Western Ghats Kokum Foundation's

Resource Book on KOKUM

(*Garcinia indica* Choisy)

Incorporating Proceedings of three National Seminars held in 2001, 2005 & 2011

Western Ghats Kokum Foundation

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(*Garcinia indica* Choisy)

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Index of Contents

Acknowledgement

We acknowledge with gratitude the gift of the plant species that the Botanists have named as *Garcinia indica* and the people affectionately know in their own native tongues as Goa butter tree, kokum butter tree, mangosteen oil tree, kokum, bheranda, bhiranda, kokamba, kokambi, ratamba, ratambi, tambada amba murgal, murgal-mara, kaattampi kokkam, murgina, punarpuli, devana huli, tintali, kokam, bhirind, kokam, vrikshamia, amlabija, amlapura, amlashaka. In French, Italian and Spanish the name is spelt as cocum and in Portuguese it is known as brindao or brindonna. Whether one believes in creation or in evolution, trees came before human beings.

The people of the Konkan who discovered uses for the fruit rind, pulp and seed, and built up the tradition of having it as a part of the daily meal, undoubtedly helped to perpetuate the tree species through cultivation of the tree for domestic consumption. Those who raised seedlings and spread them across the region have helped generate and preserve the vast plant diversity that exists in *Garcinia indica* today. We are grateful to them for giving mankind the plant diversity from which to develop elite selections and hybrids as per the requirements of the present day.

Our special thanks go to the farmers and scientists who brought different types of *Garcinia indica* fruits, dried rind, juice, syrup, agall (juice in brine), aerated Ready-To-Drink beverage, Kokum butter and other products to the first National Seminar on Kokum held at Regional Fruit Research Station, Vengurla, of the Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth (Konkan Agriculture University), Dapoli, Maharashtra, in 2001. These and the papers presented on the occasion, formed the strong foundation on which grew the Western Ghats Kokum Foundation to facilitate two more national seminars, produce a compendium and to attempt this Resource Book.

The participants in the second and third National Seminar on Kokum, scientists, farmers, processors, equipment manufacturers, bankers, journalists and others have contributed to the development of the pool of knowledge from where we have drawn deeply to produce this Resource Book. After the 1st National Seminar on Kokum new selections of Kokum varieties have been made and propagated, new equipment for cutting , juice extraction, powdering drying and packing of Kokum products have been developed. It is gratifying to note that new range of Kokum products have been developed and successfully marketed during the last decade.

We acknowledge the role of the internet in providing access to information that would otherwise have remained inaccessible in different parts of the world, and also for easy communication with the various contributors via email.

The National Horticulture Mission, Government of India, has supported the national seminars through the Directorate of Agriculture, Goa. The NABARD, State Bank of India, Sesa Goa Ltd, MCX and other donors have generously supported the activities of the Western Ghats Kokum Foundation. The Indian Council for Agricultural Research has supported the knowledge base through ICAR-Goa Research Complex and Dr. Balasaheb

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The members of the Western Ghats Kokum Foundation including Ajit Shirodkar, Chairman; P. G. Kakodkar, Vice Chairman; Ashok Joshi, Hon. Secretary; Miguel Braganza, Hon. Jt. Secretary; Shrikant Joshi, Hon. Treasurer; and members D. Jayarama Bhat and Bhimrao P. Patil have worked for more than a decade to promote the *Garcinia indica* crop cultivation, improvement, processing, packing and marketing while documenting the progress and doing course correction, when needed. Prabhakar Bhat, Shree Padre, B.P. Patil and others have closely collaborated with the committee to present the three national seminars.

To all those who have helped in putting together this Resource Book and to Roque Fernandes of Diamond Publications for the design, layout and printing, we say a big "THANK YOU".

Thank you, dear reader, for choosing to learn a little more about *Garcinia indica*.

Globalisation and Kokum

Ajit Shirodkar
Chairman, Western Ghats Kokum Foundation

Mention the words globalisation, WTO regime, trade barriers, etc. and you are met with an intense adverse response from India's industrial and agricultural communities. The country that, a mere decade ago, cruised merrily with its closed economy - an economy of inefficiencies, waste, monopolies and consumer-unfriendliness, finds itself exposed in this new millennium to intense competition, high efficiency, enhanced productivity and a consumer-friendly environment. Is it any surprise that such sudden and extreme change can create not only resistance but often despair among the affected parties?

The devastating effect that such a sudden shift can have on our predominantly agricultural economy and on its backbone, the marginal farmer, who hardly has any shock-absorbing capacity, is quite understandable. To aggravate, we have historically been, and continue to be, a nation of small land holdings, traditional agricultural practices, poor infrastructure and age-old land laws. No doubt the government does try to alleviate the immediate pain by measures such as support prices, input subsidies and adjustments in import duties etc., but these are at best short-term remedies. To take the long view, and certainly this view is gaining ground among scientists, technologists and especially enlightened horticulturists, what is often perceived as a catastrophe in the short term could actually be a boon to a country like ours that is so richly bestowed with nature's bounty.

Consider a few of India's assets:

- Highest percentage of arable land to total land area (50% of 165 million hectares)
- 800 mm average rainfall
- Diverse agro-climatic zones, ranging from tropical to temperate
- Well-developed and supportive industrial sector
- Abundant skilled and unskilled labour force available to agriculture

Looking nearer to the West Coast area, the *Garcinia indica* endemic region, the western ghats, the picture gets even rosier:

- 2500+ mm rainfall and
- 250+ hours of daylight / sunshine, critical energy sources for agri-horticulture
- Proximity to a biodiversity hotspot, estimated to hold more than 4000 of the country's endemic plant species and harbouring a rich and diverse vegetation

Therefore in this era of globalisation and liberalized economies, our paramount task as agricultural scientists, technologists or administrators would be to prepare a blueprint and a roadmap for systematic exploration and sustainable commercial exploitation of our natural wealth. Such a roadmap would chart out a complete course - identifying potential

fruit trees and medicinal plant species, devising propagation techniques, establishing large-scale cultivation and harnessing commercially exploitable products. Needless to say, it is imperative that intellectual property rights be considered for sustainable prosperity.

Historical perspectives and sustained interactions with the agricultural, medical and pharmaceutical communities of the Western Ghats Region have confirmed the belief that Kokum (*Garcinia indica* Choisy) is the fruit tree of choice for the region. With the defined goal to promote Kokum as a commercial medicinal fruit plant of the region that needs to take the centre stage as major fruit crop of West Coast of India, the Western Ghats Kokum Foundation since its formation in 2001 has worked systematically for the past decade to bring out awareness, promotion of improved varieties, scientific propagation, cultivation and harvesting and finally promoting suitable traditional and technology products of *Garcinia indica* for the markets.

All this is reflected in the three national Seminars on Kokum organized in 2001, 2005 and 2011 respectively, covered in this Resource Book of Kokum.

Throughout these activities the foundation's focus is the farmer. Ensuring that he gets remunerative prices not only for his produce but more so, shares in the value added products by developing the required intermediates to the processors, on the farm premises itself. In the globalised scenario, farmer's prosperity will be linked to increasing his share in this value creation.

Think Globally, Act Locally. . . . . Always!

An Introduction to Kokum

Kokum *(Garcinia indica* Choisy*)* is one of the native underexploited tree spice. It is mostly found in Konkan region of Maharashtra, Goa, Karnataka, Kerala and Surat district of Gujarat on the West Coast of India and to some extent in the forests of Assam, Meghalaya, West Bengal. In spite of its incredible medicinal and nutritive properties, kokum is generally not cultivated systematically on orchard scale like that of mango, cashew nut etc. It is mostly found as a kitchen garden plant or mixed crop in plantations of coconut, areca nut, as roadside plants or in forest.

The common names for Kokum are Goa butter tree, Kokum butter tree, mangosteen oil tree. In Hindi it is known as Kokum while in Marathi it is variously known as bheranda bhiranda, kokamba, kokambi, ratamba, ratambi, tambada amba. In Tamil it is known as murgal, murgal-mara and in Malayalam it is kaattampi kokkam in Kannada it is called murgina, punarpuli, devana huli. In Oriya it is tintali and in Gujarati and Konkani it is Kokam or bhirind. In Sanskrit it is variously known as vrikshamia, amlabija, amlapura, amlashaka. In French, Italian and Spanish the name is spelt as cocum and in Portuguese it is known as brindao or brindonna.

Kokum is a tropical evergreen tree, related to the mangosteens. A slender tree with sloping branches, it reaches heights of 15m (50 ft). The thin bark is lined and the leaves oblong. The dark purple fruit is round, about 4 cm ($1^{1/2}$ in) in diameter with 5 - 8 seeds. The fruits are picked when ripe, the rind is then removed and soaked in the juice of the pulp and then sun-dried. The kokum was hitherto difficult to cultivate, usually growing as solitary trees in a tropical forest environment

Kokum flourishes very well up to an elevation of about 800 m from MSL. It requires warm and humid tropical climate. It thrives well in coastal areas receiving over 250 cm of rainfall. It grows well in lateritic, alluvial soils having depth of 1.0 m and pH of 6.7. The locations where coconut and arecanut can be cultivated are suitable for kokum. Though kokum can be cultivated as a rainfed crop, it can not be cultivated on hill tops like mango or cashewnut. It can be grown as a monocrop or as a mixed crop in established coconut and arecanut plantation. Kokum plants respond well to irrigation during summer. Ripe kokum fruits harvested during April-May from a region / locality and pool the produce at one point for processing. Value added products like salted juice *(agal)*, syrup *(amrut)* or dried rind are prepared.

The precise statistics regarding area production and productivity is not available as kokum is not planted in an organized manner. As per a base line survey in 2010, kokum is grown on about 1000 ha area in the Konkan region with production of about 4500 MT fruits. According to the survey conducted earlier by Chief Conservator of Forest out of the total 46,600 Kokum trees in the state of Maharashtra; 43,000 trees existed in Ratnagiri and Sindhudurg Districts. It was also reported that in South Konkan 1674 MT of Kokum fruits were used for production of dried Kokum rind, 757 MT for preparation of Kokum syrup and 40MT for manufacture of Kokum butter. Research on production technology for Kokum is being conducted at Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, ICAR Research

Complex for Goa, University for Agricultural Sciences, Dharwad and at Indian Institute of Spices Research, Kozhikode (Calicut), Kerala.

Well known these tangy, Green/Reddish berries, Kokum fruit consist of 3 major parts:
• The Kokum Pericarp – which is the rind or peel and contains the highest level of xanthones.
• The pulp – which is the fruit and is known for being one of the tastiest fruits in the world.
• The seeds – found within the white pulp.

Properties: The Kokum rind is used widely in refreshing drinks and curries. The fruit is anthelminthic, cardio tonic, useful against piles, dysentery and is a heart tonic. Hydroxyl Citric Acid (HCA) extracted from Kokum is a fat-reducing medicine used against obesity and is available in the form of tablets in the market. The dry rind (Amsul) is mainly used for garnishing and is a good substitute of tamarind. The fruit can also be used for the manufacture of wine and liquor and could be a good substitute of grapes in the wine industry. The anthocyanin pigments obtained from it are used as natural colouring agents for food preservation. The edible fat 'Kokum butter' obtained from the seed kernels is used in the manufacture of soaps, candles ointments and pharmaceutical preparation especially in skin care products due to its ability to soften the skin and heal ulcers and also fissures on lips, hands and feet. It reduces the degradation of skin cells and restores elasticity.

The National Medicinal Plant Board has identified 'Kokum' as one of the 32 prioritized species of plants for promotion and development. Inspite of its many virtues, no systematic effort has been reported to popularize the fruit to harness its commercial potentials till the 1st National Seminar on Kokum was organized in 2001, at Sindhudurg. The need of the hour is to give pointed focus to every detailed development of the fruit with regard to its production, processing and marketing.

The challenges for development of Kokum:
• Unorganized and scattered plantation leading to poor collection of fruit.
• Only 20% of the present production is processed and the rest is wasted.
• Harvesting time is extremely limited and coincides with the rainy season.
• Absence of any post harvest technology for drying of rind, cutting of fruits or preparation of Kokum drink leading to poor quality product.
• Lack of generic promotion of Kokum about its high medicinal value.
• Lack of awareness about its medicinal virtues.
• Very narrow band of market
• Absence of a specific Nodal department - till recently there was no nodal department of the state government, for the promotion of this crop. By doing this, a road map for the development of Kokum can be constructed by working towards the following points:
-Awareness creation among farmers, processors and consumers about its economic and medicinal value.
-Developing pre- and post- harvest techniques.

Kokum fruit contains compounds that have antioxidant, anti-bacterial and anti-fungal properties. Scientific research indicates activity against several cancer cell lines, including breast cancer, liver cancer and leukemia. In addition, Kokum also exhibits anti-histamine and anti-inflammatory properties.

Traditionally, Kokum has been used for many years as a medicinal treatment for diarrhea, skin infection and wounds in throughout South Asia. Dried Kokum fruit rinds are widely used in cooking as they impart a sweetish-tangy flavor to the food. The fruits contain citric acid, acetic acid, malic acid, ascorbic acid, hydroxycitric acid and garcinol.

Life-enhancing antioxidant found in Kokum pericarp is called Xanthone.

Proven Benefits of Xanthones

1) Anti-fatigue
2) Anti-obesity
3) Anti-depression
4) Anti-anxiety
5) Anti-Alzheimer's disease
6) Anti-arthritis
7) Anti–periodontic (gum disease)
8) Anti-allergic / anti-histamine
9) Anti-seborrheic (skin disease)
10) Anti-pyretic (anti-fever)
11) Anti-Parkinsonism
12) Anti-diarrhea
13) Anti-neuralgia (nerve pain)
14) Anti-vertigo (dizziness)
15) Anti-glaucoma
16) Analgesic
17) Anti-inflammatory (without side effects)
18) Anti-ulcer (ulcers of stomach, mouth, small bowel, large bowel)

Potential Benefits of Kokum

1) Anti-viral
2) Anti-bacterial
3) Free radical fighter
4) Cardio support
5) Immune system Enhancer
6) Powerful antioxidant
7) Skin rashes, infections and wounds
8) Diarrhea
9) Anti-inflammatory
10) Vasorelaxant

Medicinal Properties and Application:

• Kokum fruits contain rich amounts of anti-oxidants that bind with free radicals and prevent oxidative damage to body cells. They also promote cell regeneration and repair.

• Kokum juice is especially popular during scorching summer months as it has a cooling effect on the body and shields the body against dehydration and sunstroke. It also helps in bringing down fever and allergic reactions.

• Kokum seeds contain a high percentage of oil that freezes to form Kokum butter. Kokum butter is extensively used in the pharmaceutical and cosmetic industry as it works wonders on dry, chapped, sensitive, irritated or burnt skin.

• Kokum butter is rapidly gaining popularity over cocoa butter as an intensive skin moisturizer.

• Due to its soothing and healing properties, it is also applied directly to wounds and infected areas on the skin.

• Kokum butter is rich in healthy fats like stearic and oleic acids and can also be used as edible oil, specially in confectionary.

• Extracts from the Kokum fruit are traditionally used to relieve gastric problems like acidity, flatulence, constipation and indigestion.

• Kokum juice is a healthier and far more refreshing option as compared to commercial bottled drinks. It acts as an appetite stimulant and also has anti-helmintic properties.

• Ayurvedic medicine also uses Kokum infusions to treat piles, dysentery and infections. Kokum is known to strengthen the cardio-vascular system and stabilize liver function.

• The hydroxycitric acid present in the fruit fights cholesterol and curbs lipogenesis, thus aiding weight loss.

The fruits are soaked in jaggery(sugar) syrup to prepare kokum juice, a refreshing and healthy drink. This drink is an excellent remedy for sunstroke and is very popular during summer.

The fruit has been traditionally used to treat flatulence, infections and heat strokes.

Traditional Ayurvedic medicine uses the fruit in infusions to treat skin ailments like allergic rashes, burns, chaffed skin and scalds; provide relief from sunstroke; tackle dysentery and mucus diarrhea; improve appetite and quench thirst; treat bleeding piles, tumors and heart problems; and as a tonic for the heart and liver.

HCA is widely used to lower cholesterol. It has been shown to be a good anti-obesity agent as it suppresses synthesis of fatty acids, lipogenesis and food consumption, and brings about weight loss.

The fruit rind has potent anti-cancer and anti-ulcer properties.

Kokum paste and oil are used to hasten healing of wounds and skin problems.

Its rind powder and decoction are useful to prevent dehydration and loss of nutrients; improve digestion and appetite; reduce constipation and provide relief from piles and anal fissures; improve the working of the liver; regulate the cardiovascular system; cleanse the blood and fight infections; and reduce fever and burning sensations that occur in the body.

Sun dried Kokum rind is an Indian spice used in many parts of the country for making several vegetarian and non-vegetarian 'curry' preparations, including the popular 'solkadhi'. The fruits are steeped in sugar syrup to make 'amrutkokum', a healthy soft drink to relieve sunstroke, which is popular during summer.

One of the ingredients of kokum, hydroxycitric acid (HCA), has been patented for use as an 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 kokum fruit rind, displays antioxidant, anti-cancer and anti-ulcer properties. Apart from HCA and garcinol, kokum contains other compounds with potential antioxidant properties. These include citric acid, malic acid, polyphenols, carbohydrates1,3, anthocyanin pigments and ascorbic acid.

Though studies have been carried out on the antioxidant activities of these two isolated components from kokum, besides an organic extract, the antioxidant activity of the rind and its various preparations as is being used in cooking, in soft drinks and medicinal preparations has not been evaluated. The levels of antioxidant action studied are (i) radical formation by Ferric Reducing/Antioxidant Power (FRAP); (ii) radical scavenging by Oxygen Radical Absorbance Capacity (ORAC) and 2,2¢-azobis-3-ethylbenzthiazoline-6-sulphonic acid (ABTS), and (iii) prevention of membrane damage as measured by lipid peroxidation.

These studies are based on standard assays used for determining the antioxidant abilities of food preparations.

The aqueous and boiled extracts were prepared so as to simulate conditions of their extraction pertaining to their use for cooking purposes. The aqueous extract was prepared by adding the crushed rind to distilled water and stirring for 60 minutes, similar to use in many curry preparations.

For boiled water extract, the crushed rind was boiled in distilled water for 30 min, similar to its use in curry preparations. Commercially available kokum syrup was also used for assessing its antioxidant effects by diluting it to 25% (v/v) concentration using distilled water as is generally consumed as 'kokum squash'.

Spice Description

Kokum is dark purple to black, sticky and with curled edges. The fruit is often halved and dried, so that the dried seeds are visible in their chambers like a citrus fruit. It is usually available as a dried rind, resembling a thick plum skin. When added to food it imparts a pink to purple colour and sweet/sour taste.

How to use :

Soak dried rind overnight in one glass of Hot water, drink early morning in empty stomach before brush your teeth, you can add little jaggery if you want. Left over rinds can be used for rasam/curry, grind and make chutney too or dry again and use later.

The kokum is native to the western coastal regions of southern India and is rarely seen beyond this area. Even in India it is used only in the regional cuisines of Gujarat Maharashrta and several southern states where large glasses of kokum sherbet are downed during parched summer months. In this region the sweltering heat demands refrigerant (cooling) ingredients in food and drink. Kokum is well known to counteract the heat.

Culinary Uses

Kokum has the same souring qualities as tamarind, especially enhancing coconut-based curries or vegetable dishes like potatoes, okra or lentils. Kokum is especially used with fish curries, three or four skins being enough to season an average dish. It is also included in chutneys and pickles. The skins are not usually chopped but are added whole to the dish. Seasoning should be checked as they are quite salty. Beware of biting on a stone as a few are often left in the skins.

Attributed Medicinal Properties

Kokum's refrigerant properties are well known. It is useful as an infusion, or by direct application, in skin ailments such as rashes caused by allergies. Kokum butter is an emollient helpful in the treatment of burns, scalds and chaffed skin. The fruits are steeped in sugar syrup to make amrutkokum which is drunk to relieve sunstroke. Source: Called *kokum, kokam*, or *bin'na* in parts of western India, the *Garcinia indica* seed contains 23-26% oil, which remains solid at room temperature and is used in the preparations of confectionery, medicines and cosmetics.

The outer cover of fruit is dried in the sun to get aamsul or kokum. It is used as a slightly sour spice in recipes from Maharashtra that yields peculiar taste and dark red colour. It is a preferred substitute for tamarind in curries and other dishes from Konkan. It is also used in Konkani cuisine, in Gujarat, and some cuisines of South India. Its squash (concentrate) is used in preparing a drink (Sherbath) which is bright red in colour.

Recently, industries have started extracting hydroxycitric acid (HCA) from the rind of the fruit.

India's second national seminar on *kokum* was held March 4-5, 2005 at the Goa University, Goa. Those researching on the crop see it as having a bright future: it is rainfed, does not have any pest or diseases apart from the monkey menace, and is almost a "zero-attention" crop

Kokum can be called as one of the most used ingredient in Konkani cooking. Almost every household at our native and Goa has a Kokum tree. I was very lucky to go to India during kokum season this year. So I took the opportunity to take pictures of this beautiful fruit. The seeds of the fruit have a white colored fleshy coating on it. When the fruit becomes very ripe, its color changes to a bit transparent. The inside of the kokum fruit looks like following.

An average kokum tree bears hundreds of fruits during summer. When they are tender, they are green in color. As they ripen, they get the beautiful purple color. The fruits are plucked when they are ripe. The outer purple skin and the inner seeds are sun-dried separately. The skin, bhirnda sol, is used in cooking as a souring agent and the seeds are used to make *bhirndel tel* (kokum oil/butter).

Our favorite way of enjoying the ripe fruit was to eat it with salt. Carefully take out the tiny cap of the fruit, which would leave a hole on the surface. Then with the help of a toothpick, push some salt crystals in the hole. Insert the toothpick in the hole and rotate it few times to mix the salt with the seeds of the fruit. Now suck the juices through the hole. Ahhh.. it's heaven. Only those who have actually tasted this can understand the sheer pleasure it gives. Once all the juices are done, break the skin into two and pop the seeds one by one in the mouth. Discard the seeds. This was our favorite fruit to eat (only after mango) during summer vacations.

The most popular dish prepared with fresh kokum is the *Sol-kadi* or Soul Curry. A sweet, spicy and sour drink with mustard seasoning. As kokum has cooling effects on the body, this is the perfect drink for hot summers.

Bottled/canned kokum syrup juice or *agal* is available in many shops in Goa which acts as replacement for the fresh fruit to make the *kadi*. Another version that is very popular is *sol kadi*, prepared with fresh coconut milk. Tetrapaks of kokum juice and carbonate kokum soda is now readily available.

The skin of the fruit – which is normally sold as 'kokum' is sun dried in large quantities to be used when the fresh kokum is not available.

Some salt crystals are added to the dried kokum, which acts as a preservative. As days pass, the dark purple skin turns black. When soaked in water for some time, the skin leaves beautiful purple color. This has many medicinal properties. The skin is soaked in water for sometime and the purple colored water is given to the patients suffering from '*pitta*'.

Sometimes the fruit is mixed with sugar and sun dried. The juice that comes out of it is preserved to make kokum juice.

The seeds are sun dried to make kokum butter *(bhirndel tel)*. The outer black shells of the seeds are peeled and the inner white colored seeds are chopped and ground into fine paste. Then they are cooked and dried to get the butter. The butter retains its solid shape at room temperature. When needed, it is held near a flame to melt it. This melted oil is applied to cracked heels and dried skin, which acts as a very effective moisturizer. Before we were introduced to different moisturizer brands, we used this as a moisturizer. Even now, we use it frequently for cracked heels.

EXHIBITION OF KOKUM

Various types of Kokum fruits at the at 1st National Seminar on Kokum held at Regional Fruit Research Station, Vengurla, of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth (2001).

Stages of development and ripening of Kokum fruits.

Western Ghats Kokum Foundation, Panaji - Goa

1st National Seminar on Kokum held at Regional Fruit Research Station, Vengurla, of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth (2001)

The representatives of organising agencies.

A view of the participants.

A technical session in progress. *12 May 2001.*

PROCEEDINGS OF
THREE NATIONAL SEMINARS
ON KOKUM

ON

BIODIVERSITY & CULTIVATION OF KOKUM

Prospects on natural diversity in Kokum- with respect to processing and value addition

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Kokum, botanically *Garcinia indica* Choisy (Thouars), is a commercially under-utilized perennial tree species, found wide spread as a native species in Goa. It belongs to family Clusiaceae of order Theales and sub class Dilleniidae. Few important genera under this family are *Garcinia, Hypericum, Vismia, Cratoxylon, Triandenum, Pentadesma, Mammea, Allenblackia, Calophyllum, Mesua etc.* (Robson and Adams, 1968). The genus *Garcinia* includes 200 species, out of which 30 different species are reported to be found / grown in India (Korikanthimath and Desai, 2005). However, Karnik (1978) have mentioned that over 400 species of *Garcinia* have been identified and 40 edible species have been listed. Though the genus *Garcinia* has got around 200 species widely distributed throughout tropical Asia, few economically important species are *G. mangostana, G. indica, G. gummigutta, G. xanthochymus, G. hombroniana, G. cowa, G. morella etc.* Around 30 species of Garcinia are available in India (Nadkarni et al., 2001). A feature of this genus is the presence of yellow or white latex plant parts. Out of thirty species, G.indica is confined to India and Sri Lanka only (Patil et al, 2005)

G. indica is commonly known as Brindonia Tallow tree or Kokum Butter tree in English. The other vernacular names are kokum, birand, amsol (Konkani and Marathi), brindon (Portuguese in Goa), murugalu (Kannada) and punarpuli (Malayalam).The chromosome number of kokum is reported as 2n = 54 by Krishnaswamy and Raman (1949) and as 2n = 48 by Thombre (1964).

Kokum has got multifarious uses and therefore, finds an inevitable place in the lifestyle of local population. The fruit juice is used for production of syrup, squash, RTS, *agal* (salted juice) etc. The dried rind is used as a souring agent in Goan cuisine. The seeds are a rich source of kokum butter, which is nutritive, demulcent, agent for smoothening, softening etc. and used for cosmetic, confectionary and culinary purposes. Raw fruits, young leaves and bark are also used as medications against several disorders. The fruit rind is a rich source of α Hydroxy Citric Acid (HCA) that prevents fat accumulation in body cells, and thereby functions as the main natural source for production of anti-obesity drugs. (Patil *et al*., 2005)

Current scenario of area, production and processing

Neglected and under utilized crops are essential to the livelihoods of millions of poor farmers throughout the world. In India, kokum trees are endemic to Konkan belt and the estimated production is 10,200 tons, of which 9000 tons are processed. (Sawant, 2005). The trees are found single or in clusters through out Goa. Exact statistics of current area and production of kokum in Goa is not available. However, the area and population of kokum trees in Goa is steadily increasing due to the efforts of Forest Department, Government of Goa. A production target of around 14.75 lakhs seedlings of different species was achieved

during 2008-09. A major emphasis was given to kokum as it also finds an important place in their list of medicinal trees. Around 15-20 ha of demonstration plots have also been developed by the department.

There is a very slow and gradual increase in area due to the Social forestry programmes of Department of Forestry, Govt of Goa. (Table 1) But the plantations are young and so there is no much change in the state production. Besides, Department of Agriculture, Government of Goa also produces kokum seedlings every year and distributes to farmers. Establishment of kokum farms is relatively new and is emerging as a land use system.

Table 1: Details on kokum seedlings produced by Department of Forests, Govt of Goa

Year	No. of seedlings produced	No. of seedlings sold	Remarks
2004-05	24900	6442	Remaining seedlings planted in mixed plantation and not as monoculture; also planted in Raj Bhavan
2005-06	40667	600	
2006-07	19819	50	
2007-08	33389	1464	
2008-09	24595	6003	
2009-10	18306	2274	
2010-11	22581	734	

Source: Department of Forests, Govt of Goa

In crops like kokum, a set or group of women collect / harvest ripe kokum fruits during April -May from a region/ locality and pool the produce at one point, perhaps a progressive planter cum processor. Value added products like salted juice *(agal)*, syrup *(amrut)* or dried rind are prepared at this centre by these folk. These farmers/ processors besides taking up the unsaid duty of conserving these resources in the locality, also act as resources of knowledge about the genetic wealth of the place.

In a case study, it was found that homesteads usually have 4-10 kokum trees, and the fruits produced in each household can range from about 50 kg to more than 200 kg. Each household processes fruits and reserves about 10 kg of rind and 10-15 litres of syrup for its own use through the year. A small quantity may be distributed among relatives and friends. The balance is sold to those collecting fruits at the rate of Rs 3 per kg. Depending upon the number of trees, the income per household through the sale of fruits is in the range of Rs. 100-400 in a year, which is an insignificant amount for the household. The collector sells the fruits to the processor or the commission agent and realises a net profit of about Re. 1 per kg

of fruit. During the fruiting season of 2-3 months, some collectors earn about Rs. 5,000-7,000 through this activity (Table 3). Having kokum in the system gives an additional income, but it does not appear to be substantial at present. (Daniel and Dudhade, 2006). But with the increasing demand for kokum rind and syrup in the international market, it is becoming a successful venture at present

Table 3: Economics of processed kokum products from 100 kg of fresh fruit.

Product	Processed quantity (kg)	Production cost (Rs)	Gross returns (Rs)	Net profit (Rs)
Rind	60	1,100	1,700	600
Syrup	85	2,500	3,025	475

Natural variation in quality characters

Kokum exhibits tremendous natural variation which is an interesting area of research. Pioneering attempts have been made in Maharashtra to study the natural variability and make selections for high yield. But so far, systematic study on natural variability of kokum in Goa was not attempted. Hence, this study was conducted by surveying throughout Goa. Extensive field surveys were conducted in all eleven talukas of Goa. During the survey, 268 accessions were selected for various morphometric and quality characters. Besides, the analysis of diversity and distribution of kokum germplasm using Geographic Information System (DIVA-GIS) has also been carried out for the first time (Hijmans *et al* 2005). Parthasarathy et al. (2006) conducted a similar biodiversity study on pepper in Kerala. Geographical Information System (GIS) has been successfully used to study geographical distribution of cultivated species as well as pests of agricultural crops (Hijimans and Spooner, 2001 and Ganeshaiah *et al*., 2003).

As a result, promising accessions in terms of quality characters were identified. Further, the accessions were clustered based on these quality characters and promising clusters were picked out for specific applications like processing. The results of this study are discussed as under:

Results:

Any fruit is expected to have an appealing sugar: acid blend, in its dessert or processed form. Kokum is hardly eaten as dessert, but fondly consumed as syrup, squash, RTS, *agal* etc. The sugar acid blend in final finished product is made up using sugar. In this context, the quality traits like TSS (^{o}Brix), total acids in rind, juice, total and reducing sugars of kokum fruits play a vital role in the quality of value added products derived. Therefore, identification of suitable candidates with highly sweet or highly sour taste has become essential in value addition point of view.

In the present study the 268 accessions surveyed showed a wide range of value-1.95 to 22.40 ^{o}Brix for TSS, total acids in fruit ranged from 1.22 to 11.24 per cent, total acids in juice from 0.43 to 10.97 per cent, total acids in extract from 0.64 to 9.6 per cent, total

sugars from 0.59 to 3.47 per cent and reducing sugars from 0.12 to 1.56 per cent. The most promising accessions for TSS is Bandarwada-3 with 22.40 o Brix followed by Dabose-1 with 17.05 ° Brix. Korikanthimath and Desai (2005) have reported a TSS range of 6 to 12 o Brix ; Nair (1986) reported as 11.04 to 16.44 per cent; Khan and Pandya (1936) recorded average TSS of 14.83 per cent ; Joshi (1994) showed 16.45 per cent and Gosavi (1998) recorded 16.47 per cent .However, the TSS of "Konkan Amruta", the first released variety has been reported to be 9.08 per cent (Patil et al., 2005a).

Joshi (2005) reported that, while producing RTS, a TSS of 20 ° Brix and 0.30 per cent acidity is usually maintained by addition of sugar. But when accession like Bandarwada-3 is used as raw material for making RTS whose TSS and total acids content in pooled juice is 22.40 ° Brix and 0.64 per cent, addition of sugar and citric acid is not required. Such accessions with promising TSS content can also be employed in preparation of syrup and squash by minimizing the quantity of sugar added.

As a result of mapping the values by point to grid method (DIVA-GIS software-Fig.3), there were five categories namely 19.0 to 22.0 ° Brix (red grids), 15.0 to 10.0° Brix (orange grids), 12.0 to 15.0 ° Brix (yellow grids), 8.0 to 12.0 ° Brix (light green grids) and a minimum range of 5.0-8.0 ° Brix (dark green grids).

As there is only one accession (Bandarwada 3) having TSS in range of 19.0-22.0° Brix, it was not depicted on the map. However, this tree was located in Pernem taluk. Similarly, maximum diversity for TSS was found in Pernem, Bicholim and Canacona taluks.

Total acids in fruits i.e fresh rind ranged from a minimum of 1.22 per cent to a maximum of 11.24 per cent with a grand mean of 4.12 per cent. Total acids in juice ranged from a minimum of 0.43 per cent to a maximum of 10.97 per cent, with a grand mean of 3.72 per cent. Average was drawn for total acids per cent in fruit, juice and extract left out. This data ranged from a minimum of 1.2 per cent to a maximum of 7.36 per cent. The grand mean was 3.78 per cent for all 268 accessions under study. As a result of subjecting the data to point to grid plotting on Goa map, a grid map was obtained with grids of five different colours viz., red, orange, yellow, light green and dark green which illustrated clusters with average acids ranges viz., 6.0-7.0, 5.0-6.0,

4.0-5.0, 3.0-4.0 and 1.0-3.0 respectively. Red grids were spotted in Pernem, Bardez, Bicholim, Sattari, Tiswadi, Sanguem and Canacona talukas; orange grids depicting average acids ranging from 5.0-6.0 per cent were spotted in Pernem, Bardez, Bicholim, Sanguem, Quepem and Canacona talukas. Accessions having medium average acids ranging from 4.0-5.0 per cent were found in all the talukas of Goa. Lower range of average acids (3.0-4.0 per cent) illustrated by light green grids were spotted in all talukas except Bicholim Ponda and Mormugao talukas. The lowest range of average acidity (1.0-3.0 per cent) symbolized by dark green grids were seen in Sattari, Bicholim, Bardez, Tiswadi, Salcete and Quepem talukas.

An attempt was made to classify the accessions into three groups based on two criteria viz., TSS and total acids in juice. The results showed that for three clusters viz., 1, 2 and 3, the cluster means were 7.34, 11.66 and 8.36 respectively for TSS (° Brix); whereas it

was 2.39, 3.64 and 5.71 for acids in juice (per cent). 57 accessions under Cluster-2 possessed a promising group of accessions with average TSS of 11.66 ° Brix and average acidity of 3.64 per cent which is an appealing sugar: acid blend.

These accessions form a valuable genetic resource for processing industries. Kokum, basically being an acidulent, showed lower values for total and reducing sugars when compared to other fruits. But still, like other traits, genetic diversity was noticed for these attributes also. Accessions like Chandor-3 and Madian-2 recorded higher values of 4.12 and 3.47 per cent for total sugars. Similarly, higher value of 1.95 per cent was recorded in Dabose-1 and 1.56 per cent in Amerem-2 and Bandarwada-2 whose TSS was the highest among the genotypes. Therefore these accessions can be considered as promising in terms of sweetness. These accessions were located in Pernem, Bardez, Satari taluks. So far, field surveys for kokum resulted in identification of superior genotypes only in terms of yield or fruit size. But, this attempt has aided in spotting mother tree for quality aspects also. Cultivation of clonal progenies of these selected superior types for quality will enhance the processing industry of kokum.

Future thrust

- Systematic data on area, production and consumption pattern need to be recorded
- Crop Improvement for yield and processing traits to be further focused upon.
- Thrust on non-traditional products besides traditional ones will uplift the processing sector
- Indian processing and pharmaceutical industries need to play a key role to realize the full potential of kokum
- Wide-spread advertisements are needed to popularise and capture market- initially in neighbouring states and then in national level.
- Indian based clinical studies have to be taken up by research organizations.

Status of existing Kokum plantation in Maharashtra

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According to the survey conducted earlier by the Chief Conservator of Forest out of the total of 46,600 Kokum trees in the state of Maharashtra 43,000 trees existed in Ratnagiri and Sindhudurg district alone. Konkan region has virtual monopoly especially in Ratnagiri and Sindhudurg district in Maharashtra state in Kokum cultivation. Naturally growing scattered trees are also observed in Raigad district. In Sindhudurg district estimated area under Kokum is about 108 hectares scattered along riverbanks, streams, valleys, roadsides and backyard wastelands. Trees are also observed in coconut and arecanut gardens. However, no systematic plantation or regular orchards of this crop are established. The government of Maharashtra has been recently promoting the farmers of this region to grow Kokum in a systematic manner under Employment Guarantee Scheme and District Rural Development Agency. Although, reliable statistics regarding area and production of Kokum are not available, Karnik *et al*, (2001) reported 1200 ha area under Kokum in Maharashtra and 10,200 MT productions with productivity of 8.50 t/ha.

Morphological Features of Kokum

A full-grown tree of Kokum attains a height of about 16 to 20 meters. The tree itself is ornamental with a dense canopy having lush green leaves with red tinged tender emerging leaves. Being a pyramid shaped handsome evergreen tree, it is a good choice for growing along the roads and railway tracts. The leaves are ovate to oblong, lanceolate, broad, dark green above and pale beneath. Kokum is predominantly a dioecious plant and cross-pollination of the flowers on female tree is very essential for fruit set. Karnik *et al* (1978) observed substantially high fruit set in both open (natural cross) and hand (artificial cross) pollination in Kokum which could be due lo large number of pollen grain produced by Kokum trees and role of wind in pollinations as judged by the atmospheric pollen.

The fruits are generally globose or spherical dark red when ripe, enclosing 5 to 8 large seeds. Kokum tree starts flowering during the month of November - December and fruits are harvested during April-May. Study conducted at Agricultural Research Station, Mulde Taluka of Kudal District in Sindhudurg revealed that seedlings trees take 6 to 7 years for commencing flowering. The ripe fruits have agreeable flavour and sweetish-acid taste. They contain substantial amount of malic acid and a little tartaric or citric acid. Hydroxy Citric Acid (HCA) extracted from Kokum rind claimed to lower human body fat. Hence, in coming decades Kokum will occupy the unique place as one of the useful and valuable perennial spice crop from the Konkan region. Fat extracted from kernel is used in confectionery preparations, cosmetics and manufacture of soaps and candles.

Processing of Kokum

The products such as Arnrit Kokum (Kokum syrup) and Amsol (dried Kokum rind) are prepared from Kokum rind. South Konkan of Maharashtra state where Kokum is grown as an important other major fruit crop and its products are commercially processed at

household level has been the traditional Kokum pocket.

Wadkar *et a*l (2001) mentioned in their survey report that the quantities of product prepared per house hold varied from product to product when data were collected by survey method of 60 respondents in the year 1995-96 for testing of economics of processing of Kokum fruits at house hold level. It is also reported that in South Konkan, it was estimated that 1674 MT of fruits were used for dried Kokum rind, 757 MT for preparation of Arnrit Kokum and 40 Mt for Kokum butter.

The existing marketing of Kokum is completely controlled by traders. Major constraints confronted by the farmers regarding scarcity of labour, damage of fruits by monkeys, non availability of grafts for planting etc.

Constraints in Production and Processing

Survey conducted during the year 1996 of South Konkan Coastal Zone of Maharashtra state by Patil et al (2001) to know the problems in marketing throw light on important constraints experienced by the farmers as well as market functionaries. Survey revealed that high cost of transport, inadequate transport facilities in interior hilly area, high wage rates and labour scarcity were the major constraints among them. Late season, irregular bearing habit and non-availability of grafts were the major problems faced by the producer. Sale and purchase of Kokum fruits is season bound business due to low shelf life and collection of produce and disposal to destination (Mumbai) has to be completed within few days. The main suggestion made by the producer and market functionaries to overcome these problems were to develop the infrastructural facilities in remote villages.

Kokum Promotion Strategies

In order to promote Kokum plantation on massive scale it is necessary to provide liberal funding and subsidies for its inter planting in coconut, cashewnut and mango orchards as well as its border planting around these gardens and field bunds. Similarly, funding and subsidies may be provided to the farmer processors for an integrated package of Kokum production and primary processing of Kokum fruits.

Status of Kokum in Goa

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Garcinia species are distributed widely throughout the tropical Asian and African countries and have tremendous potential, both as spice and medicinal plants. The typical features of *Garcinia* species include monopodial growth.

Recently *Garcinia* excited the scientific world for possessing properties that regulate obesity. Though commercially important, these species remained neglected and not much attention was given for their research and development. Present production level of Kokum is estimated at 10,200 tons from 1200 ha. (Table 1). However, there is a continuous increase in its demand as is evident by the market trends and export scenario.

Table 1: Kokum in Goa at Glance

Area	:	1200 ha
Production	:	10,200 T
Yield	:	8.5 t/ha
Rind	:	3.6 t/ha
Fresh seed	:	1.9 t/ha
Pulp	:	3.0 t/ha
Dry seed	:	0.86 t/ha
Wt. of kernel	:	0.57 t/ha
Oil content	:	0.15 t/ha
Oil (dry seed)	:	25%

This crop is gaining increasing importance, as its fruits have multifarious utilities ranging from the pharmaceutical uses to high quality beverages.

Table 2: Market - Demand and Export Scenario

1.	Estimated domestic demand (tonnes):
	1999-2000 2001-02 2004-05 272.30 466.60 1046.50
2.	Estimated demand value wise (in lakhs @ Rs. 30,000/- per ton):
	1999-00 2001-02 2004-05 81.27 140.00 314.00
3.	Estimated demand supply gap:
	2001-02 194.30 tonnes 2004-05 774.20 tonnes
4.	Export scenario
	Exported quantity and value 1997-98 1996-97 31.32
	Quantity (in tonnes) 4.22 Value (in lakhs) 150.25 9.32
	Export price realized (Rs. per kg.): 220.94 479.59 1996-97 1997-98

Composition and Uses of Kokum

Due to its versatile composition (Table 3) Kokum fruits have multifarious utilities. The fruit has an agreeable flavour - and a sweetish acid taste. Kokum has been traditionally used as an acidulant. It is used in the Konkan region, chiefly in the form of Kokum as a garnish, to give an acid flavour to curries and also for preparing syrups. For the traditional fish curry of the Konkan coast and Goa, Kokum rind is a usual ingredient. The dried rind, strained in water, is boiled into a soup called solkadi. Spiced and sweetened with jaggery it is a must for marriage feasts and functions in Uttara Kannada District of Kamataka and Goa. It is considered to promote digestion. Wine red syrup, extracted from the rind of the ripe fruit with the help of sugar is stored in the households of this region for making cool drinks in summer. The fruit of *G. indica* is anti-helmintic and cardio tonic and useful for treatment of piles, dysentery, tumors, pains and heart complaints. Kokum butter is considered nutritive, demulcent, astringent and emollient. It is suitable for ointments, suppositories and other pharmaceutical purposes. It is used for local application to ulcerations and fissures of lips, hands etc. The cake left after extraction of oil is used as manure. Kokum butter is used as a specific remedy for diarrhea and dysentery. It is now being used in cosmetics and medicines known as Vrikshamla in Ayurveda. This butter is suitable for use as confectionery butter. It is also suitable for making candle and soap industry.

Various parts of the tree like root, bark and fruit and seed oil are used for treating piles. and abdominal disorders.

Table 3: The Composition of Fresh Kokum Rind

Moisture (%) Protein (6.25)% Crude fibre (%) Total ash (%) Tannin (%) Pectin (%) Starch (%)

Crude fat (%) (Hexane extract) Acid (as hydroxy citric acid) Pigment (%) Ascorbic acid (%) Carbohydrates by difference (%)

(Values are expressed on moisture free basis)

Active ingredients, upon biochemical analysis, reported are arabin, essential oil, resin, tartaric acid, citric acid, phosphoric acid, hydroxy citric acid, cambogin and camboginol.

Botany of *Garcinia* Species

Trees in this genus can be either dioecious or polygamous. The flowers of Garcinia species may be solitary, fascicled and umbelled or panicled. The anther filaments are short and thick; though sometimes two-lobed or four-lobed. The ovary consists of 2 to 12 cells with solitary ovules positioned at the inner angle of each cell.

Garcinia indica Choisy

Garcinia indica Choisy is synonymous with *Garcinia* purpurea and is known as brindon in Goa, bhirind or anslil in Marathi and Konkani, murugal in Kannada and punampuli in Malayalam. The tree is commonly known as Kokum butter tree, mangosteen oil tree or brindonia tallow tree.

Description, Flowering and Fruiting

It has dark green and drooping foliage. The tree flowers in November -February and fruits ripen in the April-May. The flowers, which can be axillary or terminal, exist in solitary form or as spreading fascicles. The sepals are decussate, thick and fleshy. Four thick petals extend in length slightly beyond the sepals. Male flowers are characterized by numerous stamens and two celled anthers with exceed¬ingly short filaments. Female flowers are either sessile or on short pedicels, bundled two or three together. Ovary is 4-8 celled with sessile stigma. The fruit is spherical but un-furrowed and purple, 2.5 to 3.0 cm in diameter and encases 5 to 8 seeds.

In Goa, still there are no systematic orchards of Kokum plantation. However, the naturally grown trees are seen spread in forest areas, cashew plantations, homestead gardens and the like. This natural seedling population, due to cross pollination and heterozygous nature of the trees, has abundant variation with respect to growth habit, flowering and fruiting season, fruit yield and morphological and biochemical characteristics of fruits (Table 4).

Table 4: Variability in Kokum in Goa and Konkan region.

Sr. No.	Variables	Range of Variables	Remarks
1.	Tree habit	Tall & conical, pyramidal, dome shaped, spreading type	-
2.	Branching pattern	Erect, spreading, drooping	Tall & dwarf nature
3.	Tree height (m)	6- 12m	Tall & dwarf types
4.	Fruiting season	Very early (Feb-March) to Late. types (May-June)	Early &mid season types preferred
5.	Fruit yield (adult tree)	50 to >350 Kg / tree	
6.	Fruit size	21 g -85g	
7.	Fruit shape	Round, oblong, oval, fruits with pointed tips	
8.	Rind thickness	0.2 - 0.8mm	Loose juicy types have thin rind
9.	No. of segments	4-8 segments /fruit	
10.	Anthocyanin pigment	7.87-17.03mg/100g (As reported by Joshi, et ai, 2001 Konkan region)	
11.	TSS of juice	6-12 Degree Brix	Sweet & sour types present
12.	Acidity (%)	1.1-3.2	Sub acid to very acidic types
13.	Kokum fat (in seeds)	20 -26 % (as reported by Karnik et ai, 2001 Konkan region)	

Efforts are being made by ICAR and Goa University to identify and collect the promising genotypes from among the natural seedling population in Goa for further evaluation studies. Some important genotypes with their fruit characters are listed in Table 5 (Rodrigues, 2003). Establishment of clonal Genoplasm bank of Kokum is under progress at ICAR Complex for Goa.

Table 5: Fruit Characters of Some Promising Kokum Accessions of Goa.

Genotype	Fruit wt. (g)	Pulp wt. (g)	Fresh Rind wt (g)	Dry Rind wt.(g)	No. Seeds per Fruit
Mar-2	32.4	16.9	15.3	2.3	5
Sav- ver -1	33.8	16.0	17.5	3.5	4
Rib-1	30.0	12.9	17.1	3.0	3
Asn -3	28.6	13.5	14.9	1.7	3
Asn-2	23.4	12.0	12.4	1.4	4
May - 1	23.2	11.7	11.3	2.4	5
Asn-5	22.7	11.0	11.4	1.6	3
Asn - 1	22.4	12.0	10.3	1.9	5
May-2	22.1	9.0		2.3	3

Vast variability in the elite types is reported from Sindhudurg district of Maharashtra. Besides this, survey results reveal that some elite genotypes namely MLDK-3 and MLDK-5 (Gawanekar *et al*, 2001), and DVA-1, DVA-2 & DVA-3 - the spreading type of genotypes from Raigad district (Pujari *et ai*, 2001) have been already collected for further evaluation at B.S.K.K.V. Dapoli, Maharashtra.

Propagation

The conventional way of propagation of Kokum is by seeds. As the crop is cross-pollinated, the seedling progeny shows heterogeneity and thereby variability.

Softwood grafting has been found to be successful and easier. The mature scion of 5 to 6 months old without defoliation is preferred for softwood grafting. Seedling of 22 weeks and more are used as a rootstock. October is the best season for soft wood grafting. Graft could be successfully maintained under either poly shed or in open sun after grafting. Tissue culture is also being attempted for micro-propagation.

Higher Productivity

Productivity can be substantially increased by high density planting using grafted plants of improved varieties.

Prospects of Cultivation of Kokum as a Mixed Crop with Cashew

Kokum can be the best mixed crop in cashew garden, where cashew is spaced at 10m X 10 m. In between two rows of cashew, one row of Kokum can be planted at 5m intra row spacing so as 'to accommodate 200 plants of Kokum per ha (Yadukumar, 2003).

Considerable increase in income can be realized from cashew + Kokum mixed cropping system (Table 6). Kokum can also be planted advantageously and comfortably on all the

borders of coconut gardens (Korikanthimath, 2003). Further crop compatibility studies will help) in appropriate incorporation of this crop in different farming systems for sustainable production diversified farming systems.

Post Harvest Handling

Processing sector is very vital for this crop, as unlike other fruits, Kokum cannot be consumed as fresh fruit. Its utility starts only after processing. Green mature rind and Red ripe rind are invariably used for processing of dry rind. Rind is also used as base material for preparing rind products like Kokum Syrup, Kokum Agal and Amsol (Wet rind). Kokum butter is extracted from seeds. (Adsule *et al*, 2001).

The following value added products of *Garcinia indica* have potential commercial values.

A) Rind (To reduce body fat and slimming capsules)

1. HCA (Hydroxy citric acid)
2. Colour pigment (Red and yellow)
3. Garcinol
4. Squash
5. Powder
6. Kokum wine
7. Concentrate
8. Kokum khajur
9. Carbonated Rts
10. R.T.S. in tetra pack

Kokum oil is nutritive, demulcent, smoothening. softening, astringent, e-mailient and has great demand in pharmaceutical industry for preparation of ointment, cosmetic industry for face cream and lipsticks.

Medicinal Values of Kokum

Raw fruits are used as anti-helmintic, cardiotonic and useful in bleeding piles, dysentery and tumors. Young leaves, after being tied in a banana leaf and stewed in hot ashes are rubbed with cold milk and given as remedy for dysentery. Seed oil is used in preparation of ointments and suppositories, which is made use for local application to ulceration, fissures of the lips and hands (melting and rubbing on the affected part).

B) Dry Seed

1. Cosmetics
2. Cream
3. Soap
4. Edible oil
5. Confectioneries
6. Candle

Constrains of Kokum Processing Units

Unorganized production, mostly from the natural scattered plantations, non-availability of adequate raw material (fruits / seeds), high price of raw material high octroi, transport charges and marketing expenses are the common bottle necks. Labour is not available as and when required. At times failure of electricity and high cost of packaging material also become impediments.

Future Strategies

Since Kokum occurs in the natural forests of Goa, a systematic survey needs to be carried out for collection, conservation, cataloguing and evaluation of germplasm. Mass multiplication of elite planting materials should be taken up on up on priority by resorting to softwood grafting as well as approach grafting and micro-propagation. Possibility and prospects of cultivation of Kokum as a mixed crop with cashew which is an important commercial plantation crop of Goa should be explored. Concerted efforts are needed to establish large-scale commercial plantations. Kokum based soft drinks need to be popularized among international and domestic tourists alike as health drink.

Thrust Areas:

The following thrust areas could be identified for further research thereby increasing the production:

-Identification of plus trees for higher yield, earliness, regular bearing and good fruit quality.

-Commercialization of tissue culture technology for production of elite plants.

-Standardization of nutritional requirements and cultural practices. Mechanization of post harvesting operations with emphasis on hygienic processing.

-Development of more value added products.

-Considerable Wasteland available in Goa and adjoining areas may be very well utilized for profitable cultivation of Kokum. Similar to cashew, Kokum can be a brand product of Goa.

Status of existing Kokum cultivation in Karnataka and North Kerala

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Kokum is called as *Murugalu* in Uttara Kannada district of Karnataka. In Dakshina Kannada, it is known as Punarpuli. In- Karnataka, it is grown in three other districts, i.e., Shimoga, Chickmanglore and Udupi.

Most of the marketable surplus actually doesn't come as a product of farming but is commercial collection from forest lands. Ankola taluka in Uttara Kannada Dist. stands number one in production.

Statistics about States' total production and consumption is not easily available. Till recently, this was a totally neglected crop in these belts. Most of the trees weren't planted ones. Habit of planting Kokum is a recent development. Even in the homesteads where the trees yielded fruits not many families cared to collect and put it to a good use.

Compared to Karnataka, Kokum remains unknown to most parts of Kerala except for Kasaragod taluka. As such Kerala's Kokum production is practically negligible. This is quite unfortunate considering that the climate and rainfall in Kerala is most conducive for Kokum cultivation.

Since the last one decade, growing' interest in planting and value addition of Kokum is clearly visible. One reason for this is the media exposure about the medicinal properties of Kokum. The second and recent is the expose of presence of pesticide residues in many popular soft drinks.

In Karnataka, the forest department has been mass producing seedlings for forestry programmes. Department's Plus-tree programme has identified some outstanding selections. But unfortunately, there is no mention of worthy follow-up.

In Dakshina Kannada and elsewhere some grafting enthusiasts and selected nurseries have started producing Kokum grafts from selected mother-plants of their neighbourhood.

A cultivar that warrants researchers' attention is the so called bile murugalu that is unique to Uttara Kannada district. Though it is called as white Kokum, the real color is yellow. Local villagers believe that it has more medicinal properties than its maroon colored counterpart. Its butter is an excellent medicine for dysentery. Many households preserve the home-made butter in a pill form and it is widely used in treating dysentery among children.

Tn Ankola taluka, many hamlets in a radius of 10 kilometers make a living on Kokum. From March to May is murugalu season for hundred of poor families of Achave, Hillor, Kumtagani, Kadakaar, Manikaar. Sunkasala, Guthle, Mothigudda and surrounding hamlets. On the borders of areca gardens and in the foothills of forests, Kokum has grown naturally as if it is a monocrop. Their small private holdings too have yielding trees.

There are more reasons than one why Kokum enjoys top priority among these small-holders. It doesn't require irrigation, maturing or pesticides. It's a typical zero

cultivation. Only agricultural practice required is harvesting, cutting & drying. But summer rains play a villain to local economy. If rain falls on fruits, worms develop in it, turning the fruits useless.

Take for example the case of Shri Toku Naik of Kadakaar. He has four acres of paddy fields. Paddy is rainfed. The torrential rains take good amounts of nutrients from the paddy fields. He is continuing paddy cultivation only for the sentimental reasons. From 4 acres he gets an average of 20 to 25 bags of paddy. That is about 1.25 to 1.5 tonnes. After deducting the expenses of manuring, tilling, replanting, harvesting etc it is a literal loss for him. But "quite in contrast" he says, lions-share of the amount he earns from Kokum trees is a net savings.

Forty years ago Toku Naik had only 10-12 Kokum trees in his land. Now he has above 50. This is due to his careful tending and protection. In these parts, Kokum trees get regenerated due to injuries to the root by the livestock. Naik now gets about 6 to 7 Quintals of dried Kokum rinds. Four family members are fully engaged in the harvesting & drying for three months.

Marketing is not a problem for these farmers. Buyers come to their doorstep. At an average, 15 to 30 fresh fruits weigh kg. For one kilo of dried rind, 12 to 13 kg of fresh fruits are required. In 1994, purchase rate of dried rind was Rs. 8 to 10. Now it is Rs. 25 to 30. Seeds are bought at a rate of Rs. 12 to 14 kg.

Shri Shivananda Kalave, a noted development journalist from Sirsi has made detailed study about Kokum. He explains, "The yield potential of Kokum trees in Karikallu belt is surprising. Each branch gets covered with branches. A tree at Hosagadde has yielded a record crop of 550 kg of fresh fruits.

Value Addition

Both industrial and home-level value additions are being done in Karnataka. In houses, Kokum is mainly used for making *rasam* or *saaru* and juice concentrate. One interesting plus point is that Kokum juice concentrate can be made without adding preservatives. Without the courtesy of big industries, home-level processing is possible. Many households are now making juice concentrates in summer for distribution among relatives or for small-scale sales.

Puttur a taluka town in Dakshina Kannada (South Kanara) district has two industries that produce Kokum juice concentrates. A big chunk of this production is sold inside the district itself. Ankola area has a couple of soft drink and a few juice concentrate industries. An interesting product from an industry at Puttur is a 150ml Kokum juice concentrate that is adequate for making 75 glasses of the drink. Packed in a perlpet bottle, it is easy to transport this to distant areas. The same industry is bringing out dehydrated powder of Kokum that can be used for rasam or juice. One industry at Ankola claims that it's producing HCL (Hydroxy Citric Acid) in a water-soluble form.

Yet, a lot of R & D and promotional work is needed to be done in the selection, breeding and value addition front of Kokum. Kokum jam, soup ready-mix are two concepts that need to be worked. Another possibility is providing Kokum as a healthy drink by

blending it with other nutritious and products like honey or buttermilk. Kokum makes a very good combination with these products. This health-drink can be packed in tetrapacks and sold as a zero-chemical drink.

Another slot for marketing is popularizing it as a natural and medicinal souring agent for cooking. Of course, this is one ethnic habit in Goa. But in the other parts use of Kokum as a souring agent is very less among middle class and higher classes. The news reports highlighting the anti-obese, anti-cholesterol properties of HCL present in G.gummigutta has prompted many housewives to replace tamarind with gummigutta dry rinds. Kokum has the very same qualities and is *pitahara, raktavardhaka* too.

One recent and major threat for the value addition of Kokum is the flooding in the market of chemically prepared products that have negligible or no Kokum ingredients. Synthetically colored Kokum Juice leaves a red color on your lips. Such concentrates made with citric acid and colours are available in bulk for a very low price. This is spoiling the credibility of the market as well as the image of Kokum too. FPO has to act to check this unscrupulous practice.

Farmers Viewpoint

While we passionately debate about popularizing Kokum and increasing its production, the farmers' view-point regarding this has to be essentially taken into account. At the moment, just gearing up production, farmers feel, is not adequate. Unless and until parallel efforts for the procurement of Kokum at a remunerative price are done, these attempts might prove counter-productive. Many farmers who have marketable excess are not able to make earnings from it because of this reason. For the farmer, especially in a small scale, selling fresh fruits is a far easier option. But at present, there is no appreciable demand for fresh fruit. Very low keeping quality also is one of the reasons. A solution has o be sought to bridge these bottle-necks.

Bringing out a recipe book including all our traditional & home-made recipes of Kokum including Kokum wine, Kokum Hot *Kashaya*, salted drink, *Sol Kadi*, Honey-blend *Sherbath* etc would be a result - oriented step towards its promotion. Why can't some development agencies think of organizing Kokum food festival in cities where it is lesser known and Kokum parlours along highways? Visual media can play a greater role in this direction.

I am reminded of an interesting effort from the part of an agriculture officer of Kerala. He was working in Manjeshwar, a border area where he was exposed to the taste and good qualities of Kokum. He was recently transferred to Kannur District that is about 200 kms away. He took a bagful of Kokum seeds, got a nurseryman to produce seedlings. He wrote articles in Malayalam dailies about Kokum. Says he, "This is my way of protesting against Cola."

One aspect we shouldn't forget is that Kokum is a sustainable crop that doesn't require deep bore-wells to be dug or any naphtha - based or other fertilizers or any chemical pesticides. It quenches thirst on one hand and maintains our health on the other. Who knows, it may make a very good natural food colour for food industries in the coming years. A crop that can be grown with zero-attention and many many home-level uses.

Status and Prospects of Kokum in Uttara Kannada, Karnataka

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Forests in the Western Ghats harbour a rich and diverse plant life and provide a whole range of forest products to the local population. Non-Wood Forest Produces (NWFPs) have great significance for local communities in meeting their subsistence needs through the supply of food and nutrition, medicines, oils, dyes, aromatic substances, flavourings etc. Further, non-wood forest products offer local community a basis for employment and income generation along with other farming activities.

NWFPs provide livelihood for millions of rural people who live in and around the forest. They offer considerable potential in the conservation of tropical forests through judicious harvest, and by enhancing rural income and motivating people to conserve their resource base. Thus, they have become an important aspect in forest conservation programmes that are aimed at extracting NWFPs in a sustainable way and consequently conserve the forest as well.

Forests of Karnataka

Karnataka is endowed with some of the most magnificent forests in the country ranging from the majestic evergreen forests of the Western Ghats to the scrub jungles of the plains. The forests comprise of several types ranging from fragile coastal mangroves along the coastlines to tropical wet evergreen forests all along the Western Ghats. The total forest cover of Karnataka is 36991 square kilometer representing around 19.3 percent of the total geographical area of the state and 5.5% of the country. Forests in Karnataka are classified in to reserve forests, protected forest, village forests, unclassified, and private forests (Table 1). The area under dense canopy cover (canopy density more than 40%) is nearly 13.6 per cent of the total geographical area of the state while 5.6 per cent falls under open forests (canopy density between 10 to 40 per cent) and 3245 square kilometer of scrub (canopy density less than 10 per cent).

Table 1: Classification of Recorded Forest Area in Karnataka on the Basis of Legal Status

S. No.	Legal Status	Area (Sq. Km)	Percent
1	Reserved forests	28,689.97	74.94
2	Protected forests	3,930.70	10.27
3	Village forests	124.20	0.32
4	Unclassified forests	5,230.99	13.66
5	Private forests	308.42	0.81
	Total	38,284.28	100.00

Source: State of the Environment Report and Action Plan - 2003

Table 2: Forest Cover and Forest Types in Karnataka and their Extent

Forest Cover of Karnataka in sq. kms		Forest Types
'Dense forests	26,156	Evergreen 4.350 (11.36) Semi-evergreen 1,450(03.79) Moist deciduous 5,780 (15.10) Dry deciduous 7,270 (18.99) Thorn forests 8,340(21.78) (Scrub) Un-wooded 11,094(28.98) (Number in parenthesis is percent)
Open forests	10,835	
Total	36,991	

Source: State of the Environment Report and Action Plan - 2003

Forests in Karnataka support a wide range of biodiversity and play an important role in the socio-economic scenario of the state. Population meets its major share of basic needs from these forests. People gather and harvest a variety of non-wood forest products such as gum, cane, myrobalans, edible fruits, seeds, and a variety of herbs from forests. NWFPs provide sustenance to the rural and tribal people. Eleven districts in the state have the presence of Western Ghats forests and Uttara Kannada is one of them.

District of Uttara Kannada

Uttara Kannada district (13°52' to 15°31'N and 74°9' to 75°10'E) is the northernmost coastal district of Karnataka. It has a total geographical area of 10,291 km2 and accounts for 5.4% of the total area of the state. The district has lot of ecological significance with its location at the centre of Western Ghats. The district is divided in to characteristic four distinct regions depending on the physical features and natural resources available. They are Coastal region, Foothills of Western Ghat, Hilly region, Eastern transition region. The Western Ghats covers a substantial portion of the district. The hills rise to 600-700 m above msl. The average annual precipitation is 2742 mm ranging from 1000 mm in the eastern transition area to 5000 mm on the coast.

Uttara Kannada which is divided in to 11 talukas administratively has a total population of 13, 53,299 (Census, 2001) and more than 3 lakh households. By utilising available natural resources the people practice agriculture, horticulture, animal husbandry for livelihood and also have a number of small scale forest and agro-based industries.

Forest Resources of Uttara Kannada

Kannada is endowed with rich forest wealth. Total forest cover is 781,600 ha which accounts for nearly 76% of the total geographical area of the district. The district has an undulating terrain with a long contiguous tract of tropical forests. The major forest types found here are tropical wet evergreen forest (14%), semi-evergreen forest (25%), moist-deciduous (35%), dry deciduous (26%) and mangrove forests. These forests are categorized into different forests according to the ownership pattern. State Forest Department manages the most part of the forests in the district.

Table 3: The Legal Classification of Forest Lands and Area in Uttara

Sr. No.	Categories of Forests	Area in Hectares
1	Reserve forests	
la	Proper forests	6,20,218
1b	Minor forests	1,52,085
2	Protected forests	
2a	Hakkals	3,173
2b	Betta lands	51,121
2c	Village forests	2,617
	Total	8,29,214

Source: Office of Conservator of Forests, Kanara Circle, Sirsi.

There is an extremely rich diversity of plant species, which the people consume or trade formally or informally in the district. People regularly harvest about 46 species of fruits, leaves, flowers. 3 species of bees providing honey and wax, 8 species of bamboos and canes.

Kokum or murgalu as known in Kannada is one of the important tree species widely distributed in the forests of the district from which people harvest fruits and seeds. The trees of Kokum are seen growing in all categories of forests and in private lands in the talukas of Bhatkal, Honnavar, Kumta, Ankola, Karwar, Joida, Siddapur, Sirsi, and Yellapur. People protect and promote regeneration of murgalu in privilege and private forests and in some villages people even grow them. People collect fruits and seeds of murgalu for domestic consumption and also many households market a substantial quantity of their collection. People use its rind as food as a souring agent, its syrup as a drink, and use seeds for oil and medicine. In forest divisions of Honnavar and Karwar, murgalu where it is more concentrated is tendered for auction by the Forest Department in the name of amsol or bhirand (Table 4).

Table 4: Quantities of Murgalu (Amsol and Bhiranda) Extracted by MFP Contractors in Uttara Kannada

Year	Forest Divisions of Uttara Kannada (Kanara Forest circle)				
	Honnavar	Karwar	Yellapur	Sirsi	Haliyal
1999-00	0.750 t.	2.350 t.	-	-	-
2000-01	2.12 t.	1.2 t.	-	-	-
2001-02	5.830 t.	1.5 t.	0.035 t.	-	-
2002-03		1.6 t.	-	-	-

Source: Office of Conservator of Forests, Kanara Circle, Sirsi.

It is difficult to assess the actual production of fruits and seeds of murgalu in the district. Forest Department measures the annual production of murgalu by quantities declared by the contractors or their agents in order to obtain transit passes and this does not equate at all with actual volume extracted. There is no sufficient information to assess the quantity of fruits of murgalu, available for harvest from forests, quantity extracted, used

EXHIBITION OF PRODUCTS FROM KOKUM

Various types of soft drinks, jams, syrups of Kokum

Various types of dried Kokum fruit products

Western Ghats Kokum Foundation, Panaji - Goa

CONVENTIONAL PROPAGATION OF KOKUM

Kokum seedlings in nursery

Kokum graft Kokum seedling

Growth habit of Kokum graft

Kokum seedling tree

Western Ghats Kokum Foundation, Panaji - Goa

at the household level, and sold to local factories and to contractors. There is also no information on the quantity of murgalu sold outside the district.

There have been isolated studies on different aspects related to Kokum such as distribution, density, regeneration, fruit production from trees, and quantities of murgalu extracted and income generated by people etc. However, comprehensive .study on all these aspects at the district level is lacking.

Some Observations Related to Kokum in Uttara Kannada Distribution: Trees of Kokum are distributed in nine Western Ghats taluka of the district.

Plantation and Cultivation: People protect trees of murgalu. However, there has been no attempt by people of growing murgalu on large scale. Forest Department also has not done regeneration attempts on a major scale though seedlings of murgalu are included in planting activity by the Department under afforestation programme. In addition, generally survival and growth of these seedlings on KFD plantations have been poor and no systematic study is carried out on this aspect.

Collections and Harvest: In majority cases, households and primary collectors harvest ripened fruits without causing much destruction to trees.

Processing and Value Addition: Seeds and rind are separated and dried under the sun. Dried rind is stored for future use by households; part of it is used for extracting syrup which is bottled and stored while remaining part is sold in the local market or to contractor. Seeds are stored and later oil (Kokum butter) is from extracted from seed kernels by boiling them with water.

Under contract system, primary collectors at the village level harvest fruits from forests, separate rind from seeds, process- them by sun drying and sell them to contractor. Major portion of this quantity is sold outside the district.

Private entrepreneurs in the district (like the one at Gokarna) extract syrup on a much larger scale, and sell them in bottles or cans within the district and even outside.

Kokum butter is mainly used at the household level.

Household Income from Sale: There is high variation in the price of murgalu product in the market. Though it observed that household income from all NWFPs varies between 10% and 25% of total income, contribution from murgalu product in it is not available.

Future Prospects: There is immense scope for propagation of Kokum in eleven districts of Karnataka and in most area of Uttara Kannada. Until recently the fruits and seeds of this species had importance only at the household level. Now, it has importance at the commercial market. With the availability of vast area of suitable forests and private lands, and sufficient planting material an efficient approach towards propagation and cultivation of Kokum and raising of plantation should be emphasized for generation of employment as well as income for the community.

All agencies involved in conservation and promotion of Kokum should come together to take up a systematic assessment of the existing, natural stand of *Garcinia indica* tree population, status of regeneration, production, and extractable quantity of fruits and its sustainable management in Western Ghats.

CROP IMPROVEMENT

Variability for Morpho-physical Properties of Fruits in Kokum

Gawankar M. S., Shingre D. V., Dalvi M. B. and Jamadagni (2001), Dr. B.S. Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra

Kokum is one of the important fruit tree that has remained under- exploited and neglected. The tree itself is ornamental with a dense canopy having lush green leaves with red tinged tender emerging leaves followed by deep red round fruits. The pyramid shaped handsome evergreen tree; it is a good choice for growing on roadside as avenue tree. Deep red to purple coloured edible ripened fruits are mainly used for making delicious refreshing drink "Amrut Kokum". Amsols are prepared from dried kokum rind, have tremendous export potential. Fruits contain 6 to 8 seeds, which yield about 23 to 26 per cent valuable edible fat known as Kokum butter and it is in solid form at normal room temperature up to 40° C. Kokum butter is used as a base in various cosmetics and pharmaceuticals and therefore, possesses export potential (Haldankar et al., 1992). The present investigation was undertaken to identify promising strains of kokum having bold, juicy and deep purple red colour fruits and to study variability of morphophysical characters of the fruits in kokum genotypes.

A continuous work on screening of seedlings and maintenance of germplasm of Kokum is in progress at the Agricultural Research Staion, Mulde, Tal, Kudal, Dist. Sindhudurg, Maharashtra in the year 1996. Out of these fifteen genotypes, six bearing genotypes were selected for the present investigation on variability of morphophysical characters of fruits. For the sake of convenience, each entry was designated by MLDK (Mulde Kokum) with relative selection number. The grafts started bearing from the year 2000. The yield for the season 2000-2001 was considered for the present investigation. The yield in terms of number of fruits and weight of the fruits / plant was recorded. The fruit size was measured using a pair of callipers. Weight of the rind was recorded after cutting the fruits into two halves and removing the seeds and pulp. The pulp was thoroughly washed under the tap water to separate the seeds and pulp. The weight of such seeds was recorded as a weight of the fresh seed. The total number of seeds / fruit was recorded. Plant habit was decided by observing growth habit of the plant.

The data pertaining to different yield contributing characters showed variation both in productivity and quality of the fruits.

I. Weight of the fruit: average weight of the fruit varied from 25.4 g to 58.38 g. Maximum fruit weight was recorded in MLDK-3 (58.38 g/fruit) follwed by MLDK-5 (50.98 g/fruit). The lowest fruit weight (25.4 g/fruit) was recorded in MLDK-9).

II. Volume of the fruit: Fruit volume ranged from 18.7 cm3 to 53.83 cm3. maximum fruit volume was recorded in MLDK-5 (53.83 cm3) and the lowest in MLDK-2 (18.7cm3). MLDK-8 and MLDK-9 recorded fruit volume i.e. 25.09 cm3 followed by MLDK-3 (25.18 cm3)

III. Fruit length and breadth: Fruits of all the genotypes have not shown much variation in length and breadth. Khanvilkar et al. (1986) also reported least variation in different

strains of Kokum. Genotypes MLDK-5 had maximum fruit length (4.28 cm) and breadth (4.75 cm) followed by MLDK-2 having fruit length 4.18 and 4.3 cm fruit breadth.

IV. Weight of the fresh rind: Rind yield is the economically important character in Kokum (Khanvilkar et al., 1986). Genotypes under study exhibited wide range for weight of the fresh rind from 13.93 g to 35.2 g. Highest fresh rind weight of 35.2 g was recorded in MLDK-2 (13.93 g)

V. Fruit and fresh weight of seed: Maximum number of seeds/fruit was produced in MLDK-5 recorded maximum seed weight (1.23 g.). MLDK-2, MLDK-4 and MLDK-9 recorded 1.0 g seed weight per fruit. Khanvilkar et al. (1986) confirmed that the number of seed/fruit gives an idea of fruit size. The more the number of seeds, larger is its size.

VI. Yield of the plant: The data indicated that there is a great variation as far as yield and number of fruits/plant are concerned. Genotype MLDK-5 recorded total yield of 1.22 kg and 28 fruits / plant second year after fruiting. Maximum number if fruits was recorded in MLDK-3 (30.25/plant) followed by MLDK-5 (28 fruits/plant).

VII. Plant habit: Bushy plant helps in reducing cost on harvesting and other cultural practices. Bushy plants are more preferable than viny type plant. In the present study MLDK-2, MLDK-3, MLDK-5 and MLDK-8 exhibited bushy while MLDK-4 and MLDK-9 exhibited viny growth.

Kokum fat is extracted from Kokum seeds hence more number of seeds/fruits should be considered more precisely in further evaluation. In present study though out of fifteen selections planted only six started bearing in fourth year after planting. Performance of other genotypes should be investigated in future and genotype MLDK-5 is precocious and can be exploited for further improvement of Kokum.

Cultivation of 'Konkan Amruta' and Search for Elite Varieties

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Distinct agro-climatic conditions of the coastal zone to which Kokum is adapted impose limitation to extend the area under Kokum cultivation. Because of dioecious nature of the plant, surplus and unproductive maleness, large genetic variability, slow growth, late bearing and prolonged harvesting, lack of rapid, easy and cheapest propagation technique are some of the constraints for its rapid spread as commercial crop.

Considering its increasing importance and urgent need for detailed studies on various aspects for generating research information, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli Dist. Ratnagiri (M.S.) initiated research work at different centers on this crop by conducting survey, arranging exhibitions and screening the existing germplasm in the region and at various stations since 1986.

Khanvilkar *et al*, (1986) evaluated some seedling types in Kokum at Department of Horticulture, College of Agriculture, Dapoli and few of them were found promising. At agricultural Research Station, Shirgaon Taluka in Ratnagiri District, Ratnagiri, M.S. Sawant and his co-workers conducted field investigation for screening existing thirty six high yielding Kokum trees at the station during the year 1990 to 1997. Among those 36 types, 12 early bearing types were found to be superior. However, on the basis of simultaneous consideration of various characters of growth, flowering, yield and chemical composition the types S-8 (Shirgaon - 8) was found to be the most promising as it consistently recorded the higher yield and superior physical and chemical traits and which was subsequently released as a crop variety under the name " Konkan Arnruta" in year 1997 which is the first early variety of its kind released and recommended for planting in the Konkan region.

Characteristic of the Variety “Konkan Amruta”

The distinguishing morphological and physicochemical characters of the Kokum Amruta variety are presented in Table 1.

Table 1: Morphological and Physicochemical Characters of the Variety Kokum Amruta

A)	Distinguishing Morphological Characters	
a)	Growth characters of the tree	
i)	Height (m)	10.30
ii)	Trunk girth at base (m)	1.05
iii)	North - south spread (m)	3.10
iv)	East - west spread (m)	2.90
v)	Volume of the tree (m)	48.58
vi)	Growth habit	Erect with narrow oblong type crown

b)	Flowering and Fruiting Pattern	
i)	Flower bud appearance (date)	5th October
ii)	Initiation of flowering (date)	10th November
iii)	Fruit retention (%)	24
iv)	First fruit ripening	First week of March
v)	Harvesting period	March to April
c)	Yield and fruit characters	
i)	Average yield (1991- 1997) (kg.)	138.28
ii)	Average no. of fruits/ kg	29.80
iii)	Average weight of the fruit (g)	34.45
iv)	Average weight of the rind/fruit	17.55
v)	Average rind thickness (mm)	4.45
vi)	Average no. of seeds/fruit	6.40
vii)	Average no. of filled seed/fruit	3.55
viii)	Shape of the fruit	Apple shape
ix)	Shelf-life (days)	15

Prospects of Kokum as an Intercrop Border crop in Mango Orchards

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Kokum, indigenous to western Ghat, is an important fruit tree having culinary, pharmaceutical and industrial uses. Konkan region in general and Ratnagiri and Sindhudurga district in particular is famous for rich biodiversity. Kokum is one of the rare species which is adapted to the specific climate and geography of Konkan. The traditional cultivation of Kokum is done in the premises of the houses, coconut and arecanut gardens, along the banks of rivers streams and nallas and wastelands. Under the World Trade Organization (WTO) and globalization, the Kokum is crossing continents and generated interest among the people from outside the region of the country. Also it has paramount importance in the international market from medicinal point of view. The multifaceted Kokum recently proved its potential in national and international markets. Scientific cultivation of this crop has therefore been introduced recently with improved varieties, propogation techniques and package of practices developed and standardized by the Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli.

The Kokum fruits are used to prepare fruit syrup i.e. Amrit Kokum, Solkadhi, Amsol (Dry rind), Agal, Kokum powder etc. The oil of Kokum seed has tremendous export value. Considering the importance of this crop, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli has released the “Konkan Amruta" the first ever variety of Kokum as well as standardized the soft woodgrafting technique for preparing Kokum grafts. In view of numerous medicinal properties, other major economic potential and future importance of Kokum crop this crop can be grown as intercrop in mango orchard for more profitable and sustainable farm business. Being a rainfed crop, there is vast scope for expansion of this crop in near future. This promising crop has good potential to change the economy of Konkan region by providing avenues for income generation and employment opportunities through increased production by taking intercrop in mango and other rainfed orchards. The processing sector will consume increased production. The processed products of Kokum have domestic as well as international market. Eventually, this crop has good potential to compliment the established crop that is mango, in foreign exchange earnings.

An attempt has been made to study the economic viability and scientific management practices of intercropping in mango orchard to utilize the economic potential of Kokum crop. For economic and ecological sustainability it was observed that with a standard spacing, which is 6 x 6m, one can plant 275 grafts of Kokum in one hectare.

Methodology

In this study Kokum can be cultivated as an intercrop in mango orchard. The standard spacing for mango crop is 10x10m. One can plant 100 mango grafts per hectare. And if Kokum is taken as intercrop in mango orchard, as a border row as well as roadside avenue.

Mango and Kokum are perennial crop with a long pre-bearing period followed by several phases of bearing period namely: (1) steady yield increasing phase, (2) stabilized yield phase, (3) yield declining phase, (4) uneconmic yield. Actually flow of costs and returns in these crops spreads over a number of years with varying magnitude. The expenditure during the pre-bearing stage constitutes the investment on the crop, while the full benefit quite sometime to accrue. Investment in this long duration crop is subject to somewhat uncertain economic situation. Before making such investment, growers and financial institutions should have a clear understanding about capital and costs involved and returns likely from such a long term investment so as to know whether the investment will be worthwhile. For that all future costs and returns are discounted to present value at appropriate discount rate (14%) for productive life period of the investment. Following four criteria are generally used to decide the profitability of investment.

1. Net Present Value (NPV)
2. Benefit Cost Ratio (BCR)
3. Pay Back Period (PBP)
4. Internal Rate of Return (IRR)

Results and Discussion

As like mango, Kokum is a long duration crop. There are two broad stages of growing this. crop. First is the establishment stage and second production stage. Kokum crop requires 6 to 7 years to come to fruiting. During this stage, expenditure is incurred on raising this crop, but there is no production hence no income. This particular stage is regarded as capital cost. Production stage begins when vegetative growth of trees is completed. In the production stage, there is less production in the beginning and it goes on increasing upto 15 years and attains full, production at that stage as trees become more matured and adult. Then there is stabilization of production at this level for a pretty long period of about 40 years in case of Kokum. This is the prime period of economic or commercial production. In the establishment stage, the items of costs are labour required for various operations and purchase of input material. In production stage, the number of labour units and quantities of material inputs increase as trees grow older and production increases and they remain constant during stabilization phase.

Table 1: Per Hectare Cost of Establishment of Kokum upto the Year

Year	Amount (Rs.)
First	28250
Second	3781
Third	3882
Fourth	3654
Fifth	4674
Sixth	5601
Seventh	6857
Total	56699

First year cost includes value of land.

In the establishment stage, the items of costs are labour required for preparation of land, preparing of digging and filling of pits, planting of grafts providing support, watering, application of manures and fertilizers, plant protection etc. and purchase of input material like seedlings, manure and fertilizers, chemicals and other materials. Cost of land is also included as this crop is of long duration. In the production stage, few preliminary operations are eliminated while some new operations are added. In Table 1, cost incurred during establishment of Kokum on one-hectare area is given. It comes to Rs. 56699 upto seven years. Value of land is also included in the first year cost, because it is long-term investment and necessarily value of land must be included. It can be seen from Table 2 that Pay Back period of Kokum is 9 years.

It means that 9 years will be taken for the net undiscounted benefit to repay the investment. But a more sophisticated version will use discounted net benefits that NPV must be positive within a shorter period. In case of Kokum NPV is greater than cost, so the Kokum plantation can be considered favourably, as it is more than zero at started discount rate. The benefit cost ratio in case of Kokum is greater than one so decision will be in favour of Kokum plantation IRR measure is practically used for all economic and financial analysis. IRR is the discount rate at which the NPV is equal to zero. IRR is a measure of profitability of the crop. Kokum plantation can be considered favourably as IRR is greater than the cost capital.

Present status and future thrust areas in production technology of Kokum

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Kokum is one of the native underexploited tree spice. It is mostly found in Konkan region of Maharashtra, Goa, Coastal Karnataka, Kerala, forests of Assam, Khasi Jayanti hills, West Bengal and Surat district of Gujarat. In spite of its incredible medicinal and nutritive properties, kokum is generally not cultivated systematically on orchard scale like that of mango, cashewnut etc. It is mostly found as a kitchen garden plant or mixed crop in plantations of coconut, arecanut, road side plants or in forest.

The precise statistics regarding area production and productivity is missing as kokum is not planted in an organize pattern as that of mango, cashew, Arecanut or coconut. As per a base line survey (2010) in 1000 ha area is occupied by kokum in Konkan region with production of 4500 MT fruits. According to survey conducted earlier by Chief Conservator of Forest out of the total 46600 Kokum trees in the state of Maharashtra; 43000 trees existed in Ratnagiri and Sindhudurg Districts alone. It was also reported that in South Konkan 1674 MT of Kokum fruits were used for dried Kokum rind, 757 MT for preparation of Kokum syrup and 40MT for Kokum butter.

Greater variability among the genotypes in respect to yield and quality parameters, dioeciousness, dominance of tropism in vegetative propagation and harvesting at the onset of rainy season are some of the foremost important obstacles for its acceptance as a commercial crop. Presently the research work on production technology is being conducted at Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, ICAR research complex for Goa, University for Agricultural Sciences, Dharwad and at Indian Institute of Spices Research, Calicut.

The available technology for production of kokum is discussed in this chapter.

Climate and soil

Kokum flourishes very well up to an elevation of about 800 m from MSL. It requires warm and humid tropical climate. It thrives well in coastal areas receiving over 250 cm of rainfall. It comes up well in lateritic, alluvial soils having depth of 1.2 m and pH of 6.7. Kokum prefers valley situations. The locations where coconut and arecanut can be cultivated are suitable for kokum. Though kokum can be cultivated as a rainfed crop, it can not be cultivated on hill tops like that of mango or cashewnut. It can be grown as a monocrop or as a mixed crop in established coconut and arecanut plantation.

Varietal Improvement

Kokum is a dioecious plant and hence obligatory cross pollinated, due to which a lot of variability is observed in existing population. The variability with respect to

IRRIGATED, SOLE CROP OF KOKUM

Bumper yield of Kokum fruits in third year

Shrihari Subrai Naik Kurade showing his Kokum plantation at Ambaulim - Goa

Western Ghats Kokum Foundation, Panaji - Goa

NEW VARIETIES OF KOKUM

Konkan Hatis

Western Ghats Kokum Foundation, Panaji - Goa

morphological features such as leaf parameters, flowering, fruit set, fruit shape, colour, physicochemical composition and yield has been reported.

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, at various research stations have conserved more than 300 types of kokum. Uptil now two improved kokum varieties namely Konkan Amruta and Konkan Hatis have been released by Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli. The important morphophysiological characters of these varieties are as under:

S.N.	Characters	Konkan Amruta	Konkan Hatis
1	Yield (7 years) kg	138	250
2	No. of fruit/kg	29	11
3	Length of fruits (cm)	3.74	4.22
4	Circumference of fruit (cm)	13.15	20.10
5	Wt. of fruit (g)	34.45	91.50
6	Wt. of rind (g)	17.55	48.34
7	No. of seed/fruit	6.40	5.60
8	Shape of fruit	Apple shape	Apple shape
9	Shelf life (days)	15	18
10	Volume of fruit (ml)	35.50	112.8
11	Diameter of fruit (cm)	3.95	4.20
12	Thickness of rind (cm)	4.45	5.58
13	Chemical parameters		
A	T.S.S.	9.08	9.20
B	Reducing sugar	2.41	2.40
C	Total sugar	4.52	4.10
D	Acidity	5.12	5.10
E	pH	1.81	1.80
14	Flowering behaviour		
a.	Flower bud appearance	1st week of October	2nd week of November
b.	Initiation of flowering	2nd week of November	2nd week of December
c.	Harvesting period	March-April	April-May

Plant propagation

Kokum is traditionally propagated by sexual means however recently it is also propagated by the vegetative method like softwood grafting.

A. Sexual Propagation

I) Seed and seed germination

Kokum fruit generally contains 4 – 8 seeds. For propagation seeds are collected from fully ripe fruits of early and high yielding kokum tree, having good quality. Mostly the kokum fruits are harvested at the onset of monsoon. The seeds are recalcitrant and loose viability fast. It has been reported that storage of seeds for 30 days led to 30 per cent decrease in the seed germination. They do not germinate once fully dried. Seeds are extracted and spread on floor under shade. Many times seeds are left under the tree itself where they germinate naturally. Kokum seeds regenerate rapidly in open fields and need moist hot condition for germination. The seeds are allowed to soak in rains for germination. Pre sowing treatment of seed with wet packing or drying with coal ash is recommended for good germination. The seeds can be sown on raised bed or in polybag. Soil was found to be the best medium for seed germination in kokum. The mixture of soil, sand and FYM in 2:1:1 ratio is also recommended as sowing media for kokum.

ii) Seed treatment

Seed germination is not a hurdle in kokum. The seeds germinate without any treatment. 90 to 100 per cent seed germination is reported in kokum. However, the seed treatments such as soaking in water, cycocel 500 ppm have shown promise.

iii) Raising of seedling

The seedlings can be raised on raised beds or in polybags. For germination on bed, raised bed of 1 m width, 20 cm height and of convenient length is prepared. The top soil of bed should be mixed with FYM. The seeds are sown horizontally at 1.5 – 2.5 cm depth in a row. Distance between two rows should be 5 cm. After germination the seedlings are transplanted in polythene bags of 10 X 15 cm size containing potting mixture of soil and FYM in the ratio of 3:1. The transplanted seedlings should be kept under shade and watered as per the requirement.

The seeds can be directly sown in polybag. Many times two seedlings are sown in polybag in Konkan region. After sowing the seeds germinate after 40 – 60 days. The initial growth of kokum seedling is very slow. For planting in the field, 12 – 14 month old seedlings are preferred. The experience of farmers suggests that bigger size seedlings suffer less mortality in the field.

B. Vegetative propagation

Kokum is a dioecious plant. Female plants are productive whereas male plants supply pollen grains for proper fruit set but do not produce fruits. Furthermore wide variability for economical characters is found in kokum. The probability of occurring male plants is 50 per cent in sexual propagation. Only 10 – 15 per cent male plants in a population are essential. Hermaphrodite plants are also observed but they are mostly poor yielders. The vegetative method of propagation helps to obtain true to type plant. The various

asexual methods such as air layering, inarch grafting, veneer grafting, softwood grafting and root cutting were attempted. The studies conducted under Karnataka conditions revealed that among the cleft, whip, tongue and epicotyl grafting the survival was lowest in epicotyl grafting and maximum in cleft grafting. Softwood grafting is presently used commercially for vegetative propagation of kokum.

I) Softwood grafting

a) Selection of scion

The sciensticks should be selected from high yielding female trees having all desirable characters. Terminal shoots of 0.5 – 0.6 cm thickness and 10 – 12 cm length, of greenish brown colour are selected as sciensticks. The mature scions of 5 – 6 month old contribute more success. The length of scion does not have any influence on success of softwood grafting.

b) Selection of rootstock

The rootstock should be healthy and vigorous. Kokum seedlings of 10 – 12 cm height, 0.25 cm thickness at collar region with green apical softwood are selected. The age of rootstock should be more than 22 weeks. The retention of leaves on rootstock do not influence success of softwood grafting.

c) Procedure of grafting

The selected rootstock should be decapitated leaving sufficient softwood. This softwood should be split vertically into cleft from the top to the length of about 4 cm below with the help of sharp knife. The scion shoots should be prepared like a wedge giving about 4 cm slanting cut from both the sides at the lower end. This wedge should be inserted in cleft of rootstock and the joint should be tied tightly with the help of polythene sheet of 250 gauge and 1.5 cm width.

d) Season of grafting

October to November and March to August was found to be the best season for softwood grafting in kokum under Konkan conditions.

e) Effect of tropism

The vegetative propagation in kokum is significantly influenced by tropism. When orthotropic shoots are used for grafting the resulting graft take the typical architecture that of a mother tree. When plagiotropic shoot is used as a scion the resulting graft remain short and bushy. Extremely limited numbers of orthotropic shoots are available on kokum plants as compared to plagiotropic shoots. Both types of architecture have their own merits and demerits. The orthotropic plant become tall and conical shaped, occupies large area, utilises vertical space and produces higher yield. However the plucking of fruits from such tall kokum plants becomes difficult. The plagiotropic plant remains small and bushy, can be used for high density planting. The harvesting from such plant is much easier.

ii) In-situ grafting

In seedling population, many times the proportion of male seedlings is remarkably higher. Conversion of excessive male seedlings into good female types helps to augment production of kokum orchard. Coppice grafting can be useful for conversion of male kokum plants into female. In-situ grafting was reported for better establishment than planting grafts of kokum.

iii) Rootstocks

Most of the trials on grafting are conducted by using kokum seedling as a rootstock. Kokum seed yields edible oil which remains solid at room temperature and used in many pharmaceuticals and cosmetics. Alternative rootstock will help to save kokum seeds. The studies have revealed the success of kokum grafting by using *G. gummigutta* and *G. cowa*. *G. hombroniana* can be adapted to marshy soil. The rootstock selection should aim at providing drought resistant which will help to establish kokum plantation at rainfed areas.

Tissue culture

Tissue culture is being attempted for micro propagation. Morphogenic responses of matured seed segments of kokum were studied with increase in BAP concentration from 1 – 4.5 mg/per L water increased number of shoot formation. The seed segments explants cultured on WPM without any plant growth regulators did not show any regeneration.

Land preparation and planting

Kokum can be planted as a monocrop or as a mixed crop in coconut and arecanut plantation and can also be planted in a kitchen garden. Considering the growth habit and conical canopy of kokum Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli has recommended a spacing of 6 X 6 m for sole plantation of kokum. Square system of planting can be adopted. Hedge row system can also be used which provide scope for intercropping and better intercultural operations. In an established coconut plantation planted at 7.5 to 8 m spacing, Kokum can be planted in the centre of 2 coconut palms. 300 kokum plants can be accommodated per hectare as a mixed crop in coconut plantation planting of kokum as mixed crop has proved to increase the coconut yield by 34 per cent. In an arecanut plantation planted at 2.7 X 2.7 m, kokum can be planted at the alternate centre of arecanut palm. When grafts are used for planting the spacing can be reduced to 5 m. While planting in kitchen garden, kokum should be planted at least 4 to 5 m away from other tall plants.

The land should be marked at proper spacing. A pit of 60 cm3 is prepared before monsoon and filled with a mixture of top soil, 10 kg FYM and 1 kg Single Super Phosphate. Planting is done at the onset of monsoon. The plants are protected from stray cattle's and other wild animals. The initial growth of kokum seedling and graft is very slow and hence requires staking. When grafts are planted, periodical removal of suckers below graft joint is essential. For the first year, it is necessary to protect kokum plant in summer by providing shade.

Irrigation and Manuring

Irrigation helps for better establishment of kokum plant. Initially 15 L of water per week in winter and twice a week in summer is advised in Konkan region of Maharashtra. For the first three years after planting, irrigation is essential. The modern methods like drip irrigation are beneficial than the conventional methods. Mulching helps to retain soil moisture. The weed near kokum plant should be removed and used for mulching.

For Konkan region of Maharashtra application of 2 kg FYM, 50 g N, 25 g P2O5 and 25 g K2O is recommended for 1 year old kokum plant. This dose is increased in same proportion every year upto 10 years and there onwards 20 kg FYM, 500 g N, 250 g P2O5 and 250 g K2O is recommended. The fertilizers are applied in the month of August after the heavy rains, in a circular trench around plant of about 30 cm deep and 30 – 45 cm wide and covered with soil.

Farmers in the Konkan region do not apply inorganic fertilizers to kokum. FYM or available organic manures are used. Most of the kokum plantation can said to be an organic. However, since the plantation is scattered and very small the certification becomes difficult.

Training and pruning

Kokum is an evergreen plant with attractive conical shaped canopy. When seedlings are planted, the central stem is allowed to grow without pinching to develop the canopy. The plant attains a height of about 10 m when it is fully grown. It is often experienced that as the height increases the lower portion of plant comes under shade and becomes less productive. Furthermore it is also noticed that the fruits at the top of tall tree remain small in size and becomes unmarketable. The harvesting from tall plants of kokum is an important constraint. Maintaining the height of kokum tree at about 4 – 5 m by decapitating the apex have preliminary shown promise at Dapoli.

When the grafts are planted it is observed that only one branch grow in certain direction. This growth should be prevented by regular pinching. Growth in all directions should be tried to induce on a graft. The suckers from rootstock below graft union should be removed regularly.

Plant protection

Major diseases and pests are not noticed in kokum. Some times pink disease is noticed on branches. It is advised to remove the diseased portion of a branch and smearing of Bordeaux paste on the wound.

Flowering and yield

The seedlings start flowering 7 to 8 years of 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 the month of April to May. Most of the fruits are harvested in the month of May and June which is the start of rainy season. About 40 – 70 per cent fruits are trapped in rains and hence lost. Presently in Konkan region alone, this loss is estimated to be of Rs. 157 lakhs. 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 prepone harvesting by about 10 to 34 days.

All kokum fruits on a tree are not ready for harvesting at the time and hence periodical plucking is done. The number of pluckings vary 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 at the 300 ppm at the stage of full maturity of kokum fruits helps to facilitate harvesting by reducing the number of plucking 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 per cent 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 is obtained. 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 the higher yield was reported every alternate year. Considerable variability in physico-chemical composition of kokum is also noticed. The harvested fruits are exclusively used for processing.

Post harvest handling

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 per cent and stored in cool chamber and up to 28 days when stored at 13 ^{0}C + 10 c and 86 per cent RH and Waxol 3 per cent. CFB boxes and paddy straw are good packaging material for kokum.

Value addition

The products such as *Amrit* kokum (kokum syrup), kokum agal (salted syrup) and *amsul* (dried rind) are traditionally prepared from rind of fruit and oil is extracted seeds in Konkan region of Maharashtra.

Future strategies

Kokum possess tremendous potential as a crop of next generation. However so far the research work done in this crop with respect to production technology is extremely limited and is also unorganized. The following areas can be considered as the thrust areas for further studies

- Survey and identification of early and high yielding trees with good quality fruits.
- Development of technology for initial fast growth of seedlings and grafts.
- Standardization of protocol for micro propagation.
- Canopy management for high yield and better quality of fruits.
- Standardization of GAP.
- Development of device for proper harvesting.
- Development of cool chain technology in kokum.
- Innovative value addition and processing

Flowering Patterns in Kokum

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Garcinia indica is polygamodioecious type of plant. This means that the Kokum tree with many types of flower patterns such as (i) separate trees for male flowers; (ii) separate trees for female flowers; (iii) trees with bisexual flowers and the same tree contains male flowers or female flowers; (iv) trees with bisexual flowers and the same tree containing both male and female flowers.

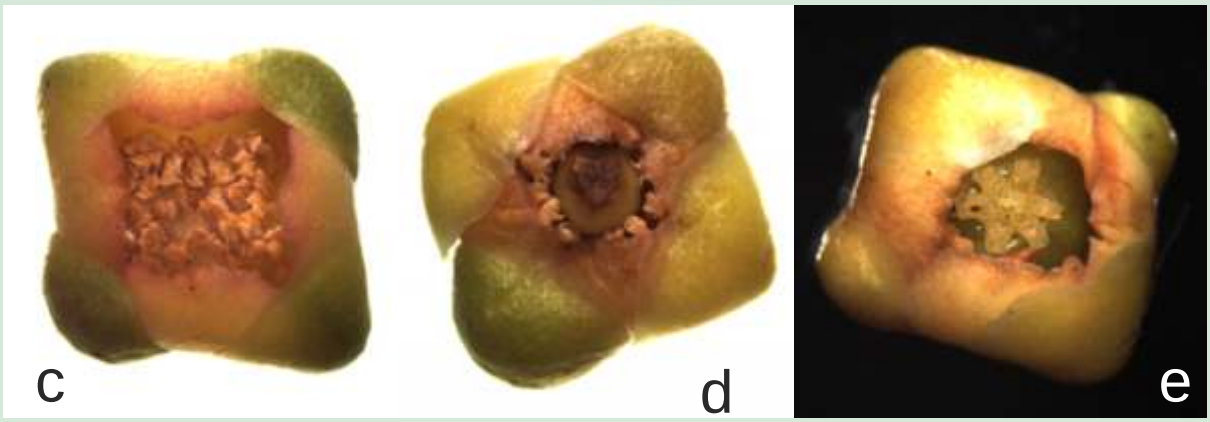
In Kokum flowering usually starts during November and goes up to February. Fruiting seasons is from April-June. The flowers are axillary or terminal. They are solitary or in the form of clusters. Flowers are with four sepals, thick and fleshy, green in colour. The petals are four with yellow to purple. Male flower has numerous short filamentous anthers and anthers are two celled. Female flower are solitary or some time they found in a group of 2-3 flowers. Ovary with short style and stigma six lobbed.

Flowering in male trees starts one week early as compare to others. It was observed that male flower has intermediate length of pedicel as compared to female flower which has short pedicel and bisexual (hermaphrodite) flowers are with long pedicel. Within bisexual (hermaphrodite) trees variation was observed with reference to number of flower, size of flower, length of the stalk (pedicel) and number of stamens (9-24).

The male flower contains more number of stamens per flower (36 to 38) in comparison with bisexual flower. Kokum plant may have strong basis for genetic self incompatibility, however, further elaborate studies needs to be carried out by examining large number of trees / populations and also in different locations to understand the sexual behavior and breeding of Kokum in order to increase the fruit yield and total production.

FLOWERING IN KOKUM

a. Cluster of flowers; b. Different stages of flower development



c. Male flower; d. Bisexual flower; e. Female flower.

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TISSUE CULTURE IN KOKUM

a. Swelling of explants; b & c. Induction of shoot buds from the explants; d. Shoot buds grown in to multiple shoots; e. Elongated, well grown shoots; f. Rooting; g. Hardened plants transferred to root trainer; h. Plantlets in pots.

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In-vitro Culture of Garcinia indica Choisy - A Review

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Garcinia indica Choisy, an endemic plant to Western Ghats of India, belongs to the family Clusiaceae and is popularly known as Kokum (Shetty and Kaveriappa 2001, Naithani et al., 1997). It is a dioecious tree flowers in November-February and fruits ripen in the April-June (Anonymous 1956, Sawant et al., 1999). The conventional way of propagation of Kokum is by seeds. These natural seedling populations, due to cross pollination and heterozygous nature of the trees, has abundant variation with respect to growth, habit, flowering and fruiting season, fruit yield and morphological and biochemical characteristics of fruits (Korikanthimath and Desai 2005). Also, the early ripening and high yielding genotypes are preferred, because harvesting and processing of fruits need to be completed before the onset of monsoon (end of April or beginning of June) in the Western India (Chabukswar and Deodhar. 2005). To overcome the above problems, the production of high yielding elite clones is necessary. In-vitro culture studies have been carried out by various scientific groups and they have developed and standardized the protocol for mass multiplication of Kokum plants through embryogenesis and multiple shoot formation. This review summarizes all the tissue culture work carried out till date on Kokum.

Somatic Embryogenesis

Direct somatic embryogenesis was achieved by Thengane et al. (2006). They have cultured immature seeds on Woody Plant Medium (WPM) supplemented with 6-benzyl amino purine (BAP) 4.44–22.19 micro mole (µm) alone or in combination with a-naphthaleneacetic acid (NAA) (2.69 µm) found somatic embryos of 80% frequency within a period of 2–3 weeks. Embryo induction was exhibited all over the explant surface. The highest number of somatic embryos was recorded in higher concentration of BAP (22.19 µm). The origin of the embryos was confirmed histologically from sub-epidermal layer of the seed. Sub-cultures of somatic embryos in same media did not support the embryo maturation up to 10 weeks. However, it increased the embryogenic mass. Maturation of embryos was achieved in the medium containing BAP (16.08 µm) in combination with indole-3-acetic acid (IAA) (2.85–5.71 µm) and/or kinetin (KN) (4.65 µm) after 12 weeks of culture. After maturation, embryos were converted into shoot pole. It was reported that the maximum number of mature embryos was obtained on the medium containing BAP (16.08 µm), IAA (5.71 µm) and kinetin (4.65 µm). Within 24 weeks, 43.80% of embryos were grown in to well-developed shoots.

For rooting, well-developed shoot pole of size 1.5–2.0 cm were transferred to the rooting media and the rooting was observed in 20-25 days. The maximum number of root was induced in NAA (10.74 µm) with indole-3-butyric acid IBA (4.90 µm). However, roots induced on NAA and IBA combination observed faster growth than those with incorporation of indole-3-propionic acid (IPA) in the rooting media. The rooted plantlets were transferred to half-strength MS (Murashige and Skoog) medium supplemented with

0.89 µm BAP for further elongation. Plantlets grown to the height of about 5–6 cm were washed in water and then transplanted to sterilized potting mixture of sand and soil (1:1) for acclimatization in green-house conditions. About 75% of the somatic embryos were successfully grown into complete plantlets and 92% of the plantlets were survived in green-house after successfully acclimatization.

Thengane *et al.* (2006) standardized protocol for repetitive somatic embryogenesis and plant regeneration of *Garcinia indica*. The immature seeds of *Garcinia indica* were excised from immature fruits and cultured on woody plant medium (WPM) with different combinations of cytokinins and auxins. The explants showed swelling within 1 week and initiation of small protuberances within 2–3 weeks of culture. After 3 weeks of culture, somatic embryos were seen in all over the seed surface. The highest percentage (80%) of somatic embryogenesis was recorded in media supplemented with 22.1µm BAP alone. While increase the BAP from 2.2–16.0µm the number of somatic embryos per explants also increased. However, further increase in the concentration there was a decrease in the number of primary embryos per explants. BA was supplemented with NAA (2.6µm) increased mean number of somatic embryos per explants. However, initiation percentage of somatic embryogenesis was reduced drastically.

Primary embryos when sub-cultured on BAP (16.0 µm) supplemented with indole-3-acetic acid (IAA; 2.8–5.7 µm) and/or kinetin (4.6 µm) exhibited clusters of secondary somatic embryos along with matured primary embryos after 12 weeks of culture. It was observed that all primary somatic embryos did not produce secondary embryos. The maximum number secondary somatic embryogenesis was noted on primary somatic embryos which were grown on the medium (22.1µm) BAP. The rooting was observed within 15–20 days of culture of somatic embryos with well-developed shoot pole on the media supplemented with NAA (5.3–10.7µm) and IBA (4.9µm) or IPA (5.2µm). The maximum percentage (76%) of rooting was noticed on medium with NAA (10.7 µm) and IBA (4.9 µm) with 15.3 roots per explants. However, the rooting was faster on the NAA and IBA as compared with medium containing IPA. The well rooted plantlets were transferred to half-strength MS medium supplemented with 0.8 µm BA for further growth and elongation. Then, they were transplanted on potting mixture of sterilized sand and soil (1:1). After acclimatization, 90% survival was noted in green-house conditions.

Multiple Shoot formation

Kulkarni and Deodhar (2002) developed efficient protocol for multiple shoots and callus formation from Kokum. Immature seeds were cultured on MS basal medium supplemented with NAA (2.69 µm), BAP (8.9 µm) and KN (0.93 µm) induced multiple shoots formation. Shoot elongation was achieved on half-strength MS medium supplemented with NAA (0.54 µm), BAP (0.44 µm) and KN (0.93 µm). For induction of rooting, the elongated shoots were treated with 4900 µm IBA for 30 seconds and cultured on half-strength MS basal medium. The rooted plantlets were successfully transferred to pots in green-house conditions.

Malik et al. (2005) reported the efficient method for rapid regeneration of plantlets via adventitious bud differentiation using mature seeds of Kokum. The maximum percentage of direct shoot proliferation was noticed in seed segments cultured on Murashige and Skoog's medium supplemented with cytokinins such as BAP, KN and thidiazuron (TDZ) alone and in combination with auxin (NAA). Seed segments cultured on MS basal medium showed development of shoot along with roots from S-end (emergence of shoot) and only roots from R-end (emergence of root), while the middle segments showed no response. Only the creamish-white seed segments produced multiple shoots on hormones supplemented media, they were subsequently used for all experiments on adventitious bud differentiation. Significant variations were recorded among the explants from different accessions. Accession numbers IC-136685-1 and IC-136682-2 showed maximum response of 100% followed by IC-136687-2 (91.67%) and IC-136687-3 (44.45%).

The concentration of BAP required for induction of maximum number of shoot buds also varied among the explants from four accessions. Seeds from accession number IC-136685-1 produced maximum number of buds per segment when cultured on 50 µM BAP in the medium. Increase in BAP concentration beyond the optimal concentration (More than 50 µM) did not improve the regeneration response in any of the accessions. The shoot buds developed at BAP concentrations was found higher than the optimal levels which were stunted, failed to elongate and their leaves did not expand even after transfer to hormone-free MS medium. There were differences amongst the genotypes in terms of *in vitro* response for adventitious shoot bud development. Seeds of accessions IC-136685-1 and IC-136687-2 developed shoot buds directly on the explants surface without forming callus or swelling. Seeds of IC-136682-2, showed swelling of explants along with the development of large number of shoot bud primordia on the whole explants surface, but only a few of these primordial differentiated into shoots. Seeds from accession IC-136687-3 on the other hand showed development of white, friable callus on the seed segment surface along with the shoot buds at all the BAP concentrations. Shoot bud formation was observed within 4–5 weeks of culture. Maximum response was observed at different concentrations of BAP (12.5–50 µm) in different genotypes investigated.

Effect of NAA (1.0 and 2.5 µM) with BAP (5–50 µM), kinetin (12.5 µM) and TDZ (0.1, 0.2, 0.5 and 12.5 µM) added singly for the induction of adventitious buds was studied in accession IC-136685-1 seed segments. Media supplemented of NAA along with BAP was deleterious, as it did not bring any improvement in the regeneration response, these bud numbers were much less compared to that induced on medium supplemented with only BAP (25.36–57.67). When the media supplemented with kinetin (12.5 µM) alone induced less shoot buds as comparison with BAP.

Effect of TDZ on shoot buds induction was 69.45–77.78% explants. However, bud to shoot conversion rate was only 5–10% when the cultures were subsequently transferred to basal medium while others turned necrotic. The higher concentration of TDZ (12.5 µM) led to development of callus in 97.22% explants, but only 36.11% explants producing shoot buds. Shoots elongation was achieved on MS basal medium containing 0.2% activated charcoal. Proliferation of shoot was done by repeatedly sub-culturing the shoot nodes on MS medium supplemented with 5 µm BAP. The maximum percentage (91.66%) of rooting

was observed on half-strength MS medium supplemented with 10 µm IBA. The rooted plantlets were transferred to pots containing soil, vermiculite and FYM in 1:1:1 ratio. The plantlets showed 90% of survival in the pots (Malik *et al.*, 2005).

De novo shoot regeneration from root cultures via somatic embryo derived plantlets was achieved by Deodhar *et al.* (2008). Roots of somatic embryo derived plantlets when cultured for long time on half-strength MS medium supplemented with BAP (0.44–2.22 µM) showed production of de novo shoots. Maximum number of shoots was obtained on medium supplemented with BAP (2.22 µM). Elongation of shoots was achieved on WPM supplemented with BAP (4.44–22.69 µM), IAA (5.71 µM) and KN (4.65 µM). Rooting was induced on WPM medium supplemented with NAA (2.69–10.74 µM) and IBA (4.90 µM) within 20–25 days. Rooted plantlets were transferred to pots containing garden soil and farmyard manure (1:1) showed 90% survival under green-house conditions.

Regeneration of plantlets via adventitious bud differentiation from leaf explants was reported (Malik *et al.*, 2010). Leaves of *in vitro* grown seedlings were cultured on Murashige and Skoog's medium supplemented with cytokinins (BAP, KN and TDZ) alone and in combination with auxin (NAA) for direct shoot proliferation. Maximum number of buds developed directly without callus development on upper leaf surface was 63.89% explants on the medium supplemented with 1µM TDZ supplemented medium after 2–4 weeks of culture. The leaves were cultured on higher concentrations of TDZ (2.5 to 12.5 µM) showed 5-6 times growth in size due to swelling followed by appearance of compact, green callus on swollen leaf area and petiole bases. Incorporation of NAA with TDZ enhanced callus formation. Elongation of the induced shoots was achieved on MS basal medium containing 0.2% activated charcoal. Direct root induction was achieved in 52.77–83.33% shoots on half-strength MS medium supplemented with IBA or NAA. Maximum rooting (83.33%) was observed in shoots cultured on half-strength MS medium supplemented with 10 µM IBA. The rooted plantlets were transferred to pots containing soil, vermiculite and FYM (1:1:1). The acclimatization of plantlets was showed 90% survival with normal growth (Malik et al., 2010).

A high frequency plant regeneration system was developed for the production of high yielding elite clones of *Garcinia indica* via direct organogenesis (Plate 1) was developed by Baskaran and Krishnan (2011). The seed segments were cultured on WPM supplemented with BAP 1.0, 2.0, 3.0, 4.0, 4.5 and 5.0 microgram per litre (mg/l) or in combinations with IAA (1.0 mg/l), NAA (1.0 mg/l) and IBA (1.0 mg/l). Seed segments showed prominent swelling after one week of culture in WPM supplemented with various plant growth regulators. Induction of multiple shoot primordia was noticed on all over the surface of explants after 2–3 weeks of culture. After one month of culture the shoot primordia differentiated into shoot buds. The frequency of shoot buds induction ranged from 20 to 100% in the media supplemented with BAP alone. BAP in combination with auxin was found to be effective for shoot bud induction. However, it took one week more for the induction of shoot buds in comparison with BAP alone. Among, the BAP and auxin combinations BAP (2 mg/l) with IAA (1 mg/l) produced highest number of shoots with the frequency of 100% regeneration. BAP and NAA combination produced 20 - 40% callus

along with shoot bud formation. BAP in combination with IBA was less effective in shoot bud induction when compared to BAP + IAA and BAP + NAA. Induced shoot buds were cultured on WPM supplemented with 1.0 mg/l BAP and 0.1% activated charcoal for better shoot growth and elongation. Two weeks later, the elongated shoots of 3–5 cm were cut at the basal region and placed on rooting media (Plate 1).

Rooting was achieved in all the combinations of IBA and NAA within a period of 2–3 weeks. IBA induced the highest frequency of rooting (100%) at 3 and 4 mg/l when compared to NAA. However, highest number of roots was observed at 4 mg/l NAA after 15 days. Among the IBA and NAA concentrations, maximum length of the roots was recorded in 3 mg/l IBA. Even though the number of roots produced by NAA was higher, the roots were stunted, swollen, greenish white and did not support the acclimatization process as compared to thick white roots produced by IBA. Shoots cultured on media without IBA and NAA did not develop any roots. For hardening, the rooted plantlets were transferred to culture tubes contained quarter-strength liquid WPM without sucrose for 10–12 days. The plantlets with healthy roots that were transplanted into a mixture of equal volume of garden soil and sand recorded 95% survival rate (Plate 1).

Establishment of multiple shoot from apical and intercalary buds of root sucker explants was done by Tembe and Deodhar, 2011. Apical and intercalary buds were cultured on WPM medium supplemented with various combinations of hormones such as BAP, Kin and TDZ. The shoot initiation was noted only in WPM medium containing 13.2 µM BAP after 4 weeks of inoculation. All buds were grown well up to 8 weeks when it was sub-cultured in the same medium. Best shoot multiplication was observed in WPM medium containing 4.40 µM BAP and 0.45 µM TDZ (few new shoot buds emerged from the meristematic end of root sucker explants). Elongation was achieved in half-strength WPM+ 0.44 µM BAP and 0.5 gram per litre activated charcoal. Better root induction was observed in shoots subjected to pulse treatment of 19.6 mM IBA for 30 seconds. About 75% rooted plants were survived in coco-peat.

The above review describes the plant regeneration through somatic embryogensis and direct shoot bud formation of Kokum. During the past 10 years, many researchers have developed and standardized the efficient protocols for plant regeneration using leaf, root, root-sucker, mature and immature seed segments as explants. Future studies may concentrate on the development and standardization more efficient protocol for the production high-yielding elite clones for farmer's cultivation.

POST HARVEST PROCESSING

TRADITIONAL DRYING METHOD & DRIED RIND OF KOKUM

Exhibition of dried Kokum rind to select superior variety at 1st National Seminar on Kokum held at Regional Fruit Research Station, Vengurla, of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth (2001)

Traditional method of drying Kokum rind on roadside.

Western Ghats Kokum Foundation, Panaji - Goa

MODERN METHOD OF DRYING RIND OF KOKUM

Perforated tray with Kokum rind

Perforated trays with Kokum loaded in a hot air dryer

Western Ghats Kokum Foundation, Panaji - Goa

Need of Standardization and Advances in Value Addition of Kokum processing

N.J.Thakor, S.B.Swami and P.M.Haldankar

In India Kokum is grown widely in Western Ghat mainly in Konkan region. Fruit as a large and small orange, purple throughout, not grooved, having 3-8 seeds embedded in a red acid pulp in a regular pattern like orange segments, in the White pulpy material. Fruit rind and seed both are economical components of Kokum fruit. The expected shelf life of fresh fruit is about one week. 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 south Indian curries, it is used instead of tamarind and also has many medicinal properties. Kokum has reported for treatment of dysentery, tumours, heart complaints, stomach acidity and liver disorders..

Many therapeutic effects of the fruit have been described in traditional medicine based on Ayurveda. These includes its usefulness as an infusion in skin ailments such as rashes caused by allergies; treatments of burns, scalds and chaffed skin; to relieve sunstroke; remedy for dysentery and mucous diarrhoea; an appetizer and good liver tonic; to improve appetite and to allay thirst; as a cardiotonic and for bleeding, plies, dysetry, tumours and heat diseases.

The fruits of Kokum are commercially exploited for making Kokum Syrup '*Amrit Kokum*'which makes an excellent sarbat and is useful in fever as a cooling, refreshing drink (Table 1).

Table 1: Chemical Composition of Kokum rind.

Sr. No.	Chemical Constituents (Moisture free basis)	%
1	Moisture	90
2	Protein	1.92
3	Crude fibre	14.28
4	Total Ash	2.57
5	Tannins	2.85
6	Pectin	5.71
7	Starch	1.00
8	Crude fat (% hexane extract)	10.00
9	Acid (hydrocytric acid)	22.80
10	Pigments (Total Anthocynine)	2.40
11	Ascorbic acid	0.06
12	Carbohydrate by difference (excluding starch & Pectin)	36.40

Kokum seed (8-10 seeds per fruit) is a good source of fat called as "Kokum Butter". Kokum is a minor oil seed crop and butter has food and non-food applications. The oil is

traditionally extracted by boiling the kernel powder in water and the oil that is collected at the top is skimmed off. The yield of oil (fat) is about 25 to 30%. Kokum fat has been reported to be used in chocolate and confectionary preparations. It is also used is 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. It is reported that Italy and some, other foreign countries are importing kokum fat from, India for use in confectionary preparations. Kokum fruit appears to be a promising industrial, raw material for commercial exploitation in view of its interesting chemical constituents.

2. Need for standardization of Traditional Processing Methods:

Presently Kokum syrup, Kokum Agal and Kokum Amsul are being prepared traditionally in Konkan region. Problems associated with the Traditional Processing Methods.

(1) Products prepared is lacking in uniformity in product quality. The final product produced it depends on the experience of a person who is preparing the product. Quality of the final product varies with the persons who are preparing it.

(2) Products developed may affect from the cleanliness. Maintaining the cleanliness during the preparation of the products is difficult in the Traditional processing.

(3) The developed products (Kokum syrup, Kokum Agal and Kokum Amsul) needs to be packed in a suitable packaging material so that it could be kept safe storage limit for longer duration. In traditional processing methods less emphasis is given to the packaging of these products. The packaging material for which these products are to be packed needs to be standardized.

(4) Kokum seeds be extracted efficiently so that more recovery of the kokum butter be possible.

(5) The nutritional composition of the food products need to be mentioned while promoting the products.

(6) Storage of these products needs to be studied and duration for storing these products needs to be determine so that its safe storage limit is to be find out.

(7) HACCP principles needs to be carried out during preparation of these products so that these could be prepared as per the international standards.

To fulfil the gaps of the traditional processes and to overcome the problems associated with these methods there is a need to standardize these products. An attempt has been made to standardize these techniques with scientific approach. Also some new products have also been developed from Kokum i.e. Kokum rind powder, kokum sarbat mixes, kokum solkadhi mixes etc.

3. Standardized Products from Kokum:

3.1 Kokum Syrup (Amrit Kokum)

The fruits are washed with clean water. The fruits were cut into two halves and seed and pulp of fruit was removed manually. Rind is cleaned internally and sugar was used to prepare the syrup. kokum rind halves were placed in layer and sugar was filled in the halves.

Alternate layers of kokum rind halves and sugar were put in the food grade plastic drums for 7 days. Kokum rind was extracted by Osmosis & while quality of sugar dissolved in it. The syrup could be strained through the 1 mm sieve or cloth to separate out the rind portion. The experiment was carried out at various levels i.e. Cutting two halves; Basket press squeezing – cold; Basket press squeezing – hot and Mixer grinding

The syrup is available in following two variants (i) Kokum syrup with no preservatives, colour, salt or water except sugar, (ii) Kokum syrup with permitted preservatives and salts. (Sodium benzoate @ 610 mg/kg of finished product).

3.2 Kokum Amsul (Dehydrated Salted Rind)

Fresh Kokum fruit washed properly and cut into two halves to separate the seed, pulp and the rind. The seed and the pulp is mixed with around 10 percent salt. The salt solution leached out from this mixture is used for the dipping of the separated rind. The rind then placed for Tray drying/sun drying. The next day the dried sample is again dipped in the salt solution, which was leached on the second day from the salt seed mixture. Then the rind is again placed for the drying. The process of dipping and drying is repeated for 4 to 5 times to get the *Amsul*.

Kokum *Amsul*, a culinary delight, is the dry Kokum rind treated with Kokum juice. It has the souring qualities similar to that of tamarind, adds taste to coconut based curries and vegetables dishes. *Amsul* is popularly used with fish curries; three or four rinds are enough to season an average dish.

3.3.Kokum Agal (Salted Juice):

Agal is a salted juice prepared from Kokum fruit locally. The salt was added Salt concentrations – 4 Levels (14, 16, 18, & 20 %) pulp was added. The mixture was stirred daily for seven days. After seven days the whole mixture was strained through stainless steel sieve of 1 mm, brined juice was the filled in presterilized bottles.

3.4. R.T.S. Drink from Kokum and other Juices

The T.S.S. and acidity of different juice are observed, then required quantity of citric acid and sugar was added to raise its 0Brix and acidity to 200Brix and 0.3 per cent respectively. Finally, the product was prepared with following Table2.

Table.2. Various parameters with the quantity required for RTS drink from Kokum.

Parameter	Quantity
Juice	20%
T.S.S.	20%
Acidity	0.3%
Water	Remaining

Preservation at the rate of 140mg /kg of final product. Sodium benzoate (NaB) is added as preservation depending upon the colour of the product.

After adding required quantity of sugar, citric acid and water, the product was boiled for few times to dissolve the ingredient. Then NaB for coloured product and was added @ 140 mg/kg of final product. Then the beverages are immediately filled into the presterilized glass bottles. Then the filled bottles are immediately sealed with crown corks. Then the bottles are pasteurized for 30min. in boiling water, then the bottles are removed, cooled, labelled and stored cool and dry places at ambient temperature.

3.5.Squashes from Kokum

The squash from Kokum could be prepared at various parameters as given in Table 3. The T.S.S. are noted and further required of sugar are added to juice to raise its 0Brix to 450Brix.

Table.3 Various parameters with the quantity required for Squash from Kokum.

Parameter	Quantity
Juice	25%
T.S.S.	45%
Acidity	1.2%
Water	Remaining

Preservative sodium benzoate @ 610mg/kg of final product. After adding the necessary quantity of sugar the product was boiled to dissolved the ingredients. The preservative sodium benzoate for coloured are added @ 610 mg/kg of final product. The final product was filled immediately into the presterilized glass bottle, further the bottles are sealed immediately with the crown corks and are pasteurised for 30 min. in boiled water. The filled bottles are then removed, cooled labelled and stored at cool and dry places at ambient temperature.

3.6. Kokum Butter

The oil is traditionally extracted by boiling the kernels in water and the oil which collects at the top is skimmed off. Now a days oil is obtained by solvent extraction also. The yield of oil (fat) is about 25%. The fat is greasy to feel and whitish yellow in colour.

The fruit contains 6 to 8 seeds. The Kokum seed contains 23-26% edible oil known as kokum butter. It remains in solid state at normal mean temperature. It is off-white in colour. The butter is valuable in preparation and is helpful in skin ailments such as rashes, allergies, burns, scalds and chaffed skin. The Kokum butter is used for manufacture of cosmetics, creams, soaps, confectionery, candles, etc. Table 4 shows the chemical characteristics of Kokum fat are as given below:

Table 2: Chemical characteristics of Kokum Fat

Melting point	39-430C
Sap value	189
Iodine value	34.7-36.7
Unsap. matter (%)	1.4%
Free fatty acid -	
(%) As oleic	7.2%
Myristic	0-1.2
Palmitic	2.5-5.3
Stearic	52-56.4
Oleic	39.4-41.5
Linoleic	1.7

4. Advances in value addition in Kokum

4.1Kokum Rind Powder:

This can be a raw material for various curry preparations, ingredients in various mixes like sarbat, solkadhi, Kokum RTS etc. The kokum rind was dried at certain temperature in a tray dryer and dried rind was ground. The ground product is sieved in a sieve to get uniform particle size. Fig. 2 shows the developed kokum rind powder.

4.2Kokum Sarbat Mixture:

It is a instant product (ready to prepare). The kokum powder, sugar, and spices are added in various concentrations and the mixture is dried in a tray dryer to get the Kokum Sherbat Mixture. Fig.3(a) shows the developed Kokum Sarbat mixture.

4.3.Kokum Solkadhi Mixture:

It is a instant product (ready to prepare). The 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 sol khadi mixture. Fig.3(b) shows the developed Kokum solkhadi mixture.

4.4.Kokum Wine:

The red Kokum juice has about 4 per cent sugars and can be fermented to produce wine. Kokum wine is prepared in Goa using the traditional method with commercial bakers yeast.

4.5.Kokum Honey:

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

4.6.Benzophenone Derivatives

Garcinol-1 is a polyisoprehylated benzophenone derivative from Garcinia indica and other species. The dried rind of *Garcinia indica* (cv. Kokum) which is used as a garnish for curry and in some of the folklore medicine in India 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 posses 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.

4.7. Anthosyanin pigments

Kokum is a rich source of anthocinins. The red colour in Kokum is due to presence of anthocyanin such as Cyanidin 3-glucoside and cyanidine 3-sambuboside. The pigment contains in Garcinia Indica Choisy (Kokum) is 1000-2400 mg/100g. Anthocyanins are

considered as a potential replacements of synthetic colours because of their bright attractive hue and water solubility that allows their incorporation into aqueous food systems; they may also posses health benefits.

4.8. Hydroxycitric acid (HCA)

One of the ingredient in Kokum is Hydroxycitric acid (HCA), is a anti-obesity agent. It suppresses the fatty acid synthesis, lipogenisis, food intake and induces the weight loss. Fruit reduces fat, cools the body, purifies blood and lowers cholesterols. The bioactive phytochemical responsible for these attributes is Para - hydroxycitric acid (Para -HCA) and is found in abundance ranging from 10-30% in the rind of dried fruit of kokum.

5.Conclusions:

Garcinia indica (dried rind known as 'kokum') is an Indian spice used in many parts of the country for making several vegetarian and non-vegetarian 'curry' preparations, Kokum powder, Kokum sarbat mixture, kokum solkadhi. The fruits are steeped in sugar syrup to make 'amrut kokum', a healthy soft drink to relieve sunstroke, which is popular during summer. It is a traditional home remedy in case of flatulence, heat strokes and infections Many therapeutic effects of the fruit 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 diarrhoea; 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. Utilization of the advanced products like HCA, Garcinol, wine, purified pigments and others processes would create more domestic and international demand of kokum.

Traditional Methods of Kokum Fruits Processing

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Traditionally, fresh fruits are collected from the forest areas and are pooled and marketed when freshly harvested, the fruits are reddish green in colour turns into full-red-purple colour in a day or two. The fruit has an agreeable flavour and sweetish acid taste. The normal shelf-life of the fresh fruits is about 5 days. Hence sundrying is practised for preservation. For sun drying, the fresh ruits are cut into halves and the fleshy portion containing the seeds is removed. The rind which constitutes about 50-55% of whole fruit 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 Kokam of commerce. A salted variety, where in common salt is used during soaking and drying of the rind is also marketed. Lonavala kokum, Pakali kokum, Khanee or edible kokum and Khoba kokum are some of the trade varieties.

The composition of the fresh Kokum rind is found to be as follows

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

The following beverages can be prepared from the juice of the above mentioned fruits as straight beverages.

1. R.T.S. (Ready-to-serve)
2. Squash
3. Syrup

Selection of Fruits

Properly matured ripe fruits of kokum are selected and arid are washed throughly under running water. Then juice from different fruits are obtained by the following methods.

Raw Kokum juice extraction

After destalking and washing of fruits, the seeds are removed from the fruits. Then the rind pieces along with juice from the fruit was passed through hand operated screw type juice extractor and the juice obtained was filtered through the four folds of muslin cloth and the clear juice obtained was used to prepare the R.T.S., squash and syrup.

Preparation of R.T.S.

The T.S.S. and acidity of different juices are observed, then required quantity of citric acid and sugar was added to raise its °Brix and acidity to 20°Brix and 0.3 per cent respectively. Finally, the product was prepared with following recipe.

Parameters Quantity
Juice 20 %
T.S.S. 20%
Acidity 0.3 %
Water Remaining

Preservative at the rate of 140mg/kg of final product. Sodium benzoate (NaB) is added as preservative depending upon the colour of the product.

After adding required quantity of sugar, citric acid and water, the product was boiled for few times to dissolve the ingredient. Then NaB for coloured product and was added @ 140mg/kg of final product. Then the beverages are immediately filled into the presterilized glass bottles. Then the filled bottles are immediately sealed with crown corks. Then the bottles are pasteurized for 30 min. in boiling water, then the bottles are removed, cooled, labelled and stored cool and dry places at ambient temperature.

Preparation of Squashes

The T.S.S. are noted and further required of sugar are added to juice to raise its Brix to 45° Brix.

Parameters	Quantity
Juice	25 per cent
T.S.S.	45 per cent
Acidity	1.2 per cent
Water	Remaining

Preservative sodium benzoate @ 610 mg/kg of final product. After adding the necessary quantity of sugar the product was boiled to dissolve the ingredients. The preservative sodium benzoate for coloured are added @ 610 mg/kg of final product. The final product was filled immediately into the presterilized glass bottles, further the bottles are sealed immediately with the crown corks and are pasteruised for 30 min. in boiled water. The filled bottles are then removed, cooled labelled and stored at cool and dry places at ambient temperature.

Preparation of Syrup (Amrut Kokum)

Selection of fruits ripe, fresh and sound fruits are selected and washed with water. Stalks are removed. Preparation of fruits. The fruits are cut into four pieces by quar tearing. The pulp and seeds are removed.

The pieces of rinds are mixed with sugar in 1:2 (Rind: Sugar) proportion. This mixture was kept in a big stainless steel vessel for about 7 days. The mixture was well stirred every day.

After 7 days whole juice from Kokum rind was extracted due to osmosis and whole quantity of sugar was dissolved in it. The syrup was strained through 1 mm stainless steel sieve to separate out the rind portion. The preservative sodium benzoate was added at the rate of 610 mg/kg of the finished product.

The syrup was filled in the presterilized glass bottles. The bottles are then crown corked, labelled and kept in a cool and dry place at ambient temperature conditions.

Ripe Kokum Rind Powder

Selection of fruits ripe, fresh and sound Kokum fruits are selected. The fruits are cut into pieces. Inner pulp and seeds are removed. The pieces are dried in cabinet drier at 50-55°C and after drying, powdered 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 conditions.

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 per kg pulp was added. The mixture was stirred daily for seven days. After seven days the whole mixture was strained through stainless steel sieve. Thus, brined juice was then filled in presterilized bottles.

Kokum has been traditionally used as acidulent in certain foods in some regions of Karnataka and Maharashtra. It is also used to make an attractive red pleasant flavoured extract for use as a beverage. The kokum fruit is anthelminitic and cardiotonic and used in piles, dysentery, tumours, pains and heart complaints. Syrup from the fruit juice is given in bilious affections.

Kokum seed (8-10 seed per fruit) is good source of fat which is called as "Kokum butter" in commerce. Kokum seed is a minor oil seed crop; butter has food and non-food applications. The seeds are decorticated by beating with a rod.

The oil is traditionally extracted by boiling the kernels in water and the oil which collects at the top is skimmed off. Now a day's oil is obtained by solvent extraction also. The yield of oil (fat) is about 25%. The fat is greasy to feel and whitish-yellow in colour.

Chemical Characteristics of the Fat	
Melting point	39° - 43°C
Sap value	189
Iodine value	34.7 - 36.7
Unsap matter (%)	1.4%
The component fatty acids percent by wt. are	
Myristic	0-1.2
Palmitic	2.5-5.3
Stearic	52.0 -56.4
Oleic	39.4-41.5
Linoleic	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. It is reported that Italy and some other foreign countries are importing kokam fat from India. For use in confectionery preparations.

Flow sheet 1

Raw Kokum R.T.S. (Ready to Serve)

Selection of fruits

⮟

Washing of fruits

⮟

Preparation of fruits
(Destalking of fruits and boiling of fruits)

⮟

Straining of the juice

⮟

Preparation of the product according to recipe

⮟

Addition of preservative
(Sodium benzoate @ 200 mg/kg of finish product)

⮟

Boiling of the product for 5 minutes

⮟

Filling the product in presterilized bottles and crown corking

⮟

Pasteurization of bottled product

⮟

Cooling and labelling

⮟

Storing the product at cool and dry place.

Flow sheet 2
Raw Kokum squash

Selection of fruits
⮟
Washing of fruits
⮟
Preparation of fruits
(Destalking of fruits and boiling of fruits)
⮟
Straining of the juice
⮟
Preparation of the product according to recipe Boiling of the product for 5 minutes
⮟
Addition of preservative
(Sodium benzoate @ 610 mg/kg of finish product)
⮟
Filling the product in presterilized bottles and crown corking
⮟
Pasteurization of bottled product
⮟
Cooling-and labeling Storing the product at cool and dry place.

Flow sheet 3
Ripe Kokum syrup (Amrut Kokum)
Selection of fruits
⮟
Washing of fruits
⮟
Preparation of fruits
(Destalking of fruits and removal of inner pulp and
seeds from fruits and cutting the rind into pieces)
⮟
Preparation of the product according to recipe
(Addition of sugar and keeping the mixture for 7 days with
daily stirring and then straining the syrup)
⮟
Addition of preservative
(Sodium benzoate @ 610 mg/kg of finished product)
⮟
Filling the product in presterilized bottles and crown corking Labelling
⮟
Storing the product at cool and dry place.

Flow sheet 4

Brined Kokum Juice (Agal)

Selection of fruits

⮟

Washing of fruits

Preparation of fruits

(Destalking of fruits and separation of inner pulp)

⮟

Preparation of the product according to recipe

(Addition of salt @ 160 g/kg and keeping the mixture for 7 days with daily stirring)

⮟

Straining of pulp

⮟

Filling the product in presterilized bottles and crown corking Labelling Storing the product at cool and dry place

Flow Sheet 5

Ripe Kokum Rind Powder

Selection of fruits

⮟

Washing of fruits

⮟

Removal of inner pulp and seeds from rind

Drying the rind in cabinet drier at 50-55°C

Grinding the dried rind into fine powder

⮟

Packing the powder in polythene bags and sealing the bags and store at cool and dry place

⮟

The presentation was followed by questions which were put forward by the participants and were simultaneously answered by the speaker of the paper.

TRADITIONAL PREPARATIONS OF KOKUM

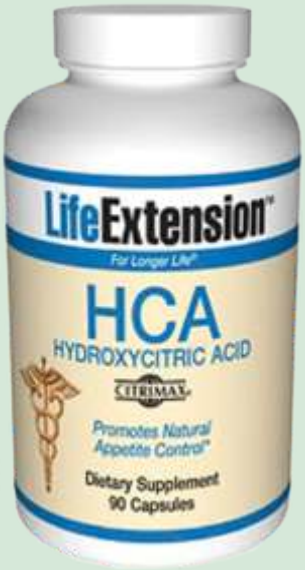
SOL KHADI
(Water extract of Kokum rind)

SOL KHADI
(Water extract of Kokum rind with coconut milk)

Western Ghats Kokum Foundation, Panaji - Goa

MODERN PREPARATIONS FROM KOKUM

COSMETICS



FOOD & DRINKS

Western Ghats Kokum Foundation, Panaji - Goa

Konkan Kokum - A ready to serve, Kokum fruit drink in Tetrapack

Mukund Bhave, Aparant Agro Foods Pvt.Ltd., Maharashtra.

Aparant Agro Foods Pvt.Ltd. was formed by like minded people as a vehicle to promote kokum drink nationally & internationally. The company was registered in September 2009 and its first product a long shelf life kokum fruit drink with a brand name *Konkan Kokum* was launched with much fanfare on 19th February 2010 at the Raigarh fort ropeway base camp. The product received rave reviews from the print and electronic media and a lot of encouragement from well known personalities of the western Ghats or konkan region.

For a sustainable growth of the product it was necessary to understand the linkages between all the stakeholders in the value chain namely, Consumers, Marketers, Manufacturers and Farmer Producers.

The result of a comprehensive study is stated below for comments and discussions,

Consumer : Kokum Fruit drink is as well known as Salt & Sugar in the households of coastal belt of Maharashtra, Goa and Karnataka. with some of its associated medicinal properties but not all. In the rest of these states however the product awareness is limited.

Even in this belt the drink is taken in summer only as a thirst quencher. Price affordability of the available product was no issue

Marketer : Given the limited awareness ,it was a big challenge to promote the product, Position it properly and Price it correctly, Creating awareness of the product's various medicinal properties first and then the necessity of bringing the product in a long shelf life package perceived to make it expensive had to be tackled.

Distribution of the product in various cities in small quantities remains an issue.

Manufacturer : The manufacturing involves thermally treating the single strength fruit drink to make it bacteria free and then aseptically (without ingress of surrounding air) filling it in a specially designed package that will protect it from ingress of oxygen ,thereby offering a very long shelf life .This processing capability and packaging technology is available from a company called Tetra Pak who are world leaders is liquid food packaging .They profess that : A package should save more than it costs !

Implying that their package is for high value (not price) product that needs to be taken from a manufacturing plant to consumer all over the world in safe and secure condition till it reaches its discerning consumer .

The processing and packaging plant works on a continuous basis through out the day with planned intermittent cleaning in place. The smallest packaging plant has a throughput of 1500 liters per hour which translates on 20 hours and 300 days in a year basis to 9 million liters or 45 Million Packs of 200 ml size. Consequently the investment in a

new plant is upwards of 15 crores! Besides the packaging material has to be ordered in million packs at a time by making advance payment .

Shri Warana Sahakari Dudh Utpadak Prakriya Sangh magnanimously offered to process and package our product on hearing the product we are launching and the value it will bring to the consumer . Without them Aparant's dream could not have turned to reality so soon. A lot of patience is required to get the product co-packaged with accompanying un foreseen costs. A dedicated plant will go a long way in popularizing and reaching the product all over the world .If a Coke can come all the way from Atlanta to India ,we do not see a reason why kokum can not reach from India to all corners of the world. One just has to compare the negative effect coke has on consumer and a superlative advantage that Kokum will bring about, investment in such a plant would be small change !!

Farmer / Producer : Kokum fruit is effectively available for just over a month in a limited geographical area. Most of the fruit is even today brought in by the Gatherers and organized cultivation is still a daydream. The fruit does not command a price because there is no demand and is sold currently for a throwaway price. When a processor like us approach the cultivators/ Gatherers the price quoted is awesome and quantity is not guaranteed. Aparant came in contact with a NGO run pilot project supported by the Collector of Sindhudurg, who helped us collect the dried fruit rind through the self help groups trained by them. We paid all the price for the produce in advance and in such numbers that were hitherto unheard of.

A proper understanding of the linkages enumerated above guided the making of our Business plan and product strategy.

Product Recipe : Departing from the conventional method of Syrup to RTS we decided to add clarified sugar syrup at the manufacturing plant. The excellent quality of dried kokum rind made it possible to retain the Anthocynin in the final drink eliminating the need for any added colour. The Tetra Pak processing and packaging Technology made it possible to do away with any added preservative or flavour.

Package Design : A professional designer was commissioned to create a proper image of product and to display the product characteristics.

Product Positioning : The backbone of our product is the medicinal properties that it offers ,So we positioned it as a "Functional Food" and decided to promote it as an every day drink .

Product Promotion: A website was launched to describe the product in detail and articles written of eminent scientists were posted on it.

Courtesy an Ayurvedik formulation company that was impressed with our product, gift hampers of our product was sent to some 1000 doctors and pharmacists last summer and this summer.

Participation in trade fairs in Pune , Mumbai and as far as Nagpur was undertaken. Hoardings were erected in some cities to compliment the efforts of distributors in those cities.

A well laid out product information leaflet was widely circulated. Flex boards and Posters were made and circulated to retailers.

Product was launched at the high profile functions at Raigad Fort, Ratnagiri and Sindhudurg at the hands of popular leaders.

What remains to be done is appointment of brand ambassadors and advertisements in print and electronic media. That being an expensive proposition is decided to be taken up once the product's acceptance feedback is received from all corners of the country.

Product Pricing : Before the commercial launch of the product one batch of some 2000 packs was produced at the Tetra Pak Innovation center by paying a princely sum in the month of October 2009. The objective was twofold. One to understand the product characteristic post processing and packaging with our unique recipe and second was to distribute this product to our target consumer groups and elicit their feedback on value proposition. A price of Rs. 15 was thus discovered.

Product Manufacturing and raw material sourcing : A commercial contract was put in place with the owners of Tetra Pak Processing and Packaging Plant . Packaging material in large quantities and raw material in adequate quantities were purchased by paying in advance.

Product Distributors : The product is available to day through the efforts of our distributors in the retail outlets of Mumbai, Pune and some other cities of Maharashtra.

The product is also available in Singapore and Dubai and has been test marketed in the United States of America !

A small beginning has been made and the product is kept alive for over a year from its launch time . A lot needs to be done yet to communicate the excellent product properties of this drink.

The issues that need to effectively communicated are :

The drink is rich in antioxidant properties and when measured on ORAC scale it comes at the top. Taken every day like milk and tea it will bring about immunity from variety of diseases.

The drink is very well suited as a remedy for Urinary tract Infection.

It is a very good agent for weight reduction despite of the sugar used in it.

The drink is undoubtedly proven as an anti acidity drink a natural thirst quencher.

The drink is most suitable for IT professionals who have to spend long hours in front of the computers that causes generation of heat in their bodies causing acidity. Imagine this class of people are offered unlimited access to free Tea and coffee during office hours !

A kokum drink is tried and welcomed by them .What remains is easy availability to them.

The connoisseurs of Kokum who are passionate about the promotion of this drink like the participants in this seminar have a issue cut out for them .I am sure this will be attempted and some day in near future Kokum will replace if not tea and coffee at least the harmful soft drinks .

Food Processing - A Growing Business

Sanjay Orpe, Jt. Managing Director, Hardikar's Food Technologies Pvt. Ltd., Pune, Maharashtra.

The picture of Indian Food Processing Industry is changing. Government initiative, changing lifestyles, changing taste & habits, surplus incomes and increasing buying power have created a great demand for "Processed Food" which rapidly on increase. Therefore the growth rate is phenomenal.

Hardikar's Food Technologies Pvt. Ltd., Pune, produces the following products Fruit Powders of Kokam, Amala: Sweetened Fruit Powders of Mango, Pineapple, Jackfruit, Sapota, banana and dried Fruit Slices (Osmotic) of Ripe Fruits like Mango, Pineapple Sapota Banana, Papaya, Coconut. It also produces instant sherbat mixes from fruit powders like Kokum, Mango, Amala.

It undertakes turn key work for Project Conceptualisation, Project Feasibility Study, Project Design, Model Project Report, Machine Selection & Execution, Processing Technology, Packaging, Marketing Guidenance as also Government Liasion.

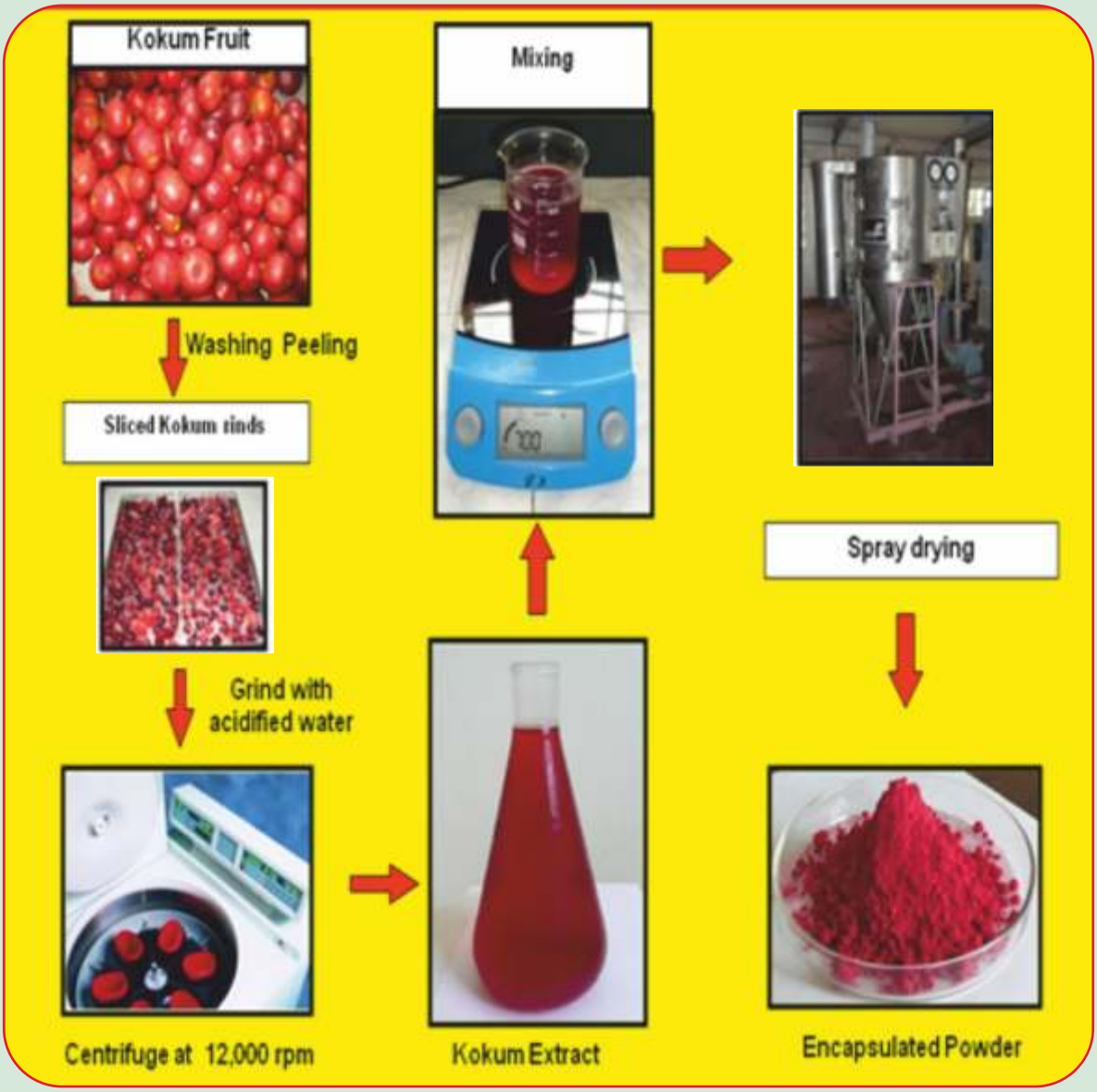
It has undertaken a NAIP project tilted "A VALUE CHAIN FOR KOKUM, KARONDA, JAMUN AND JACKFRUIT" with Dr. B.S. Sawant Konkan Krishi Vidyapeeth, Dapoli, as the Consortium Leader.

Hardikar's current Kokunm product range includes Kokum Rind Powder, Kokum Sarabat Powder (Instant) With Sugar & Without sugar Kokum Solkadhi Powder (Instant), RTD Kokum Sarabat in Glass Bottle, RTD Kokum Solkadhi in Glass Bottle and RTD Kokum Soda (Carbonated).

KOKUM RIND POWDERS AND MIXTURES

Western Ghats Kokum Foundation, Panaji - Goa

PRODUCTION OF MICROENCAPSULATED ANTHOCYANIN POWDER



Nayak C A., and Rastogi N K, (2010) *Drying Technology*, 28: 1396–1404.

Western Ghats Kokum Foundation, Panaji - Goa

HCA Extraction From Kokum

Deepak Shetty, General Manager, Prakruti Products Pvt. Ltd.

The major phytochemicals in Kokum are: Hydroxy citric acid (HCA), Garcinol, Fatty Acids and Anthocynins. Of these Hydroxy citric acid has become the major component applicable for todays world.

Salts of HCA include:
Dry extracts are the salts of metals from Group 1A and 2B
Divided into single salts and double salt
Ca Salt of garcinia with HCA content varying from 40% to 65%
Mg salt with HCA content from 40% to 60%
K salt with HCA content from 40% to 60%
And double salt are Ca-K salt and Ca-Na salt.

Garcinia fruit rind

⮟

Extract with water:

⮟

Combined extract

⮟

Hydrolyze to 8 pH at 800 C and precipitation

⮟

Filtration

⮟

Drying

⮟

Milling and sieving

⮟

Autoclaving

⮟

Packing

Process Flowchart For Extraction Of Hydroxy Citric Acid From Garcinia Indica

Identification, Extraction, Membrane concentration and Microencapsulation of Anthocyanin from Kokum

Chetan A. Nayak and Navin K Rastogi
Department of Food Engineering, Central Food Research Technological Institute (CFTRI), Mysore -570 020, INDIA

A color additive is any dye, pigment or substance which when added or applied to a food, drug or cosmetic, or to the human body, is capable (alone or through reactions with other substances) of imparting color.

Role of Food Colorant

- To restore the original food appearance because of the occurrence of changes during the processing and storage,
- To assure the color uniformity to avoid variations in tone color by seasonal variations,
- To intensify colors that are normally found in food and the consumer will associate this improved color with food quality,
- To protect the flavor and light susceptible vitamins,
- To give food an attractive appearance, whereas without the additive food will not be appetizing item,
- To preserve the identity or character by which food is recognized,
- To help in the visual assignation of the food quality

Cosmetic industry:

- Kokum pigments has a potential to absorb UV light. This property may be exploited for the production of sun screens lotions and pastes in cosmetic industry

As a Medicine:

- To be effective in the treatment of dysentery, tumors, and heart complaints. Kokum juice is also used as natural remedy for stomach acidity and liver disorders

Anthocyanins Extraction:

- The two peaks are obtained at 15.63 min and 16.19 min

Acid hydrolysis :

- Anthocyanindin peak obtained.
- The glucose molecule attached to the pigments is hydrolyzed and peak of cyanidin aglycon is obtained.

Saponification :

- Two pigments found did not contain acylating groups

Extraction of the anthocyanin pigment

Traditional Extraction Methods

- Maceration Method
- Solvent extraction method
- Acidified solvent extraction

Modern Extraction Technologies

- Supercritical fluid extraction (SFE)
- Pressurized liquid extraction (PLE)
- Microwave Assisted Extraction
- Ultrasound Assisted Extraction

Source	Scientific Name	Pigment content (mg/100g)
Banana bracts	*Musa paradisica*	32 to 250
Roselle	*Hibiscus sabdariffa*	230
Kokum	*Garcinia indica*	1000 to 2400
Nayak, CA., Rastogi, NK & Raghavarao, KSMS., (2010). Int. J. Fd. Prop, 13, 441-453		

WOW! 'Wine Of Waste' tropical fruits

Miguel Arcanjo Braganca and Dr. John Carmo Rodrigues, Goa

It is possible to make fruit wine from tropical fruits, with or without addition of external sugar source. The process is often fruit specific and can be organic if rigorous attention is paid to hygiene during crop production and post harvest processing of the fruit and sugar source. Different fruits have different biologically active compounds and, hence, there is a need to explore the possibilities of using fruits hitherto not used commercially for wine-making. Inspired by the tremendous work done for the development of OrWine from grapes, a concerted effort was made in Goa, India, to produce a good quality wine of tropical fruit with consumer acceptability. This paper discusses the work done on one such fruit.

Ever since the inhibiting effect of hydroxyl citric acid (or HCA) on lipogenesis was reported by Dr. John Lowenstein, there has been a growing interest in the *Garcinia* species to control obesity. Antioxidants and poly-phenols, biologically active compounds found in red wine, are reported to have beneficial effects. In the Vedic era of ancient India, wine was known as soma or sura and drunk in religious rituals. Medical research has shown that consuming a small glass of red wine daily can help cure diabetes Type 2. The opportunity to use fruits that are grown organically by tradition and to make wine on a commercial scale through an organic process needs to be considered with the seriousness it deserves.

Kokum is a fruit species native to the Western coast of India known as the Konkan, of which the state of Goa is the centre with the cities of Mumbai (Bombay) and Kochi (Cochin) near the two extremes. Locally known as Kokum, Bhirand or Birinda and in Portuguese as Brindao or Brindonna, it is a close relative of the Mangosteen, *Garcinia mangostana* Linn. The maroon-red rind has been used in the Konkan cuisine as a souring agent for meat and fish curries and to break down the mucilage in some vegetables like *Abelmoschus esculenta*. It is also consumed as a post-lunch drink, with coriander, green chili, garlic and asofoetida as optional additives. The ripening of fruits often coincides with the onset of the South-West monsoon rains, thereby preventing their sun drying as per the traditional practice.

Kokum rind is used to make syrup, and in recent times, into a juice or RTS drink with TSS adjusted 20 Brix and acidity to 0.3% with the addition of sugar and citric acid as needed. This has opened up an opportunity to process the late season fruits. This waste of edible fruits can now be prevented by use for aseptic packaging and processing into value-added products including fermentation into wine.

The recipes for wine making were closely-guarded household secrets in Goa. A large area of Goa was a colony of Portugal for 451 years (25 November, 1510 to 19 December, 1961), while others were under Portuguese influence for shorter periods. Each family clan had its own brand of wine with a body, flavour and bouquet that was different from the rest. The recipes were rarely written and generally passed from generation to generation by hands-on learning. Mr. Edwin Saldanha put all the secret recipes he knew and tips on wine making in a manuscript and published it as a book. The slim 95 (now 105) pages book was as iconoclastic as the atom bomb over Hiroshima in 1945 and as path-breaking as the discovery of the Bordeaux mixture in 1885. More people are now able to understand and experiment with wine-making. The development of the Garcinia wine since 2005 is one of the down-line benefits of this book.

Fruits grown organically by tradition, without synthetic fertilizers and harmful pesticides, retain the taste, body and soul of the wine. Good wine should not be clouded by pesticide residues and preservatives. Kokum cultivation is organic by tradition in the entire Konkan region, and so it has a head-start.

No one knows the precise chemistry of the fruit that one uses to make wine. The level of ripeness determines the level of sugar content. A difference in the level of ripeness will affect the quality of the wine. One learns how to make adjustments through experience. This cannot be taught or learnt any other way. If one uses the recipes as guides, then one will naturally start adjusting ingredients to fit the circumstances. One needs to add more sugar when the fruit is less sweet as in Garcinia.

Sweet (doce) wines or dry (Sec and Demi-Sec) with high alcohol content are made from various tropical fruits. These recipes include addition of cane sugar to the base fruit. The sugar must be from organically grown sugarcane or it can contaminate the wine with pesticides. If fermented with a kitchen yeast or regular baker's yeast, this will result in a sweet wine of 10 to 13% alcohol. If fermented with high-alcohol tolerant wine yeast, this will result in a dry wine of 16 to 19% alcohol. Some may like the heady feeling, but this is too high for a table wine. One has to be careful about the addition of sugar if using wine yeast. It is better to reduce the sugar in the 'must' that is fermented and to sweeten the wine later if one wants to make the wine sweet. Better yet, let the must stand overnight. Test the sugar content with a Brix meter or hydrometer and adjust it as necessary before putting in the activated yeast.

Hygiene of the process from fruit cultivation, harvesting, transportation, sorting, grading, cutting, juice extraction, fermentation, racking and bottling is essential if one wants to avoid the use of chemicals to kill all wild bacteria and fungi that come in with the fruit, sugar and water and to let the cultured wine yeast get a head start. The boiling water will kill off the bacteria, fungus and wild yeast.

Original method used by Mr. Edwin Saldanha

Use only the ripe fruit (with TSS of about 16.5 Brix) and discard both, the green fruits and the over-ripe fruits with the white pulp tinged red inside.

4 kgs Garcinia rind
3 kgs cane sugar
400 g wheat grain
10 g or 3 teaspoons yeast
4 g KMS (Potassium Metabisulphite)
6 litres boiling water

(1) Remove the seeds and white pulp, after cutting open the fruit. Keep the red rind with some white pulp. (2) Put the rind in a stainless steel vessel and pour boiling water over it the cut rind and keep to cool for 24 hours. Strain the extract/infusion into the fermentation jar. Add 1.5 kg sugar and stir to dissolve in the must. (3) Activate the yeast in warm water. (4) Wash the wheat in water at room temperature. (5) Add the wheat and activated yeast to the must. Ferment for eight days stirring the 'must' twice a day. On the 9th day, add the remaining 1.5 kg sugar. Let it ferment for another 10 days, stirring every

alternate day. (6) After 21st day, siphon or decant the clear wine leaving behind the solid residue, which is to be discarded. Rack after 48 hours in a large jar and bottle. Rack again, if needed, and top up the bottles for maturing the wine. Sweeten with sugar, as per taste.

Improved method developed by Dr. John Carmo Rodrigues.

1. The most important step is to sanitize all containers and equipment used in wine making, especially if they are being re-used. Use only food grade stainless steel and glass containers. Wash thoroughly, sun dry, treat with steam of boiling water.
2. Boil water and cool. Wash the fruit in cooled lukewarm water. Drain the water over a stainless sieve and dry the fruit.
3. Discard all green and over-ripe fruits with discoloured pulp. Mechanically split open the shell of just ripe Kokum fruits and separate the seed and pulp from the rind.
4. Put the rind pieces in a steel sieve and add sugar in order to extract the juice from the rind by reverse osmosis. Keep the container covered during the process.
5. When all the juice is collected, measure it, transfer this to another sanitized container and add about 2 g pectinase enzyme per litre of juice. Stir well at periodic intervals. Cover the mouth of the container by cloth so that air passes freely but prevents flies from settling on the mixture. Allow the mixture to stand for a day till all the pectin in the juice is inactivated and settles down.
6. Filter or siphon the contents into another sanitized container.
7. Adjust the Specific Gravity of the juice to be in the range of 1.09 to 1.160 by adding sugar. Specific gravity of 1.09 and below will give a dry wine and 1.160 and above, a sweet wine. Values in between will give a semi dry wine.
8. Adjust the acidity of the juice to be in the range of 3.1 to 3.4 pH by using citric acid if necessary.
9. Activate the dry yeast by putting it in a dilute solution of sugar in warm water. When bubbling, add this to the filtered juice. Use red wine yeast as the strain of yeast will determine the quality of the wine.
10. Stir the mixture vigorously at periodic intervals till the production of bubbles indicates the beginning of aerobic or primary fermentation. Cover the mouth of the jar with a cloth to allow free flow of oxygen. Cessation of the bubbles marks the end of the primary fermentation. This may take 10 to 12 days.
11. Filter or siphon the contents into another sanitized jar. Put a fermentation cork and allow the contents to stand for a period of another 15 days till all the sediments settle down. This represents the end of the "secondary or anaerobic fermentation".
12. When all the sediments have settled down, transfer the fresh wine into bottles, seal tightly and allow the wine to age for six months. The wine is now ready to be served.

Marketing of home-made wines made from Kokum has been promoted by the Botanical Society of Goa, and the Western Ghats Kokum Foundation through the Konkan Fruit Fest, annually since 2003. Inspired by the presentation by Ms. Cristina Micheloni on 'OrWine' at the East Asia Conference, 2009, at Seoul-Korea, conscious efforts led by Dr. John Carmo Rodrigues [Ph D in microbiology] to make the Kokum wine-making process entirely organic began in Goa during the summer of 2010.

CELEBRATING KOKUM WINE

Kokum Wine at the Organic World Congress at Korea, 2011

Tosting to Dr. John Carmo Rodrigues 'Kokum Wine in Korea

Western Ghats Kokum Foundation, Panaji - Goa

UTILIZATION OF KOKUM

←100%

42%

58%

RIND

CUT-OPEN FRUIT

PULP

10%

SEEDS

BEVERAGES & SPIRITS

KOKUM BUTTER

Western Ghats Kokum Foundation, Panaji - Goa

Recipes

Xarope de Brindao

The Xarope deBrindao, or a syrup made from the fresh fleshy rind of the Brindonna (*Garcinia indica* Choisy) fruit, is a refreshing summer drink.

This is pure sol and sugar preparation with no preservatives, additives or colourants. The brindao has a natural scarlet to burgundy red colour. It is generally consumed within the same summer season. In the Konkan region of Maharashtra state, the Brindonna is known as Kokum. The syrups here are known as Amrit or sherbet. Besides fruit juice and sugar there are flavour additives like citric acid, salt, condiments (nutmeg, jeera, etc) and salt. Class II preservatives are added by commercial Kokum syrup manufacturers to increase shelf- life to 12 months.

Kokum Agal is a rind juice concentrate preserved in brine or salt. The Agal can be used to make instant 'sol-kadi' instead of the e. The excess salt in the instant sol-kadi is the price of this convenien ce. lengthy process of soaking dried sol and extracting the juice each time. The excess salt in the instant sol-kadi is the price of this convenience.

The freshly removed rind of ripe Brindonna contains just one per cent starch and no sugar at all. For this reason, the quantity of sugar added to make syrup is twice the weight of the rind used.

INGREDIENTS

3-4 kg kokum solam
2 kg sugar
15 gm citric acid
a few drops raspberry flavour
3 gm sodium benzoate

Wash the kokum shells thoroughly. Add water double the quantity of the shells. Cook for 30 minutes and filter the extract. Add enough water to the extract to raise its volume to 2 litre. Add sugar and citric acid. Heat the sugar till it dissolves. Filter and coo!. Add essence and sodium benzoate.

Fill into bottles.

Note: In case of fresh kokum, take 50-60 kokum fruit. Cut them into halves. Remove the seeds and prepare the squash in the same way as above. Add half teaspoon salt.

If a red wine coloured syrup can be made from sugar-less kokum or Brindonna, why not wine itself? Indeed, red red wine can be made from Brindonna with a good body and bouquetto boot. Some households in Goa do make good brindao wine. The Western Ghat Kokum Foundation (WGKF) has also embarked on a journey for wine preparation from kokum.

Brindonna rind contains about 22 per cent hydroxy citric acid, a suppressant of lipogenesis or fat production in the body. It contains 2.4 per cent of natural pigments like

anthocyanin and garcinol. An attractive red wine with these natural properties is unbeatable. Next summer, drink to your health with Brindao wine! If a red wine coloured syrup can be made from sugar-less kokum or Brindonna, why not wine itself? Indeed, red red wine can be made from Brindonna with a good body and bouquet to boot. Some households in Goa do make good brindao wine. The Western Ghat Kokum Foundation (WGKF) has also embarked on a journey for wine preparation from kokum.

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Rasam

Servings : 2
Time Taken : 15-30 mins

Method

1. Add enough water to the kokum and boil well, for about 7-10 mins;
2. If you are using dry kokum, soak it in water for about 30-40 mins before boiling.
3. Add salt, jaggery and boil further for a couple of more minutes;
4. Adjust ingredients according to taste;
5. Add extra water if the rasam turns out too strong and tangy.
6. Heat ghee in a pan and temper with mustard seeds, jeera, curry leaves, garlic, hing and red chilies;
7. Serve hot with steamed rice and enjoy!

Tip: This rasam could also be had as is, like a soup!
This dish is also called Punarpuli saaru.

The second guessing game was fun, though not as much as the first. People went berserk with the imaginative concoctions for the Pudina Juice, but this time, everyone just stuck to names of fruits/veggies. Playing it safe I guess! I hope to keep give you all something engaging like this once in a while. So Kokum juice it was this time! Nivedita got it right

Kokum is believed to be very healthy, and cooling as well. The Kokum fruit contains rich amounts of anti-oxidants that bind with free radicals and prevent oxidative damage to body cells. They also promote cell regeneration and repair. Kokum seeds contain a high percentage of oil that freezes to form Kokum butter. Kokum butter is extensively used in the pharmaceutical and cosmetic industry as it works wonders on dry, chapped, sensitive, irritated or burnt skin. Kokum butter is rich in healthy fats like stearic and oleic acids and can also be used as edible oil. Extracts from the Kokum fruit are traditionally used to relieve gastric problems like acidity, flatulence, constipation and indigestion. Kokum juice is a healthier and far more refreshing option as compared to commercial bottled drinks. I

believe it acts as an appetite stimulant and also has anthelmintic properties too. Kokum juice is especially popular during scorching summer months as it has a cooling effect on the body and shields the body against dehydration and sunstroke. It also helps in bringing down fever and allergic reactions. So there you go, all this being said, it should prompt you to make some of this for yourself to cool off in this scorching heat. What's more, it tastes yummy too!

You should be able to procure dry Kokum seeds in any supermarket, without much difficulty.

Ingredients:

- Dry Kokum seeds – 4-5 nos for each glass of juice
- Jeera/Cumin seeds – 1 tsp (dry roasted and powdered)
- Sugar – 1 tsp
- Salt – 1/4 tsp
- Water – 1 glass

This proportion is for one glass of juice. Increase all ingredients appropriately to suit your requirement.

Procedure:

- Soak the dry kokum seeds overnight, or for about 6-8 hours. If you wish to make it sooner, then soak in hot water for about 4 hours or till they get soft and squishy.
- Once the seeds soften, nicely squish them and extract the pulp. The more you squish them, the tangier your juice gets, so work accordingly.
- Discard the skin once you have extracted the pulp.
- To the pulp, add sugar, salt, jeera powder and adequate water. Stir well.
- Serve chilled for a refreshing drink. Makes for a wonderful summer-soother!

Kokum Sherbet

Kokum sherbet is an exotic popular coastal drink made from the thick extracted juice of kokum, sugar and citrus acid. It is a refreshing tangy chilled beverage extremely beneficial during the hot summer days.

Kokum sherbet is one of the favorite beverages amongst all the Konkanis, people living in and around the Konkan region of Maharashtra and Goa. It is also popular in the Karwar region of Karnataka. There are many traditional ways of preparing this Kokum Sherbet. Using of both coriander and cumin seeds are also considered to be coolants and used in preparing this sherbet. This soothing summer cooler Kokum Sherbet is revitalizing and an exceptional cure for acidity and chilled sherbet is a healthy substitute for carbonate or caffeinated drinks and an brilliant acidity reliever.

Kokum sherbet is also added to many cocktails especially in most of the Goan bar attracting customers with delectable chilled cocktails to give an amazing punch and kick. For example Kokum, roasted cumin, lychee, lime and gin are mixed together to make a spicy, sweet sour drink with gin for that added kick.

Kokum as such is not known to many as it is a graceful tropical tree and grows mainly in the Konkan, Malabar and Kanara region of Western India. Kokum is scientifically known as Garcinia Indica or also called as Amsool or Sol. The Kokum tree blooms from November to February and the fruits ripen in April-May. The Kokum fruit (ratamba) looks very similar to the small variety plum and is dark purple color when ripe. The fruits are harvested when ripe and only the rind is preserved by drying in the sun which is the Kokum. Sometimes salt is also rubbed onto the rind to speed up the drying process.

Kokum is mainly used as a souring agent just like tamarind. It has a fruity and tangy flavor. Kokum fruit is considered to act as a Cholagogue, and is also used in treatment of skin rashes caused by allergies. Kokum fruit is steeped in sugar syrup to make Amrut-Kokum, and is used to avoid sunstroke. While buying kokum, look for soft, pliable rinds. Good quality kokum is dark purple in color. Another element of kokum is the kokum butter, an excellent emollient and is now used by cosmetics industry for lotions, creams, lip balms and soaps. Kokum butter has fairly high meting point, considered one of the most stable exotic butters (Shea butter, cocoa butter, etc) and hence doesn't need refrigeration. It is extracted from the kokum seed and is supposed to reduce degeneration of skin cells and restore elasticity.

Sol Khadi

It is one of the excellent appetites arousing drink prepared with kokum and coconut milk. It involves almost no cooking. This is one of the amazing drinks from the Konkani cuisine. To prepare the Kokum sherbet, firstly extract the kokum juice and add sugar and mix both in a heavy bottomed deep vessel. Heat and stir gently until the sugar gets dissolved. Bring to boil and simmer the heat for 2 to 3 minutes. Take off from fire and cool. Add sodium benzoate and mix well. Once cooled pour this sterilized sauce bottles and seal. Refrigerate the kokum sherbet.

Kokum sherbet is an exotic and delicious juice well known to counteract the heat. Hence do prepare this juice and enjoy the enriching and soothing taste of the juice.

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Kokum Websites, Blogs & Links

[This list is indicative and not exhaustive]

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Annexure

Western Ghats Kokum Foundation

Till recent past, there had been no specific and systematic efforts to promote cultivation of Kokum *(Garcinia indica Choisy)* throughout the coastal regions of Maharashtra, Goa, Karnataka and Kerala. While considerable attention z-s been paid in promoting mango and cashew along with existing coconut, with ir.ous subsidized schemes as major fruit crops of the region, Kokum was conveniently relegated to the status of minor fruit crop or spice and thus neglected. It was the farming community of Ratnagiri and Sindhudurg districts of Maharashtra, Sahyadri adjoining talukas of Goa, Sirsi, Ankola, Puttur and five grounding areas of Karnataka whose livelihood to some extent depended on Kokum kept the natural cultivation and processing going.

The Western Ghats Kokum Foundation (WGKF) was established with a mission to promote and broadcast globally Kokum as a commercial medicinal fruit produce of the Western Ghats region, and in turn assist in bringing additional 50.000 hectare land under Kokum cultivation by year 2010. The Western Ghats Kokum Foundation was formed by a group of horticulture enthusiasts of the region as a registered non-governmental Agro-Eco Promotion Society in Goa during 2001.

The timely initiative taken by Western Ghats Kokum Foundation with help from Dr.. Balasaheb Sawant Konkan Krishi Vidhyapeeth, Dapoli, Maharashtra, resulted in organizing the first ever National Seminar on Kokum in Vengurla, Maharashtra, in May 2001. This brought Kokum into focus and set the momentum rolling with scientific evaluation of elite varietal selection, propagation, quality grafts production and their supply to farmers of the region, etc., the activities being partly sponsored by the WGKF. Simultaneously the Foundation promoted development of non-traditional value-added products such as Kokum wine with a research project to Goa University. The international attention that Kokum, with its Hydroxy Citric Acid content, is 'receiving as an anti-obesity fruit has resulted with one of the WGKF associates receiving trial order from a EU country, of supplying 300 tonnes of Kokum juice during the current year.

In the last two years, governments, both at the center and the state level have taken notice of the potential of Kokum cultivation and processing in the region and accordingly initiated implementing various schemes through District Rural Development Agencies, Agriculture and Forest Departments, Self-help Groups and progressive farmers. Recent recognition that Kokum is a fruit tree rather than a spice, by the National Horticulture Board, Government of India, is a welcome change.

Specific Objectives of the Foundation are:

1. To promote research and development in propagation, cultivation and commercial exploitation of Kokum, particularly throughout the Western Ghats of India and in general around the country.

2. To develop and standardize crop improvement methods, propagation, production and post harvest technologies and medicinal value of Kokum.

3. To interact with farmers, local government, local bodies to encourage cultivation of Kokum and produce value added traditional/non traditional products.

4. To interact with institutions, local / national international, government and non-government organizations in promoting research and development in all aspects of Kokum cultivation and commercial exploitation.

5. To build up and mobilize high quality scientific and technical manpower to undertake modern horticultural practices for Kokum.

6. To develop intellectual property on Kokum and enjoy the benefits from it for the agricultural community at large and

7. To bring WGKF to the level of an apex body in Kokum. The main personalities associated with WGKF are :

- Dr. Ajit Shirodkar Chairman
- Mr. P. G. Kakodkar Vice Chairman
- Mr. Ashok Joshi Hon. Secretary
- Mr. Miguel Braganza Hon. Jt. Secretary
- Mr. Shrikant Joshi Hon. Treasurer
- Prof. D. Jayarama Bhat, Dr. Bhimrao P. Patil,

Research & Agro Programmes co-ordinators

Brief Report Of The 1st National Seminar On Kokum

In general, the Konkan region and Sindhudurg district are famous for their native biodiversity. Kokum *(Garcinia indica* Choisy*)* indigenous to the Western Ghats is an extremely important fruit tree having culinary, pharmaceutical and industrial uses. It is mainly found in forestlands, riversides, wastelands and generally cultivated on a small scale. The Kokum recently has proved its multifaceted potential in national and international markets. In the light of globalization and changing the market scenario this crop undoubtedly has an immense potential.

Considering its increasing importance, it was felt that the crop needs detailed studies on various aspects to generate research information and collect available information in the Konkan and elsewhere to understand the present status. Accordingly, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri district initiated research at different centres on this crop for varietal development, propagation and post-harvest management. On the basis of the above consideration, the National Seminar cum Exhibition on Kokum was held to provide a platform for scientists, farmers and entrepreneurs to exchange their views/ideas regarding the present status of research and plan future approaches and strategies for the promotion of the crop. Further, to focus upon it as a cash crop in the near future and provide boost to the economic upliftment of the farming community around the Western Coast of India.

The joint venture by the Western Ghats Kokum Foundation (WGKF) and Dr. Balasaheb Sawant Konkan Krishi Vidhyapeeth, Dapoli Sindhudurg district (Maharashtra), National Horticulture Board, Government of India, resulted in organizing the first ever National Seminar on Kokum. It was held on the 12th and 13th May 2001 at the Regional Fruit Research Station, Vengurla, Ratnagiri district (Maharashtra). Research on production, processing of Kokum is limited and needs to be strengthened. Hence this seminar was held to accomplish this endeavour.

The main personalities responsible in conducting this seminar were Prof. B.P. Patil, Associate Director of Research and his colleagues at the Regional Fruit Research Station, Vengurla; and Dr. Ajit Shirodkar, Western Ghats Kokum Foundation, Goa.

The Seminar witnessed technical sessions on four main aspects of Kokum:

? Crop improvement.

? Propagation technology.

? Production technology and economics.

? Post harvest technology and uses.

A total of 27 technical papers contributed by 34 experts were presented which covered the above four mentioned aspects. Some notable papers included from Maharashtra: Variability from morpho-physical properties on fruits on Kokum; *Garcinia* a unique genus

for coming decade, Graft induced modification in plant architecture of Kokum, Effect of shade and season on success on soft wood grafting on Kokum, Performance of Kokum graft and seedlings during initial years, Studies on pest infesting in Kokum, Economics of establishing Kokum plantation, Home scale preparation of Kokum products, Economics of processing of Kokum fruits at household level, Economic analysis of Kokum fruit processing units, Problems and future thrust areas in Kokum. From Kerala: Collection and conservation of Garcinia germplasm at Indian Institute of Spices Research, Calicut; Kokum - neglected fruit for a bright tomorrow. From Karnataka: Kokum the future crop and Garcinia- a gold mine in the forest. From Goa: Some medicinal uses of *Garcinia indica*.

A Kokum exhibition was also organized for the fruits and processed products category. Large number of Kokum types were displayed in the exhibition. The first and second prize for the fruit samples were bagged by cultivators from Maharashtra whereas the third prize was shared by the cultivators from Goa and Maharashtra. In the processed products category, the first and third prizes were awarded to processors of Maharashtra and the second prize was bagged by a processor from Karnataka.

The 1st seminar generated tremendous enthusiasm among the cultivators and the Kokum processors. For the first time it brought together people from the Western Ghats states on a single platform for a common cause. It helped in networking the various role players in the four states. The experience gained from this seminar was useful in conceptualizing the 2nd National Seminar.

2nd National Seminar on Kokum held at Goa University 2005

After May 2001, the WGKF was engaged in identifying specific areas to focus and assist Kokum producers and processors spread across the four states. Efforts were made to organize the displays of Kokum fruits and products in plant Utsav and Konkan Fruit Fest organized by Botanical Society of Goa. Towards the end of 2003, it was realized that Kokum as a fruit needed to be promoted vigorously at National and International level in the light of trade liberalization and globalization. Therefore steps were taken to organize the 2nd National Seminar with a focused theme of Kokum cultivation in the Western Ghats for Prosperity and Healthcare.

Organizing Group

The preparations for the 2nd national seminar were launched by forming an organizing group with the Vice Chancellor of Goa University, Prof. P. S. Zacharias and the then Chief Secretary of Goa, Dr. D. S. Negi, IAS as Patrons. The Head of Department of Botany, Prof. D. J. Bhat, the former Chairman of State Bank of India Mr. P. G. Kakodkar and the Chairman of WGKF Dr. Ajit Shirodkar were the Convenors. Dr. Nandkumar Kamat was nominated as Organizing Secretary. Strategic support was extended by Dr. Prabhakar Bhat, Sirsi, Karnataka, Shri Padre, Kasaragod, Kerala, Dr. B. P.Patil, KKV, Maharashtra, Dr. Sangam Kurade, Dr. V. S. Korikantimath, Shri Kalidas Savoikar, Smt. Ujjvala Shilkar, and Shri Satish Tendulkar from Goa. Treasurer of WGKF Mr. Ashok Joshi was entrusted the task of looking after the accommodation and catering; Mr. Miguel Braganza, Joint Secretary of WGKF was entrusted with the task of giving adequate publicity. Mr. Ashok Joshi of Goa Bagayatdar Sangha shouldered the responsibility of mobilizing the farmer delegates. From the local mediapersons Shri Prakash Kamat, Frederick Noronha and Jagdish Wagh provided the support. The student and staff of the Department of Botany and the University administration extended excellent support for the successful organization.

Seminar Highlights

The organizing group decided to invite well-researched papers, which were then compiled and published in the seminar preview volume. The seminar had an inaugural function, six technical sessions, a panel discussion and a short valedictory function. Each technical session witnessed one or more presentations followed by a brief discussion. All the sessions were presided over by eminent personalities. Written recommendations received from the delegates were considered and later presented in the valedictory function. The proceedings of the seminar are included in the PART B.

Technical Sessions

In all, ten review papers were presented in six technical sessions during the second National Seminar held at Goa University. Technical sessions 1, 2 and 3 took place on March 4th and the rest on March 5th 2005.

The following papers were presented using MS-PowerPoint based media. Each session was chaired by a chairperson. Written questions were invited from the delegates on a printed

question slip. These were then sorted and the appropriate questions were answered by the concerned speaker. At the beginning of each session, the chairperson and the speakers were introduced. The chairperson made a few opening remarks and after the discussion was over concluded the session.

Status of Kokum in Goa- Dr.V. S. Korikanthimath & Dr. A. R. Desai. ' - Status of Existing Kokum Plantation in Maharashtra - Dr. B. P. Patil et al. Status and Prospects of *Garcinia indica* in Uttar Kamiada, Karnataka-Mr. Prabhakar R. Bhat.

Status of Existing Kokum Plantations / Cultivation in Kamataka and North Kerala - Mr. Shree Padre.

Cultivation of Kokum Amruta and Search for Elite Varieties-Mr. B. P. Patil *et al.*

Kokum in Forest lands of Western Ghats - Dr. D. Pandey.

7. Prospects of Kokum as an Intercrop / Bordercrop in Mango Orchards - Dr. K. H. Pujari et al.

8. Traditional Methods of Kokum Fruit Processing - Dr. G. D. Joshi.

9. Non-Traditional Products from Kokum Inland and Global Opportunities - Dr. Nandkumar Kamat.

10. Credit Support from NABARD for Development of Kokum in India - Mr. R. N. Hegde.

2nd & 3rd National Seminars on Kokum held at Goa University, 2005 & 2011

Lighting of the lamp to mark the inauguration of 2nd National Seminar on Kokum (2005).

Watering of Kokum plant to mark the inauguration of 3rd National Seminar on Kokum (2011).

Western Ghats Kokum Foundation, Panaji - Goa

3rd National Seminar on Kokum held at Goa University, 2011

Concluding discussion at 3rd National Seminar on Kokum.

Mr. Shrihari Kurade making a point at the 3rd National Seminar on Kokum.

Western Ghats Kokum Foundation, Panaji - Goa

Recommendations of the 2nd National Seminar on Kokum

The 2nd National Seminar on Kokum, organized by the Western Ghats Kokum Foundation (WGKF) and Goa University on the 4th and 5th March 2005 at the conference hall, Goa University received 58 suggestions from the delegates. The organizers classified the suggestions into six categories:

- Production or Cultivation of Kokum.
- Kokum Processing.
- Marketing of Kokum and Kokum Products.
- Studies, Research and Development.
- Awareness, Education, Training and Extension.
- General Suggestions.

There were more suggestions regarding awareness, education, training and extension followed by production and cultivation of Kokum. Interestingly, only four delegates made suggestions regarding processing and marketing. The organizers would use these suggestions to prepare a road map for the development of Kokum as a multi-crop for health and prosperity in the coming years. We have selected few of the most important suggestions for this report.

Production or Cultivation of Kokum

1. Along with the hybrid varieties like Kokum amruta, elite grafts need to be used in the Kokum Plantation because this would solve the problems of dioeciousness.
2. Kokum needs to be promoted as an avenue tree for border plantations. It can also be used around the houses for protection against the sun.
3. Cultivators interested in planting Kokum as an intercrop or a multi-crop needs to be given necessary subsidies.
4. The cultivation package needs to focus on the spacing required for Kokum plantations as inter- and multi-crop species.
5. Kokum can be domesticated for reclamation of wasteland, mining or as a homestead garden species.
6. Seedlings or grafts of early flowering varieties should be made available for field trials under different climatic and soil conditions.
7. Assistance needs to be given for raising specialized nurseries of Kokum, which could meet the demand from farmers. The universities then could transfer Kokum nursery technology to the nurserymen.

8. All along the Western Ghats states, the representative state revenue departments and agricultural departments must identify land available for raising Kokum plantations.

9. In each taluka, in the Western Ghats, the government could establish a demonstration farm for training Kokum cultivators. A beginning could be made in this direction by supporting Goa University to setup a model demonstration plantation in its campus.

10. In promoting Kokum as multi- or inter-crop species stress needs to be given on environmentally sound organic farming principles.

11. Through development of social forestry excess land in schools, except playgrounds, Kokum plantation can be undertaken. By this the government sponsoring these plantations can gain a small benefit.

Kokum Processing

1. Collection of Kokum seeds by collection vehicles or mobile collection centre is possible. Post harvest semi-processing at farm level and actual processing, packaging and marketing at a central place can be done to avoid losses; again standardized process for each level is needed. Cost of seeds should be finalized.

2. Arrangements should be made to provide dehumidifiers to dry rinds of fruits that ripen after the monsoons.

3. Collection centre involving NGOs could be set up to procure fresh Kokum fruits and products at village leveling the Western Ghats.

4. There is need to fix quality standards for Kokum cultivars and all Kokum products according to the grades. Remunerative prices should be fixed for the welfare of the cultivators. These prices have to be attractive till the time the market forces take the control of the pricing mechanism.

Marketing of Kokum and Kokum Products

1. Assure farmers or growers of marketing especially high-end marketing to encourage and promote greater participation and production.

2. The government of India as well as the State governments, departments, corporations, agencies, etc could adopt Amrut Kokum or Kokum syrup as a state sponsored drink and promote it in all the canteens in public premises. The railway board on all railway stations can also promote Kokum drinks.

Studies, Research and Development

1. Studies should be made about varieties of Kokum that ripen early because of monsoons.
2. A national mission mode program has to be undertaken for research on all the biomolecules and products from Kokum. Chemical and biotechnological aspects need to be thoroughly explored by university scientists for self reliance in commercial applications of Kokum.

Awareness, Education, Training and Extension

1. Standardization of agro-techniques. Available information may be passed on to the farmers through publications of literature and package of practice.
2. For this income generating program, training on Kokum and its products must be undertaken. Medicinal value of Kokum must also be included in this.
3. Networking of individuals and institutions is required in the Western Ghats for the promotion of Kokum.
4. A series of publications, documentations, movies, television programs, advertisements, posters and publicity brochures are required for promotion of Kokum species in the Western Ghats.
5. Kokum products entrepreneurship development program could be launched with the support from NAB ARE) and SBL

General Suggestions

1. The farmers need to be trained to keep field records regarding their experiences in field cultivations.
2. A Kokum documentation cum market information research centre needs to be set up.

The Garcinia species

Adapted from : The World of Kokum and Kokum in the Globalized World

Dr. B. P. Patil

Genus *Garcinia* that belongs to the family Clusiaceae comprises of more than 200 species of evergreen trees, shrubs and herbs distributed in the tropics of the Old World especially in Asia and Africa.

According to conventional classification *Garcinia* was placed within the family *Guttiferae* which included about 1350 species. Some of the species in this family possess medicinal properties, whereas most of the plants are known for their oil glands or secretary canals or cavities, which contain yellow or brightly coloured resins. *Guttiferae* is further divided into 42 genera and five sub-families: Kielmeroideae, Hypericoideae, Calophylloideae, Moronbeioideae and Clusioideae. Of these, the subfamily Clusioideae consists of two tribes, Clusieae and Garcicieae and Garcinieae in turn has two genera namely *Garcinia* and *Mammea.* (Muhammed *et al.*, 1994)

Out of the 35 species found in India *viz, Garcinia gummigutta, G. morella, G. livingstonei, G. mangostana, G. paniculata, G. pedunculata, G. atroviridis, G. indica, G. hombroniana, G, lanceaefolia, G. microstigma, G. dulcis, G. echinocarpa, etc.* (Roberts, 1984), 17 are endemic. Of these, seven are endemic to the Western Ghats region (lying along western coastal India), six in the Andaman and Nicobar Islands and four in the North-Eastern region of India. These plants prefer evergreen forests, but some also thrive in relatively low-rainfall areas.

The species of Garcinia that are found all over the world are: *Garcinia ananamanica, G. anomala, G. eugeniafolia, G. forbesi, G. gummigutta, G. gutta G.hanburyi, G. harmanadii, G. hermonii, G. hessii, G. heterandra, G. hombroniana, G. huillensis, G. indica,' G. kydia, G. kola, G. laddii, G. lanceaefolia, G. lateriflora, G. latissima G. linii, G. livingstonei, G. longifolia, G. macrophylla, G. madruno, G. malaccensis, G. mammeoides, G. mangostana, G. megaphylla, G. merguensis, G. microstigma, G. moaensis, G. morella, G. multiflora, G. myrtifolia, G. nervosa, G. ophiticola, G. pachycarpa, G. paniculata, G. pedunculata, G. pictoria, G. pinctoria, G. polyantha, G. polyneura ,G. portoricensis, G. pseudoguttifera, G. pyrifera, G. revolute, G. rubro, G. ruscifolia, G. rostrata, G. schombucgkiana, G scortechinii, G. smithii, G. speciosa, G. spicata, G. stipulate, G. subelliptica, G succifolia, G. terpnophylla, G. tinctoria, G. thwaitesii, G. travancorica, G. viellardii, G. vilersiana, G. virgata, G. volkensii, G. waghttii, G. xanthochymus, G. zeylanica, etc.*

The species found in India are *Garcinia ananamanica, G. anomola, G. atrovidis, G. cambogia, G. cornea, G. cowa, G. dulas, G. gummigutta, G. hanburyii, G. hombroniana, G. indica, G. kydia, G. lanceaefolia, G. mangostana, G. microstigma G. morella, G. paniculata, G. pedunculata, G. pinctoria, G. spicata, G. stipulate, G. succifolia, G. travancorica, G waghttii and G. xanthochyymus* (Roberts 1984). *Of which only 4 species namely G. gummigutta*

(Koampuli), *G. indica* (Kokum), *G. mangostana* (Mangosteen), *G. morella and G. spicata* are restricted to the Western Ghats, of which the former two are the most widely spread species in Goa, Konkan belt and the Northern part of Kerala.

Four species are economically very important to India but only three species are cultivated. *Garcinia indica* Choisy is a source of Kokum grown in the Konkan coast. In Kerala, G. gummigutta (L.) Rob locally known as Kodampuli or kodapuli is traditionally grown in homesteads for the fruit rind. *G. mangostana* L. is cultivated for its delicious fruit in the lower Nilgiris, Courtallam and other parts of South India. *G. morella* is still in the wild and is the principal source of gamboges used in medicines.

Botany of Garcinia Species

Trees in this genus can be either dioecious or polygamous. In dioecious species, reproductive organs are unisexual. In the polygamous species, male, female and hermaphrodite flowers are found in the same plant. Male flowers in the *Garcinia* are noted for their distinctive pistilodes (Raven *et al*, 1986).

The flowers of *Garcinia* species may, be solitary, fascicled and umbelled or panicled. Flowers usually have 4 to 5 sepals, which form the outer layer of the unopened flower bud. Four to five imbricate petals are generally present. In the male flowers, the stamens exist either free or joined to form a ring or lobular mass that surrounds a rudimentary ovary.

Two-lobed or four-lobed, anthers are straight/horse-shoe shaped with annular dehiscence. In the female flowers, the staminodes are free or joined together. The ovary consists of 2 to 12 cells with solitary ovules positioned at the inner angle of each cell. The female flower has a largely conspicuous but varied stigma, which is sub-sessile. The peltate leaf may be lobed, entirely smooth or tubercled with wart like growths. The berry encapsulated by a tough rind, sits on top of the calyx. Most *Garcinia* berries contain several large seeds suspended in a pulpy interior (CSIR 1956; Roberts 1984).

Garcinia cambogia

Other Common Names: Malabar tamarind,

Family - Guttiferae.

Range: SE Asia, West and Central Africa

Habitat: Moist forest

Garcinia cambogia is a relative newcomer to the ranks of Western herbalism, but was apparently used for thousands of years in China as a food supplement. It is used as an appetite suppressant and to inhibit the absorption and synthesis of fat, cholesterol and triglycerides. In other words, it is a dietary aid. It is a brown hygroscopic powder.

Garcinia has been used historically in India for treatment of edema, delayed menstruation, constipation and intestinal parasites. This herb is currently used in the United States as a component of weight loss formulas. Various species of South Asian plants of the genus Garcinia (particularly *Garcinia cambogia)* have high contents of hydroxycitrate

(HCA), which is the active ingredient in this and many other currently marketed weight loss products. However, it has not yet been shown, in controlled studies published in the scientific literature, to be effective in weight loss in humans.

A decoction of the fruit rind is given in rheumatism and bowel complaints. The organic acid known as (-) HCA is the primary acid found in the fruit and rind of *Garcinia*. The fruit rind and extracts of *G. cambogia* are used in many traditional recipes. In the Ayurvedic system of medicine, some flavors are said to activate digestion and are used as purgatives, in the treatment of worms and parasites, tumours and dysentery. Neither acute nor chronic toxicity is reported with regular consumption of *Garcinia* products as either food or tonics. These products have been used routinely in the coastal areas of South Asia for centuries and they continue to be consumed in large amounts.

Garcinia cambogia fruit have been reported to have around 20-30% of hydroxy citric acid lactone along with tracer amount of citric acid. HCA inhibits lipogenesis, lowers the production of cholesterol and fatty acids, increases the production of glycogen in the liver, suppresses appetite, and increases the body's production of heat by activating the process of thermogenesis. Potential dietary supplement for weight loss and appetite control. *Garcinia cambogia* works by suppressing appetite and inhibiting lipid synthesis. This latter mechanism is based on the theory that inhibition of lipid biosynthesis or enhance lipid metabolism interfere with mechanisms that produce and maintain obesity. Specifically, HCA prevents the enzyme from catalyzing the cleavage of citrate to acetyl coenzyme A and oxaloacetate. This inhibition significantly reduces the synthesis of triglycerides, cholesterol and body fat, without diminishing energy production. The result is significant loss of body weight in animals made obese genetically and by hypothalamic lesions. Animal studies demonstrate that fatty acid and cholesterol synthesis in liver are significantly inhibited after oral administration of HCA.

Garcinia cowa

The tree was located in one of the farms of State Agriculture Department in Cannanore district of Kerala probably introduced from elsewhere. The tree is huge compared to Kodampuli. Though the resemblance is there, the leaves of this tree are large and the fruits are smooth hanging, orange colour both outside and inside, having the size of Kokum fruits but highly acidic. The tree is a hermaphrodite one with 7 anthers compared to Kodampuli. The identification as G. cowa needs verification. The tree is reported to be common in Eastern India and the Andamans. Fruits are used for making jams and preserves. A yellow dye is also obtained from the bark. A resin is also obtained and is used as a varnish for metallic surfaces. Tender leaves are eaten as a vegetable.

Garcinia gummi-gutta (L.) Robson

Local names: Murugana huli, Upage mara, (Kannada) kodampuli/kodapuli, distributed from Konkan to Southwards in the Western Ghats upto Nilgiris

Trade name: Kokam

Family: Clusiaceae

Habit: Medium sized tree, 5 - 15 m tall Tree forests

Distribution: The species is endemic to the Western Ghats in Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu. In Karnataka and Kerala, common throughout the Ghats. Found in home gardens and forest (dispersed throughout).

Flowering and Fruiting: Flowering is from December to February and fruiting is from March to August.

Local Medicinal Uses: The dried fruit rind is used for garnishing fish curries in Kerala. It is prescribed in ayurveda for ailments as varied as rheumatism, rickets, enlargement of spleen, uterine complaints and in animal disorders. The translucent yellow resin is used as a purgative. The rind is also used for polishing silver and gold and coagulating rubber latex. Fruit juice or syrup is used as a coolant and helps reduce body weight

Habitat: Semi-evergreen to evergreen

Propagation: By seeds, stem cuttings and grafts

Trade: Local, regional, national and global. Large-scale export of 'Garcinia extract' from India has been recorded in recent years. Fruit pulp is used as a condiment. Fruit rind is marketed in large quantities. It is mixed with Garcinia indica and sold as Kokum. In practice it was seen that about 100 kg of mature fruits yield 12-14 kg of dried rind. The total export of *Garcinia indica* in the 2001-2002 as Kokum (dried pericarp) was 2.56 tonnes valued at Rs. 216 million while that of *G. gummi-gutta* fruit rind was 54.58 tonnes valued at Rs.17.15 million. Also under the trade name of Camboge extract (*Garcinia gummi-gutta* fruit rind) about 920 tonnes valued at Rs.440 million has been exported.

Garcinia hombroniana

The tree resembles mangosteen and hence nurseries mistakenly sell the seedlings as mangosteen. It is supposed to be a good rootstock for mangosteen but the growth is extremely poor. The tree is susceptible to drought but more adapted to marshy areas and root suckers are very common. It is distributed in Nicobar islands and produces red coloured fruits in clusters which are edible though acidic in nature. The timber is useful for house building and preparation of oars. This species is graft compatible with kodampuli.

Garcinia kola

Garcinia kola is found in moist forests and grows as a medium size tree, upto 12 m high. It is cultivated and distributed throughout west and central Africa.

It is mainly used as a purgative, anti-parasitic, antimicrobial. The seeds are used in the treatment of bronchitis and throat infections. They are also used to prevent and relieve colic, cure head or chest colds and relieve cough. Also the plant is used for the treatment of liver disorders and as a chewing stick.

The constituents include—biflavonoids, xanthones and benzophenones. The antimicrobial properties of this plant are attributed to the benzophenone, flavanones. This plant has shown anti-inflammatory, antimicrobial and antiviral properties. Studies show very good antimicrobial and antiviral properties. In addition, the plant possesses anti-diabetic and antihepatotoxic activities.

Garcinia malabarica

The tree was located in Munnar from high elevations of Kerala. The trees are of medium size with thick oblong leaves resembling *G. xanthochymus* to which it is easily graftable. The shoots have red pigmentation. The fruit is slightly less than the size of kodampuli. The tree is slow growing and identification needs confirmation to conclude, it is imperative to collect and conserve the existing variability of Garcinia in this era of depleting bioresources. The priority species are G. indica, G. gummigutta, G. morella and G. mangostina

Garcinia –Mangosteen

Common name: English: mangosteen; Spanish: mangostan, mangostin; French: mangoustan; Indonesia, Malaysia: manggis; Philippines: manggustan, manggis; Cambodia: mongkhut; Laos: mangkhud; Thailand: mangkhut; Vietnam: cay mang cut

Origin and Distribution: Native to Southeast Asia. Cultivated throughout the tropics, but primarily in Thailand, Malaysia, the Philippines, Indonesia, Brazil, Honduras, Panama, and in the USA, in Hawaii.

Botanical Source, Description, and History

The tree furnishing the mangosteen is large and handsome, having elliptic, oblong or oblong-lanceolate, deep-green glossy leaves. The bark of the tree is bitter and exceedingly astringent. The fruit is brownish or brownish-gray, marbled with yellow, and is crowned by the 4-parted, sessile stigma. There are from 6 to 8 seeds, and the pulp is juicy, white, and delicious in taste and odor. It is about the size of an orange.

Garcinia mangostana is found in the Malay islands. It was grown in the gardens of the Duke of Northumberland in 1855, and produced both blossom and fruit. The fruit of this tree is the famous *mangostan or mangosteen,* said to be among the most luscious of tropical fruits. Its rind is about the fourth of an inch in thickness, contains a very astringent juice, from which, during wet weather, a yellow gum exudes, which is a variety of gamboge. The Chinese use the bark of the tree to produce a black dye, and it is also used in dysentery.

Propagation and Culture

Mangosteen is usually propagated by seed. The seeds lose viability quickly, and must be planted fresh or stored in moist peat moss, sawdust or paper. Germination occurs at 2-3 weeks, and the seedlings are somewhat slow growers. They need from 50 to 75% shade for the first 3 to 4 years, then can be grown in full sun. They are sensitive to high levels of fertilizer, and should be fertilized with a dilute fertilizer solution or an organic fertilizer. Trees can be transplanted to the field after 1 to 2 years, when they are a foot (30 cm) or more in height. Mangosteen can be successfully grafted onto rootstocks of Garcinia venulosa, *G. xanthochymus and G. hombroniana.*

Mango steen grows best in a fertile, well-drained soil with an acid pH and high organic matter content. Rainfall or supplemental irrigation should be available throughout the year, although they tolerate brief periods of drought, and this stress may induce flowering. Mangosteen will grow from sea level to 5,000 feet (1,524 m), but suffers if temperatures drop to 40°F (4C) or lower.

Trees should be fertilized every 3 to 4 months during the first 3 years of growth, and thereafter one to two times per year. Mulching is recommended to add nutrients and organic matter to the soil, conserve moisture and control weeds. With good care, trees can begin to produce fruits at 6 to 8 years from planting. Young trees produce about 100 to 200 fruits per year, while a mature tree can produce from 500 to1,000 or more. In Puerto Rico, mangosteen fruits from July to December.

Cultivars and Related Species

Mangosteen is apomictic, with female plants producing clonal seeds without fertilization. Thus, there is little variation in mangosteen and almost no cultivars exist. However, the Malaysian Department of Agriculture has identified two clones, 'GA1' and 'Ga2', whose fruits differ in shape, weight, external color, and number of seeds. It is hypothesized that mangosteen is a polyploid that arose from natural hybridization between Garcinia hombroniana y G. malaccensis.

There are over 100 Garcinia species, mostly from south-east Asia. Of these, approximately 30 have edible fruits, but the mangosteen is the most important and has the best quality fruit. Other important *Garcinia* species include *G. atroviridis* (assam gelugur), *G. hombroniana* (seashore mangosteen), *G. indica* (Kokum), *G. parvifolia* (assam aur aur), *G. prainiana* (cherapu) and *G. xanthochymus* (yellow mangosteen).

Chemical Composition

The bitter and astringent rind of the fruit of Garcinia mangostana, according to W. Schmid, contains tannin, resin, and crystallizable mangostine (C20H22O5), forming golden-yellow, tasteless scales, melting at 190° C. (374° F.), readily soluble in alcohol or ether, insoluble in water. Basic lead acetate precipitates it from its alcoholic solution. Its solution in alkalies reduces gold and silver solutions. The acidity of the fruit is due to malic acid. The resinous exudation of the trunk of the tree was investigated, in 1858, by N. Reitler in Wittstein's laboratory (Vierteljahresschr. f. prakt. Pharm., Vol. VII, p. 170), and found to consist of 88 percent of resin, soluble in alcohol and in ether. Ammonia differentiates it into a soluble and an insoluble resin.

Kokum butter exists in the seeds of Garcinia purpurea to the extent of 30 per cent, and consists chiefly of tristearin and the glycerides of oleic and myristic acids (Jahresb. derPharm., 1896, p. 71).

Action, Medical uses and Dosage

The rind of the fruit is highly recommended for dysentery, and has been extensively employed in India for that disease. A few years ago the rind was introduced into Europe by Gruppe, of Manila, who prepared an extract, which was administered in the Vienna hospitals, as an astringent, with success in catarrhal conditions of the throat, bladder, urethra, and uterus, etc. The dose of the solid extract is 1 grain, repeated 6 or 8 times per day, in pill form, or rubbed up with syrups.

Uses

Mangosteen is primarily consumed fresh, but is also canned and used to make juices and jellies. The fruit rind is ground and used in the treatment of diarrhea and dysentery, and for skin diseases. A tea made from the leaves and bark is used to lower fever and for urinary disorders.

Nutritional composition per 100 g mangosteen fruit

Carbohydrate	6-20 g
Fat	O.l-l g
Protein	0.6 g
Calcium	7-11 mg
Phosphorous	4-17 mg
Potassium	19 mg
Iron	0.2-1 mg
Vitamin A	14IU
Vitamin B1	0.03 mg
Vitamin B2	0.03 mg
Niacin	0.3 mg
Vitamin C	4.2-66 mg

Related Products

1) Kola Bitter or Male Kola

These seeds have a coffee-like, astringent and bitter taste. They are produced by the Garcinia Kola, Heckel, of western Africa.

2) Mammee Apple

A subglobular, brownish-yellow fruit, about the size of a large orange, the pulp of which is yellow and aromatic, and the rind coriaceous and bitter. The seeds are 3 or 4 and rough. It is the product of the West Indian Mammea americana, Linne, Nat. Ord.—Guttiferae. Another fruit is also known in the West Indies as mammee. It is the rusty-brown, oblong-ovoid berry of Lucuma mammosa, Jussieu, of the Nat. Ord.—Sapotaceae. It has one large polished seed of a yellow-brown color. The pulp of the fruit is sweet and mucilaginous, and of a yellowish or reddish color.

Garcinia Morella

The trees are seen on the banks of rivers and resemble kodampuli but the fruits are small and smooth. This tree is the original source of gamboges used in medicine. The tree is distributed in the Western Ghats, Assam and Khasi Hills. The gamboges have astringent, tonic aphrodisiac, antibacterial, verminfuge, amenorrhoea, and antibacterial properties. This species is graft compatible to kodampuli.

Garcinia xanthochymus Hook

The tree is quite common in the Western Ghats, lower Hills of Eastern Himalayas and Andamans. In Kerala, it is called 'Anavaya' meaning 'elephant mouth'. The children relish the fruits. A shade loving tree preferring cool, humid or moist areas. It has large oblong leaves that are smooth. The yellow fruit is used for preparation of jams, and preserves and as a substitute for tamarind. The gamboge obtained from the bark is inferior. Exudates from bark and fruit are used as dye. It is not graft compatible with kodampuli or mangosteen in the long run.

Garcinia parvifolia

Mangosteen {Garcinia mangostana) is known throughout the world. However, in the hills of Brunei Darussalam, other Garcinia species, relatively unknown outside Brunei, thrive. Asam aur aur (G. parvifolia) is highly revered by Bruneians. The juicy, tart yet sweet white pulp has long persistence on the palate. The attractive crimson fruit wall is usually dried and used as sour relish in curries and other culinary dishes requiring acidulous base. The demand for this fruit and the dried product is seemingly unsatiable.

Fruits are produced from scattered trees in the backyards and ‘pulau buah'. With strong demand and inconsistent supply, there is good potential for cultivation of asam aur aur. Trees are adapted to a wide range of soils, but prefer well-drained alluvial soils. Healthy trees can come into production within 4 years from seeds. With such high demand, there is good potential for large-scale production to meet fresh fruit demand and possible downstream processing.

Medicinal Properties of Kokum

Antioxidant activity of *Garcinia indica* (kokum) and its syrup.

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Garcinia indica (kokum) is an Indian spice, the fruit rind of which is used in cooking, cosmetics and has several medicinal properties. Its syrup is consumed as a soft drink during summer. We have examined the antioxidant activity of aqueous and boiled extracts corresponding to their use in cooking and home remedies, besides the commercial kokum syrup. The assays employed are ORAC, FRAP, ABTS and the ability to inhibit lipid peroxidation in rat liver mitochondria.

Kokam syrup and the two aqueous extracts had significant antioxidant effects in the above assays. They have high ORAC values (29.3, 24.5 and 20.3), higher than those reported for other spices, fruits and vegetables. The high antioxidant activity of kokum adds one more positive attribute to its known medicinal properties and hence its use in cooking, home-remedies and as a soft drink may be promoted.

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, neural disorders, 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

Garcinia indica (dried rind known as 'kokum') is an Indian spice used in many parts of the country for making several vegetarian and non-vegetarian 'curry' preparations, including the popular '*solkadhi*'. The fruits are steeped in sugar syrup to make 'amrutkokam', a healthy soft drink to relieve sunstroke, which is popular during summer

It is a traditional home remedy in case of flatulence, heat strokes and infections. Many therapeutic effects of the 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 diarrhoea; 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 an 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 with potential antioxidant properties. These include citric acid, malic acid, polyphenols, carbohydrates, anthocyanin pigments and ascorbic acid

Though studies have been carried out on the antioxidant activities of these two isolated components from *G. indica*, besides an organic extract, the antioxidant activity of the rind and its various preparations as is being used in cooking, in soft drinks and medicinal preparations has not been evaluated. The levels of antioxidant action studied are (i) radical formation by Ferric Reducing/Antioxidant Power (FRAP); (ii) radical scavenging by Oxygen Radical Absorbance Capacity (ORAC) and 2,2¢-azobis-3-ethylbenzthiazoline-6-sulphonic acid (ABTS), and (iii) prevention of membrane damage as measured by lipid peroxidation.

These are standard assays used for determining the antioxidant abilities of food preparations. The aqueous and boiled extracts were prepared so as to simulate conditions of their extraction pertaining to their use for cooking purposes. The aqueous extract was prepared by adding the crushed rind to distilled water and stirring for 60 min, similar to use in many curry preparations. For boiled water extract, the crushed rind was boiled in distilled water (DW) for 30 min, similar to its use in curry preparations. Commercially available kokum syrup was also used for assessing its antioxidant effects by diluting it to 25% (v/v) concentration using DW as is generally consumed as 'kokum squash'.

In FRAP assay, the FRAP reagent is prepared by adding 2,4,6-tripyridyl-s-triazine (TPTZ) and ferric chloride, forming the Fe3+–TPTZ complex. This is reduced to Fe2+ TPTZ, at low pH, when an antioxidant is present, which has an intense blue colour with absorption maximum at 595 nm. The calibration curve was plotted with OD versus concentration of FeSO4 in the range of 0–1 mM. The results are expressed as Ascorbic acid Equivalent Antioxidant Capacity (AEAC) in terms of mM. In ferrylmyoglobin/ABTS+ assay, the inhibition of radical formation by the extracts was determined. The calibration curve was plotted with lag time in seconds versus concentration of the standard antioxidants (L-ascorbic acid). The results are expressed as AEAC in terms of mM. In ORAC assay, oxygen radical absorbance capacity was measured by detection of 2.2¢-azobis (2-amidinopropane) dihydrochloride (AAPH)-induced chemical damage to b-phycoerythrin through decrease in fluorescence emission. Fluorescence was recorded every 5 min till the last reading is less than 5% of the first reading. ORAC values were calculated in terms of micromoles of trolox equivalent/g of fresh weight. This is considered as a 'standard' assay, especially while comparing different food preparations. Three-months-old female Wistar rats (weighing about 250 ± 20 g) were used in the preparation of mitochondria.

Mitochondria from rat liver was isolated as described earlier. Protein was estimated and pellets suspended in the 0.15 M Tris-HCl buffer, pH 7.4 at a concentration of 10 mg protein/ml. Oxidative damage was induced by ascorbate–Fe2+ system. Thiobarbituric acid reactive substances formed were estimated spectrophotometrically (532 nm), as

malondialdehyde equivalents after accounting for appropriate blanks. Malondialdehyde standard was prepared by the acid hydrolysis of tetraethoxypropane.

Table 1 presents data on AEAC values for the extracts and syrup with the FRAP and ferrylmyoglobin/ABTS assays at low concentration of 0.1%, besides values of ORAC assay. In FRAP assay, boiled aqueous kokum extract possessed the highest AEAC value of 0.057 mM, followed by the syrup and aqueous extract with AEAC of 0.049 and 0.047 mM, respectively. In case of ferrylmyoglobin/ABTS assay, among all kokum extracts, Kokum syrup was the most potent in the inhibition of ABTS radical formation with AEAC of 1.005 mM, followed by aqueous extract and boiled aqueous extract with AEAC of 0.754 and 1.19 mM respectively.

The aqueous extracts of G. indica showed significant values by ORAC assay having 29.3, 24.5 and 20.3 mmol of Trolox equivalent/g fresh weight values for aqueous, boiled aqueous extracts and kokum syrup respectively.

The data reveal that among the kokum extracts, the aqueous extract possessed the highest antioxidant potential. Table 2 shows data on lipid peroxidation in rat liver mitochondria on ascorbate–Fe2+-induced oxidative damage. Among the kokum extracts, kokum syrup (final concentration 2.5%) was the most effective giving 78%

protection against lipid peroxidation, followed by 0.1% aqueous and boiled aqueous extracts with 40 and 51% protection, respectively.

Aqueous kokum extract and kokum syrup exhibit inhibition of peroxyl radical-induced phycoerythrin oxidation in ORAC assay. Our results show that the values of kokum extract ranging from 20 to 29 are higher than those observed for some fruits and vegetables, including those for garlic (19.4), blueberry (15.9), strawberry (15.36), aqueous turmeric extracts (13.49), spinach (12.6), plum (9.49), beets (8.4), orange (7.5), onion (4.5), cauliflower (3.8), cabbage (3.0), banana (2.21) and carrot (2.10). It is worth noting that the ORAC values of kokum and its syrup are higher than those reported for fruits used for syrups such as strawberry, plum and orange. Hence kokum syrup may be considered healthier than juice prepared from other fruits due to its higher antioxidant availability. In case of FRAP assay, the values for kokum extract are found to be lesser than

Table 1. Antioxidant measurement of Garcinia indica extracts and kokum syrup

Garcinia indica extract	FRAP assay (AEAC, mM)	Ferrylmyoglobin/ ABTS assay (AEAC, mM)	ORAC assay (mmol of TE/g of fresh wt)
Aqueous extract	0.047 ± 0.002	1.005 ± 0.08	29.3 ± 0.80
Boiled aqueous extract	0.057 ± 0.001	0.754 ± 0.12	24.5 ± 0.43
Kokum syrup	0.049 ± 0.001	1.19 ± 0.06	20.3 ± 0.08

Data expressed as mean ± SE of four individual experiments for all three assays. Data expressed as micromoles of Trolox equivalents per g of fresh weight for ORAC assay. Data expressed as TAA as% ascorbic acid equivalent measured. Ascorbic acid equivalent antioxidant capacity (AEAC, mM).

Table 2. Effect of G. indica extracts and kokum syrup on ascorbate–Fe2+-induced lipid peroxidation in rat liver mitochondria Condition nmol TBARS/mg protein Per cent

inhibition Control (untreated) 4.83 ± 0.20 –Damage (treated with ascorbate-Fe2+) 30.94 ± 0.51 –

Aqueous extract (0.1%) 20.62 ± 0.49 39.5
Boiled aqueous extract (0.1%) 17.76 ± 0.05 50.5
Kokum syrup (2.5%) 10.56 ± 0.98 78.1

Values are mean ± SE from four individual experiments. TBARS, Thiobarbituric acid reactive substances. those of turmeric and other medicinal preparations, whereas in ferrylmyoglobin/ABTS assay, kokum extract and kokum syrup possessed higher antioxidant capacity than turmeric extract. The mechanisms involved in many human diseases such as hepatotoxicities, hepatocarcinogenesis, diabetes, malaria, acute myocardial infarction, skin cancer include free radicals-induced lipid peroxidation as the main source of membrane damage. The antioxidant action can also be measured by inhibition of damage caused by free radicals. In our studies, ascorbate–Fe2+, a system relevant to endogenous oxidative damage was used for rat liver mitochondria.

Modulation of diseased states such as cardiovascular ailments, neurological disorders, cancer and diabetes using dietary components, including fruits and vegetables, natural products and medicinal plants as a possible therapeutic measure has become a subject of active scientific investigations. The very concept of food is changing from a past emphasis on health maintenance to the promising use of food to promote better health to prevent chronic illnesses. The advent of functional foods may allow us to improve public health. 'Functional foods' are those that provide more than simple nutrition; they supply additional physiological benefits to the consumer. In India also, the demand for functional foods is increasing in recent years. In this aspect, foods rich in preparations from kokum and its syrup can be considered as functional foods.

The assays used for testing the antioxidant capacities of kokum extract act at various levels of antioxidant activity at which the damage caused by free radicals can be prevented. Thus these experiments could be useful in detecting the mechanism of prevention of free-radical damage by various preparations of kokum. Our study reveals that kokum has significant antioxidant effects acting at different levels. Its antioxidant activity is higher than that reported for many fruits and vegetables. Besides, it is cheap, readily available to all strata of society, with medicinal properties attributed to it. At present, the use of kokum and its syrup is mainly restricted to certain states on the west coast of India. Due to its health benefits, it needs to be promoted.

In conclusion, our studies using biochemical assays pertaining to different levels of antioxidant action, show that various preparations of kokum have significant antioxidant activities.

Source http://www.ias.ac.in/currsci/jul102006/90.pdf

https://www.google.com/#hl=en&sugexp=ppwl&cp=10&gs_id=12&xhr=t&q=Garcinia+indica&pf=p&sclient=psy-ab&source=hp&pbx=1&oq=Garcinia+i&aq=0&aqi=g4&aql=&gs_sm=&gs_upl=&bav=on.2,or.r_gc.r_pw.,cf.osb&fp=69a5a0c4679207eb&biw=1024&bih=677

Emerging role of Garcinol, the antioxidant chalcone from *Garcinia indica* Choisy and its synthetic analogs

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Garcinol, harvested from *Garcinia indica*, has traditionally been used in tropical regions and appreciated for centuries; however its biological properties are only beginning to be elucidated. There is ample data to suggest potent antioxidant properties of this compound which have been used to explain most of its observed biological activities. However, emerging evidence suggests that garcinol could be useful as an anti-cancer agent, and it is increasingly being realized that garcinol is a pleiotropic agent capable of modulating key regulatory cell signaling pathways. Here we have summarized the progress of our current research knowledge on garcinol and its observed biological activities. We have also provided an explanation of observed properties based on its chemical structure and provided an insight into the structure and properties of chalcones, the precursors of garcinol. The available data is promising but more detailed investigations into the various properties of this compound, particularly its anti-cancer activity are urgently needed, and it is our hope that this review will stimulate further research for elucidating and appreciating the value of this nature's wonder agent.

It is difficult to imagine that the pink sweet smelling drink that is served to the world travelers spending summer holidays on the beautiful beaches of Goa in India, upon their arrival at the hotel, could one day end up on the laboratory tables of Cancer Institutes around the world. The welcome drink happens to be made from the syrup formulated from the fruits locally known as 'Kokum' which is steeped in sugar syrup to make a drink which is used to avoid skin damages and allergies from the sun and tropical climate. The plant grows extensively on the western coast of India and is known by various names across India including Bindin, Biran, Bhirand, Bhinda, Katambi, Panarpuli, Ratamba or Amsool. In English language, it is also known by various names such as Mangosteen, wild Mangosteen, or Red Mango. According to botanical classification the tree is classified as *Garcinia indica* (Family: Clusiaceae; Genus: Garcinia)which has many culinary, pharmaceutical and industrial uses. The genus Garcinia includes some 200 species found in the tropics, especially Asia and Africa. Out of 35 species found in India, 17 are endemic. Of these, seven are endemic to the region of Western Ghats including the state of Goa, six in the Andaman and Nicobar Islands and four in the North-Eastern region of India.

Kokum seed contains 23-26% oil, which remains solid at room temperature and is used in the preparation of chocolates, medicines and cosmetics. It is used as a slightly bitter spice in recipes from Maharashtra and as a souring agent and a substitute for tamarind paste in Indian curries. Recently, some industries have started extracting hydroxycitric acid (HCA) from the rind of the fruit which is an important constituent used as a hypocholesterolaemic agent. HCA is also a potential anti-obesity agent [1]. It suppresses fatty acid synthesis, lipogenesis, and food intake, and thus induces weight loss. Kokum

Butter is an excellent emollient used by the cosmetic industry for preparations of lotions, creams, lip-balms and soaps. It has relatively high melting point and is considered as one of the most stable exotic butter which does not need refrigeration. It is extracted from the Kokum seed and is supposed to reduce degeneration of the skin cells and restore elasticity. The extract of the plant finds place in the specialty cuisine of West Coast of India as an appetizer while decoction of the bark is used for treating paralysis. The antioxidant activity of aqueous extract of the plant has been reported, which is higher than other reported spices and fruits thus promoting its use in cooking, home remedies and as a soft drink [2]. Kokum extract has also been shown to inhibit *Aspergillus* flavus and aflatoxin B1 production thereby demonstrating its putative bio-preservative properties [3]. Addition of Garcinia extract to fresh skipjack (dark muscle fish) has been demonstrated to prevent histamine formation by lowering the pH to 3.2-3.6 [4]. Since histamine is known to give rise to allergic reactions, Garcinia extracts can potentially find use in anti-allergy medications.

Conclusions and perspectives

The chalcone garcinol is a potent antioxidant and anti-cancer agent among its many other biological effects as discussed above. Its structure makes it a very efficient scavenger of oxygen free radicals and an excellent inhibitor of NO. Various biological activities of garcinol have been reported (summarized in Table Table1)1) and most of them relate to its antioxidant nature. More recently, garcinol has generated considerable interest among cancer researchers, and emerging data suggests its ability to protect against chemically-induced carcinogenesis, as well as highlights its potential use as a chemopreventive agent. An interesting observation in this context is its ability to modulate NF-κB, directly or indirectly [29,31]. Since NF-κB is known to be a key player in the progression of human cancers [93,94], its suppression by garcinol indicates a putative potential molecular target of this compound, which requires thorough testing for establishing the scientific rationale for the use of garcinol as an anti-cancer agent prior to its use as a novel therapeutic agent for the treatment of human malignancies. Our preliminary results (unpublished data) suggest an anti-cancer activity of garcinol against human cancer cell lines through induction of apoptosis, and inhibition of NF-κB-DNA binding activity.

Source http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2743703/ ; http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2743703/

Kokum seed butter is derived from the garcinia indica fruit tree and has been a longtime health remedy and confectionery butter in India. It has been used historically as a remedy for diarrhea and dysentery in ayurvedic medicine, and it is even used in cooking and baking to add tart flavoring. However, recent research indicates that the health benefits of garcinia indica seed butter may have even more health benefits than initially thought.

Garcinia indica Seed Plant

The benefits of Kokum seed butter are derived from the evergreen *garcinia indica* tree, according to the Western Ghats Kokum Foundation. Kokum, whose botanical name is garcinia indica, is a flowering fruit tree native to India that is about 10 to 15 meters long. It produces a miniature fruit that turns from red to purple as it ripens. It has a tart taste, but

the rinds expel a sweet aroma. Historically, there are numerous health benefits linked to nearly every part of the tree, but the seeds of the Kokum tree may hold even more beneficial properties, according to research conducted at the Department of Pathology at Wayne State University School of Medicine in Detroit, Michigan.

Ayurveda for Weight Loss Eight Days Therapy in Centres in South India. www.dhathri.com

Historical Benefits

Ayurvedic physicians have long used Kokum seed butter to help heal numerous ailments. According to the National Institutes of Health National Center for Complimentary and Alternative Medicine, ayurvedic medicine is a historically based healing arts system originating in India. This alternative medicine practice involves using products such as spices, herbs, vitamins, proteins, minerals, and metals for healing - and *garcinia indica* seed butter is a common remedy used.

Garcinia indica seed butter, according to ayurvedic physicians, is helpful in treating mouth sores, prevents numerous types of infection and digestion imbalance, and can relieve joint pain. However, according to the Food and Drug Administration, consumers should know that ayurvedic products are generally not reviewed or approved by the FDA, and scientific studies are limited on most ayurvedic products.

Modern-Day Health Benefits

The *garcinia indica* tree's major health benefits are derived from garcinol, a substance found in the seeds and other parts of the tree. Kokum seed butter, in particular, has non-greasy moisturizing properties that are being used in many cosmetics, creams, conditioners and soaps. This substance has antioxidant properties and displays antibacterial and anti-inflammatory agents, according to researchers at Wayne State University. The research conducted at the Barbara Ann Karmanos Cancer Center shows that garcinol is able to kill the H. pylori bacteria that can cause ulcers and evidence suggests that garcinol could be useful as an anti-cancer agent because it inhibits the growth of cancer cells. It also promotes brain health by facilitating the growth of cells and can prevent cardiovascular disease by suppressing the production of reactive oxygen.

KOKUM FRUIT PROCESSING MACHINES

Sieving Machine

Fruit Cutter & separator

Western Ghats Kokum Foundation, Panaji - Goa

KOKUM JUICE PROCESSING MACHINES

RTD Pouch & contents

Pouch Filling Machine

Western Ghats Kokum Foundation, Panaji - Goa

Other Benefits and Considerations

Recent research in Mumbai, India, at the Institute of Science has recognized the Kokum plant as a possible appetite suppressant. Hydroxycitric acid, or HCA, is an appetite suppressant that works by suppressing fatty acid synthesis, lipogenesis, food intake and promotes weight loss. The research also solidifies the use of the Kokum plant as an antioxidant. However, as with any product, intake should be monitored by a health care provider, and you should be aware that this product has not been reviewed by the FDA.

http://www.livestrong.com/article/550600-benefits-of-garcinia-indica-seed-butter/#ixzz1de4lWMqn

http://www.livestrong.com/article/550600-benefits-of-garcinia-indica-seed-butter/

KOKUM IN THE KONKAN

Western Ghats Kokum Foundation, Panaji - Goa


Konkan
Kokum
Konkan
Kokum
LifeExtension
For Longer Life
HCA
HYDROXYCITRIC ACID
CITRIMAX
Promotes Natural Appetite Control
Dietary Supplement
Mapro
Restore
Kokum Crush
A VALUE CHAIN FOR KOKUM, KARONDA, JAMUN AND JACKFRUIT
Kokum Amsul
(Dried Salted Rind)
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli (M.S.)
Solkadhi
POWDER
Nutri
INDIKO K2
KOKAM SHARBAT
KOKAM
Kokum Butter Body Wash
BURT'S BEES
BURT'S BEES
कोकम
कोकण अमृता
कोकम
कोकण हातीस