**Review Article**

# *Averrhoa Carambola*: An Updated Review

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**ABSTRACT**

Increasing knowledge of metabolic process and the positive effects of plants on human physiology have enlarged the range of application of medicinal plants. 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. Although review articles on this plant are already published, but the present attempt is to review and compile all the updated information on botany, phytochemical and pharmacological properties, drug interaction, contraindication and toxicity studies of *Averrhoa carambola*. These results are very encouraging and indicate that this plant should be studied more extensively to confirm the reproducibility of these results and also to reveal other potential therapeutic effects, along with some "leads" with possible isolation of active biomoieties and their mechanism of action.

**Keywords:** *Averrhoa carambola*, oxiladaceae, pharmacological activities, toxicity

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## INTRODUCTION

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 [1]. 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 [2]. 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 [3]. Natural products and especially those derived from higher plants have historically played a pivotal role in the discovery of new pharmaceuticals [4]. 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 [4].

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 [5]. WHO has listed over 21000 plant species used around the world for medicinal purposes. In India, about 2500 plant species belonging to more than 100 genera are being used in indigenous systems of medicine [6]. India ranks 2nd in terms of both quantity and value of the medicinal plants exported [7]. India is one of the 12 mega biodiversity centers of the world with 16 agro-climatic zones [8, 9]. It has about 45000 plant species of which 7000 species identified as medicinal plants [1]. There are about 400 families in the world of the flowering plants, of which at least 315 are represented by India [9]. 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 [1].

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 [10]. 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 [11]. Undoubtedly, the plant kingdom still holds many species of plants containing substances of medicinal value which have yet to be discovered [12].

**CLASSIFICATION** [13]

Scientific Name: *Averrhoa carambola*
Kingdom: Plantae – Plants
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

**VERNACULAR NAMES** [14, 15]

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

**ORIGIN AND DISTRIBUTION:**

Star fruit is believed to have originated in Ceylon and the Moluccas, but it has been cultivated in Southeast Asia and Malaysia for hundreds of years. [16] The perennial herb is commonly grown in Malaysia, Taiwan, Thailand, Israel, Florida, Brazil, Philippines, China, Australia, Indonesia, in the warmer parts of India, Bangladesh and other areas of the world with the same climate [17].

**DESCRIPTION:**

**Botanical Description/ macroscopy-** *Averrhoa carambola* is a small, attractive, multistemmed, slow growing evergreen tree with a short trunk or a shrub, 5-7m of height or rarely, 10m high, spreading 20-25 ft in diameter. It has a bushy shape with many branches producing a broad, rounded crown. At the base, the trunk reaches a diameter of 15cm [18, 19].

**Leaves:**

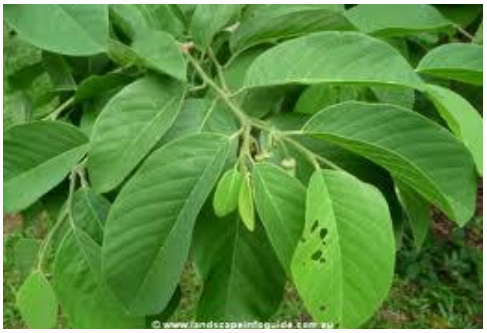

**Fig.1: *Averrhoa carambola* Leaves**

Leaves are 15-25cm long, alternate, spirally arranged, ovate to ovate-oblong in shape, imparipinnate, shortly petiolate with 5-11 green pedant leaflets of 2-9cm long and 1-4.5cm wide. The compound leaves are soft, pubescent, medium-green, smooth on the upper surface and whitish on the underside. The leaflets are reactive to light and tend to fold together at night; they are also sensitive to abrupt shock.

**Flower:**

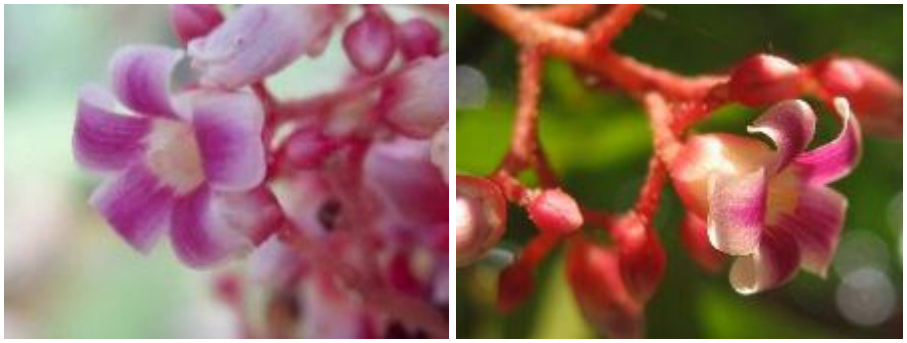

**Fig. 2: *Averrhoa carambola* Flowers**

Purple to bright purple colored flowers are produced in the axils of the leaves. The flowers are arranged in small clusters and each cluster is attached to the tree with red stalks. The flowers are small, about 6mm wide, pedicellate with 5 petals (having curve ends) and sepals.

**Fruits:**

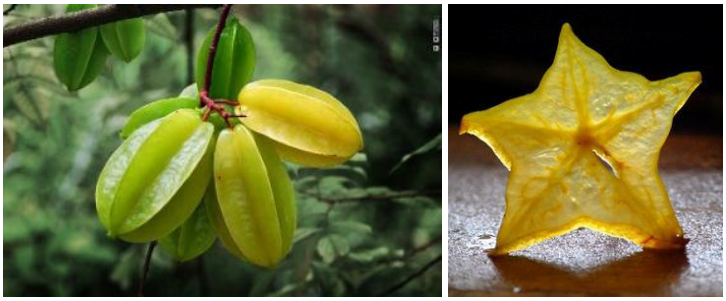

**Fig. 3: *Averrhoa carambola* Fruit**

The fruits are green when small and unripe but turn to yellow or orange when matured and ripe. The fruits are fleshy with an oblong shape, longitudinally 5-6 angled, 5-15 cm long and up to 9cm wide. The fruits are crunchy, having a crisp texture and when cut in cross-section are star shaped, hence its name. The odor of the fruits resembles oxalic acid and their taste varies from very sour to mildly sweetish or sweetish. The flesh is light yellow to yellow, translucent and very juicy without fiber.

**Seeds:** There may be up to 12 flat, thin, 5 mm long seeds or none at all. The brown colored seeds are enclosed by a gelatinous aril and lose viability in a few days after removal from the fruit. Star fruit is easily propagated from fully developed seeds [18-21].

**Microscopic study:** The outline of transverse section shows star shape. The pericarp shows following two distinct regions;

**Exocarp-** It is outermost layer of the fruit made up of thin rectangular cells with

simple & glandular trichomes in young fruits & simple trichomes in mature fruits & 3-4 layers of sub epidermal collenchymas.

**Endocarp-** In young fruit, it is made of many layer of thin compactly arranged parenchymatous cells,in ripe fruit, large lysogenously formed cavities are present in parenchyma, ill developed vascular tissue is also observed in parenchymatous region.

The powdered fruit of *A.carambola* showed the presence of simple trichomes, parenchymatous cells, tannin filled cells, collenchymatous cells, schlerenchuymatous fibers [21].

**CHEMICAL CONSTITUENTS:**

Preliminary phytochemical analysis of carambola fruit showed the presence of saponins,alkaloids,flavonoids and tannins [21]. The fruit was also found to contain proanthocyanidins, epicatechin, gallic acid in gallotannin form and L-ascorbic acid [22]. It was reported that the major sterols present in the fruits of carambola are β-sitosterol, campesterol, lupeol and isofucosterol; it also contained the four major plant fatty acids – palimitic, oleic, linoleic and linolenic acid [23]. Carambola have identified o-glycosyl flavonoid component such as quercetin-3-o-β-d glycoside and rutin. Edible portion of the fruit is a good source of reducing and non-reducing sugars,minerals, volatile favours, tannins, dietary fibers, pectin, cellulose, hemicelluloses, iron, calcium, phosphorous and carotenoid compositions [24].

Other components identified are cyaniding-3-o-β-dglucoside, cyaniding-3-5-o-β-d-diglucoside, β-amirin [25] and C glycoside flavones, such as apigeni-6-C-β-L-fucopyranoside and apigenin-6-C-β-1-fucopyranoside.this latter compound are also known a carambolaflavone [26]. Presence of p-Anisaldehyde,5-hydroxymethyl-2-furfur-al, gallic acid and dihydroabscissic alcohol in the stem bark of *A.carambola* [27].

Moreover, fifteen compounds, which included six chiral lignans and nine phenolic glycosides, were separated from the butanol fraction of *Averrhoa carambola L.* root andmidentified. All of the compounds, namely 3,4,5-trimethoxy-phenol-1-*O*-*β*-*D*-glucopyranoside (**1**), benzyl-1-*O*-*β*-*D*-glucopyranoside (**2**), (+)-5'-methoxyisolariciresinol 3α-*O*-*β*-*D*-glucopy-ranoside(**3**), (+)-isolariciresinol 3α-*O*-*β*-*D*-glucopyranoside (**4**), koaburaside (**5**), (+)-lyoniresinol 3α-*O*-*β*-*D*-glucopyranoside (**6**), (−)-lyoniresinol 3α-*O*-*β*-*D*-glucopyranoside (**7**),(−)-5'-methoxyisolariciresinol 3α-*O*-*β*-*D*-glucopyranoside (**8**), (−)-isolariciresinol 3α-*O*-*β*-*D*-glucopyranoside (**9**), 3,5-dimeth-oxy-4-hydroxyphenyl 1-*O*-*β*-apiofuranosyl (1''→6')-*O*-*β*-*D*-glucopyranoside (**10**), 3,4,5-trimethoxyphenyl 1-*O*-*β*-apiofuranosyl (1'' →6')-β-glucopyranoside (**11**), methoxy-hydroquinone-4-*β*-*D*-glucopyranoside (**12**), (2*S*)-2-*O*-*β*-*D*-glucopyranosyl-2-hydroxy-phenylacetic acid (**13**), 3-hydroxy-4-methoxyphenol1-*O*-*β*-*D*-apiofuranosyl-(1'' →6')-*O*-*β*-*D*-glucopyranoside (**14**) and 4-hydroxy-3-methoxyphenol 1-*O*-*β*-*D*apiofur-anosyl-(1''→6')-*O*-*β*-*D*-glucopyranoside (**15**) were isolated from this plant for the first time [28].

**NUTRITIONAL VALUE OF STAR FRUIT:**

*Averrhoa carambola* is fully packed with vital nutrients. It is a very good source of natural antioxidants like L-ascorbic acid, (-) epicatechin and gallic acid in gallotannin forms [22]. Consuming 100g of this fruit can provide, 35.7g calories, 0.38g proteins, 9.38g carbohydrates, 0.80g-0.90g dietary fibre, 0.8g fat, 4.4-6.0mg calcium, 0.32-1.65mg iron, 15.5-21.0mg phosphorus, 2.35mg potassium, 0.003-0.552mg of carotene, 4.37mg tartaric acid, 9.6mg oxalic acid, 2.2mg α-ketoglutaric acid, 1.32mg citric acid. Moreover, various amino acids like 0.03-0.038mg of thiamine, 0.019-0.03mg of riboflavin, 0.294-0.38mg of niacin, 3mg of tryptophan, 2mg of methionine and 26 mg of lysine are also present in 100 g of the fruit [29].

**TRADITIONAL USES** [30-32]

**Fruits:** In India, the ripe fruits or its juice are used as anti-pyretic, laxative, appetite stimulant, sialogogue, astringent and antiscorbutic. In Brazil, the fruit is recommended as diuretic in kidney and bladder related problems. In Chinese Materia Medica, it is used to quench thirst and to increase the secretion of saliva. In Ayurveda, the ripe fruit is considered as digestive, tonic and causes biliousness. Moreover, the fruits are also used to treat throat inflammation, mouth ulcer, toothache, cough, asthma, hiccups,

indigestion, food poisoning, colic, diarrhea, jaundice, malarial splenomegaly, hemorrhoids, skin rashes, pruritis, sunstroke and some eye related problems. They are used as aphrodisiac for both men and women. In women, the fruits can be used to increase lactation and in large doses, they can act as an emmenagogue.

**Leaves:** The crushed leaves or shoots are externally applied in the treatment of chicken-pox, ringworm and headache. A decoction of boiled leaves is used to relieve aphthous stomatitis and angina. Moreover, the leaves are found to be useful in treating oliguria, boils and pyodermas, postpartum edema, gastroenteritis and traumatic injury.

**Flowers:** The boiled flowers are used as vermifuge, in fever and malaria. In Southeast Asia, the flowers are used in dermatitis.

**Roots:** The roots of *Averrhoa carambola* are used to treat arthralgia, chronic headache, epitaxis and spermatorrhea. The roots with sugar are considered as an antidote for poison.

**Seeds:** A decoction of the crushed seeds acts as a galactagogue and emmenagogue. The powdered seeds are used for asthma and colic.

**Bark:** A preparation of the inner bark with sandalwood and *Alyxia* sp. is applied on prickly heat.

**PHARMACOLOGICAL ACTIVITIES** [33-45]

**Anti-inflammatory:** Sripanidkulchai B. *et al* (2002) reported that *Averrhoa carambola* inhibited carrageenan-induced rat paw inflammation. In a study to evaluate the anti-inflammatory and bactericidal properties of aqueous extract of the stem of *Averrhoa carambola* used for dysuria, it was observed that, intraperitonially, the *Averrhoa carambola* stem extract showed comparable anti-inflammatory effects to that of acetyl salicylic acid at a dose of 300 mg/kg during the first hour and showed stronger activity over a longer duration of time [33].

In another investigation, Cabrini DA. e*t al* (2010) reported that upon topical application of the ethanolic extract of *Averrhoa carambola* leaf and its butanol, ethyl acetate and hexane fractions, croton oil-induced ear edema and cellular migration in mice were both reduced effectively. Topically applied ethanolic extract from *Averrhoa carambola* (0.03-1.0 mg/ear) reduced ear edema in a dose dependent manner with an $ID_{50}$ value of 0.05 (0.02-0.13) mg/ear and a maximum inhibition of 78 ± 5% (at 0.6 mg/ear). Myeloperoxidase (MPO) activity was also inhibited by the ethanolic extract, resulting in a maximum inhibition of 61 ± 16% (at 0.6 mg/ear) and the $ID_{50}$ value was 0.22 (0.08 – 0.60) mg/ear. All the fractions were tested caused inhibition of edema formation and of MPO activity of which the ethyl acetate fraction was the most effective, resulting in inhibition levels of 75 ± 5% and 54 ± 8% for edema formation and MPO activity respectively, which were comparable to that of the reference drug Dexamethasone (DE) at 0.1mg/ear, resulted in an inhibition of edema and MPO activity by 89 ± 5% and 79 ± 4% respectively [34].

**Analgesic:** 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 fail flicking time 60 minute after oral doses of 200 & 400mg/kg body weight respectively [35].

**Hypoglycemic:** Genasekara L.C.A *et al* (2011) studied the hypoglycemic effect of *Averrhoa carambola* ripe fruit pulp significantly decreased the blood glucose levels (mean131.0+_10.2mg/dl) after a treatment period of 8 weeks in healthy male Sprague dawley rats compared to that of normal rats(blood glucose level mean153.4+_ 11.2mg/md) [37]. Chau *et al* (2004) reported that several insoluble fiber rich fractions(FRFs)including insoluble dietary fibers, alcohol insoluble solid and water insoluble solid (46.0-58.2g/100g of panace) isolated from the pomace of *Averrhoa carambola* possessed potential hypoglycaemic effects as demonstrated by a study on general *in-vitro* methods. The apparentabilities of these FRFs to absorb

glucose, retard glucose diffusion, postpone the release of glucose from starch and reduce amylase activity implied that they might help in controlling post prandial serum glucose level [37].

**Anthelmintic:** 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 [38].

**Anti-ulcer:** 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 ;at doses 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 effects [39].

**Hypotensive**: Soncini R.*et al* (2011) investigated the hypotensive effect of aqueous extract of *Averrhoa carambola*(AEAc) leaves and its underlying mechanisms in the isolated aorta of rat. The effect of aqueous extract of *Averrhoa carambola* leaves on the mean arterial pressure (MAP) was determined *in vivo* in anesthetized rats. *In vitro*, thoracic aortic rings were isolated and the effects of AEAc were studied by means of isometric tension recording experiments. The study showed that the AEAc (12.5-50.0 mg/kg i.v.) induced dose dependent hypotension in normotensive rats. *In-vitro*, AEAc caused a depression in the E(max)response to phenyl ephrine without a change in sensibility. Also in a depolarized a Ca (2+) free medium, AEAc inhibited CaCl(2) induced contraction and these effects may be due to the inhibition of Ca (2+) [40].

**Anti-Oxidant**: 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 $110^0$ C [42].

**Hypocholesterolaemic & Hypolipidemic activity:** 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 faceces [43].

**Antimicrobial:** 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 [33].

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 auriginosa, Salmonella typhi, S. paratyphi* etc.) and fungi (*Candida albicans, Aspergillus*

*niger*). The average zone of inhibition produced by produced by the petroleum ether, carbon tetrachloride and chloroform soluble fractions of the methanol extract at a concentration of 400µg/disc were found to be 8-12mm, 8-12mm and 8-15mm respectively.

The degree of lethality was also calculated by brine shrimps method and the $LC_{50}$ values were found to be 0.32, 0.70, 0.06 and 3.14 µg/ml for standard vincristine sulphate, petroleum ether, and carbon tetrachloride and chloroform soluble fractions respectively. The degree of lethality was directly proportional to the concentration of the extract ranging from the lowest concentration (0.78125 µg/ml) to the highest concentration (400 µg/ml) while the carbon tetrachloride soluble fraction of the methanolic extract exhibited most promising activity [44].

**Anti-tumour:** Lastly, selective activity against brain tumor cells was observed with an alcoholic extract from the stems of *A. carambola*, while an extract from the leaves was effective against liver carcinoma cells [45].

**DRUG INTERACTION**

Zhang *et al*. (2007) reported the inhibitory effects of star fruit (*Averrhoa carambola*) juice in Human Liver Microsomes (HLMs). The study was conducted on the inhibitory effects of star fruit towards seven CYP isoforms (CYP1A2, CYP2A6, CYP2D6, CYP2C8, CYP2C9, CYP2E1 and CYP3A4) and it was found that CYP2A6 was more potently inhibited than other isoforms by star fruit [46].

Hidaka M. *et al* (2004) reported that star fruit juice inhibited the midazolam 1′-hydroxylase activity and the juice was found to be the most potent inhibitor of human CYP3A activity [47]. *In vivo* evidence also suggested that star fruit juice inhibited the activity of CYP3A in rats [48].

**CONTRAINDICATION:** In acute inflammation in the urinary tract, as star fruit juice contains oxalates which can cause acute oxalate nephropathy [49].

**DRUG TOXICITY**: Muir CK. and Lam CK. first reported the toxicity of star fruit in 1980. Their study showed that the fruit extracts in doses exceeding 8g/kg produced convulsions in mice when injected into the peritoneal cavity [50].

Martin *et al.* (1993) reported the first toxic effect of *Averrhoa carambola* to human in a case study where an intractable hiccup occurred in eight patients with regular hemodialysis program after ingestion of *Averrhoa carambola* fruit [51]. The hiccups occurring in patients on dialysis after ingestion of *Averrhoa carambola* fruit had not seen a threat until 1998.

But, Neto *et al*. (1998) reported that six uremic patients in a dialysis program who were apparently intoxicated after ingestion of 2-3 fruits or an equivalent of 150-200 ml of the fruit juice. Those six patients developed a variety of manifestation that ranged from hiccups, nausea, insomnia, agitation, mental confusion and one case of death due to seizure and hypotension. Neto et al. (1998) investigated to characterize the hypothetical neurotoxin in the fruit, an extract when injected in rats, provoked persistent convulsions [52].

Further, Carolina *et al.(*2005) conducted a study in chromatographic isolation of the convulsant fraction from the aqueous extract of the star fruit. The effects of the neurotoxin fraction AcTx given to experimental animals (rats and mice) showed behavioral changes acting on G-amino butyric acid (GABA) receptors. These excitatory neurotoxins, probably GABAergic antagonists, may be responsible for seizures in renal patients and animal models [53, 54].

Chang *et al*. (2000) investigated the *Averrhoa carambola* intoxication on twenty patients, among them 19 patients were uremic hemodialysis and one patient had advanced chronic renal failure without dialysis. According to their report, eight patients including the patient with advanced renal failure did not survive despite of hemodialysis interventation. They concluded that *Averrhoa carambola* fruit ingestion by patients with renal failure will cause high mortality even after dialysis. There is no report of star fruit toxicity in people with normal renal function [55].

Neto *et al*. (2003) studied the largest group of star fruit intoxication where the neurological symptoms following star fruit ingestion were exhibited by 32 uremic

patients. The neurotoxic effects of star fruit were classified into mild, moderate and severe intoxication depending on severity of symptoms and the onset of symptoms ranged from 30 minutes to 6 hours. It was reported that, all the patients who were promptly and properly treated with hemodialysis got recovered but those represented severe intoxication that were not treated or treated with peritoneal dialysis or by late dialysis, did not survive [56].

Vasoconcelos *et al*. (2006) reported that an aqueous extract of *Averrhoa carambola* leaves induced some electrophysiological changes in a normal guineapig heart. In six rats, the extract induced many kinds of atrio-ventricular blocks (1st, 2nd and 3rd degrees); increased the QT interval; increased the QRS complex duration and depressed the cardiac rate [57].

**CONCLUSION**

In spite of the many impressive accomplishment of western medical science, the typically fragmented approach of modern allopathic medicine has not been able to cope with the growing array of chronic degenerative environmental, lifestyle and personal stress-related disorders that plague modern society. A significant complementary role is emerging for traditional herbal medicines and holistic approaches to health in the prevention and treatment of the passive illness of modern civilization. Recognizing the importance of broadening western medical perspective, the World Health Organization has recommended that traditional health and folk medicine systems be integrated with modern medical therapies to more effectively address health problems worldwide.

*Averrhoa carambola L.* fruit is widely distributed throughout India. The plant appears to have a broad spectrum of activity on several ailments. The phytoconstituents are reported to be present in the plant are mainly flavonoids, alkaloids, tannins and saponins, which are responsible for the actions. Various parts of the plant have been explored, antioxidant activity, analgesic activity, anti inflammatory activity, hypoglycemic activity, hepatoprotective activity, antimicrobial activity and anti-ulcer activity. .So from the current review of literature and ayurvedic text it can be concluded that the plant is having high medicinal value and it may thus be considered an important gift from nature to mankind.

Several phyto-chemical studies have reported but still it needs to be progressed. Further investigations are needed to explore individual bioactive compounds responsible for these pharmacological effects and the mode of actions. However, less information is available regarding the clinical study, toxicity study, phyto-analytical studies of this plant. With the availability of primary information, further studies can be carried out such as phyto-analytical studies, clinical trials, toxicity evaluation and safety assessments. The plant is pre-clinically evaluated to some extent; if these claims are scientifically and clinically evaluated then it can provide good remedies and help mankind in various ailments.

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