** (2002) again, reported that *Averrhoa carambola* stem extracts exhibited antibacterial activity by inhibiting *Staphylococcus* aureus and Klebsiella *sp*. As indicated by a minimal bactericidal concentration (MBC) of 15.62 mg/ml and 125 mg/ml respectively. Again, Mia Masum Md. *et al* (2007) investigated the anti-microbial activity of *Averrhoa carambola* by disc diffusion method and reported that the methanolic extract and its petroleum ether, carbon tetrachloride, chloroform and aqueous soluble fractions of *Averrhoa carambola* bark inhibit the growth of various Gram +ve bacteria (*Bacillus cereus*, B.megaterium, B.subtilis, Staphylococcus aureus etc.), Gram –ve bacteria (*Escherichia coli*, *Pseudomonas* giaurinosa, Salmonella typhi, *S*. paratyphi etc.

Anti-Tumour[24]

Lastly, selective activity against brain tumour cells was observed with an alcoholic extract from the stems of *Averrhoa carambola*, while an extract from the leaves was effective against liver carcinoma cells.

Anti-Oxidant[25-26]

Shui G.et al (2004) analyzed the polyphenolic antioxidants present in the juice and residue extract of *Averrhoa carambola* fruit by liquid chromatography and mass spectroscopy.[41] The picks were mainly antioxidants which are attributed to phenolic compounds. They were characterized as L-ascorbic acid, (-)epicatechin, gallic acid in gallotannin forms and proanthocyanidins. The residue of the star fruit was found to contain much higher antioxidant activity than the extracted juice. It was also showed strong antioxidant activity in delaying oxidative rancidity of soyabean oil at 1100 C.

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