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Review based study on nutritional composition, health benefits and bioactive compounds of kokum

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Abstract

Kokum is one of the under-utilized fruits with many health benefits. Kokum scientific name is *Garcinia indica* it mainly grows in Maharashtra they commonly found in forests it also grows in west Bengal Kerala. Fruit is size of orange and it lasts fresh up to 1 week, seeds of kokum have more oil content. Kokum is rich in vitamins, minerals, organic acids and phenolic compounds consumption of kokum cause many health benefits like anti-oxidant activity, anti-ulcer activity, anti-fungal, neuro protective activity and anti-bacterial activity. It has bio active compounds like garcinols, HCA. There are many by products in market which are made from kokum and its fruit parts like kokum butter made seeds kokum syrup is made from rinds and also these by products are used for many industrial purposes like cosmetic making, chocolate making.

Keywords: Kokum, garcinols, hydroxyl citric acid, antioxidant activity, nutritional composition, vitamins

1. Introduction

The Kokum (*Garcinia indica*) is a tree spice which belongs to Guttiferae. It is one of those underexploited tree spices which are found in forests of Assam, Meghalaya and West Bengal. They are generally found in the Konkan region of Maharashtra, Goa, Karnataka, Kerala and small district of Gujrat on the west coast of India and also in some parts of North-eastern India. Around 35 species are commonly found in India. It has a magnificent Nutritive and Medicinal properties kokum is not cultivated in a normal way like other fruits.

However, it is mostly found either as a garden plant or as a mixed crop in the plantations of coconut and areca nut or it is found as a roadside plant or in forest. This tree spice has different names in different regions such as kokum, kokum, amlaveta, vishambila in Hindi, Mahad in Bengali, Dhupadamara, murgala, huli, purnapuli, tittidika in Kannada, Ratambi in Deccan, Brindao, Amsel in Goa, it is called Ratainbasal, Brindoesiro in Gujrati.

The tree is tall having an oblong, elliptic and deep- green glossy leaves which is 5.5-8cm long and 2.5- 3cm broad. The flowers of kokum are pink in color and are fleshy. The fruit is generally brownish or brownish grey in color with a yellow marbled pattern.

It is crowned by a stalkless stigma. Generally, 6 to 8 seeds are seen in each pod, the pulp of the kokum is white in color with a unique taste and odor.

A fruit of kokum is about a size of an orange. Ripe fruit have a self-life of a week. The seed of the fruit bears the quarter weight of the total fruit and contains approximately 40-42 percent oil. During summer on an average all the kokum tree bears the fruit.

When the fruit is unripe its tender and green in color, when it is ripe its purple in color. This is a native tree spice which is generally used in South Asian cuisine. The dried rind is used as an Indian spice or condiment in curry preparation. Syrups are made from kokum and used as a healthy soft drink which helps to get relief from sun stroke. They are good for making bonsai or a feng-shui plant. This evergreen tree can reach up to a height of 30 meters. Its juice is used as natural dyeing agent. The kokum butter which is widely used in cosmetic industry is also used for treating dysentery and mucous diarrhea. Almost all species possess antibacterial, anti-fungal, anti-ulcerogenic, cardioprotective, anti-cancer, chemo preventive, free radical scavenging and anti-oxidant properties. Kokum is a slim and an evergreen tree which does not require frequent irrigation or use of fertilizers, Pesticides or herbicides. They are generally found nearby forests, wastelands and riversides. *Garcinia* species is spread all around the tropical Asian and African countries.

It is a potential colorant, spice with medicinal value. Kokum tree is red tinged tree and have a dense canopy. It is well known as Indian butter tree. It belongs from *Garcinia* genus and it is either polygamous or dioecious. The flowers are generally small and unisexual, as both the male and female flowers are found in the same tree. There is a corolla and 4 sepals in the calyx. There are only 2 stages of kokum crop. The first stage is the establishment stage and the other second is called the production stage. It requires 6-7 years to bear fruit in the tree. The maximum yield is observed in 20-50 years. The generation can be increased through adventitious bud differentiation using mature seeds. Generally, the growth of the kokum tree is slow so propagation is done through seeds and softwood grafting which lead to heterozygosity and its character. The factors responsible for the branching pattern, leaf morphology, flowering fruit season, fruit shape, size and color, thickness of fruit rind and biochemical composition of fruit is its pollination and its polygamous nature.

Kokum savory taste is due to hydroxyl citric acid (HCA) which is also a fat reducing supplement. It has been patented for the use as an hypocholesterolemia agent. Oil is found in the seeds of the kokum which remains solid at room temperature and have its application in pharmaceuticals, food and cosmetics.

The kokum contains Garcinol which is a fat-soluble yellow pigment and cyanidin -3 glucoside, cyanidin-3 sambubioside are the 2-water soluble pigment found in kokum. Garcinol has been found as an anti-oxidant a glycation inhibitor, and antiulcer agent. It shows inhibitory effect against human leukemia HL- 60 cells. Antibacterial activity could be seen against Methicillin Resistant *Staphylococcus aureus* by Garcinol. Garcinol is natural histone acetylase transferase inhibitor in both *in vitro* and *in vivo* as it suggests it wide application of diseases like Cancer and Aids. *Garcinia* contains other compound like citric acid, malic acid, anthocyanins and ascorbic acid. The syrup of *Garcinia* helps alcohol intoxicated individuals in liver protection. The outer rind of the kokum imparts a sweet and tangy taste which is used as a substitute for tamarind. Kokum is also used as a substitute to grapes in wine making. The rind of the kokum is used as a coloring agent as it works as a pink or purple coloring agent. Several health drinks are made used kokum. The Konkani tribes of the goa and Maharashtra make bhindi Saar, a soup using kokum juice or kokum kadi is made using kokum juice and coconut milk which is used as a digestive drink used after meal to relieve the gastrointestinal issues. Traditionally the decoction of the rind is used as the remedy against diabetes. The kokum butter is used as a wound healing ointment and also for making candles. The kokum paste and oil are used for the wound healing and skin problems.

1.1 Potential applications of kokum in food and allied industries

1.1.1 Kokum Beverages

Kokum contains approximately 4 percent of sugars which can be fermented to produce a high-quality wine. kokum is used for preparing these squashes and health drinks. The red syrup extracted from the ripe fruit is made during summers which is aided as a cool health drinks. Generally, the shelf life of the syrup is 6-8 months due to the higher percentage of sugar in it. A drink is prepared using coconut milk, jaggery and kokum which is well known for its digestive properties is known as solkhandi.

1.1.2 Dehydrated Kokum

Kokum powder is prepared by drying the kokum fruit and grinding it in powder. The powder is sieved and the fine powder is used as a spice in Indian cuisines.

1.1.3 Cosmetic Industry

The pigments in the kokum have the potential to absorb UV rays because of which it is used in the production of sunscreen and lotion in the cosmetic industry. Kokum Pigments Based pH Indicators Kokum pigments can be used as a pH indicator as it turns red to blue as the pH increases beyond 5.0. It can also be used as a natural colorant in the food. The limitations they are susceptible to light, pH. And oxygen.

2. Nutritional composition of kokum

2.1 Primary metabolites of kokum (Fruit)

A fruit's nutritional value is estimated by the availability of the components like Carbohydrates, proteins, sugars. They can directly impact the taste of the fruit, growth and development of fruit Carbohydrates are the major metabolites present in kokum. Carbohydrates are the major nutrients in fruits.

They are main source of energy for the cell and the simplest bio molecules that are naturally synthesized. Reducing sugars are the simplest carbohydrate molecules having free aldehyde or ketone group and can reduce metal ions to lower oxidation state. Reducing sugars like glucose and fructose are the sweetness principles of a fruit. Proteins are important to repair cells and form new ones. Fats helps to absorb vitamins. Here kokum is a protein and carbohydrate rich fruit.

Table 1: primary metabolite composition of kokum

S. No	Primary metabolite	Quantity (g/100g)
1.	Carbohydrates	6.24
2.	Reducing sugars	0.63
3.	Proteins	4.78
4.	Crude fats	0.12

2.2 Mineral composition of kokum (Fruit)

Minerals play a major role in metabolism and functioning of cells and are required in small amount for human health. Kokum contains macro minerals like sodium, potassium, calcium, magnesium and phosphorus, micro minerals like iron.

Kokum has high levels of potassium, calcium, magnesium and iron. Minerals helps in many ways like Sodium and potassium helps in fluid balance, magnesium helps in making protein, calcium and phosphorus are important for healthy bones and iron helps to increase blood level. Magnesium and potassium have been found to be the major minerals. Potassium, calcium and magnesium are present in a good percentage of fruit tissue and make kokum as an important medicinal fruit.

Table 2: Mineral composition of kokum

S. No	Mineral	Quantity
1.	Sodium	1.55 (mg/100g)
2.	Potassium	44.55 (mg/100g)
3.	Calcium	13.21 (mg/100g)
4.	Magnesium	33.45 (mg/100g)
5.	Iron	12.06 (mg/100g)
6.	Phosphorus	4.51 (mg/100g)

2.3 Vitamin composition of kokum (Fruit)

Vitamins are essential micronutrients which are organic in nature, they play a major role in enzyme regulation and metabolism. As shown in table kokum is packed with vitamins it is rich in vitamin B2 which is water soluble it is not being stored in body and not synthesized in body we have take it through foods since kokum is rich in vitamin B2 it is good to consume regularly for vitamin balance. Vitamin B2 helps in conversion of carbohydrates to glucose. Vitamin C is also water soluble it has antioxidant properties, Vitamin B1 also helps in digestion, Vitamin B3 helps to lower cholesterol, and vitamin B12 helps to keep blood and nerves healthy.

Table 3: vitamin composition of kokum

S. No	Vitamin	composition
1.	Thiamine (B1)	52(µg/100g)
2.	Riboflavin (B2)	320 (µg/100g)
3.	Niacin (B3)	63 (µg/100g)
4.	Vitamin C	33.45 (µg/100g)
5.	Vitamin B12	12.06 (mg/100g)

2.4 Phenolic compounds of kokum (Fruit)

Phenolic compounds are secondary metabolites they are responsible for antioxidant activity they improve color in fruits. In kokum fruit xanthenes are major phenolics, they are yellow in color they help in many medical activities The major secondary metabolites reported from kokum are polyisoprenyl benzophenones, xanthenes and bioflavonoids. xanthenes have been reported to be useful in the treatment of cancer, oxidation, microbial infection, diabetes, inflammation, virus infection.

Table 4: Phenolic compounds composition of kokum

S. No	Phenolic compounds	Quantity
1.	Total xanthenes	0.91(g/100g)
2.	Total phenolics	5.01g/100g)

2.5 Organic acids of kokum

The organic acids play a key role in food products because of their influence on organoleptic properties. Besides, they also provide the sour flavor to the product and also act as antimicrobial agent for enhancing shelf life. The total content of organic acids in a food affects the product's acidity, whereas the levels of a specific organic acid can directly influence the flavor and taste of the drink. Malic acid and citric acids are reported to have functions like enhancing salivation, gastric secretion and exfoliation. Hydroxy citric Acid (HCA) is one of the major organic acids in kokum, it acts an inhibitor of the synthesis of fat and cholesterol, hydroxy citric acid has been shown to significantly reduce the body weight and lower lipid accumulation. Due to its presence in high amounts in *Garcinia* species it is also called as *garcinia* acid.

Table 5: Organic acid composition of kokum

S. No	Organic acid	Quantity
1.	HCA	7.43 (%)
2.	Malic acid	2.67 (%)
3.	Oxalic acid	0.63 (%)
4.	Citric acid	0.79 (%)
5.	Tartaric acid	0.51 (%)
6.	Acetic acid	0.31 (%)

2.6 Nutritional composition of kokum butter

Kokum butter is obtained from kokum seeds, kokum seeds contain 23% to 26 % of edible oil it is extracted by crushing seeds boiled with water and top fat layer is removed kokum fat can also be separated by solvent extraction, kokum butter contains 30% of fat crude kokum butter is yellow in color after refining it is white in color. Due to its fatty acid content, it is used in soaps, balms, lipsticks and cosmetic industry. It is edible fat and melting point is 39 to 43°C due to its high melting point it is used in chocolate making to prevent from melting at low temperatures. Kokum seeds are rich in fatty acids like.

Table 6: Fatty acids of kokum butter

S. No	Fatty acid	Quantity
1.	Stearic acid	55 – 56.4%
2.	Oleic acid	40%
3.	Palmitic acid	2.5 - 3%
4.	Linoleic acid	1.5%
5.	Hydroxyl citric acid	10%
6.	Myristic acid	0.5%

2.7 Nutritional composition of kokum rinds

Kokum rinds are separated from fruit and they are used for making syrups, sharbat, wine and dried powder to make available in off season. Kokum is also used as natural color in food it has 2 -3% of anthocyanins which are responsible for color, Kokum rind is *garcinol*, a polyisoprenyl benzophenones, *isogarcinol* and *camboginol*. The kokum crust contains 80% moisture, 2% protein, 2.8% tannin, 5% pectin, 14% crude fiber, 4.1% total sugars, 1.4% fat, 2.4% pigment, 22% hydroxy citric acid, 0.06% ascorbic acid. Dried is also used in many products like they can be used to make soups and curries. Rind extract contains 4% sugar that can be used to prepare wine.

3. Medicinal benefits of kokum

Kokum (*Garcinia indica*) is a medicinal plant mentioned in Ayurveda and is used to treat various health-related problems such as liver failure, diarrhea, cancer, and heart disease.

Kokum exhibits various phytochemical features like anti-ulcerogenic, cardio-protective, anticancer, chemo-preventive, radical scavenging, and anti-obesity effects. It is also useful in treating acne, diarrhea, bladder pain, and heart problems. *Garcinia* seeds contain about 33 to 44 percent fat, known as "kokum butter". It is considered nutritive, astringent and emollient. Due to the high content of di-saturated glycerides, it is much needed instead of cocoa, extender in chocolate, and confectionery products. Kokum butter is easily absorbed into the skin and contains vitamin E. it shows excellent moisturizing and nourishing properties. It is therefore in good demand in the cosmetics industry and outside of the confectionery industry.

3.1 Antioxidant Activity

Antioxidant properties of the plant are due to the presence of phenolic or flavonoid components. The presence of phenolic or flavonoid components. The unique health benefits of kokum are mainly due to its high antioxidant content. Free radical extraction and antioxidant activity are exemplified by the hot liquid extraction of kokum, a market-based syrup. Using the β -carotene linoleate assay and the DPPH assay, the chloroform-free radical extract extracted from the kokum rind was investigated by a scientist. The kokum fruit containing methanol exhibits strong antioxidant activity compared to regular ascorbic acid. The presence of chloroform in me

causes its color. All kokum cultivators contain very high antioxidant activity. The activity of releasing superoxide anion in *Garcinia indica* is demonstrated by garcinol.

3.2 Anti-neoplastic activity

Performing to prevent, prevent or stop the development of neoplasm (tumor) is called antineoplastic activity. In the case of kokum, garcim-1, garcinol and its derivatives, garcina-2, cambogia have limited growth effects on immortal intestinal cells and neoplastic colon cancer cells.

3.3 Anti-Fungal Activity

Pathogenic fungi are the most contagious plants, causing changes during the stages of growth and post-harvest growth. In fruits and vegetables, there are a variety of fungal species that cause genetic problems related to the factor, the amount of healthy food, the organoleptic properties, and the limited shelf life. In addition, in some cases, the fungus indirectly causes allergic reactions or allergies among customers as a result of the production of mycotoxins or allergens. The antifungal activity of kokum rind aqueous extract against candida albicans and penicillium has been investigated by some researchers. chloroform containing rind extracts of kokum suppress aflatoxin production and aspergillus flavus growth.

3.4 Neuroprotective Effects

Neuroprotective refers to the related preservation of neuronal structure and function of those Mechanisms; neuroprotective therapy often identifies oxidative stress and excitotoxicity, both of which are strongly related to central nervous system disorders (CNS). Against 6- OHDA, the extraction of methanol-containing fruit showed great potential neuroprotection, so antiparkinsonian activity was observed in the mice. Neurite outgrow inhibits cyandin-3- glucoside filament proteins expression representing its neuro-protective properties. a major component of garcinia is garcinol and reduces the expression of anti-inflammatory mediators made by LPS. Anti-cholinesterase properties are also indicated by garcinia.

3.5 Anti-Ulcer Activity

Ulcer protective effect of ethanolic and aqueous extract of *Garcinia indica* fruit rind. The aqueous and ethanolic extract of *Garcinia indica* was investigated for anti-ulcer function against HCL ethanol induced gastric ulcer and indomethacin induced ulcerogenesis. Garcinol in oral administration reduced stomach ulcers caused by water immersion and indomethacin. Oral administration of garcinol (40-200 mg/kg) reduces indomethacin-induced gastric ulcer in mice. Positive effects were observed at 200 mg/ kg and immune effects were better than cetrarate- HCl used as a positive control. Garcinol was also effective in reducing water stomach ulcer and side effects similar to cetrarate HCl used as a good control method.

3.6 Anti-inflammatory Activity

The process of preventing acute inflammation that helps the body cope with infections, tissue damage and immune reactions. The aqueous extract of *Garcinia indica* fruit rind was suited for anti-inflammatory activity in carrageenan induced granuloma in mice. It is not expected that kokum is traditionally used for centuries to effectively treat inflammatory diseases. The fruits of *Garcinia indica* contain active substances such as anthocyanins and pythopoly compounds. Polyphenols and anthocyanins are powerful

antioxidants that are beneficial in their anti-inflammatory activity.

3.7 Antibacterial Activity

Kokum rind extract containing hexane, benzene and garcinol exhibits potent anti-bacterial activity. The aqueous extract of *Garcinia indica* fruit rind was studied for anti-inflammatory activity in carrageenan induced paw edema and cotton pellet induced granuloma in mice. Antiviral action such as salmonella paratyphi a, salmonella typhimurium and salmonella typhi was found to be susceptible to kokum leaf extract. Against bacillus subtilis the main antibacterial activity, followed by Escherichia coli, is expressed through a wet discharge from the rind.

3.8 Anti-Aging Activity

during aging, skin elasticity decreases due to the enzyme elastase leading to deterioration and at the same time the hyaluronic acid on the skin also decreases and the skin becomes dry and wrinkled. Therefore, there is a need to preserve the matrix metallic protein by inhibiting the activity of these matrix metallic proteinases. Some plant fragments are reported to be good antioxidants. Garcinol and cambogia present in fruit containers of *Garcinia indica* have been reported to be good antioxidants due to the presence of a phenolic group. Along with this various G preparations, indica has shown significant antioxidant potential. To test whether the fragments are separated from the G-fruit pieces. Indica play a role in increasing aging, separating methanolic extract (ME) into a raw ethyl acetate and water fraction (WF) and those components were tested for anti-hyaluronidase and anti-elastase activity.

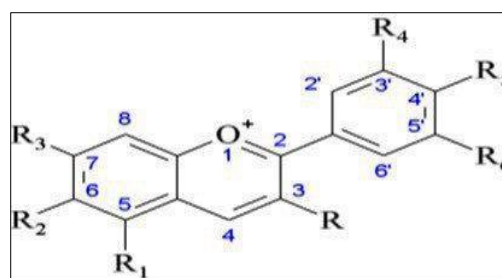
4. Bioactive compounds of kokum

Kokum contains three major bioactive compounds namely anthocyanin, hydroxy citric acid and garcinol

4.1 Anthocyanins

They are found in kokum and they have the ability for coloring the fruits red and purple colors. Its pigmentation is cyanidin-3-glucoside and cyanidin3-sambubioside. Anthocyanins are water soluble and can be extracted by hydraulic pressure and can also be dissolved by polar solvents such as methyl alcohol and ethyl alcohol. Using TLC and HPLC help to identifies. It can reduce the cholesterol, triglyceride, and high-density lipoprotein, enhance low density of lipoprotein, inhibit atherosclerosis, regulate blood fat. It contains of about 2.4% of the total fruits.

Using chemical bonds C-15 with a chromane ring having a second aromatic B-ring in position2 (C6- C3-C6). Anthocyanins have a strong antioxidant. Due to increase in hydroxyl groups in B ring antioxidant activity increase when present as glucosides. anthocyanins have an effect on lipids peroxidation.

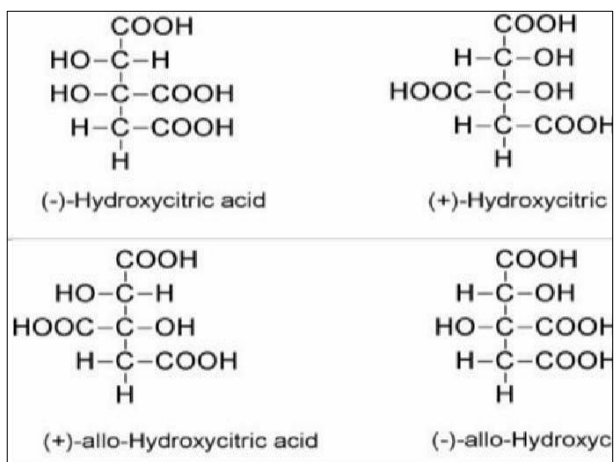


Extraction

Extraction of kokum is need to know what it is in the process as we've known anthocyanins is coloring properties. By extracting all the water and sugar, it helps to sustain for a longer period of time. By extracting anthocyanins from plant which involves disintegrating of raw material. Using alcohol and methanol help to extracted the anthocyanins. By stabilize extraction of anthocyanins it helps to promote color retention. Concentration of natural color extract such as evaporation and distillation resulted in loss of hue and chroma, which led to the low-quality product of anthocyanins.

4.2 Hydroxy citric acid

They are found in kokum especially in leaves and rind as HCA which is in the range of 4.1-4.6. And other called Garcinia acid. HCA has a hydroxyl group at a second and its third carbon atom. HCA has two asymmetric carbon and two pair of diastereoisomers. Out of the four, (-)- hydroxycitric acid is found in garcinia species. Free HCA is readily converted to HCA Lactone while evaporation or concentration. HCA is unstable and it is commercially available as a calcium salt. It has inhibitory effect on ATP citrate lypases. This enzyme has a role in fatty acid synthesis from carbohydrates. HCA can be used to increase activity of carnitine palmitoyl transferase. HCA consumption was reported to enhance fat mobilization and fat burning. HCA can be determined by HPLC and titration process.



Extraction

Using osmotic membrane distillation under a thermal process concentration. kokum is extract from fruits rind using deionized water. It takes in a no phase change and can be operated at ambient temperature and pressure and no thermal damage take place.

4.3 Garcinol

Garcinol is a fat soluble and it is a polyisoprenylated benzophenone and contain phenolic hydroxyl groups and can be also called camboginol a triisoprenylated chalcone, pigment and are found in unrind of kokum. And it is a yellow colour. And it can be separated by ethanol. Garcinol is easily available in large amount and high purity by extraction of kokum by chromatographic and crystallization. Contain of a hydroxyl group. High yields of garcinol can be obtain from dried kokum and can easily be converted under acidic condition. Molecular weight of garcinol is 605 and its melting point 122 °C. it may have neuroprotective effect against brain injury.

5. Conclusion

Processed products of kokum are increasing these days, kokum and it products such as syrup, powder, butter and juice are rich source of nutrients and helps to cure many diseases, bio active compounds in kokum like HCA plays vital role in many ways it is extracted separately in many industries The kokum rind has also medicinal value and used in the treatment of piles, dysentery, tumors 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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