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Garcinia indica (Kokum): A Comprehensive Review On Its Botanical Characteristics, Phytochemistry, Nutritional Value and Comparative Therapeutical Potential

Dhara Gharat[1], Rajan Kothari[2], Sonali Uppalwar[3]

Ideal Institute of Pharmacy
Posheri village, Pimplaj Road, Taluka-Wada District-Palghar 421303

Abstract:
The tropical evergreen tree Garcinia indica, also referred to as kokum, is found in some parts of India and is a member of the Clusiaceae family, which includes the mangosteen family. It has served a number of functions in both industrial and culinary settings, such as acting as an acidulant in pickles, butter, wine, health drinks, and curries [1]. Every year, from March to May, the trees bear fruit during the summer. When fully mature, the fruits turn scarlet to dark purple, but when uncooked, they are green. They add acidity to curries and are used to make pickles and juice [2].In Ayurvedic medicine, kokum has a long history. It was originally used to cure ear infections, dermatitis, diarrhea, dysentery, wounds, and to help with digestion. Oil is extracted from kokum seeds [4]. High-performance liquid chromatography was used to identify the organic acids present in the leaves and rinds of Garcinia indica (Kokam). Using UV detection at 210 nm and isocratic elution with 8 mM sulfuric acid as the mobile phase at a flow rate of 1.0 ml/min, it was shown that the main organic acid in leaves and rinds is (−)-hydroxycitric acid, which is present to the extent of 4.1–4.6 and 10.3–12.7%, respectively.Citric acid and hydroxycitric acid lactone are found in trace amounts in leaves and rinds. The coefficient of variation for this approach ranges from 2.8 to 4.2%, demonstrating its high reproducibility. This is the first HPLC report on the organic acid composition of G. indica leaves and rinds. All rights reserved[7].

Keywords: Garcinia indica, Hydroxycitric acid, Mangosteen, Authentication.

INTRODUCTION:

The oldest known medical treatment is the use of medicinal herbs, which have been practiced throughout history in all civilizations [1]. Garcinia is a member of the Clusiaceae (mangosteen) family and is used in a variety of industrial, medicinal, and culinary applications [10]. The plants can be found all across the world, especially in Western Polynesia, Africa, and tropical Asia [11]. Extracts of various plant parts of the Garcinia species, such as Garcinia brasiliensis, Garcinia cambogia, Garcinia gardeneriana, Garcinia penduculata, and Garcinia mangstana, have drawn a lot of attention in recent decades and have shown promise in the prevention and treatment of chronic diseases that are not communicable [17].Wild mangosteen, kokam, goa butter tree, and kokum butter tree are some of its English names; in Sanskrit, it is called Vrikshamia, Vrikshamla, Amlabija, raktavrikshamla, Amlapura, and Amlashaka; in Hindi, it is called kokum; in Malayalam, it is called bheranda; in Tamil, it is called punarpuli; in Tamil, it is called bhiranda, murgal, and murgal-mara; in Kannada, it is called murgina, punarpuli, and devana huli; in Oriya, it is called tintali; in Gujarati, it is called kokam; and in Konkani, it is called bhirind [8]. When ripe, the dark purple, globose or spherical fruit of G. indica is thought to have numerous health benefits.It is used to treat piles, diarrhea, tumors, pain, and heart conditions in Ayurveda, the traditional Indian medical system, and is believed to have antidiabetic, anthelmintic, cardiotonic, and anti-obesity

qualities [15]. Traditionally, the dried rind of G. indica has been used as a culinary spice to give meals a sour taste. It is also frequently used to make soft beverages. The primary cause of the sour taste is hydroxycitric acid (HCA), which is frequently found in anti-obesity medications and may have anti-obesity properties [40].

Fig 01: Fruit of Garcinia indica (Kokum)

Pharmacological actions of Garcinia indica:

Table 01: Summery of pharmacological studies for Garcinia indica[1]

Sr.No	Pharmacological activity	Tested substance	In vivo/ In vitro	Model	Dose/ Concentration
1	Antioxidant	Aqueous extract	In vivo	Wister albino rats	400 & 800 mg/kg
		Fruit extract	In vitro	-	1.5 mm
		Garcinol enriched fraction	In vivo	C57BL/6 male mice	25,50 & 100 mg/kg
		Aqueous extract	In vitro	-	-
		G.indica fruit rind powder	In vivo	Swiss albino mice, Wister rats	0.5, 1, & 2%W/W
2	Anti-obesity	Garcinol-enriched fraction	In vivo	C57BL/6 male mice	25, 50, &100 mg/kg
			In vitro	3T3-LI preadipocytes	1 & 2 micro.g/ml
		Fruit extract	In vivo	C57BL/6 male mice	0.01% w/w
3	Anti-arthritic	Garcinol-enriched fraction	In vivo	Male Wister rats	10mg/kg
4	Anti-Inflammatory	Garcinol-enriched faction	In vivo	C57BL/6 male mice	25,50 & 100 mg/kg
5	Antidepressant & anxiolytic effect	G.indica fruit rind powder	In vivo	Swiss albino mice, Wister rats	0.5, 1 &2%
6	Antibacterial	Fruit extract	In vitro	-	1.5 mm
7.	Hepatoprotective	Aqueous extract	In vivo	Wister albino rats	400 & 800 mg/kg

BOTANICAL DESCRIPTION:

Since Kokum is a small but incredibly resilient evergreen, it doesn't require extensive irrigation or the application of fertilizers, pesticides, or herbicides. The trees have recently been grown for their fruits, however they are typically found growing in wastelands, woodlands, and riverbanks. This tree grows slowly, and the most common method of multiplication is to place the seeds in plastic bags or pots and then move the seedlings into the pits. Additionally, in vitro propagation and adventitious bud differentiation on mature seeds can produce plantlets [48]. It takes roughly six to seven years for a seedling to mature and bear fruit after it is planted.Trees between the ages of 20 and 50 often provide the most [50]. Kokum trees can reach heights of 12 to 20 meters and are dioecious, meaning that their male and female plants are distinct from one another. The tree's canopy is thick with verdant foliage, and its branches are drooping. The juvenile leaves that emerge are delicate and have a hint of scarlet [49]. Simple, opposite, elliptic or oblong, the leaves are pale on the underside and rich green on the upper. They shine and measure 5 to 8 cm in length and 2.5 to 3.5 cm in width [47]. The dark pink, fluffy blossoms can be found alone or in spreading clusters. The mature trees bear fruit every year between November and February.

The ripe fruits are ready for harvesting in May after the fruiting phase, which takes about five months, is finished [40]. The stigma, which is stalkless and has four parts, crowns the round, rectangular, or oval fruits, which have pointy points. They range in color from dark to light green when raw to crimson red with a hint of yellow to dark violet or purple when ripe. Initially tiny, the fruits eventually reach the size of a lemon [42].

CHEMICAL CONSTITUENTS OF GARCINIC INDICA (KOKAM FRUIT):

Three significant chemical components—garcinol, hydroxycitric acid, and anthocyanin pigment—are present in kokum rind. Garcinol is a yellow pigment that dissolves in fat; hydroxycitric acid is used as an acidulant and is a physiologically active substance that has been demonstrated to drastically lower body weight. The various chemical components of kokum fruit are listed in the table.[46]

Table 02: Chemical constituents of kokum fruit[44]

Constituents	**%**
Moisture (g/100g)	80.0
Protein (N x 6.25 %)	1.0
Total ash (%)	2.6
Tannin (%)	1.7
Pectin (%)	0.9
Total sugars	4.1
Crude fat (%)	1.4
Organic acid (as HCA) (%)	5.9
Pigment (%)	2.4

TRADITIONAL USE OF GARCINIC INDICA FRUIT:

Ayurveda has long used kokam to treat a variety of conditions, including burns, chaffed skin, scalds, and allergic rashes; sunstroke; dysentery and mucus diarrhea; boosting appetite and reducing thirst; treating bleeding piles, tumors, and heart issues; and as a liver and heart tonic. The fruit's well-known traditional use has led to extensive research into its potential medical benefits. The two main phytoconstituents that were separated from the tree's fruit were garcinol, an antioxidant, and hydrocitric acid, which is known to have anti-obesity properties.[28].

Fig 02: Garcinic indica

CLASSIFICATION OF GARCINIC INDICA FRUIT:
Kingdom: Plantae
Division: Mangoliphyta
Class: Mangoliopsida
Order: Malpighiales
Family: Clusiaceae
Subfamily: Clusiodeae
Tribe: Garcinieae
Genus: Garcinia
Species: indica

Different components of the plant are employed for their therapeutic qualities or in culinary preparation. Vinegar is made from the astringent bark [6]. Young leaves are utilized in food preparations, include components identical to the fruit, and are naturally acidic [7]. Additionally, the leaves are reported to have anti-salmonella properties. The tree's seeds are used to manufacture kokum butter, which has been shown to have sun protection properties and contains fat. After oil is extracted, the oil cake is turned into manure. The fruit and its rind, called kokum, are the most often used parts of the plant [8]. The fruit skin has therapeutic value since it is a rich source of phytochemicals [25].

JUICE PREPARATION AND FERMENTATION:
Fresh fruit was used to extract kokum juice, whereas banana pulp was processed with 0.8 g of commercial pectinase/L for 8 hours at 45 °C to extract banana juice. To prepare the juice, the required amount of water was added. The prepared juice mixes were assigned the code V. All juice blends received 50 mg/L of potassium metabi sulfite (KMS), and the juice was kept at 4 °C for 24 hours to prevent the formation of undesirable microorganisms. 10% v/v yeast was used to inoculate the musts. At 28 °C, fermentation was continued until consistent Brix values were noted.[47].

AUTHENTICATION OF SELECTED PLANTS:
In September 2020, the leaves of Garcinia cambogia (GC) and Garcinia indica (GI) were gathered at the Central Horticultural Experiment Station in Chettalli, Kodagu district, Karnataka, India. Through letter no. SKPND: CR: 113: Herbarium Collection/19-20, the Principal Scientist at PND Herbarium in Mangalore, Karnataka, India, identified and verified both species of Garcinia. For future reference, the

herbarium is maintained in the PND Herbarium in Mangalore as G. indica (accession no. 2286) and G. cambogia (accession no. 9743).[36].

PREPARATION OF PLANT EXTRACT:

Fresh GC and GI plant leaves were cleaned with running tap water, then rinsed with deionized water and allowed to dry in the shade. Using a mixer grinder, the air-dried leaf samples were ground into a coarse powder. The powdered sample was kept at 4°C in an airtight brown bottle until it was needed. 50 grams of leaves that had been shade-dried were coarsely ground, combined with 500 milliliters of double-distilled water, and then left in a shaker incubator for a full day. The incubator was set to 150 rpm and the temperature was set to 37°C. The extract was first cleaned with muslin cloth and then with Whatman No. 1 filter paper. The residue was scraped and kept at 4°C until further use, and the iltrate was evaporated in a hot air oven at 50°C until it was dry [23]

PHYTOCHEMICAL SCREENING:

In order to collect bioactive ingredients, the aqueous crude extracts of GC and GI leaves were separated using water. These compounds were then qualitatively screened using conventional protocols for secondary metabolites such as phenols, alkaloids, saponins, tannins, lavonoids, and glycosides [48].

PREPARATION OF SAMPLE FOR ANALYSIS USING HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY:

For Soxhlet water extraction, 10 g of dried leaves from each of the four samples were dissolved in 50 ml of double-distilled water and boiled for 45 minutes at 100°C. After evaporating the extract, the residue was combined with 50 milliliters of 30% orthophosphoric acid [25].

PREPARATION OF STANDARDS FOR COMPARATIVE ANALYSIS USING HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY:

The ethylenediamine salt of HCA, lactone (D-(+)-Glucuronolactone), and citric acid acquired from Merck Life Sciences Pvt. Ltd. were used to generate the working standards. Mumbai [40] Five milligrams of 50% H2SO4 were added to five milligrams of HCA's ethylenediamine salt, and the mixture was diluted with ten milliliters of HPLC-grade water. 500 µg/mL of HCA was used to create the stock solution. The lactone (D-(+)-glucuronolactone) salts were dissolved in HPLC-grade water to create lactone standards. Salts of citric acid were also dissolved in water of HPLC quality. A concentration of 500 µg/mL was maintained for the standard solvents of lactone and citric acid [18].

COMPARATIVE ANALYSIS USING HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY:

Twenty microliters of each of the standard samples were injected into a Shimadzu chromatographic system LC 8A model dual pump, photodiode array detector (SPD M10AVP), and Class LC 10 software after 200 microliters of the samples had been filtered using a 0.45 microliter filter. Reversed-phase C 18, 2.7 µm with a spherical solid-core, 4.6 mm × 150 mm column, and gradient elution solvent containing 0.2 M sodium sulfate with a pH of 2.5 adjusted with diluted H2SO4 were the HPLC instruments used to acquire the data. Using ultraviolet (UV) detection at 215 nm, a reading is obtained while maintaining a flow rate of 0.5 mL/min. To get the evaluation's correctness, many trail sets were injected [26].

RESULT:

The dried leaves' lactone, citric acid, and HCA were separated from the processed leaves. The leaf samples that were gathered came from regions with an average annual rainfall of 2000 mm. GPS coordinates are taken from the Western Ghats belt in South India to determine the plants' location. Researchers have looked into a variety of extraction procedures. Following these extractions, the stability of (-)-HCA is also examined [47]. The current strategy is a quick approach that is based on the

ethnomedical knowledge that the local population has heard. For herbal preparations, the quantity of organic acids extracted are necessary. Even in trace amounts, the pharmacological effects of organic acids have been documented [46]. Up to 65%w/w and 23%w/w of (-)-HCA, respectively, are produced by the fruits of Garcinia cambogia and Garcinia indica. It was calculated that G. xanthochymus contained 0.02%w/w of (-)-HCA, 0.06%w/w of lactone, and 0.18%w/w of citric acid. The findings indicate that there is zero HCA and lactone present. The extraction shows the existence of citric acid, which is not an HCA derivative salt. It was calculated that G. morella contained 0.0%w/w of (-)-HCA, 0.01%w/w of lactone, and 0.29%w/w of citric acid.Lactone and HCA are absent from dried leaf samples of G. morella. Samples of dried leaves from Garcinia cambogia and Garcinia indica have substantial levels of lactone and (-)-HCA. () G. morella does not contain lactone or HCA. The leaves of G. Morella were discovered to contain high levels of citric acid [20].

POTENTIAL APPLICATION OF GARCINIA INDICA (KOKUM) IN FOOD AND ALLIED INDUSTRIES:

Kokum's color can be utilized in a variety of foods and food compositions. The section that follows discusses a few examples.

1.Kokum bevarages:

A premium red wine can be produced by fermenting the 4% sugar content of kokum extract. When sugar is added, the kokum extract can be transformed into a variety of health drinks and squash-like goods. When sugar is added to kokum rinds, crimson syrup that is collected from the ripe fruit can be preserved in the home for use in summer time to make refreshing health drinks [40]. The syrup should last six to eight months because of its high sugar content. Another well-liked kokum-based beverage is "solkhadi," which is made by mixing kokum extract with coconut milk and jaggrey. It can be consumed with meals as a digestive beverage [3].

2.Dehydrated kokum:

Kokum pieces are dried in a dryer and then ground to create kokum powder. After being sieved, the powder is kept in sealed containers. This substance is used as an acidulant in a variety of Indian cuisines, including fish and coconut curries, as well as in a wide range of other food preparations [5].

Fig 03: Dehydrated Kokum

3.Kokum butter:

It is possible to extract the 23–26% edible oil found in kokum seed by boiling it in water. Kokum butter is the term for the oil that separates and accumulates in the top layer. It has the color of cream and stays

firm at room temperature. According to reports, kokum butter is used in a variety of chocolates and confections [18]. In addition, it can be used to make candles, soaps, and a variety of pharmaceutical items [8].

Fig 04: Kokum butter

4.Cosmetic industry:

There are other non-food uses for kokum in addition to its culinary use. According to reports, kokum pigments have the ability to absorb ultraviolet radiation. The cosmetics sector may use this feature to produce sunscreen creams and pastes [35].

5.Kokum pigment based on Ph:

As the pH rises above 5.0, the kokum pigment's hue shifts from red to blue/violet. pH indicators were created using this characteristic. [35] Compared to other artificial hues, kokum has certain drawbacks as a natural food coloring, including heightened vulnerability to exposure to light, oxygen, and extremes in pH. Before employing Kokum in food processing, it is important to assess and acknowledge these limits [17].

6.Kokum syrup:

There are some therapeutic benefits to kokum fruits. Many people enjoy the sweet and sour juice that is produced from this fruit. In addition to being delicious, a glass of cold kokum syrup helps to strengthen the digestive tract. The product has long been well-liked in the state and is currently available in neighboring states as well. Many people prefer it because it is a natural fruit extract. The conventional procedure involves removing the fruit pulp and seeds in order to remove the kokum rind. Squash is not produced using pulp or seeds. In a wide-mouth container, combine an equal amount of sugar and kokum rind.For eight to ten days, this sugar and kokum mixture remained exposed to the sun. During this method, juice is extracted from the kokum rind and combined with sugar. No further sugar has to be added if a balanced sugar buildup is discovered at the vessel's bottom. Using a cotton cloth, filter the juice and rind. It is necessary to fill a clean glass bottle with this Kokum syrup. These filled bottles were once more exposed to sunlight for ten more days without being sealed for long-term preservation. At the conclusion of the procedure, the bottles must be capped [4].

CONCLUSION:

Garcinia indica, popularly known as kokum, is a nutritionally rich and medicinally important plant that remains relatively under-researched but holds considerable promise for scientific and therapeutic advancement [29]. This review presents an overview of its unique botanical features, diverse phytochemical constituents, substantial nutritional value, and wide-ranging pharmacological effects [20].

Key bioactive molecules-including hydroxycitric acid, garcinol, anthocyanins and various polyphenols are largely responsible for its antioxidant, anti-inflammatory, anti-obesity, cardioprotective, hepatoprotective, antimicrobial and gastroprotective activities. Compared with other species of the Garcinia genus, G.indica stands out for its elevated anthocyanin concentration and robust free-radical-scavenging capacity, giving it a distint therapeutic edge [25].

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