

Promotion of Underutilized Kokum (*Garcinia indica* Choisy.) through Scientific Interventions: an Overview

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Abstract

Kokum (*Garcinia indica* Choisy.), a native species of the Western Ghats in India, is an important tree spice that has largely remained underexploited. It is found in the home gardens and is cultivated at a limited scale as a rainfed crop in the Konkan region, usually mixed with other fruit trees. Fruits are commercially exploited for making traditional products from rind such as Kokum Syrup (*Amrit Kokum*), *kokum agal* (salted syrup) and *amsul* (dried rind). The oil extracted from seeds is edible and remains solid at room temperature. Kokum is useful in the treatment of rashes caused by allergies, burns, scalds and chaffed skin. It is known to relieve sunstroke, dysentery and mucous diarrhea apart from use as an appetizer, liver tonic, cardio-tonic *etc.* It is a source of active ingredients such as hydroxycitric acid (HCA), garcinol (a polyisoprenylated benzophenone), anthocyanins and other compounds with potential antioxidant properties. Apart from traditional value added products, novel products such as rind powder, sherbet mix, *solkadhi* mix, wine, honey, beverage dip bags *etc.* have recently been prepared from Kokum. In future, emphasis needs to be given on economic exploitation through organized plantations of elite types, development of value chain management and development of novel value added products.

Key words: *Kokum, post harvest management, value addition, phytochemicals*

Introduction

The Western Ghats covers an area of 160,000 km² in a stretch of about 1,600 km and is situated parallel to the western coast of the Indian peninsula along the states of Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu. Konkan region of coastal Maharashtra and Goa is a narrow strip of land between Arabian Sea and the Western Ghats. Geography, geomorphology and climate of this region have given rise to high heterogeneity which has contributed to its vast and unique diversity. Various horticultural crops such as mango, cashew nut, coconut, arecanut, kokum, jackfruit, jamun, nutmeg, cinnamon *etc.* are specialty of this region.

Among these, kokum (*Garcinia indica* Choisy) is a unique tree spice belonging to the family Clusiaceae. Some of the species in this family possess medicinal properties, whereas most of the plants are known for their oil glands or secretory canals or cavities, which contain yellow or brightly coloured resins. Kokum is one

of the important tree spices that have largely remained underexploited and neglected. It is native to the Western Ghats in India and is mostly found in Konkan region of Maharashtra, Goa, Coastal Karnataka, Kerala, forests of Assam, Khasi and Jaintia hills of Meghalaya, West Bengal and Surat of Gujarat.

Kokum is found in evergreen and semi-evergreen forests, as a home garden tree and is cultivated on a limited scale as a rainfed crop or as a mixed crop in plantations of coconut and arecanut. The defined statistics regarding area under kokum production and productivity is not documented as it is not being planted in an organized pattern as that of commercial fruit crops like mango, cashew, arecanut or coconut. As per a baseline survey (2010), about 1,000 ha area is occupied by kokum in Konkan region with production of 4,500 t fruits. According to survey conducted earlier by the Chief Conservator of Forest, out of the total 46,600 Kokum trees in the state of Maharashtra; 43,000 trees existed in the Ratnagiri and

Sindhudurg districts. It was also reported that in South Konkan, 1,674 t of fruits were used for dried Kokum rind, 757 t for preparation of Kokum syrup and 40 t for Kokum butter.

Uses

Kokum is used in many parts of the country for making several vegetarian and non-vegetarian culinary preparations, including the popular ‘*solkadhi*’ and the sugar syrup ‘*Amrit kokum*’. *Amrit Kokum* makes an excellent sherbet and is useful in as a cool and refreshing drink. Besides this, *kokum agal* (salted syrup) and *amsul* (dried rind) are traditionally prepared from rind of fruit and oil is extracted from seeds.

Kokum is mostly used in the form of dried rind to give acid flavour to curries and the fresh fruit juice for preparing cooling syrup and curries. It has tremendous potential in curries as a substitute to tamarind. Many therapeutic effects of 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, to cure dysentery and mucous diarrhea. It is a good appetizer, liver tonic, cardiogenic and is useful in the treatment of bleeding piles, tumors and heart diseases.

One of the active ingredients of kokum, hydroxycitric acid (HCA), has been patented for use

as a hypocholesterolaemic agent. HCA is a potential anti-obesity agent. It suppresses fatty acid synthesis, lipogenesis, food intake and induces weight loss. Garcinol, a polyisoprenylated benzophenone purified from *G. indica* fruit rind, displays antioxidant, anti-cancer and anti-ulcer properties. Apart from HCA and garcinol, kokum contains other compounds such as citric acid, malic acid, polyphenols and ascorbic acid, with potential antioxidant properties.

Recently, *Garcinia* species have received considerable attention worldwide from scientific as well as industrial sectors and several novel structures, bioactivities and potential utilities have been reported. Kokum is being considered as a functional food that provides, in addition to nutritional components, other physiological benefits. The consumption of high value products of kokum has increased tremendously due to the awareness of the potential health benefits associated with the diverse bioactive constituents in the plant.

Improved varieties

Systematic research on collection, characterization and evaluation of kokum was carried out at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra. After the evaluation, two varieties of kokum have been developed for promoting commercial cultivation in the region. The important morpho-physiological characters of these varieties are given in Table 1.

Table 1. Key features of improved varieties of kokum

Characters	Konkan Amruta	Konkan Hatis
Yield (7 years, kg)	138	250
No. of fruit per kg	29	11
Length of fruits (cm)	3.74	4.22
Circumference of fruit (cm)	13.15	20.10
Wt. of fruit (g)	34.45	91.50
Wt. of rind (g)	17.55	48.34
No. of seed/fruit	6.40	5.60
Shelf life (days)	15	18
Volume of fruit (ml)	35.50	112.8
Diameter of fruit (cm)	3.95	4.20

Thickness of rind (mm)	4.45	5.58
T.S.S.(°B)	9.08	9.20
Reducing sugar (%)	2.41	2.40
Total sugar(%)	4.52	4.10
Acidity	5.12	5.10
pH	1.81	1.80
Flower bud appearance	1 st week of October	2 nd week of November
Initiation of flowering	2 nd week of November	2 nd week of December
Harvesting period	March-April	April-May

Crop cultivation

The seedlings start flowering 7 to 8 years after planting, whereas flowering in grafts is noticed after 3 to 4 years. Generally, kokum plant flowers during December to January. Flowers are borne singly or as fascicular cymes on leaf axils and are tetramerous. The period from flower bud appearance to initiation of flowering is about 30 days. Pollination is through wind. The fruits are harvested after about 120 days of fruit set. Kokum fruits are ready for harvesting from April to May and most of the fruits are harvested in May-June which is the start of rainy season. Nearly 40-70% of the fruits are trapped in rains and hence lost. Presently in Konkan region alone, this loss is estimated to be of Rs. 157 lakh. Not only farmers suffer seriously because of this loss but the processing industry is also adversely affected as large quantity of kokum fruits is required for value addition. Post flowering foliar spray of potassium nitrate and monopotassium phosphate helps to pre-pone harvesting by about 10 to 34 days (Haldankar et al., 2012b).

All kokum fruits on a tree are not ready for harvesting at a time and hence periodical plucking is done. The number of pluckings varies from tree to tree. Generally, 6 – 8 pluckings are required in high yielding plants. Number of pluckings in kokum is a constraint in harvesting. Spraying of ethrel (300 ppm) at the stage of full maturity of kokum fruits helps to facilitate harvesting by reducing the number of pluckings and improving the yield as well as chemical composition of fruits. Fully ripe fruits are plucked by hand. Skilled persons climb on the tree and shake the branches. The ripe fruits which fall down are collected.

It leads considerable loss of fruits. Approximately 35-40% fruits are lost, which include immature and broken fruits. In a seedling population, 30-50 kg yield per plant is obtained. In a well managed plantation, 100 kg yield per plant could be obtained (Haldankar et al., 2012a). When kokum is planted as mixed crop in coconut plantation, 15 kg yield per plant is obtained. Annual fruit yield fluctuation is reported in kokum and higher yields are reported every alternate year. Considerable variability in physico-chemical composition of kokum is also noticed. The harvested fruits are exclusively used for processing.

Postharvest handling

The postharvest operations *viz.* grading, packaging, storage and transport play significant role in processing of kokum and shelf life extension (Haldankar et al., 2020). The shelf life of kokum fruits is 5.4 days under ambient temperature storage. It can be extended to 15 days when treated with Waxol (12%) and stored in cool chamber, and up to 28 days when stored at 13 °C ± 1 °C with 86% RH and Waxol (3%) treatment. CFB boxes and paddy straw are good packaging material for kokum.

Value addition

Traditionally, fresh fruits are collected from the forest areas, pooled and marketed. Freshly harvested fruits are reddish green in colour, which turn into full-red to purple colour in a day or two. The fruit has an agreeable flavour and sweetish acid taste. Various value added products prepared from kokum are given below (Thakor et al., 2012).

Dried rind

The normal shelf-life of the fresh fruits is about 5 days. Hence, sun drying is practiced for its preservation. For sun drying, the fresh fruits are cut into halves and the fleshy portion containing the seeds is removed. The rind constitutes about 50-55% of whole fruit. It is repeatedly soaked in the juice of the pulp during the sun

drying. About 6-8 days are required for complete drying. The product so dried, constitutes the unsalted Kokum of commerce. A salted variety, wherein common salt is used during soaking and drying of the rind is also marketed. *Lonavala kokum*, *Pakali kokum*, *Khane* or edible kokum and *Khoba kokum* are some of the trade varieties. The composition of the fresh kokum rind is given in Table 2.

Table 2. Composition of the fresh Kokum rind

Particulars	Value
Moisture (%)	87.50
T.S.S. (°Brix)	16.44
Protein (N × 6.25%)	1.92
Crude fibre (%)	14.28
Total ash (%)	2.57
Tannins (%)	2.85
Pectin (%)	5.71
Starch (%)	1.00
Crude fat (%) (Hexane extract)	10.00
Acid (as hydroxycitric acid)	22.80
Pigment (%)	2.4
Ascorbic acid (%)	0.06
Carbohydrates by difference* (%)	35

Raw Kokum juice extraction and beverage

After destalking and washing of fruits, the seeds are removed from the fruits. Then the rind pieces along with juice from the fruit are passed through hand operated screw type juice extractor. The juice obtained is filtered through four folds of muslin cloth and the clear juice obtained is used to prepare the ready to serve (RTS) beverage, squash and syrup. For RTS, the total soluble solids content and acidity of different juices are observed. Required quantity of citric acid and sugar is added to juice (20%) to raise its °Brix and acidity to 20 °Brix and 0.3%, respectively. Sodium benzoate (140 mg/kg) is added to the product as a preservative. After adding required quantity of sugar, citric acid and water, the product is boiled for few minutes to dissolve the ingredients and

preservative is added. Beverage is then filled into the pre-sterilized glass bottles and sealed with crown corks. Then the bottles are pasteurized for 30 minutes in boiling water, removed, cooled, labelled and stored in cool and dry place at ambient temperature.

Squash

The TSS content is noted and required quantity of sugar is added to juice (25%) to raise its TSS to 45 °Brix. Acidity of 1.2% is maintained in this product. After adding the necessary quantity of sugar the product was boiled to dissolve the ingredients. Preservative *i.e.* sodium benzoate is added at the rate of 610 mg/kg of final product. The final product is filled immediately into the pre-sterilized glass bottles followed by sealing of bottles with the crown

corks and pasteurization for 30 minutes in boiling water. The filled bottles are then removed, cooled, labelled and stored at cool and dry place at ambient temperature.

Syrup (Amrut Kokum)

Fresh and sound fruits are selected, washed with water and stalks are removed. The fruits are cut into four pieces, and pulp and seeds are removed. The pieces of rinds are mixed with sugar in 1:2 (rind: sugar) proportion. This mixture is kept in a big stainless steel vessel for 7 days. The mixture is well stirred every day. After 7 days, whole juice from Kokum rind gets extracted due to osmosis and whole quantity of sugar gets dissolved in it. The syrup is then strained through 1 mm stainless steel sieve to separate out the rind portion. The preservative i.e. sodium benzoate at the rate of 610 mg/kg of the finished product is added. The syrup is filled in the pre-sterilized glass bottles. The bottles are then crown corked, labeled and kept in a cool and dry place at ambient temperature conditions.

Ripe Kokum Rind Powder

Fresh fruits are cut into pieces and pulp and seeds are removed. The pieces are then dried in cabinet drier at 50- 55 °C followed by powdering in electrically operated grinder. The powder is then sieved through 1 mm mesh sieve and then packed in polythene bags and kept in a cool and dry place at ambient temperature condition.

Brined Kokum Juice (Agal)

The fruits are cut into pieces and inner pulp and seeds are utilized. The pulp along with the seeds is taken into a big stainless steel vessel. The salt at the rate of 160g/ kg pulp is added. The mixture is stirred daily for seven days. After seven days, the whole mixture is strained through stainless steel sieve and filled in pre-sterilized bottles.

Kokum RTS

The RTS of kokum can be prepared by diluting kokum syrup to 1: 5 proportion with UV purified water. Salt and cumin powder is added to it for taste.

Natural kokum juice

Kokum juice extracted from kokum rind can be preserved for longer duration after adding 1,000 ppm sodium benzoate and stored at cool and dry place. This juice can be used for preparation of various processed products.

Kokum Butter

The oil is traditionally extracted by boiling the kernels in water and the oil which collects at the top is skimmed off. Nowadays oil is also extracted by solvent extraction. The yield of oil (fat) is about 25%. The fat is greasy to feel and whitish yellow in colour. Kokum seed contains 23-26% edible oil, known as kokum butter. It remains in solid state at normal mean temperature. The chemical characteristics of the butter are as given in Table 3.

Table 3. Chemical Characteristics of the Fat

Particulars	Value
Melting point	39 - 43°C
Sap value	189
Iodine value	34.7 - 36.7
Unsap matter	1.4%
The component fatty acids	
Myristic acid (%)	0-1.2
Palmitic acid (%)	2.5-5.3
Stearic acid (%)	52.0 -56.4
Oleic acid (%)	39.4-41.5
Linoleic acid (%)	1.7

Kokum fat has been reported to be used in chocolate and confectionery preparation. It is also used in the manufacture of soap, candle and ointments. An ointment made out of Kokum fat, white dammar resin (resin exuded by *Vateria indica* tree) and wax is said to be effective in treating carbuncles.

Table 4. Nutraceutical activity in butter of various *Garcinia* species

Content	Nutraceutical activity
Palmitic acid (%)	<ul style="list-style-type: none"> • Ionic surfactant (soaps, cosmetics and releasing agents) • Softens skin, heals ulceration, fissures of the lips, hands and soles of feet. • Controls obesity and helps to recover some reproductive abnormalities • Diet enriched, good for diabetes
Stearic acid (%)	<ul style="list-style-type: none"> • Use in soaps, detergents, shampoo, shaving creams and other cosmetic products • Used in margarine and other spreads • Diet enriched, 14 % total plasma cholesterol decreased
Oleic acid (%)	<ul style="list-style-type: none"> • Hinders the progression of adrenoleukodystrophy, a fatal disease that affects the brain and adrenal glands
Linoleic acid (%)	<ul style="list-style-type: none"> • Helping people loose body fat & controlling weight • Possibly preventing colon or breast cancer. • Strong antioxidant, lowering high cholesterol
Arachidic acid (%)	<ul style="list-style-type: none"> • Anti-inflammatory diet
Vit. E (mg/100g)	<ul style="list-style-type: none"> • Antioxidant
Phytosterols (0.10 – 1.02)	<ul style="list-style-type: none"> • Block cholesterol absorption sites in the human intestines • Cardio-tonic
Monounsaturated fats (34.5-39.7 %)	<ul style="list-style-type: none"> • Improve heart health, help to lose belly fat • Keep cholesterol down
Polyunsaturated fats (1.32-11.38%)	<ul style="list-style-type: none"> • Lowers LDL cholesterol level, raises HDL cholesterol level • Reduces inflammation

(Utpala and Nandakishore, 2014)

Novel value added products

Kokum Sherbet Mixture

It is an instant product (ready to prepare) in which kokum powder, sugar and spices are added in various concentrations and the mixture is dried in a tray dryer to get the Kokum Sherbet Mixture.

Kokum Solkadhi Mixture

It is an instant product (ready to prepare) in which kokum powder, coconut milk powder, milk powder, salt, sugar and spices are added in various concentration and the mixture is dried in a tray dryer to get the Kokum *solkadhi* mixture.

Kokum Wine

Majority of produce in kokum is used for syrup and juice preparation during summer months apart from some produce which is dried and stored. Remaining part is not harvested and goes as waste. It can be used to produce fermented beverages like wine. The kokum juice is having dark colour and more acidity, hence in order to reduce colour and acidity of wine and to get good amount of quality wine with light alcohol, the wines were prepared from kokum juice by diluting the juice and adjusting the pH levels of must (Pawaskar et al., 2020). Kokum juice has about 4% sugar and can be fermented to produce wine. Kokum wine is prepared in Goa using the traditional method with commercial baker's yeast.

Kokum Honey

Honey is concentrated floral nectar. So far no efforts are reported to establish apiculture unit in Kokum plantations. But, if this is done then 'Kokum honey' can be obtained with excellent medicinal qualities.

Benzophenone derivatives

Garcinol-1 is a polyisoprenylated benzophenone derivative from kokum and other species. The dried rind of kokum contains 2-3% garcinol. Garcinol is structurally similar to a well known antioxidant-Curcumin, which contains both phenolic hydroxyl groups and diketone moiety. Garcinol has been reported to possess antibiotic activities, antiulcer activities, suppressed colonic aberrant crypt foci (AFC) formation, and induction of apoptosis through cytochrome C release and activation of caspases in human leukemia HL-60 cells.

Anthocyanins pigments

Kokum is a rich source of anthocyanins. The red colour in kokum is due to presence of anthocyanins such as Cyanidin 3-glucoside and cyanidine 3-sambuboside. The pigment content in kokum is 1,000-2,400 mg/100g. Anthocyanins are considered as potential replacements to synthetic colours because of their bright attractive hue

and water solubility that allows their incorporation into aqueous food systems. They also possess health benefits.

Hydroxycitric acid (HCA)

One of the important uses of kokum is as an anti-obesity agent. The bioactive phyto-chemical responsible for this property is *Para* - hydroxycitric acid and is found in abundance, ranging from 10-30% in the rind of dried fruit of kokum. Attempts were made at author's institute to assess these phytochemical properties of selected kokum types. The highest anthocyanins were observed in two types, which were greater than the earlier reports. Similarly, HCA content was found highest in Variety Kokum Amruta, which was better than previous reports. Further, three types from Diveagar location had superior HCA content.

Development of process of preparation of Kokum beverage dip bag

A novel kokum beverage dip bag product was recently prepared and patented (application ID: 201721009815) by the author's institute. The process includes a) extraction of juice from fresh kokum fruit rind by means of basket press, b) treating the rind residue with sodium chloride (common salt) c) drying the rind residue in cabinet dryer d) grinding the dried residue to obtain a free flowing powder (infusion material) e) filling the residue powder in the double layer filter paper bags and heat sealing The kokum beverage can be prepared by dipping the bags having kokum rind residue infusion material in chilled water for kokum juice infusion and addition of powdered sugar in the reconstituted juice.

Economics

The processing of the kokum fruits is a home scale as well as the commercial (factory) entrepreneurship avenue. The benefit: cost ratio for the processing is given in Table 5. These entrepreneurship options could create more opportunities for employment to family labour (Kshirsagar et al., 2014).

Table 5. Benefit: cost ratio for kokum processing

Particulars	B : C ratio		
	Dried kokum rind	Amrit kokum	Kokum agal
Home scale processing	1.43	2.11	1.40
Commercial (factory)	1.52	1.23	1.83

(Kshirsagar et al., 2014)

The economics of the fresh fruit and value added products of kokum is given in Table 6. It is apparent that the entrepreneurship of value addition of kokum fruits definitely gave higher economic returns to growers.

Table 6. Economics of fresh fruit and value added products of kokum

Particulars	Value
Average yield of kokum fruits/plant	30 kg
Returns from the sale of fruits/plant (@ Rs. 20/- per kg)	Rs. 600/-
Preparation of kokum syrup from 30 kg fruits (15 lit recovery)	Rs. 2,250/-
Sale of RTS by vending machine (90 lit) (@ Rs. 10/- per 200 ml tetra pack)	Rs. 4,500/-

Prospects for exploitation of kokum

Besides the novel medicinal and phytochemicals properties of kokum, it has largely remained commercially underexploited and hence, emphasis needs to be concentrated on economic exploitation through various approaches.

1. Organized plantation of elite types and development of cluster model, contract farming with backward and forward linkages.
2. Development of value chain for reducing postharvest loss.
3. Development of novel value added products.
4. Value addition of immature fruits.
5. Evaluation of diversity of kokum with special reference to phytochemically superior types.

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