

Phytochemistry and medicinal uses of underutilized tree *Garcinia indica*: A detailed review

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Abstract

Garcinia indica belongs to the Clusiaceae family commonly known as Kokum, is a tropical fruit native to India around 200 species are present. It does not require spraying, irrigation or fertilizers. The *Garcinia indica* tree has great health benefits that are from the fruits which is highly enriched in polyisoprenylated benzophenone derivatives such as Garcinol that a yellow, fat soluble pigment and contain isogarcinol which is its colorless isomer. Garcinol possess anti-oxidative, chelating, anti-inflammatory, free radical scavenging, anti-ulcer and anticancer activities. The fruit contains compounds including hydroxycitric acid lactones, citric acid and oxalic acid. Its oil can be freeze and used as butter. Kokum seed butter is non-greasy that's why used in many creams, cosmetics, soaps and conditioners. Amrut kokum is sugary syrup of kokum fruit, which is a strong soft drink to reduce thirst that is very popular throughout the summer season. Kokum is loaded with B complex, minerals and vitamins which help to control blood pressure and heart rate. This is versatile golden fruit helps to fight for health problems such as acidity, flatulence, constipation.

Key words: Clusiaceae, Garcinol, Kokum, Vitamins, Constipation

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1. Introduction

Garcinia indica is a plant commonly known as kokum, belongs to mangosteen family (*Clusiaceae*). It is a small, evergreen, fruit-bearing tree commonly present to the west coast of India. It has many applications in culinary, industrial and pharmaceutical industry. The genus *Garcinia* is native to Asia, tropical and southern Africa, Australia, and Polynesia. Generally, the plants in this genus are called mangosteens (which may also refer specifically to the purple mangosteen, *G.mangostana*), saptrees, garcinias or, ambiguously, "monkey fruit". Almost 200 species are present in *Garcinia* that are widely present in Asia. *Garcinia indica* is just one of the most important plant of this genus which inhabitant to regions in Asia, southern and tropical Africa, Australia and Polynesia. These plants exist in forests that are evergreen, while these plants also grow in areas where rainfall is low. On a small scale its cultivation occurs [1]. *Garcinia indica* has eleven types of flowers and is dioecious. Cross pollination usually occurred in this plant. Generally trees are either male or female but bisexual types [2]. *Garcinia indica* is known by different names throughout the world depending upon the location. *Garcinia indica* is generally called tallow tree in English, in

Konkani and Marathi it is called birand, in Portuguese and Goa it is called as brindon, murugalu (in Kannada), and in Malayalam it is called punarpuli. In India it is called Kokam, kokum, rutambi, other common names of kokum are gharikinia indyka (in Arabic), cocum in French, Italy and Germany and murgala, kannada, kokan in gujrat. Kokum is popularly known as Red Mango, Wild Mangosteen tree, Brindonia tallow tree, Malabar Tamarind tree, Indian butter tree. The essential oil content of kokum is variable between species and cultivars and is thought to be related to growing conditions, geographic origins, genetic factors, different chemotypes and differences in the nutritional status of plants. The majority of the essential oil of kokum is concentrated in the leaves and flowers; there are small amounts of essential oils in the branches and stems, but the quantities are not commercially significant. This plant particularly used for flavours, aromas and medical purposes.

2. History/Origin

Thousands of years back, the people of India first discovered it in Mumbai and then used this beautiful ornamental fruit tree for an array of needs and wants. Kokum has always been integral to these people and used in the historic practice of Ayurvedic medicine. Kokum is

belong to the Western Ghats of India, has a great contribution in the country's history for centuries. Subcontinent of Southeast Asia is still famous for recognition of kokum fruits, while a few kokum butter-based cosmetic products have begun to emerge in the worldwide markets.

3. Location

Garcinia indica is commonly native to India. Kokum (*Garcinia indica*) is an important original tree crops originated and grown in South Konkan region of Maharashtra, Coorg, Wynad Western Ghats of India, and Goa. It is distributed throughout North & south Karnataka, Goa, North Malabar, in West Bengal and Assam as well as in Coorg & Wynad. It is and rodioecious tree having bisexual flowers. The Kokum tree bears drought circumstances and water-logged conditions. It grows very well alongside bank of rivers. For cultivation of Kokum, moderate moist zones are most favorable. Although kokum is grown in a variety of climatic and environmental conditions, the optimum conditions are found in countries with a warm climate. Warmth, light and moisture are the key ecological requirements for kokum cultivation. *Garcinia indica* tree is susceptible to frost so outdoor cultivation is restricted to frost-free regions of the world. It is mainly present world widely in North America, Middle East and Africa, Latin America, Eastern Europe, Western Europe and Asia-Pacific. In local markets, Asia Pacific is the leading producer of kokum followed by Africa. India is the leading manufacturer of kokum across the globe [3].

4. Botany, Morphology, Ecology

Kokum species contains eleven types of flowers and usually dioecious, that is classified into staminate, pistillate and hermaphrodite. These feature are responsible for successive natural heterogeneous population of kokum and for cross pollination. In addition to this, heterozygosity results in the the sexual mode of propagation (population is of seedling origin) in the genetic makeup of trees. These features are responsible for each and every individual tree to be different from each other [2]. After 7 to 8 years of planting the seedlings start flowering whereas grafted plants starts flowering after 3-4 years. Normally kokum plant starts flowering during December to February depending on the climatic conditions. In coastal areas, it flowers in November -December while it flowers in January - February in the hilly regions. Flowers are tetramerous or born as fascicular cymes or singly on axils of leaves. Total duration about 30 days is required from the appearance of flower bud to the start of flowering. Fruit setting starts after 120 days. Harvesting time for this plant is in May and June. At the time harvesting of all kokum fruits on trees is not possible and that's why regular plucking is usually made. Kokum is a small, slender, evergreen tree reaching to a height of 10-15 metres with spreading branches; young leaves are red; while mature leaves on the top surface are dark green in colour

and in the lower surface are pale in colour. Generally trees are either male or female but bisexual types. Flowers can be terminal or axillary, exist either as spreading fascicles or in solitary form. Slightly beyond the sepals, four thick petals extend in length. The kokum fruit is a berry, 2.5-3.8 cm in diameter. Spherical or globose in shape but not furrowed and purple or red when ripe and encases 5 to 8 seeds that are compressed and embedded in pulp. Leaves are elliptic, rounded, lanceolate, narrowed at base, sharp or abruptly acuminate [4].

5. Chemistry

Kokum contains the following main chemical component such as anthocyanins, kokum butter, garcinol and hydroxycitric acid. Hydroxycitric acid (HCA) has attained so much attention in recent years for its vital role in fat/lipid metabolism, with its implications in weight loss activity. Kokum contains about 2 to 3 % of red colour pigment. Anthocyanins of kokum are water soluble and possess antioxidant activity. Some types of sugars associated with *Garcinia indica* are glucose and xylose. Thus, the extract of kokum contains water, pigment and sugars.

5.1. Chemical composition

The kokum fruit consists of different constituents such as crude fat, ash contents, crude fibre, carbohydrates, starch, pigments, pectin, ascorbic acid and hydroxyl citric acid etc. [5]. However, these are varies with different season [6]. In a research, leaves of kokum were reported to contain L-leucine, fat 0.5g, carbohydrates 17.2g, fiber 1.24g, protein 2.3g, calcium 250mg, 75% moisture [7].

5.2. Phytochemistry

Phytochemical studies are usually carried out by GC-MS analysis [8-10]. It was studies revealed that when any other natural sources are compared with kokum, anthocyanins are present in highest concentration in rind of kokum (2.4 g/100 g of kokum fruit). The major pigment present in kokum are anthocyanins [11]. Iso garcinol and two poly iso prenylated phenolics garcinol are present in the outer rind. Studies have revealed that the major organic acid is hydroxycitric acid present in leaves and outer skin of kokum. This compound is responsible for the good taste of kokum and respectively in leaves and fruits; it is present to the amount of 4.1–4.6 and 10.3–12.7%. In minor quantities, the plant also contains hydroxyl citric acid and lactone.

Table 1: Composition of Fat

COMPOSITION OF FAT	% BY WEIGHT
Stearic acid	56.5
Palmitic acid	2.5
Olein acid	39.4
Linoleic acid	1.7

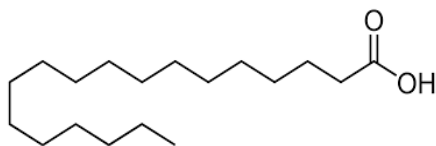


Fig.1. Structure of stearic acid



Fig.2. Structure of Palmitic acid

6. Post-harvest technology

Garcinia indica fruit harvested during the month of April and May. The collected rinds and seeds are separated and dried under the sun [12]. For the future use by households, dried rinds are stored, while remaining part is sold to industries. Seeds are preserved and by boiling seeds with water oil is extracted. Whole plants or chopped leaves can be stored frozen, with and without oils, to be used for extended periods of time beyond the fresh shelf life. Alternative traditional methods for preserving kokum leaves include storage in salt and in the form of oil concentrates.

7. Processing

Kokum, like other herbal plants, is consumed in a variety of ways and for various purposes. In addition to the use of fresh leaves, other common processed forms of kokum include whole dry leaves, frozen or powdered leaves, and extracted essential oils. The manufacturing process is simple and standardised. The fully ripe and fresh kokum fruits are cleaned and cut into two pieces and seeds are isolated. Then along with sugar, these pieces are kept in translucent glass jars and jars are kept under sunshine for about 8-10 days. With the melting of sugar, juice is naturally extracted from fruits and with the period of time syrup is formed. This syrup is filtered and before packing some preservatives is added into 1 litres capacity plastic jars. Around 35 ltrs of syrup is made from 100 kgs of fruits of kokum. The remaining ingredients are wasted. Kokum is also processed to make butter which is usually pure whitish in colour. Kokum seeds are gathered from various wild sources and cleaned in order to remove dust, dirt and foreign matter. These seeds are dried in the sun to remove excess moisture. Dry seeds are then hulled to expose kernels and shells. These go through a process of winnowing to retain kernels whereas seed shells are discarded. Clean Kokum are boiled/ heated and sent to the oil expeller to obtain Kokum oil. Crude Kokum oil is heated to remove traces of moisture by heating/ boiling the oil. This hot Kokum oil is then physically filtered twice to remove scum, floating debris and heavier impurities. After filtration, this pure oil is transferred in 20 kg cube sized containers to become cool and solidify. These cubes then packed boxes.

8. Value addition

Crop of kokum is an economically important crop. The consequence of this activity provides employment

opportunities in the rural area and on the other hand develops suitable products for earning the foreign exchange through the export of kokum derivatives. The antioxidant and medicinal properties of kokum butter and flowers are highly renowned and very helpful in cosmetic application. Due to this reason various pharmaceutical industries have been shown devoted interest in kokum and its derivatives. India is the only country enjoying the domination with respect to kokum production in the world. Kokum has a lot of the processing value. The different value added products are prepared from the processing of kokum e.g. kokum sarbat, kokum solkadhi, agal, amsul, butter etc. The kokum and its derivatives, such as dried rind powder, sarbat, solkadhi, and butter from seed are considered as wealthy sources of many high qualities with possible advantageous physiological activities. Kokum has a rich bioactive profile which makes it highly healthful and popular fruit crop.

9. Uses

Many herbs and spices contribute significantly to health inspite of their less amount of consumption, because they are full of antioxidants [13-14] and many mineral compounds. Kokum has great culinary as well as medicinal uses. Kokum has minerals like magnesium, potassium, and manganese and manage blood pressure, heart rate, give protection against heart disorders. That multipurpose kokum is used to fight for health problems such as flatulence, acidity, indigestion and constipation. It has popularity as a refreshing cold drink.

9.1. General uses

Garcinia indica has many uses in all aspects of life. It has medicinal, culinary and industrial uses. It is actually a very beneficial fruit with a lot of health benefits. Clear-red sugary syrup is made when kokam fresh fruit is mixed with it that is preserved in bottle. This sugary syrup is mixed with water to make a refreshing drink. In cuisine it is used as a staple souring agent. Kokum yields blackish red colour and a strange flavor. As a substitute to tamarind kokum is used as a souring agent. It is also used in cuisine in South India, and gives tartness and flavour to dal (lentil soup) for flavor balance. Kokum fat is utilized in confectionary preparation. It is utilized in production of soaps, ointments and candles. Amsul, the unsalted kokum as well as salted kokum is prepared in different industries. Khane or edible Kokum Lonavala Kukam, Khoba Kokum and Pakali Kokam are among the varieties that are prepared industrially and well traded. Kokum has traditional medicinal uses. Kokum fruits contain high amounts of anti-oxidants that bind with free radicals and prevent oxidative damage to body cells. They also promote cell regeneration and repair. As a demanding skin moisturizer, kokum butter is gaining popularity than cocoa butter. Kokum rind can be applied to cure skin lesions and on wounds due to its relaxing and therapeutic properties. Kokum butter can be used as edible oil because it is rich in healthy fats such as oleic acids and stearic acid,

especially in confectionary. Gastric problems like flatulence, acidity, indigestion and constipation are cured by kokum fruit extracts. In comparison to commercial bottled drinks kokum juice is far more refreshing and healthier one. Anti-helminthic properties are also present in it and also act as stimulant of craving. Kokum infusions are used in Ayurvedic medicine to treat dysentery, piles and infections. Cardio-vascular system is strengthened by kokum and function of liver is stabilized by it. Hydroxycitric acid is present in fruit that beats lipogenesis effect and lowers cholesterol level, so give a helping hand for weight loss. Hydroxycitric acid is present in kokum used to minimize cholesterol level. It is used to prevent obesity because it minimizes the production of lipogenesis, food consumption and fatty acids and weight loss occurs. To avoid loss of nutrients and dehydration, powder of kokum rind is used. Also improve appetite and digestion, reduce constipation, cleans blood and fight infections, control the cardiovascular system, and minimize burning sensations that happens in all over the body. The rind of kokum fruit has powerful anti-ulcer and anti-cancer properties. Kokum oil and paste are used for skin problems and healing of wounds [15].

9.2. Pharmacological uses

Aromatic plant has very significant antioxidant properties [16-17]. Research has shown the oil contains strong anticancer, antimicrobial and antiviral compounds [18-19]. Similarly kokum oil also shows these properties. Antioxidants are important for maintaining a balanced and healthy lifestyle [20]. The nutritional and pharmacological properties of the whole kokum in natural form, as it has been traditionally used, results from the interaction of many different active phytochemicals.

9.2.1. Antioxidant activity

Antioxidant properties of plant are due to the presence of phenolic or flavonoid components [14]. The unique health benefits of kokum are primarily due to its very high antioxidant content. Free radical scavenging and antioxidant activity is shown by hot aqueous extract of Kokum, concentrated marketed syrup. By using β -carotene linoleate assay and DPPH assay, free radical scavenging property of chloroform extract of Kokam rind was investigated by scientist. Extract of Kokam fruit containing methanol exhibited strong antioxidant activities as compared to standard ascorbic acid. The presence of chloroform in kokum is responsible for its pigmentation. All of the cultivars of kokum contain very high antioxidant activity. Scavenging activity of superoxide anion in *Garcinia indica* is showed by garcinol [21].

9.2.2. Anti-neoplastic activity

Acting to prevent, inhibit or halt the development of a neoplasm (a tumor) is called antineoplastic activity. For example, oxaliplatin (Eloxatin) is an antineoplastic used in the treatment of metastatic colon cancer. The term is applicable to dozens of other chemotherapy agents used to

treat this and other forms of cancer. In case of kokum, Garcim-1, garcinol and its derivatives, garcim-2, cambogin has a strong growth restricted effects in normal immortalized intestinal cell and on the neoplastic colon cancer cells.

9.2.3. Anti-fungal activity

Pathogenic fungi are the main infectious agents in plants, causing alterations during developmental stages including post-harvest. In fruit and vegetables, there is a wide variety of fungal genera causing quality problems related to aspect, nutritional value, organoleptic characteristics, and limited shelf life. In addition, in some cases fungi are indirectly responsible for allergic or toxic disorders among consumers because of the production of mycotoxins or allergens [13]. Antifungal activity of kokum rind aqueous extract against *Candida albicans* and *Penicillium* was investigated by some researcher. Chloroform containing rind extracts of kokum repressed the aflatoxin production and growth of *Aspergillus flavus* [22]

9.2.4. Anti-bacterial activity

Kokum rind extract containing hexane, benzene and garcinol exhibit potent activity against bacteria. Inhibitory action against disease causing bacteria like *Salmonella paratyphi* A, *Salmonella typhimurium* and *Salmonella typhi* was observed to be possessed by kokum leaf extract. Against *Bacillus subtilis* maximum antibacterial activity, followed by *Escherichia coli* was expressed by aqueous kokum rind extract.

9.2.5. Anti-inflammatory activity

A protective process is acute inflammation that assists the body in dealing with infections, tissue injury and immune reactions. It is not unexpected that kokum has being used traditionally for centuries to effectively cure inflammatory diseases. *Garcinia indica* fruits contain active constituents like anthocyanins and phyto poly compounds. Polyphenols and anthocyanin which are potent antioxidants are beneficial for their anti-inflammatory activity.

9.2.6. Anti-ulcer activity

Different scientist reported the ulcer protective effect of ethanolic and aqueous extract of *Garcinia indica* fruit rind. The aqueous and ethanolic extract of *Garcinia indica* were investigated for ulcer protective activity against HCl/ethanol induced gastric lesion and indomethacin induced ulcerogenesis. Garcinol on oral administration influentially reduced gastric ulcers induced by water immersion and indomethacin [23]

9.2.8. Neuroprotective Effects

Neuroprotection refers to the relative preservation of neuronal structure and/or function of these mechanisms; neuroprotective treatments often target oxidative stress and excitotoxicity, both of which are highly associated with central nervous system (CNS) disorders. Against 6-OHDA, extract of kokum fruit which contain methanol showed considerable potential neuroprotection, so

its antiparkinson's activity was observed in rats. Neurite outgrowth is prevented by Cyanidin-3-glucoside and neuro filament proteins expression representing its potential for neuro protection. The major component of *Garcinia* is garcinol also minimize the LPS induced anti-inflammatory mediators expression. Anti-cholinesterase property is also exhibited by garcinia [24].

9.2.9. Anti-ageing activity

Due to UV light absorbing properties of kokum plant, different pigments present in kokum are beneficial for skin care and helpful in all skin disorders. Kokum showed activities against elastase and hyaluronidase activities that are beneficial for skin treatment [25].

10. Summary

Garcinia indica, belongs to the Clusiaceae family commonly known as Kokum, is a tropical fruit native to India around 200 species are present. It does not require spraying, irrigation or fertilizers. The *Garcinia indica* tree has great health benefits that are from the fruits which is highly enriched in polyisoprenylated benzophenone derivatives such as Garcinol that a yellow, fat soluble pigment and contain isogarcinol which is its colourless isomer. Garcinol possess anti-oxidative, chelating, anti-inflammatory, free radical scavenging, anti-ulcer and anticancer activities. The fruit contains other compounds including hydroxycitric acid lactones, citric acid and oxalic acid. Its oil can be freeze and used as butter. Kokum seed butter is non-greasy that's why used in many creams, cosmetics, soaps and conditioners. Amrut kokum is sugary syrup of kokum fruit, which is a strong soft drink to reduce thirst that is very popular throughout the summer season. Kokum is loaded with B complex, minerals and vitamins which help to control blood pressure and heart rate. This is versatile golden fruit helps to fight for health problems such as acidity, flatulence, constipation.

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