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Review of Pharmacological and Phytochemical properties of *Garcinia indica*

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ABSTRACT

Kokum (Garcinia indica) is an ancient fruit which is widely consumed in the form of sarbat in a western ghat of India. Kokum is a fruit tree of culinary, pharmaceutical, nutraceutical uses. Kokum has a long history in Ayurvedic medicine as it was traditionally used for treatment of different health related problems like sores, dermatitis, diarrhea, dysentery, ear infection and to facilitate digestion. Kokum seeds are used for oil extraction. Kokum fruit has an antioxidant, acidulant and appetite stimulant properties that helps to fight against cancer, paralysis, ageing, obesity, ulcer etc. Kokum fruit is a good digestive tonic and used to overcome the skin related problems. It is also used for the preparation of the products like Kokum syrup, Sharbat, Butter, Aamsul, beverages. The aim of this paper was to present an overview of the nutritional value, health benefits, traditional uses and its application in food industry.

Keywords:

Anthocyanin, Garcinol, Hydroxycitric acid (HCA), Kokum (Garcinia indica).

INTRODUCTION

Kokum (Garcinia indica Choisy) is one of the important indigenous tree spice crops originated and grown in Western Ghats of India, South Konkan region of Maharashtra, Coorg, Wynad and Goa and is found in evergreen and semi evergreen forests and as a home garden tree.(1) It is mostly found in the western peninsular coastal regions and the adjoining Western Ghats in the state of Maharashtra, Goa, Karnataka and Kerala as well as parts of Eastern India in the states of West Bengal, Assam and North Eastern Hill region, but is today found growing in other parts of peninsular India.(2) Kokum is a slender but very sturdy evergreen tree and does not need elaborate irrigation or use of fertilizers, pesticides or herbicides. Kokum trees are generally found growing in the riversides, forests, wastelands. Plantlets can also be generated by adventitious bud differentiation on mature seeds and by in vitro propagation (Nayak et al.,2010). It is an under exploited tree and generally known as Kokum tree, Wild mangosteen and Goa butter tree .(2) The locally Kokum has different names such as, Kokum in Hindi, while bheranda, bhiranda, kokamba, kokambi, ratamba, ratambi, tambada amba in Marathi. In Tamil it is known as murgal, murgal-mara and in Malayalam it is known as kaattampi kokkam, in Kannada it is called murgina, punarpuli, devana huli. Tintali in Oriya and Kokum or bhirind in Gujarati and Konkani. In Sanskrit it is known with different names such as vrikshamia, amlabija, amlapura, amlashaka. (3)

Fruit kokum, rind and seed have many applications such as culinary, foods, fruit drinks, pharmaceuticals and industrial.(1) 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.(4) Garcinia indica or Kokum is known to be a rich source of anthocyanin. Cyanidin-3-glucoside and cyanidin-3-sambubioside are the major pigments present in kokum, and is reported to occur in the ratio of 4:1 [4] . Garcinia indica, is an indigenous, endemic and underutilized perennial medicinal fruit tree.(5) Garcinia species out of 350 species estimated worldwide (Whitemore, 1g73; Stevens, 2001). InIndia, 30 species were reported by T.Anderson in Flora of British India (1824) and subsequently, Sharma & Sanjappa (1gg3) included 35 species in the Flora of India.Among the 35 species reported by Mahesh-wari (1964), 15 species are shown to be found in the North-East India. Kanjilal et al. (1984-40) reported 9 species from undivided Assam.Kar et al. (2008) reported 8 species from the Sonitpur district of Assam. The members of the genus Garcinia L. are potential, highvalue medicinal plants and have anti-microbial activity (Anonymous 2002).

G. indica is an important medicinal plant distributed mainly in peninsular India(Sutar et al. 20L2). The rind of the fruit contains Hydroxy Citric Acid (HCA), garcinol and the colouring pigment anthocyanin. HCA, which is claimed to have fat-reducing properties, is often used to reduce obesity(Lopes 2007). The plant has been mentioned in Ayurveda for treatment of liver disorders,dysentery, sunstroke, cancer and heart diseases etc. (Deorc et q.t. 2o]l)" Garcinia' species are commonly known as "Thelzera" by Assamese people in Assam and have rich

traditional uses (Baruah & Borthakur 2012).(6)

fig no 1- kokum (*Garcinia indica*) fruit

1.2 TAXONOMIC CLASSIFICATION

Domain – Eukaryote
Kingdom – Plantae
Subkingdom- Tracheobionta- Vascular plants
Class- Manoliopsida
Sub division – Spermatophyta -Seed plants
Order- Malpighiales
Family- Clusiaceae – Mangosteen family
Genous- *Garcinia*
Species- *G.indica* choisy

2.Geographical distribution

Kokum (Garcinia indica) is also known by different English names such as wild mangosteen or red mango. In India, it is known by names such as Bindin, Biran, Bhirand, Bhinda, Katambi, Punarpuli, Ratamba or Amsool.(7) The tropical humid rainforests of Western Ghats in South India is the predominant place for growth of Garcinia indica with elevation of around 800 meters. It is a slender tree with drooping branches. November to February gokumis
flowering and from April to May ripening occurs. About 30 to 50 kg of fruit can be obtained
after 15 years properly cared single plant. The ripe Kokum fruit is red or dark purple colored
containing 3-8 large seeds. The diameter of the spherical gokum fruit is 2.5 to 3.0 cm.(8)

3. Chemical Composition of Kokum

Kokum rind contains three important chemical constituents' viz, Garcinol, Hydroxycitric acid and anthocyanin pigment. Garcinol is a fat soluble yellow pigment; Hydroxycitric acid is used as an acidulant and physiologically active compound has been shown to significantly reduce body weight. Chemical composition of the kokum fruit is mentioned in Table 2.

3.1 Garcinol

Garcinol is a polyisoprenylated benzophenone derivative and contains phenolic hydroxyl groups. This makes it active antioxidant. It is also called as camboginol, a triisoprenylated chalcone. It has β-diketone moiety and thus resembles a known antioxidant viz. curcumin (Pan et al., 2001). Molecular weight of Garcinol is 602 ($C_{38}H_{50}O_6$) and its melting point is 122°C (Nayak et al., 2010). It is crystallized out from hexane extract of the fruit rind. The absorption
spectral data and molecular formula indicate relation to isomeric xanthochymol and in terms of optical rotation to cambogin. The 1, 3-diketone systems is enolisable since presence of two isomeric trimethyl ethers. The UV spectrum of garcinol shows that 1, a 3-diketone system is conjugated to the 3, 4-dihydroxybenzoyl moiety. The IR spectrum of trimethyl ethers shows there is presence of saturated carbonyl group and two α, β-unsaturated carbonyl groups. Some features of the garcinol molecule indicate it can be derivable from Maclurin (2,4,6,3',4'- pentahydroxybenzophenone) and five isoprenyl units (Padhye et al., 2009). The general structure of garcinol is shown in Fig 2.

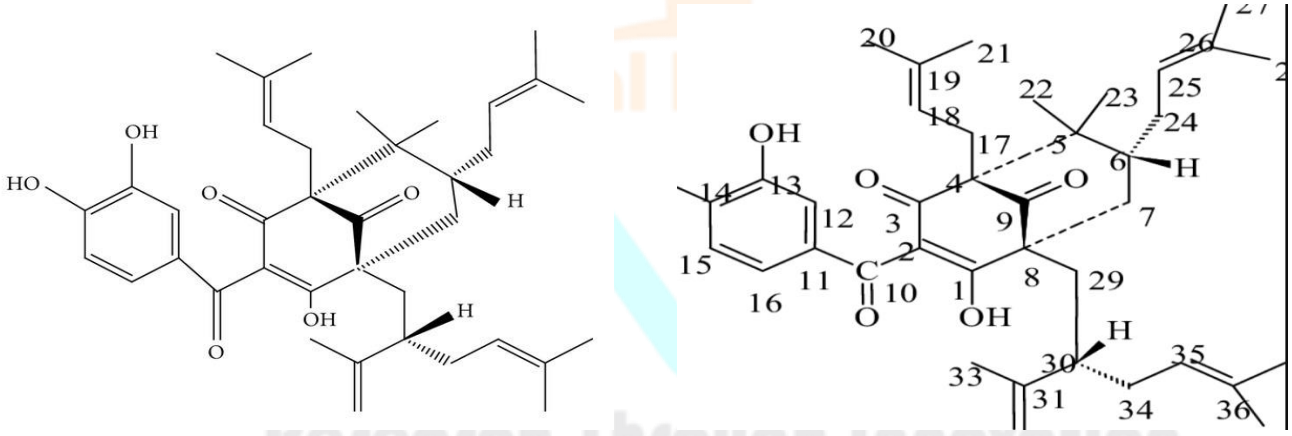

fig 2.struture of garcinol

3.2 Hydroxy citric Acid (HCA)

Hydroxy citric acid (HCA) is mainly found in the fruit. It is also known as garcinia acid and has a large number of commercial applications. It is shown that HCA can inhibit ATP-citrate lyase (EC 4.1.3.8 an important enzyme in Kreb's Cycle) which is needed for conversion of carbohydrates into fat. [41] HCA have been extensively studied for its unique regulatory effect on fatty acid synthesis, lipogenesis, appetite, and weight loss. [41,49] HCA consumption was reported to enhance fat mobilization and fat burn-ing. [50] The HCA is used as an ingredient in anti-obesity formulations. The derivativesof HCA have been incorporated

into a wide range of pharmaceutical preparations forclaimed purpose of enhancing weight loss, cardio protection, and endurance in exercise.HCA comprises of citric acid with a hydroxyl group at the second carbon. [51] HCA canbe determined by HPLC or by titration method. The major organic acid in leaves andrinds are found to be HCA, which is in the range of 4.1–4.6 and 10.3–12.7%, respec-tively. Minor quantities of hydroxycitric acid lactone and citric acid are also presentalong with the HCA. [52]
A process for large-scale isolation of HCA was demonstrated by Ibrahim and co-workers [53] from the fresh/dried rinds of Garcinia indica, Garcinia combogia and Garcinia atorvirdis. The dry rinds of the fruit were sliced and soaked in boiling water for about 20 h. The aqueous sodium hydroxide was added to the extract at around 80°C. Methanol was added to the extract until two layers are formed. The lower layer contained the sodium salt of HCA, which was separated and neutralized by hydrochloric acid. Further, acetone was added to filtrate to obtain pure crystals of HCA.
Athermal process of obtaining concentrated HCA using osmotic membrane distillation (OMD) was employed by Anandaramakrishnan and coworkers. [54] Garcinia extract were extracted from Garcinia fruit rinds with deionized water. The extract was subjected to concentrate using OMD in a co-current flat membrane module using micro porous hydrophobic polypropylene membrane. HCA was concentrated from 6.0–62°Brix, with-out any formation of HCA lactone in this process. This process involves no phase change and can be operated at ambient temperature and pressure and hence no thermal damage of the desired product takes place.(9)

3.3 Anthocyanins

The two major anthocyanin pigments found in Kokum are characterized as cyanidin-3-glucoside and cyanidin-3-sambubioside. They have been identified by thin layer chromatography as well as HPLC, mass and NMR spectroscopy [5,9]. Anthocyanins constitute approxi-mately 2.4% of the total fruit biomass. These pigments can scavenge free radicals and are water soluble. They can be extracted from the fruit rind by hydraulic press using 1% acidified water as a solvent [5]. The monomeric anthocyanins in Kokum can be measured using
pH differential method [10]. Anthocyanins are group of important compounds which are part of flavonoids and responsible for red and purple colours in fruits. Chemically, anthocyanins are based on a C-15 skeleton with a chromane ring having a second aromatic B-ring in position 2 (C6-C3-C6).

4.Ayurvedic and Industrial application of kokum

n traditional medicine, kokum has a long history of uses in the Indian Ayurveda. The leaves and fruits are well known for their sour and astringent taste, thermogenic, constipating and digestive. The herbal preparations made from kokum rinds are used in the treatment of inflammatory ailments, for rheumatic pains and bowel complaints. The fruit is considered to be antihelmintic and cardiotonic [4]. The Kokum agal (Juice) and squash made out of the rind is used to cure various diseases such as piles, haemorrhoids, colic problems, ulcers, inflammations, treat sores, dermatitis, diarrhoea, dysentery, ear infection, etc. It is also used to facilitate digestion and to prevent over perspiration or hyper perspiration [4]. Kokum is a natural antacid and the preparation rind, yogurt and salt is supposed to relieve gastric ulcerations and burning sensation [4]. The Kokum butter is useful in dysentery, diarrhoea, phthisis pulmonalis and scorbutic diseases. Application of kokum butter on the skin is known to possess wound healing property and to be useful in ameliorating ulcerations, fis-sures of the lips, hands, chapped skin and inflammatory sores [4].
The kokum rinds are commercially used to prepare concentrated syrups, which on appropriate dilution gives the ready to use cool health drinks especially during the off-season. The local community of Goa, also uses the rinds for prepare wine. Dried rinds are powdered and marketed to be used as acidulant for traditional curries [5]. Kokum butter isolated from the seeds is in great demand in confectionery, medicines and cosmetic industries. Kokum butter has fatty acid and triacylglycerol compositions, tolerance toward milk fatand solidification properties similar to those of cocoa butter [6].
These properties are considered ideal in confectionary industry and kokum is used as a replacement to cocoa butter in the prepa-ration of chocolates [6]. Studies have also shown that kokum butter when used along with cocoa butter increases the heat-resistanceproperty of cocoa butter and chocolate and is helpful in preventing the heat induced softening and loss of consistency of chocolates [6-7].The kokum butter is also of use in the production of soaps and candle [5,8].

table1: name of kokum fruit

Language	Name
English	kokum, Goa butter tree, Kokum butter tree
Sanskrit	Vrikshamia, Vrikshamla, Amlabija, Raktavikshamla, Amlapura, Amlashaka
Hindi	Kokum
Marathi	Bheranda
Tulu	Punarpul
Tamil	Bhiranda, Murgal, Murgal-mala
Malayalam	Kaattampi
Sinhala	Goraka
Kannada	Murgina, Punarpuli,Devana huli
Oriya	Tintail
Gujarati	Kokum
Kokani	Bhirind

(Chemexcil, 1992 and Chandran, 1996).

table2:chemical composition of kokum

Nutrients	Quantity(%)	Nutrients	Quantity(%)
Mositure	80	Starch	1
Proteins(Nx6.25)	1.92	Pigments	2.40
Crude fat	10	Tannin	2.85
Crude fiber	14.28	Pectin	5.71
Total ash	2.57	Ascorbic Acid	0.06
Carbohydrates(by difference)	35	Hydroxyl citric acid	22.80

(Krishnamurthy et al. (1982)

table3: traditional uses of kokum(*Garcinia Indica*)

Traditional uses	Plant parts used
Digestive	Fruit
Anti-dysentery	Fruit, Rind and leaves
Antacid	Kokum Rind and leaves
Anti-diarrheal	Fruit, Rind and leaves
Anti-piles	Fruit, Rind and leaves
Anti-colic	Rind and Leaves
Anti-obesity (Fruit)	Fruit
Anthelmintic	Fruit
Anti-asthmatic	Fruit
Cardiotonic	Fruit
Hepatoprotective	Fruit
Anti-tumor	Fruit
Anti-hyperplasia	Leaves
Wound healing	Kokum Butter
Analgesic	Rind,Fruit
Anti- inflammatory	Rind
Anti-dermatitis	Rind
Anti-perspirant	Rind
Astringent	Leaves Fruits and Leaves
Demulcent	Kokum butter
Anti-ulcer	Rind

(Jagtap et al. 2015)

5.Antifungal activity

Garcinia indica extract has both antifungal and antibacterial properties and has potential for use as a biopreservative in food applications and therapeutic agent in cancer treatment.Study revealed that kokum rind extracts showed antifungal effects against Candida albicans, Penicillium sp. And Aspergillus flavus (Varalakshmi et al. 2010).

6. In vitro antioxidant study

DPPH radical scavenging activity:

The free radical scavenging activity of G. indica fruit extract was determined in vitro by slightly modified method using a 96 well microtiter plate (Sulaiman et al., 2011). Briefly, 100 µL of various concentrations of extract (6.25-200 µg mLG1) or ascorbic acid were added in DMSO and 100 µL of DPPH (200 µM) solution was added to each well. The plates were incubated at 37°C for 30 min without exposing to light. The absorbance was read at wavelength of 540 nm using a microtiter plate reader. And the percentage inhibition was calculated using equation (Abs-absorbance).

7.Anti-Cancer Agents

t was found that garcinol from kokum suppresses colon carcinogenesis in rats by inhibiting inducible nitric oxide synthase (iNOS) and cyclooxygenase (COX-2) enzymatic reactions. Histone acetyltransferase (HATs) has a key function in the modulation of gene transcription, cellular differentiation and cellular proliferation. However, if the HAT enzyme is altered, this affects the cell cycle or gene transcription causing cancer, neurodegenerative diseases, or other neurological syndromes. Balasubramanyam et al.(2004) have demonstrated that garcinol from kokum inhibits HAT activity and induces cell apoptosis. Hence, this investigation suggested that the garcinol from kokum acted as an anti-cancer agent by inhibiting HAT activity and instigating apoptosis.

8.Antioxidant Activity

Antioxidants are micronutrients that have gained importance in recent years due to their ability to neutralize free radicals or their actions. Free radicals have been implicated in the etiology of several major human ailments, including cancer, cardiovascular diseases, diabetes and arthritis. Due to the recent trends in nutrition towards development of healthy foods in the form of 'functional foods', one of the desirable properties in a dietary component is considered to be its antioxidant effect (Mishra et al., 2006).

Many therapeutic effects of the kokum fruit have been described in traditional medicine based on Ayurveda. These include its usefulness as an infusion, in skin ailments such as rashes caused by allergies,treatment of burns, scalds and chaffed skin, to relieve sunstroke, remedy for dysentery and mucous diarrhea, an appetizer and a good liver tonic, to improve appetite and to allay thirst, as a cardiotonic and for bleeding, piles, dysentery, tumours and heart diseases. One of the ingredients of kokum, hydroxycitric acid (HCA), has been patented for use as a hypocholesterolaemic agent.HCA is a potential anti-obesity agent. Hydroxycitric acid and its derivatives are useful in the treatment of obesity (Jena et al., 2002).

9.Anti-Ulcer Activity

Gastric and duodenal ulcers are illnesses that affect a considerable number of people in the world and they are induced by several factors like stress, smoking,alcohol consumption, nutritional deficiencies and ingestion of non steroidal-anti-inflammatory drugs (NSAIDs) e.g. In domethacin, has side effects such as gastrointestinal irritation, erosion, bleeding, ulceration and perforation (Basil and Howard, 1995; Loguercio etal., 1993; Naito et al., 1998; Nash et al., 1994; Sagar and Ahamed, 1999; Suleyman et al., 2002). Although a number of antiulcer drugs such as H2 receptor antagonists, proton pump inhibitors and cytoprotectants are available for ulceration all these drugs have various undesirable effects such as arrhythmias, impotence and hematopoietic changes and limitations (Ariyoshi et al.,1986; Del et al., 1985; Satoh et al,, 1988).

The fruits of Garcinia indica have been suggested in the Indian system of medicine for a number of diseases. These include its usefulness as an infusion,in skin rashes caused by allergies, treatment of burns, torelieve sunstroke, remedy for dysentery and mucous

diarrhea, an appetizer and antiulcer, liver tonic, to allay thirst and as a cardiotonic (Deore et al., 2011). The outer rind of the fruits of Garcinia indica has been shown to be antioxidant activity (Devasagayam et al., 2006;

Khare 2007; Kirtikar and Basu, 1991; Sheth etal., 2006). Garcinol a polyisoprenylated benzophenones, has antioxidative, chelating, freeradical scavenging, antiglycation, anticancer,anti-inflammatory and antiulcer activities (Lin and Liao,
2005; Ho et al., 2002; Yamaguchi et al., 2000). One of the ingredients of kokum, hydroxycitric acid (HCA), has been patented for use as a hypocholesterolaemic agent(Heymsfield et al., 1998; Mattes and Bormann, 2000; Sakariah et al., 2002). Kokum contains othercompounds with potential antioxidant properties include citric acid, malic acid, polyphenols, carbohydrates, anthocyanin flavonoids and ascorbic acid (Cadenas andPacker, 1996; Peter, 2001; Einbond et al., 2004;Rastogi and Nayak, 2010; Yoshikawa, 2000).

10. In vitro anti-inflammatrory activity

HRBC Membrane Stabilisation Method

The Human red blood cell membrane stabilisation was used to determine the in vitro anti-inflammatory activity.The blood sample was collected from healthy humanvolunteers (who has not consumed any NSAIDS for period of 2 weeks).Collected blood sample was mixed with equal volume of Alsever solution(2% dextrose, 0.8% sodium citrate, 0.5% Citric acid and 0.42% of Sodium chloride) and the centrifuge at 3000 rpm. The packed cells were washed with isosaline and 10% suspension was made. Different concentration of the extracts were prepared (10-1000µg/ml) using DMSO to all the above solution add 1ml Phosphate buffer, 2ml of hyposaline and 0.5ml of HRBC Suspension. All the above solution were incubated 37 o C for 30 minutes and centrifuge at 3000 rpm for 20 minutes. The clear supernatant liquid was estimated using UV visible spectrophtometer at 560 nm. Reference standard used are Diclofenac sodium.(10)

Cosmetic Application of Kokum

Kokum has emollient property, it is used as a natural moisturizer to keep skin supple and silky smooth. Effective for treatment for severely dry skin, ulceration and fissures of lips, hands, feet, etc. Kokum butter is also nutritive and astringent. Uses include candle, soap, ointments and other pharmaceutical purposes.

RESULTS AND DISCUSSION

Inflammation is a common phenomenon and it is a eaction of living issue towards injury. Phytochemical screening indicates the presence of flavonoids, tannin, saponins, glycosides etc. In this current research work invitro anti-inflammatory, antiarthritic activity was performed using HRBC Membrane stabilization method and protein Denaturation method. HRBC is similar to lysosomal membrane and its stabilization implies that the extract may as well stabilize lysosomal membrane.

Conclusions

The consumption of kokum by various processed form has increased tremendously due to its reported health benefits. The kokum and its derivates, such as dried rind powder, sarbat, solkadhi, and butter from seed are rich sources of several high-value compounds with potential beneficial physiological activities. The rich bioactive profile of kokum makes it a highly nutritious and desirable fruit crop. The research evidences that kokum and its extract may protect against and even improve several diseases including cholesterol, antioxidant, digestion tonic, paralysis; it may even help to prevent and arrest the development of certain cancers, in addition to protecting the health of mouth and skin. The kokum rind has also medicinal value and used in the treatment of piles, dysentery, tumours and heart complaints. Apart from the medicinal values kokum has the 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.

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