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REVIEW ARTICLE

ORIGIN, TAXONOMY, BOTANICAL DESCRIPTION, GENETICS AND CYTOGENETICS, GENETIC DIVERSITY, BREEDING AND CULTIVATION OF KOKUM

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ABSTRACT

Kokum is a fruit that is indigenous to India's southern states and never made it to the rest of the world. In general, the darker the purplish-black colour, the greater the quality of the dried kokum. Sun-drying the rind and pulp of the fruit is done after the fruit has been harvested. A large amount of salt may be used to hasten the drying process. The "Indian Butter Tree," or Kokum, is another name for this fruit-bearing tree. Health benefits can be found in all of Kokum's components (fruits, peels, and seeds). A flavorful component for curries is the fruit's dried peel. Kokum juice is a famous summer drink in Goa. Every store has Kokum in small cans and bottles. Kokam Nutrient Value: Kokam is a nutrient-d 100 g kokam = 60 cal Kokam is low in calories and fats, but high in fibre, with roughly 2 grammes per 100 grammes. Caffeine, vitamin A, vitamin B3, vitamin C, folic acid and zinc are all present. Kokam contains acetic and citric acids. 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. In this review article on Origin, Taxonomy, Botanical Description, Genetics and Cytogenetics, Genetic Diversity, Breeding and Cultivation of Kokum are discussed.

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INTRODUCTION

Kokum belongs to the family Clusiaceae/ Guttiferae, genus *Garcinia* and species *Garcinia indica* (Wikipedia, 2024). *Garcinia indica*, a plant in the mangosteen family (Clusiaceae), commonly known as *kokum*, is a fruit-bearing tree that has culinary, pharmaceutical, and industrial uses. It grows primarily in India's Western Ghats: in the states of Maharashtra, Goa, Karnataka and Kerala. It is considered as an endemic species to the Western Ghats and forests in India (Wikipedia, 2024). Other names are kokam, vrikshamia, amlabija, amlashaka (Sanskrit), kokum (Hindi, Gujarati, Konkani), bheranda, kokambi (Marathi), kaatampi (Malayalam), murgina, punarpuli, Devana hul (Kannada and Tulu), tintali (Oriya), Goa butter tree, Indian berry, Indian tallow tree, Indian butter tree, kokum butter tree (Priya Devi *et al.,*2012; Devi *et al*., 2013; Handwiki, 2024; Yogish, 2024; Kampa, 2024; Products, 2024; Jhaveri, 2024). There does not appear to be any records of escape and naturalisation anywhere in the world. The likelihood of it becoming a problem weed is low due to the relatively large size of the fruit and seed, which makes them not easily dispersed (Yogish, 2024). Farmers harvest kokum commercially throughout the western coastal regions of India, from Gujarat to Maharashtra to Kerala. Its ubiquity along the Konkan coast is a reason for the fruit's predominance in Konkan cuisine. The trees flower from November to February, and the fruit season lasts through March, April and May (Yogish, 2024). 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 (Gawankar *et al*., 2001). 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 (Gawankar *et al.,* 2001). 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 (Gawankar *et al*., 2001). 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 (Gawankar *et al*., 2001). Kokum fat is extracted from Kokum seeds hence more number of seeds/fruits should be considered more precisely in further evaluation (Gawankar *et al*., 2001). Kokum is one of the most important indigenous tree spice having numerous medicinal properties (Kshirsagar, 2008). The value addition to the kokum fruits through processing assumes an important activity because raw/ripe fruits needs to be processed before their consumption (Kshirsagar, 2008). The per hectare cost of establishment of kokum orchard for initial five years was found to be higher (Rs.69,205.67) in grafted kokum orchard as compared to seed origin kokum orchard (Rs.38,883.96) (Kshirsagar, 2008). The cost of production of seed origin kokum orchard at overall level was worked out to Rs.26,424.20 per ha whereas it was Rs.42,826.49 per ha for grafted orchard (Kshirsagar, 2008). For this cost structure kokum fruit production was observed to be highest in seed origin orchard compared to grafted orchard. The seed origin orchards enjoying this performance due to early orchard establishment. The financial feasibility test in kokum plantation for grafted kokum orchard as well as seed origin kokum orchard were positive and indicated the kokum cultivation observed to be economically feasible (Kshirsagar, 2008). It was also observed that Rs.10,31,875.53 realized at overall level as the net return per factory by processing kokum fruit into kokum syrup, kokum agal, kokum rind and kokum RTS (Kshirsagar, 2008). The processed product like kokum syrup and kokum agal incurred the highest marketing cost (Rs.1.88/litre) compared to others processed product viz., kokum RTS (Rs.0.10/packet) and kokum rind (Rs.0.50/kg) by the kokum processor, whereas kokum grower was found to be highest marketing cost in Lonawala kokum and kokum ghul (Rs.35.00/q) followed by kokum fruits (Rs.30.00/q) and kokum seed (Rs.25.00/q) (Kshirsagar, 2008).

Kokum 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 (Miguel *et al.,* 2012). 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 (Miguel *et al*., 2012). 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 (Miguel *et al*., 2012). 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 (Miguel *et al.,* 2012). In spite of its incredible medicinal and nutritive properties, kokum is generally not cultivated systematically on orchard scale like that of mango, cashew nut. It is mostly found as a kitchen garden plant or mixed crop in plantations of coconut, areca nut, as roadside plants or in forest (Miguel *et al.,* 2012). 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 (Miguel *et al.,* 2012). Kokum is a tropical evergreen tree, related to the mangosteens. A slender tree with sloping branches, it reaches heights of 15m. The thin bark is lined and the leaves oblong. The dark purple fruit is round, about 4 cm 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 (Miguel *et al*., 2012). 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 (Miguel *et al.,* 2012). The locations where coconut and arecanut can be cultivated are suitable for kokum. Though kokum can be cultivated as a rainfed crop, it cannot be cultivated on hill tops like mango or cashewnut (Miguel *et al.,* 2012). It can be grown as a monocrop or as a mixed crop in established coconut and arecanut plantation (Miguel *et al.,* 2012). 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 (Miguel *et al*., 2012). 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 (Miguel *et al*., 2012). 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 (Miguel *et al*., 2012).

Kokum is a native fruit to the western coastal regions of southern India. In Kannada it's called Murugalu. You rarely find it grown or used in cuisine beyond this area (BuDa, 2015). Also known as *Garcinia indica*, the Kokum tree bears hundreds of fruits during the summer. The fruit is green when tender and ripens to a red-purple color, at which point its plucked (BuDa, 2015). Fresh fruit is usually reserved for juice while most of what is plucked will be dried. For drying, the skin and seeds of the Kokum are seperated and traditionally sun-dried (BuDa, 2015). The seeds are used to make Kokum butter. As a well know counteractive to heat, Kokum is often used as a coolant (BuDa, 2015). The medicinal benefits of Kokum are wide ranging. Many of its benefits, when consumed, come from antioxidant properties. But it is known to reduce cholesterol, promote weight loss, reduce constipation, relieve pain from anal piles/fissures, improve working of the liver, reduce fever and burning sensations in the body, fight infections and cleanse the blood (BuDa, 2015). Additionally it is used in some Ayurvedic medicines in infusions for skin ailments as well as providing relief from sunstroke and thirst (BuDa, 2015). The application of Kokum butter quicken the healing of wounds and can be used for cosmetic purposes (BuDa, 2015). Kokum is one of the native underexploited tree spices. In spite of its incredible medicinal and nutritive properties, kokum is generally not cultivated systematically on orchard scale like that of mango, cashew nut (Ranpise *et al.,* 2019). It is mostly found as a kitchen garden plant or mixed crop in plantations of coconut, areca nut, as roadside plants or in forest (Ranpise *et al*., 2019). Kokum belongs to the genus Garcinia, which is large genus of polygamous evergreen trees and shrubs native of Asia, Southern Africa and Polynesia (Ranpise *et al.,* 2019). *Garcinia indica* is synonymous with Garcinia pur purea and

is known as brindon in Goa, bhirind or amsul in Marathi and Konkani. Murugal in Kannada and Punampuli in Malyalam (Ranpise *et al*., 2019). Kokum is found grown widely in tropical rain forests of Western ghats in Konkan, Goa, South Karnataka and Kerala. It also flourishes in evergreen forests of Assam, Khasi, Jayantia hills, West Bengal and Surat district of Gujarat (Ranpise *et al*., 2019). There are no regular orchards of this fruit tree. The trees are found scattered over road jungles, back yards, waste lands and also in coconut and areca nut gardens (Ranpise *et al*., 2019). The kokum is being traditionally used as an acidulant in Konkan region. The fresh ripe fruit rind with sugar makes an excellent sharbat called as 'Amrit Kokurn' and is useful in fever as cooling refreshing drink and also as an antidote against bilious infections (Ranpise *et al*., 2019). Sun drying of rind is also practiced to prepare dried kokum. The rind is repeatedly soaked in juice of the pulp during sun drying. A salted product 'Amsol' is used as condiment in a traditional fish curry of the Konkan coast and the Goa in place of tamarind (Ranpise *et al*., 2019). An acid drink "Solkadhi" prepared from "Amsol" which serves as a substitute for the butter milk. The Kokum seed oil (fat) called as Kokum butter in commerce is very famous in cosmetic industries (Ranpise *et al.,* 2019). As the kokum fruits are utilized for much household purpose, value added commercial products and the medicinal products, now –a days it is deemed to be the most commercial crop, next to mango and cashew (Ranpise *et al.,* 2019). The standardization of protocol for preservation and processing of kokum fruits is an urgent need, for the preparation of quality products on large scale. These fruits could be used at the fullest extent for processing them into suitable kokum products, since the taste of this fruit is relished only after processing. Kokum Butter is exported to Japan, Taiwan, USA from India for use in confectionery (Ranpise *et al.,* 2019). The fresh rind of kokum fruit constitutes about 50 to 60 per cent of the whole fruit. The ripe fruit contains substantial amount of malic acid and a little tartaric or citric acid and has sweetish acid taste. A new fat soluble yellow pigment namely garcinol is isolated from the fruit rind (Ranpise *et al*., 2019). Kokum fruit has an agreeable flavour and a sweetish acid taste. Kokum has been traditionally used as an acidulent (Ranpise *et al*., 2019). 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 cooling syrups (Ranpise *et al*., 2019). 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 Karnataka (Ranpise *et al.,* 2019). 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 (Ranpise *et al*., 2019). The sweet pulpy cover of the seeds is eaten or made into curries. The fruit is also pickled. Kokum butter is suitable for use as confectionery butter. It is also suitable for making; candle and soap(Ranpise *et al.,* 2019). The fruit of Kokum is anthelmintic and cardiotonic and useful for treatment of piles, dysentery, tumours, pains and heart complaints. Syrup from the fruit juice is given in bilious affections. The main active component in kokum is hydroxycitric acid (HCA) which is regarded as a reducer. The root is astringent (Ranpise *et al*., 2019). Kokum is one of the native underexploited tree spices. It is found in Western Ghats of India and some parts of north-eastern India (Sharath *et al.,* 2019). In spite of its incredible medicinal and nutritive properties, it is generally not cultivated systematically on orchard scale. It is mostly confined to kitchen garden or as a mixed crop in plantations of coconut and arecanut, as roadside plant or in forest (Sharath *et al.,* 2019). It is commonly known as kokum (Hindi), kokum butter tree, Goa butter tree and mangosteen oil tree. It is a tropical evergreen tree, related to the mangosteens (Sharath *et al.,* 2019). It flourishes well up to an elevation of about 800 m a.s.l., requiring warm and humid tropical climate. Ripe fruits are harvested during April-May (Sharath *et al.,* 2019). Fruit rind is widely used in refreshing drinks and curries (Sharath *et al.,* 2019). The fruit is anti-helminthic, appetizer, cardio-tonic, useful against piles and dysentery. Hydroxyl citric acid (HCA) extracted from kokum is used against obesity, which is available in the form of tablets (Sharath *et al*., 2019). The fruit is rich in anti-oxidants that bind with free radicals and prevent oxidative damage to body cells. The anthocyanin pigments obtained from it are used as natural colouring agents for food preservation (Sharath *et al*., 2019). From kokum many processed products can be prepared *viz.*, kokum syrup (amrit kokum), kokum amsul, kokum agal (salted juice), R.T.S., kokum butter, kokum rind powder, kokum honey are prepared (Sharath *et al.,* 2019). Advanced processed products like HCA, garcinol, wine and purified pigments would create more domestic and international demand for kokum (Sharath *et al.,* 2019). There has been immense scope for kokum cultivation in 11 districts of Karnataka and in most areas of Uttara Kannada (Sharath *et al.,* 2019). Until recently, the fruits and seeds of this species had importance only at the household level. Now, it has importance at the commercial market (Sharath *et al.,* 2019). With the availability of a vast area of suitable forests and private lands and sufficient planting material an efficient approach towards propagation and cultivation of kokum should be emphasized for generation of employment and income to the community (Sharath *et al*., 2019).

Kokum belonging to the Clusiaceae family (mangosteen family), is a tropical evergreen tree distributed in certain regions of India (Lim *et al*., 2021). It has been used in culinary and industrial applications for a variety of purposes, including acidulant in curries, pickles, health drinks, wine, and butter (Lim *et al*., 2021). In particular, *G. indica* has been used in traditional medicine to treat inflammation, dermatitis, and diarrhea, and to promote digestion. According to several studies, various phytochemicals such as garcinol, hydroxycitric acid (HCA), cyanidin-3-sambubioside, and cyanidin-3-glucoside were isolated from *G. indica*, and their pharmacological activities were published (Lim *et al.,* 2021). The use of medicinal herbs as medicine is the oldest form of medical treatment known to humanity and has been used in all cultures throughout history. Since time immemorial, humans have recognized their dependence on nature for healthy living, and have relied on a variety of plant resources for medicine to cure numerous diseases. This indigenous knowledge, passed down from generation to generation in different parts of the world, has contributed significantly to the development of traditional medical systems, as well as provided a scientific basis for their traditional uses by exploring various biologically active natural products (Lim *et al.,* 2021). Among medicinal plants, Clusiaceae contains approximately 50 genera and 600 species, and has been extensively used in ethnomedicine to treat a number of disease conditions, including wounds, ulcers, dysentery, cancer, inflammation, and infection (Lim *et al.,* 2021). *Garcinia* belongs to the Clusiaceae family (Mangosteen family) and has multiple application in the culinary, pharmaceutical, and industrial fields (Lim *et al*., 2021). The plants are distributed around the world including tropical Asia, Africa, and Western Polynesia. In the last few decades, they have received considerable attention and extracts of different plant parts of the *Garcinia* species, *e.g., Garcinia brasiliensis*, *G. cambogia*, *G. gardneriana*, *G. pedunculata*, and *G. mangstana* have demonstrated potential effectiveness in the

prevention and treatment of non-transmissible chronic diseases (Lim *et al.,* 2021). Furthermore, it was reported that they contain a wide range of biologically active metabolites and that the chemical compositions of their extracts are rich in bioactive molecules including hydroxycitric acid (HCA), bioflavonoids, procyanidines and polyisoprenylated benzophenone derivatives including garcinol, xanthochymol and guttiferone isoforms (Lim *et al.*, 2021). These compounds have been implicated in biological activities such as antioxidant, anticancer, and antiviral effects. In particular, the major bioactive ingredients such as garcinol, HCA, and cyanidin-3-glucoside have been isolated, characterized and evaluated for their therapeutic properties (Lim *et al*., 2021). Recent studies demonstrated its anticancer effects by inducing apoptosis and cell cycle arrest, inhibiting of angiogenesis, and regulating of gene expression in oncogenic cells (Lim *et al*., 2021).

Used in drinks, kokum is traditionally considered a natural coolant for beating the summer heat (Abhyankar, 2023). Traditionally thought to have cooling properties, India's kokum extract makes for an electrolyte-balancing drink that offers a natural, refreshing way to fend off the summer heat (Abhyankar, 2023). Scrawled with chalk on a small blackboard in Maharashtra, India, there was a list of items available at the small restaurant where I took shelter to escape from the sweltering midday heat (Abhyankar, 2023). The deep red *sherbet* (a traditional Indian beverage prepared with fruits and spices) almost instantly relieved me of my thirst and exhaustion (Abhyankar, 2023). My drink was made from the fruit of *kokum*, a tropical evergreen tree from the mangosteen family that's indigenous to Konkan, a western coastal belt of land that extends from Maharashtra to the states of Goa and Karnataka (Abhyankar, 2023). For centuries, the tribal communities have used *agal*, or the extract from the [kokum] fruit, as a souring and colouring agent in curries, gravies and fish preparations," said food historian Kurush Dalal. They have also utilised it for medicinal properties (Abhyankar, 2023). According to Ayurveda – India's ancient natural system of medicine, deriving from the Sanskrit words *ayur* (life) and *veda* (knowledge) – the kokum fruit has many medicinal uses and health benefits. A storehouse of antioxidants, B-complex vitamins, magnesium and potassium, kokum can be used as a digestive tonic and as a treatment for flatulence, diarrhoea, sores and skin rashes (Abhyankar, 2023). It is traditionally also considered to be a natural coolant and helpful in beating the summer heat (Abhyankar, 2023). Kokum, rich in essential vitamins and minerals, makes for an excellent electrolyte-balancing drink on mixing with some sugar and water. It prevents dehydration and dryness due to summer heat (Abhyankar, 2023). Konkanis consume it in extract form in refreshing and energising drinks like the kokum sherbet I had (which was also mixed with roasted cumin powder and sugar), as well as *solkadhi*, a rich, pink-coloured beverage that's made by blending kokum extract and coconut milk (Abhyankar, 2023). The rain-fed kokum tree flowers in March and its red-purple fruits are harvested around April and May. After picking, the fibrous rind of the ripe, lemon-sized berry is separated from its large seeds and is sundried for six to eight days, causing the rind to turn almost black (Abhyankar, 2023). The dried rind is then boiled in water and reduced to make a concentrate or turned into a syrup with the addition of sugar for use in drinks or dishes (Abhyankar, 2023). The oil from seeds, known as kokum butter, makes for a natural emollient that is utilised as a base for cosmetic products (Abhyankar, 2023). Kokum is used very often in Goan food. Our restaurant has kokum in pickles, jams and chutneys besides the traditional dishes like *solkadi* [a cold coconut milk and kokum soup], seafood *sukke* [clams and prawns cooked in a thick coconut and kokum gravy], mushroom *xacuti* [mushrooms cooked in a kokum-coconut gravy] or shark *ambottik* [shark cooked in tangy coconut-kokum gravy]. The kokum gives beautiful colour to the thick coconut gravy and its sourness subdues the typical seafood odour (Abhyankar, 2023). With its unique flavour – and naturally cooling and hydrating properties – kokum might have caught the fancy of chefs and cookbook authors at just the right time. As temperatures across the planet continue to rise, the traditional Indian fruit extract might be the next best thing for providing a little respite from the scorching heat (Abhyankar, 2023).

Kokum has a special place in Karnataka. Found on the edges of forests and farmlands in the Konkan region, the juice wrenched out of the fruit is a favourite household drink (Amulya, 2023). It is considered to have tremendous medicinal value. It is believed to cool down the body (Amulya, 2023). Scientific studies have also documented its many health benefits including how it acts as an anti-inflammatory agent (Amulya, 2023). Since a little over a decade ago, Hegde and his wife Divya have been earning their livelihood by manufacturing and selling various kinds of kokum beverages. They make it in different flavours – with sugar, with ginger and even chilli. But irrespective of the taste, their kokum drink is a big hit (Amulya, 2023). Initially, he and his wife stood before marriage halls to distribute their product free of charge. They even went to government-sponsored fairs and travelled as far as Bengaluru (500 km away) to find potential customers (Amulya, 2023). In 2010, the Hegde family was struck by a misfortune when the family patriarch slipped and suffered a bad injury. The family too slipped into a financial crisis (Amulya, 2023). It was then that Bhagirathi – Ganapathi's mother – decided to take the advice of a well-wisher. Till then, she would collect raw kokum rinds and sell them to the businessman (Amulya, 2023). Kokum has been traditionally used in cooking as well as a remedy against body heat. But we had never sold or marketed them. This was entirely new (Amulya, 2023). Once in the trade, she learnt the ropes quickly. She learnt to extract kokum juice on a large scale and the amount of sugar to be added. She did not understand litres as a unit of measurement. Instead, she learnt everything through the measurement of bottles (Amulya, 2023). Today, the production stands at 25,000 kg per day from 25 kg in 2012. At 63, her health is not as great as before. But she is extremely proud of all the accolades she has received. "I'm getting goose bumps even thinking about it," she quipped, recalling an award ceremony in Dharwad (Amulya, 2023). But the most fascinating product is their kokum tea – an invention of sorts. Sales of kokum juice usually fell around the winter and he wanted to remedy that by offering a kokum drink for the colder months (Amulya, 2023). I'm paying farmers more if they bring kokum rinds that are properly ripened and then dried. The juice can only be extracted from properly ripened fruits. If they fall on the ground and get soiled, the rind can't be used. So, he has been encouraging farmers to properly harvest fruits by using tarpaulins (Amulya, 2023). If you visit us during April-May, you can see men, women and even local tribes people bringing us 5-10 kg of rinds every day. We pay them immediately (Amulya, 2023).

Kokum, the little red powerhouse that has been a cornerstone of Ayurveda for centuries (Ayurveda, 2024). Known to the ancients as "Vrikshamla," this unassuming fruit has a rich history and a deep connection to our wellness traditions (Ayurveda, 2024). While modern wellness buffs rave about Garcinia for its potential weight-loss perks, Ayurveda has long praised this gem for its bigger-

picture benefits—from taming the appetite to fine-tuning digestion and keeping metabolism humming (Ayurveda, 2024). With a natural hydroxy citric acid (HCA) boost, Garcinia packs a punch for managing cravings and helping the body balance (Ayurveda, 2024). Ayurvedic superstar isn't just about fitting into skinny jeans; it's about inspiring holistic health and harmony and finding that sweet spot where mind and body sync up perfectly (Ayurveda, 2024).

Kokum is a versatile Indian specialty spice which ranks highly by both culinary and medical standards. The major culinary uses of kokum are as a garnish for curries and in the preparation of syrups (Products, 2024). Kokum has an agreeable flavour and a sweet, acidic taste that enhances coconut-based curries (Products, 2024). Kokum has the same souring qualities as tamarind, and the two are sometimes used interchangeably. Adding a few pieces of kokum to a curry while cooking gives the pleasant fruity flavour and agreeable acidic bite so characteristic of South Indian dishes (Products, 2024). The famous Malvani Solkadhi, a type of curry usually had with rice or sometimes drunk after meals, is made from coconut milk and kokum. Solkadhi is renowned for its digestive properties (Products, 2024). Deeper colour of the rind indicates better quality kokum. Kokum petals can be very strong, so add only a few at a time. It will keep in an airtight jar for about a year (Products, 2024).

Kokum is a versatile Indian specialty spice which ranks highly by both culinary and medical standards (Dry-kokum, 2024). The major culinary uses of kokum are as a garnish for curries and in the preparation of syrups (Dry-kokum, 2024). Kokum has an agreeable flavour and a sweet, acidic taste that enhances coconut-based curries (Dry-kokum, 2024). Kokum has the same souring qualities as tamarind, and the two are sometimes used interchangeably. Adding a few pieces of kokum to a curry while cooking gives the pleasant fruity flavour and agreeable acidic bite so characteristic of South Indian dishes (Dry-kokum, 2024). Kokum is especially used with fish curries, three or four rinds being enough to season an average dish. The skins are not usually chopped but are added whole to the dish (Dry-kokum, 2024). It is used in vegetarian dishes of potatoes, okra or lentils and is also used in chutneys and pickles. Kokum is frequently used in Gujarati cooking to add flavor and tartness to dal (Dry-kokum, 2024).

Narayana Rai, a visionary farmer, began cultivating 'kokum' to conserve it as plantations started declining. His flourishing estate, now managed by his son Ramesh Rai, boasts over 10,000 kokum trees. The family has also distributed over two lakh saplings to other farmers (Freese, 2024). Known scientifically as *Garcinia indica*, kokum is a fruit-bearing plant in the mangosteen family (Freese, 2024). It is commonly found in the Western Ghats region of India (Freese, 2024). Devoured for its savoury taste, it is also known as *bheranda* in Marathi, *kudampuli* in Malayalam, and *kodampuli* in Tamil (Freese, 2024). While Ramesh's father was farming different plants, it was about 15 years ago that he began planting Kokum, anticipating its future demand due to its medicinal value (Freese, 2024). He started growing *kokum* because of his love for the fruit! Furthermore, *kokum* plants don't need much water and grow well in the local climate (Freese, 2024). *Kokum* is highly sought after in North India for its use in making oils and beverages (Freese, 2024). We were confident that the price of *kokum* would rise, and we decided to wait for the plants to mature. Initially, the price was around Rs 10 per kg, but it has now risen to Rs 120 to 130 per kg, and in some places, it can go up to Rs 300 per kg (Freese, 2024). Kokum oil comes from the seeds of the kokum tree (Handwiki, 2024). This fruit-bearing tree is also known as the wild mangosten tree, and also the red mangosten tree (Handwiki, 2024). This tree belongs to the Guttiferae family of the plant kingdom. The oil extracted from the seeds is edible, and it can also be used for things other than cooking (Handwiki, 2024).

Kokum butter or kokum oil is a fat derived from the seeds of the kokum tree (Wikipedia, 2024a). Kokum butter is edible and can also be used for things other than cooking (Wikipedia, 2024a). Kokum fruits contain five to eight large seeds which account for 20-23% of the fruit's weight. The kernels account for 61 percent of the weight of the seed, while the oil content of the kernel accounts for about 44%. The seeds are compressed and embedded in an acidic pulp (Wikipedia, 2024a). The oil content of the seeds is 23-26%. The average yield of seeds for a tree is 10-15 kilograms. The fruits are collected for seeds from April to May. The kernels account for 60% of the fruit by weight. The oil content of a kernel is 41-42%. A kernel contains protein up to 17% (Wikipedia, 2024a). Fruits are collected manually by handpicking. The tree branches are shaken with long sticks and fallen fruits are collected. The fruits are broken by sticks to separate the seeds, which are picked up by hand. Then the separated seeds are dried to reduce their moisture content (Wikipedia, 2024a). Kokum oil or kokum butter is light gray or yellowish in color. After refining, the kokum fat is equivalent to Vanaspati ghee (Wikipedia, 2024a). Kokum oil contains up to 60-65% saturated fatty acid, making it solid at room temperature, so this oil is known as kokum butter or kokum fat. Its triglyceride composition is uniform and consists of up to 80% of stearic-oleic-stearic (SOS) triglycerides. Because its slip melting point is close to human body temperature (37°C), it tends to melt on skin contact (Wikipedia, 2024a).

Kokum(called '*bhirnda*' or '*bhinda*' in Konkani, '*murugala hannu*' in Kannada) 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 (WWW, 2024). 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 (WWW, 2024). 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) (WWW, 2024). 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 (WWW, 2024). This has many medicinal properties. The skin is soaked in water for some time and the purple colored water is given to the patients suffering from '*pitta*'(WWW, 2024). Sometimes the fruit is mixed with sugar and sun dried. The juice that comes out of it is preserved to make kokum juice (WWW, 2024). The seeds are sun dried to make kokum butter. 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 (WWW, 2024).

Kokum is a fruit that is indigenous to India's southern states and never made it to the rest of the world. In general, the darker the purplish-black colour, the greater the quality of the dried kokum (Singh, 2025). Sun-drying the rind and pulp of the fruit is done after the fruit has been harvested. A large amount of salt may be used to hasten the drying process (Singh, 2025). The "Indian Butter Tree," or Kokum, is another name for this fruit-bearing tree (Singh, 2025). Health benefits can be found in all of Kokum's components (fruits, peels, and seeds) (Singh, 2025). A flavorful component for curries is the fruit's dried peel (Singh, 2025). Kokum juice is a famous summer drink in Goa. Every store has Kokum in small cans and bottles (Singh, 2025). Kokam contains acetic and citric acids (Singh, 2025). In this review article on Origin, Taxonomy, Botanical Description, Genetics and Cytogenetics, Genetic Diversity, Breeding and Cultivation of Kokum are discussed.

ORIGIN AND DISTRIBUTION

The kokurn tree originated from the tropical rain forests of the western ghats of Kerala and Malaysia. Its cultivation is confined to the coastal, hilly regions of Maharashtra (Ratnagiri and Sindhudurg) and Goa states and is popularly known as ' Ratamba'. Some kokum trees are also observed in Tamil Nadu, the Western ghats of Karnataka and Kerala, as well as parts of West Bengal, Assam and Gujarat. It also flourished well on the lower slopes of the Nilgiri hills (Ranpise *et al*., 2019). Kokum is favourably growing 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 Maharashtra, Kokum cultivation has been virtually monopoly in Konkan region, especially in Ratnagiri and Sindhudurg district. It is estimated that in Sindhudurg district the area under Kokum is about 108 hectares scattered along riverbanks, streams, valleys, roadsides and backyard wastelands. In Goa, the production level of Kokum is estimated at 10,200 tons from 1200 ha and it has shown continuous rising as importance crop as evident by the market trends and export scenario. In Karnataka, Uttara Kannada district is the major producer of kokum. It is also grown in Dakshina Kannada, Shimoga, Chickmanglore and Udupi regions (Ranpise et al., 2019). Kokum is native of the Western Ghats in India (Tripathi, 2021). It is found growing naturally in evergreen and semi-evergreen forests or in home garden tree in the Western Ghats of Maharashtra, Karnataka and Goa. The major kokum growing areas are in Maharashtra, Goa and Karnataka (Tripathi, 2021).

Kokum is indigenous to the Western Ghats of India, and has been a part of the country's history for centuries. The fruit's recognition is still limited to the subcontinent of Southeast Asia, although a few kokum butter-based cosmetic products have begun to appear in the global markets (Yogish, 2024). Although some people place the kokum's origins in Africa, others believe kokum is indigenous to the Western Ghats of *India.* The kokum tree has been a part of India's history for centuries (Handwiki, 2024). Native to evergreen forests of western mountain range (Ecourses, 2024)**.** It is found in Maharashtra, Goa, Karnataka, Kerala, South Gujarat, Assam and West Bengal (Kampa, 2024). *Garcinia indica* is indigenous to the tropical forest regions of India. Of the 35 species found in India, 17 are endemic. Of these, seven are endemic to the Western Ghats, six in the Andaman and Nicobar Islands and four in the northeastern region of India. The kokum variety from the Ratnagiri and Sindhudurg districts from the coastal Konkan region of the state of Maharashtra in India has received the GI (Geographical Indication) tag. *Garcinia indica* is found in forest lands, riversides and wastelands. These plants prefer evergreen forests, but sometimes they also thrive in areas with relatively low rainfall. It is also cultivated on a small scale. It does not require irrigation, spraying with pesticides or fertilizers (Wikipedia, 2024).

TAXONOMY

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. The genus *Garcinia* includes 200 species, out of which 30 different species are reported to be found / grown in India. However, 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.* Around 30 species of *Garcinia* are available in India. 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 (Priya Devi *et al*.,2012). Few important genera under this family are *Garcinia, Hypericum, Vismia, Cratoxylon, Triandenum, Pentadesma, Mammea, Allenblackia, Calophyllum, Mesua.* The genus *Garcinia* includes 200 species, out of which 30 different species are reported to be found / grown in India. However, over 400 species of *Garcinia* have been identified and 40 edible species listed. Few economically important species distributed in tropical Asia are *G. mangostana, G. indica, G. gummigutta, G. xanthochymus, G. hombroniana, G. cowa, G. Morella.* Around 30 species of *Garcinia* are available in India. A feature of the 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 (Devi *et al*., 2013). Kokum, *Garcinia indica* (Thouars) Choisy belongs to the family Clusiaceae. Its family Clusiaceae belongs to the order Theales and sub class Dilleniidae. The genus *Garcinia* consisting of about around 200 species which are widely distributed throughout Tropical Asia. Out of 200 species, few are economically important, *viz.,G. mangostana, G. indica and G. gummigutta, G. xanthochymus, G. hombroniana, G. cowa, G. Morella.* Thepresence of yellow or white latex plant parts is the main feature of genus *Garcinia* (Ranpise *et al.,* 2019). Out of 35 species reported to exist in India, seven are

endemic to Western Ghats, six in Andaman and Nicobar Island and four in North East India (Ranpise *et al.,* 2019). Some of these are detailed in Table 1

Sr. No.	Name of Species	Distribution Area
1.	*Garcnia andamanica King*	Andaman Islands
2.	*G anomala Planc*	Khasi Hills
3.	*G atroviridis* Griff	North Eastern districts of Assam
4.	*G cornea L.*	Bengal
5.	*G cowct* Roxb. *(G. kydia Roxb)*	Eastern parts of India, Assam, Bihar Bengal, Orissa, Andaman
6.	*G dulcis (Roxb) Kurz*	Introduced info India from Malaysia
7.	*G echinocarpa Thw.*	Tirunelveli forests
8.	*G. gummi gutta (L.) Robsmall (G. cambogia (Gatin) Desr)*	Western Ghats, Maharashtra, Goa, Karnataka, Kerala, Shola forests of Nilgiris
9.	*G. hanburyii Hook*	South India
10.	*G. hombroniana Pierre*	Nicobar Island
11.	*G.imbertti Bourd*	S. India
12.	*G. lanceaefolia Roxb*	Assam, Khasi Hills
13.	*G. livingstonei* T.Anders	Introduced to India from East Africa
14.	*G. malabarica Talbot*	S. India
15.	*G. mangostana* L.	Introduced to S. India
16.	*G. Microstigma Kurz*	Andaman Islands
17.	*G. Morella Dest.*	Assam, Khasi Hills, Western Ghats
18.	*G. paniculata Roxb*	Foot hills of Himalayas, Assam, Khasi Hills
19.	*G. Pedunculata Roxb*	Assam, Manipur
20.	*G. speciosa Wall*	Andaman Islands
21.	*G. spitcata* Hook *(Govalifolia* Hook. *f)*	Western Ghats from Konkan Southwards
22.	*G. Stipulate T. Anders*	Eastern Himalayas
23.	*G. Succifolia* Kurz	S. India
24.	*G. travancorica* Beddome	Western Ghats
25.	*G. wightil* T. Anders	S. Indian Forest
26.	*G. xanthochymus* Hook *(G tinctoria* Wight *G pictorious* Roxb.)	Eastern Himalayas, Western Ghats, Andaman Islands

The genus *Garcinia* includes more than 200 species of trees and shrubs, distributed in the tropics of the world chiefly in Asia and Africa. About 35 species are reported to exist in India including some exotic ones many of which are economically important. The genus *Garcinia* includes *Garcinia atroviridi, G. dulcis, G. echinocarpa, G. gummigutta, G. xanthochymus, G. cowa, G. Morella, G. hombroniana, G. indica, G. lanceaefolia, G. livingstonei, G. mangostana, G. microstigma, G. morella, G. panicuiata, G. pedunculata.* These species can be useful as sources of gamboges, dyes, hydroxyl citric acid (HCA), as good rootstock or for breeding purpose. There are reports that over 400 species of Garcinia have been identified with 40 species have been documented as edible and 24 species are used for various purposes. The presence of yellow or white latex plant parts is the main feature of genus *Garcinia* (Ranpise *et al.,* 2019). The genus *Garcinia*, belonging to the family Clusiaceae, includes about 200 species found in the Old World tropics, mostly in Asia and Africa. *Garcinia indica* is an evergreen, monoecious tree, which can grow up to 18 meters high, on maturity attaining a pyramid shape. The fruit, an orange-sized purple berry with fleshy endocarp, contains five to eight seeds, which account for 20–23% of the fruit's weight. The kernels account for 61 percent of the weight of the seed and about 44% of its oil. The seeds are compressed and embedded in an acidic pulp (Wikipedia, 2024). Well known these tangy, Green/Reddish berries, kokum fruit consist of 3 major parts. 1) The kokum pericarp – which is the rind or peel and contains the highest level ofxanthones. 2) The pulp – which is the fruit and is known for being one of the tastiest fruits in the world. 3) The seeds – found within the white pulp (Miguel *et al.*, 2012).

BOTANICAL 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 (Miguel *et al.,* 2012). A large evergreen tree with long drooping branches and yellow latex. Leaves are opposite, leathery, red when young and oblong lanceolate. Flowers are small (4-8 mm.), axillary as well as terminal, solitary or in fascicles with pedicels thickening upwards. Petals are four while the stamens are many. Fruit is globose, 3 cm., smooth and purple. Bark grey-brown, relatively smooth but with inconspicuous light-coloured vertical fissures; exudes orange-yellow resin when cut. Fruit pulp, edible. Rind in used in making sambar (Sankara Rao *et al*., 2012).

G.indica is confined to India and Sri Lanka only. It is an evergreen graceful tree growing with conical canopy attaining about 10 m in height. The main shoot is orthotropic whereas branches are plagiotropic exhibiting branch dimorphism. Three sex forms are seen in Kokum namely female, male and hermaphrodite types though it is generally reported to be dioecious. The dried rind of its fruit is the traditional kokum' or binda' of commerce used for garnishing curries. It is a popular tree spice having tremendous potential and also has many medicinal properties. In South India, it is used instead of tamarind in curries. The juice of the fruit is used as a mordant and the expressed oil of the seed is the kokum oil of the natives, extensively used to adulterate ghee. The seeds of the fruits yield valuable edible fat known in commerce as kokum butter. The recent understanding on the effect of hydroxyl citric acid (HCA) in preventing obesity in humans has boosted its economic value due to its HCA content. It is also the richest source of red pigments in the plant kingdom. The tree grows extensively in the Konkan region of Maharashtra, Goa, coastal areas

of Karnataka and Kerala, evergreen forests of Assam, Khasi, Jantia hills, West Bengal and Gujarat. Kokum is a spice with great medicinal values occurring in the western coast in a semi wild state. It is a native of Western Ghats of Kerala (India) and Malaysia. It grows in the evergreen forests of the Western Ghats in South India and its habitat extents from Konkan southward to Travancore and into the Shola forest of Nilgiris where it can reach an altitude of up to 2000 m above mean sea level (Ranpise *et al.,* 2019).

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 (Korikanthimath and Desai, 2021). 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 exceedingly 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 (Korikanthimath and Desai, 2021).

Kokum is an evergreen tree reaching to a height of 10-15 m with spreading branches. The ripe fruits are bright red, spherical or globose. The rind is thick and red is colour. Pulp is white, acidic and encases 5 to 8 seeds. The rind contains anti-obesity compounds, anthocyanin. It has a sweetish acid taste and is dried and used as a souring agent in traditional dishes in Konkan, Goa and Karwar region and also used for the preparation of syrup, juice, dried flakes, powder. White pulp is also edible. The rind has medicinal purposes, for the treatment of obesity, piles, dysentery, tumors, and heart complaints. Seed contains high amount of oil and seed oil or butter is extracted. The oil is used as an ingredient in cosmetic products. Kokum is generally not used as fresh fruit. It is used for making squash, syrups and dried for use as souring agent in various preparations since long in entire Western Ghats region. Kokum contains anthocyanin, fatty acids, hydroxycitric acid (HCA) and garcinol. Anthocyanins are well known for their antioxidant, anti-inflammatory and anti-carcinogenic activity. Kokum is rich in anti-obesity compound, *i.e*., Hydroxycitric acid (HCA). It has gained much attention in recent years for use in weight loss and now lot of anti-obesity products are being prepared from Garcinia. Apart from the medical value, it is rich in many other nutrients (Tripathi, 2021).

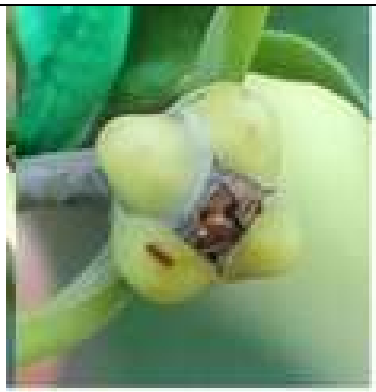
Garcinia indica or Kokum is originating in humid tropical India, its natural range limited to the Western Ghats and the West coast of the sub-continent, extending from near Matheran, in the hills to the east of Mumbai (Bombay), south through the states of Goa and Karnataka to Kerala. Medium sized evergreen dioecious tree with milky exudate. Branchlets drooping. Leaves reddish when young, obovate-oblong. Flowers greenish-white, male 4-8 in axillary and terminal fascicles, female solitary, terminal. Berry globose, smooth, 2-4 cm diameter, green turning red on ripening, 4-8 loculed and seeded. It is a slow-growing tree, to heights of up to 20 m. However, it is more typically 10 to 15 m tall with a slim, low-branching trunk supporting a densely leafy pyramidal crown. The bark is dark grey or dark brown, scaly, rough and sometimes mottled by lichens, mosses and algae, which thrive in the humid conditions in which the tree grows. Leaves are lance-shaped or elongated-oval, 5 to 10 cm long, crimson red and soft when they emerge, becoming dark glossy green with a leather texture. Arranged in pairs along stems, they remain on the tree in all seasons. Flowers are small with fleshy, waxy pink petals and with female and male flowers on separate trees. They are borne directly on the stems, singly or in clusters of up to four and bloom in the dry winter season. They are followed on female trees by small round fruit, 3 to 4 cm in diameter. The fruit are green when young, become dark purple-red when ripe and have a thick rind that encloses soft, juicy pulp embedded with six to eight kidney-shaped seed. Kokum is a heavy bearer, each female tree producing hundreds of fruit that ripen around the start of the rainy season (Yogish, 2024).

Garcinia indica is a medium-sized evergreen tree. It grows to a height of about 18 m. The tree has drooping branches. The fruits ripen in summer. They are berries. The trees bears a lot of fruits in favourable conditions. The fruits are spherical with a diameter of about 5 cm, with indentations on the top, on the stalk and on the bottom. The fruit has 5 to 8 seeds surrounded by sweet and sour pulp. It contains some fibers. The fruits are initially green but turn red as they ripen (Wikipedia, 2024). This evergreen tree is mainly found along the west coast of the Konkan, Goa, Karnataka and North Malabar. The tree is also found in Jaintia Hills, West Bengal, the Nicobar Islands, and Assam. It is typically found along the westward slopes of the Western Ghats, between the sea level plains up to an elevation of about 800 m. The Kokum tree grows to varying sizes. It is characterized by a dense canopy of green leaves and red-tinged tender emerging leaves. The mature tree grows up to 15 to 18 meters in height. It is predominant in the East Indies. Its propagation is generally through seeds and silviculture. It takes about 7 to 10 years for it to bear an economical amount of fruit. The leaves are oblong and lance-shaped with a glossy surface. The young leaves have a red tint to them; mature leaves are deep green and 5.5–8 cm long and 2.5–3 cm broad. The leaves are dark green in the upper portion and pale in the lower portion. The kokum blooms between the months of November and February. The flowers are a fleshy, dark pink and can appear either solitary or in spreading clusters. The flowers of the kokum are unisexual, axillary or terminal or solitary. **Fruits** ripen in April and May. An average tree yields 60 to 80 kilograms of fruit, the fruit is berry-like; it appears dark purple when ripe and is spherical in shape and lemon-sized, with a diameter of about 2.5-3.0 cm. The fruit has an agreeable flavor and a sweet, acidic taste. The fruits contain 10 percent malic acid and a small proportion of tartaric and hydroxy citric acid. They contain anthocyanin, coloring matters, cyanidin-3-glucoside and sambubioside. The fruit is anthelmintic and cardiotonic and useful in the treatment of piles, dysentery, tumors, pains and heart problems. 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. The fruits contain five to eight large seeds which account for 20 to 23 percent of the fruit's weight. The kernels account for 61 percent of the weight of the seed, while the oil content of the kernel accounts for about 44 percent. The seeds are compressed and embedded in an acidic pulp. The oil content of the seeds is 23-26 percent. The average yield of seeds for a tree is 10-15 kilograms.

The fruits are collected for seeds from April to May. The kernels account for 60 percent of the fruit by weight. The oil content of a kernel is 41-42 percent. A kernel contains protein up to 17 percent (Handwiki, 2024).

Kokum is a tree with a dense canopy of green leaves and red-tinged tender emerging leaves. It is indigenous to the Western Ghats region of India, along the western coast. The tree is large and handsome, having elliptic, blong or oblong-lanceolate, deep-green glossy leaves, 5.5-8 cm long and 2.5-3 cm broad. The flowers are fleshy, dark pink, solitary or in spreading cluster. The fruit is brownish or brownish-gray, marbled with yellow, and is crowned by the 4-parted, stalkless 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. 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 tree is a source of kokam butter which is used in cosmetics and confectionary. Flowering: November-February (Jhaveri, 2024).

Botanical description of kokum is given in Fig. 1.

		
Tree	**Flower buds**	**Flower**
		
Flower bud	**Flower bud**	**Immature fruit**
		
Immature fruit cut open	**Immature fruit**	**Mature fruit**

Continue ….

Mature fruit cut

Fruits

Fruits

Fruits

Fruits

Fruits

Fig. 1. Botanical Description

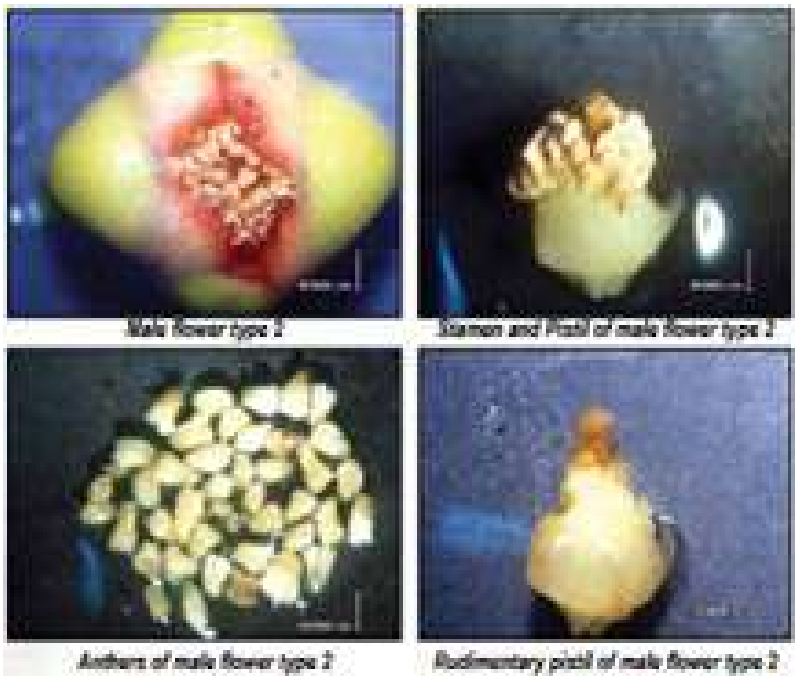
Sex types: The trees could be designated into the following types on the basis of preponderance of particular type of flowers and the bearing tendency of individual tree (Ecourses, 2024):

Tree type -1 – Staminate or male tree: The flowers have mostly long pedicels, mass of stamens crowded on receptacle and sometimes rudimentary pistil with pointed apex. They are incapable of producing any fruit and serve as pollinators only.

Tree type- II- Hermaphrodite or bisexual: Young fruits produced by the tree are generally irregular in shape containing 0 to 6 underdeveloped seeds. Yield per tree may vary from 1 to 3 kg of fruits.

Tree type III- Pistillate or female: Flower is identified by short pedicel, well developed pistil and two or four tufts of staminodes below. Fruits are round to globose, dark red when ripe and contain 1 to 7 well developed seeds. Adult tree bears heavy crop. In a population of 62 trees observed 37 per cent turned out to be male, 8 per cent bisexual and 55 per cent female.

Fig. 2 shows the staminate or male flowers, hermaphrodite or bisexuval flowers and pistillate or female flowers



Male Flowers

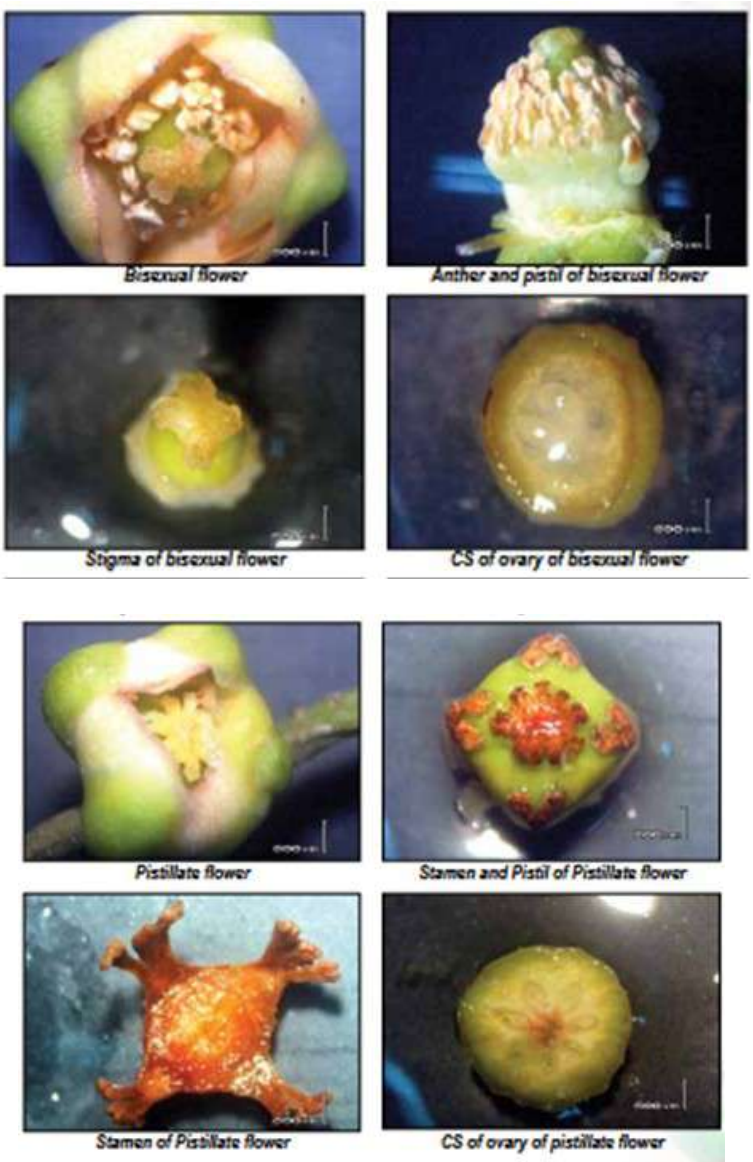


Fig. 2. Male, Biseual, Female flowers of Kokum

Floral Biology: *Garcinia indica* is polygamo dioecious type of plant. It is a slender, pyramid shaped evergreen tree with drooping branches. The leaves are ovate or oblong, lanceolate, 6.25 to 8.75 cm long and 2.5 to 3.75 cm broad, dark green above and pale beneath. The kokum tree is described 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. Flowering occurs on past seasons shoot in the axil of the leaves. 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. Flowering in male trees starts one week early as compare to others. Kokum is androdioecious, consisting male and bisexual flowers on separate plants. Flowers are with four sepals, thick and fleshy, green in colour. Flowers are pale yellow in colour, borne either singly or in cluster. Calyx is sepaloid consisting of four sepals arranged in decussate pairs. The petals are four with yellow to purple. Male flower has numerous short filamentous anthers and anthers are two celled and oblong. Female flower are solitary or some time they found in a group of 2- 3 flowers
whereas the male flowers are 3- 4 in number. The male buds are short and roundish, whereas, the female buds are oval in shape and vary in size; their weight also varies from 50 g to 180 g. Ovary with short style and stigma six lobbed. 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. Two flower types and hermaphrodite type was actually located for the first time from Konkan region. Anthesis occurs early in the morning *i.e.* 6 to 8 am with anther dehiscence occurring about 20 minutes before anthesis. The stigma is receptive on the day of anthesis and for the following 3 days (Baskaran and Krishnan, 2012; Ranpise *et al*., 2019). The species is dioecious with around eleven types of flowers being reported, that can broadly be classified into staminate, hermaphrodite and pistillate. This feature owes to the cross pollination and subsequent natural heterogeneous population of kokum. Besides this, the sexual mode of propagation (population is of seedling origin) has resulted in heterozygosity in the genetic makeup of trees. This renders each and every individual tree to be different from each other (Devi *et al*., 2013).

Pollination: Substantially high fruit set in both open (natural cross) and hand (artificial cross) pollination in Kokum which could be due to large number of pollen grain produced by Kokum trees and role of wind in pollinations as judged by the atmospheric pollen. 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. Seedling types need due consideration for increasing the number of fruits and automatically the selection for better yielding types (Ranpise *et al.,* 2019).

GENETICS AND CYTOGENETICS

The chromosome number of kokum is reported as 2n = 54 and as 2n = 48 (Devi *et al.,* 2013). The chromosome number of kokum is varies with authors, for instance 2n = 54 and 2n = 48 (Ranpise *et al.,* 2019). Inheritance pattern is very essential to develop any breeding program, especially in fruit trees where juvenility is very long. Kokum is still being considered as underutilized fruit crops. Hence, very little works has been undertaking to study the inheritance pattern of characters associated with important traits in kokum (Ranpise *et al*., 2019).

GENETIC DIVERSITY

A total of 268 trees were identified during the extensive surveys conducted in Goa for kokum diversity. The kokum accessions studied were spread all over Goa covering all eleven taluks /zones representing different eco regions. Various morphometric and quality characters were observed in all the accessions studied. Among these accessions, Acc.No. 86 had oblong fruits with a pointed tip at the stylar end. Six accessions *viz.*, 45, 47 and 89 (Bicholim taluk), 139 (Ponda taluk), 177 (Sattari taluk) and 188 (Salcete taluk) were uniquely pear shaped. Besides these, the remaining 240 accessions recorded spherical or round shaped fruits. Such accessions were widely spread throughout the state of Goa. Among these accessions having spherical fruits, two were spherical in shape with a pointed beak or tip towards stylar end (Acc.No. 18 and 150 from Pernem and Ponda taluks respectively). Therefore, among 268 accessions studied, 1.12 per cent of accessions had conical shaped fruits, 7.09 per cent had oblong fruits, 2.24 per cent had pear shaped fruits, 88.81 per cent of accessions had spherical shaped fruits and only 0.75 per cent had spherical shaped fruits with pointed ends (Devi *et al.,* 2013). In spite of the multifarious uses and economic importance, kokum has remained a neglected fruit crop. Unavailability or lacks of standard varieties, comparatively long juvenile period and dioecious nature have resulted in under exploitations of this very useful tree. Almost all the existing plantations have sprung up from seedling originated which has obviously led to genetic variation and reveal heterozygosity. Lot of variability in seedling population has been reported with respect to flowering period, sex expression, percentage of fruit set, weight of fruit, weight of rind and pulp, dry weight of seed , seed : fruit ratio and number of seeds per fruit.

Correlation studies have indicated that higher fruit rind, seed yield and pulp yield are the important economic characters in kokum (Ranpise *et al.,* 2019). There are several other trade varieties of kokum also available in the Indian market: (i) Plain kokum (ii) Salted kokum (iii) Lonawala kokum (iv) Pakali kokum (v) Khane or edible kokum and (vi) Khola kokum. A promising thick rind type MLDK S, which is under evaluation, out of five selections made at Ratnagiri. Though fruits are acidic, sweet forms are also reported, which may be as good as mangosteen as dessert fruit. However, the naturally grown trees are seen spread in forest areas, cashew plantations and homestead gardens. 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 2) (Ranpise *et al.,* 2019).

Table 2. 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	Tal & dwarfnature
3.	Tree height (m)	6- 12m	Tall & dwarf types
4.	Fruiting season	Very early (Feb-March) to Late types (May-June) types preferred	Early &midseason
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 al.*, 2001 Konkan region)	–
11.	TSS of juice	6-12° Brix	Sweet & sour types present
12.	Acidity (%)	1.1-3.2	Sub acid to veryacidic types
13.	Kokum fat (in seeds)	20 -26 % (as reported by Karnik *et al.*, 2001 Konkan region)	–

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 and DVA 1, DVA 2 and DVA 3 the spreading type of genotypes from Raigad district have been already collected for further evaluation at B.S.K.K.V. Dapoli, Maharashtra (Ranpise *et al.,* 2019). 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 3) (Korikanthimath and Desai, 2021).

Table 3. 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
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BREEDING

Germplasm: Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, at various research stations have conserved more than 300 types of kokum (Haldankar *et al*., 2012; Ranpise *et al*., 2019). Intensive and systematic surveys taken up throughout Goa have resulted in identification of certain promising mother trees for earliness, yield and quality characters. As an attempt towards ex-situ conservation, a core germplasm block 34 Genetic diversity of Kokum in Goa-Tree and fruit characters for such elite or outstanding accessions has been established at ICAR Research Complex for Goa (Devi *et al*., 2013).

Objectives of Breeding (Ranpise *et al*., 2019). Development of high yielding, precocity and early bearer cultivars. Development of cultivars having fruits of good processing attributes. Development of cultivars having fruits of thick skin, red colour and bold size which have commercial value. Development of fruit fly resistant cultivars Fruit flies are the most important pests and selection needs to be made for resistant types. Selection of types having fruits of year round availability. Some trees bearing fruits throughout the year have been observed. Development/selection of seedless types as seedless types are observed rarely.

Problems in Breeding (Ranpise *et al.,* 2019).

- Kokum plant may have strong basis for genetic self incompatibility.
- Greater variability among the genotypes in respect to yield and quality parameters.
- Dioeciousness.
- Dominance of tropism in vegetative propagation.
- Surplus and unproductive maleness.
- Large genetic variability, slow growth, late bearing.
- Prolonged harvesting and harvesting at the onset of rainy season.
- Lack of rapid, easy and cheapest propagation technique.

Crop Improvement Methods: So far our knowledge is concerned only selection has been attempted in crop improvement in this crop based on the existing variation among population. In 1996, Agricultural Research Station, Mulde, Tal, Kudal, Dist. Sindhudurg, Maharashtra worked continuously on screening of seedlings and maintenance of germplasm of Kokum. This has resulted in the selection of fifteen genotypes, out of which, six bearing genotypes were selected for further evaluation of fruits for morpho physical variability (Ranpise *et al*., 2019).

Selection

Kokum is a dioecious plant and hence cross pollinated leading to high variability existing population. Variability with respect to morphological features such as leaf parameters, flowering, fruit set, fruit shape, colour, physicochemical composition and yield has been observed. This variability is of great use in the improvement of the crop in the coming years. Excellent variability for various fruit characters is reported. The colour varies from bright red, dark purple, white or even lemon yellow. However, only the red forms have commercial value. Gradations in red colour are seen. Another character is big size or boldness. Generally the fruit weight is only 34.0g. The rind is quite thin whereas thick skinned types are pried and are available. More surveys need to be concentrated in the South Kanara district for collection of biodiversity of kokum. The variability of other species in the Andaman and Nicobar Islands and in the North Eastern States of India needs to be collected for conservation. The correct identities of many species also need to be confirmed. A free exchange of germplasm by the forest departments of various states is also necessary to achieve the objective of kokum improvement (Ranpise *et al*., 2019).

Varieties

Two improved kokum varieties, *viz*., Konkan Amruta and Konkan Hatis had been released by Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli (Haldankar *et al*., 2012; Ranpise *et al*., 2019; Tripathi, 2021):

Konkan Amruta

A variety 'Konkan Amruta' was released in 1998 by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra. A full bearing tree of this improved variety attains a height of 10.3 m with 48.58 m2 volume. This is an early bearer and the fruits can be harvested well before the onset of the monsoon. It has the shortest harvesting period (78 days). It bears attractive, apple shaped fruits with a maximum self life of 15 days. The average fruit yield is 138.28 kg per tree per year. Fruit weight is 34.00g (Haldankar *et al*., 2012; Ranpise *et al.,* 2019; Tripathi, 2021):

Konkan Hatis: This is seedling selection made at Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Maharashtra in year 2006. This is high yielding seedling selection from female plant. Average yield is 150 155 kg fruit per tree. It is special character is early bearing and good shelf life to fruits. Fruit weight is 91.50 g (Haldankar *et al*., 2012; Ranpise *et al*., 2019; Tripathi, 2021):

Few promising lines of Kokum have been identified by CHES (IIHR), Chettalli and IIHR, Bengaluru (Tripathi, 2021).

Characteristic of the Variety "Konkan Amruta" (Patil *et al.,* 2012).

Table 4. Morphological and Physicochemical Characters of the Variety Kokum Amruta

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.

Konkan Amrit: Released from KKV Dapoli. Konkan Amrit variety fruits are bigger in size weighing about 30 g.

Yellow kokum: A unique variety of kokum in Uttara Kannada district. It is locally called as 'bili murugalu' though the colour is yellow. It is believed to posses more medicinal properties. Skin will turn yellow at the time of ripening. Kokum is one of the important non timber forest produces (NTFPs) collected from the western ghats of Karnataka.

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 (Haldankar *et al*., 2012).

Kokum fruit consist of 3 major parts, *viz*., Kokum pericarp, it is the rind or peel, contains the highest level of xanthones; pulp, which is the fruit and is known for being one of the tastiest fruits in the world; seeds, found within the white pulp. The fruits are globose or spherical, 2.5 to 3.75 cm in diameter, dark purple when ripe, and enclosing 5- 8 large seeds. The fruit has 7 -10 ridges and it takes 4- 5 months to ripen. The tree takes about 8- 10 years to reach the commercial bearing stage, when grown from seeds. The fruits are edible with an agreeable flavour and sour sweetish taste inducing cool feelings. Generally the fruits mature by late May or June that interferes with harvesting and processing. The preference is for early maturing types (February March) (Ranpise *et al*., 2019).

Harvesting

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 (Haldankar *et al*., 2012).

Checking for Ripeness: Open kokum by gently pressing on both sides of the fruit with the thumb and index finger. If the fruit is ripe, the pliable skin will come apart and reveal the fruit. If the fruit is under ripe, the thick skin will not yield. Once the fruit's soft, thick skin is "cracked," opening the fruit and removing the white fleshy pods inside is effortless.Some prefer using a teaspoon to make a small indentation in the skin, and then gently pry into the kokum. This indentation makes it easier to apply force with one's fingertips and open the fruit. Always wash dried kokum before use, as this will remove dust and other particles that may accumulate on the fruit over time. If using dried kokum, soak it beforehand. This will soften the rind enough to blend it in drinks, curries and sauces (Yogish, 2024).

As kokum ripens on the tree, it turns from green, yellow, to red, and finally, to dark mauve. The thick skin is initially hard and firm, but when ripe, can be gently pried open. Avoid selecting fruits with noticeable dents, blotched skin and bruises. Bruising causes the bitter latex in the skin to permeate the edible portion of the fruit, thereby rendering the whole fruit inedible. The fruit should be shiny and its shape perfectly round. Kokum is sweet, but acidic. It has a juicy texture common among other fruits in the mangosteen family: each of the fruit's five to eight sections has edible, watery yet potent flesh surrounding a malleable flat seed. Kokum shares several traits with cochin goraka, and the fruits may be used interchangeably. Dried kokum peel tastes exceptionally sour and metallic, with no trace of sweetness. The lack of sugar gives the fruit a salty disposition, not unlike fresh cranberry. The fruit is seldom consumed raw and is instead used as a flavoring agent in curries or drinks (Yogish, 2024).

Nutritional Compositions: Kokum rind contains three important chemical constituents Garcinol, Hydroxycitric acid and anthocyanin pigment respectively. Garcinol is a fat soluble yellow pigment; Hydroxycitric acid is used as an acidulant and physiologically active compound has been shown to significantly reduce body weight. Anthocyanin pigment is a natural antioxidant present in the kokum (Chate et al., 2019). Kokum has not undergone a formal nutritional analysis. It is, however, high in vitamin C, low in fat and calories, low sugar and high in fiber (Yogish, 2024). Physico chemical composition of ripe kokum fruit is presented in Table 2 (Ranpise *et al*., 2019).

Table 5. Physico chemical composition of ripe kokum fruit

Physical characters	Range	Chemical composition	Average
Weight (g)	17.48	Moisture (%)	87.50
Length (cm)	2.58-3.26	TSS (°Brix)	16.44
Diameter (cm)	3.06-3.49	Acidity (%)	3.36
Weight of rind (g)	9.10-14.40	TSS: acidity ratio	4.90
Weight of pulp (g)	5.73-11.72	Total sugars (%)	8.15
Dry weight of seed (g)	1.2-2.44	Reducing sugars (%)	3.71
Seed: fruit ratio	1:4.42	Non-reducing sugars (%)	4.44
No. of seed/fruit	5-8	Ascorbic acid (mg/100g)	9.40
Fruit colour	Dark purple	Tannins (%)	0.28
Pulp colour	Red	pH	2.98

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 (Miguel *et al*., 2012). 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 (Priya Devi *et al.,* 2012). 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). 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, 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 (Devi *et al*., 2013). Kokum is used as a natural moisturizer to keep skin supple and silky smooth. Effective for treatment for severely dry skin, ulceration and fissures of lips, hands, feet. Kokum butter is used in preparation of cosmetics, bar soaps and skin lotions (Chate *et al.,* 2019). Kokum has got multiple uses and finds various applications among the local population (Chate *et al.,* 2019). -The shelf life of kokum fruits under ambient temperature is 4 -5 days and it can be extended up to 28 days if properly stored at 13°C temperature and 86% relative humidity (Tripathi *et al*. 2014). The following types of the products prepared from the Kokum fruit (Chate *et al*., 2019).

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 (Korikanthimath and Desai, 2021).

Potential uses of Kokum Singh (2025)

Kokum in Butter: Kokum butter, extracted from Kokum seeds, is a rich and creamy butter widely used in skincare products such as moisturizers, lotions, and creams. It is known for its excellent moisturizing properties and ability to nourish and hydrate the skin. Kokum butter is especially beneficial for dry and sensitive skin, helping to improve skin elasticity and soothe irritation.

Kokum in Beverages: Kokum is a popular ingredient in beverages, especially in the coastal regions of Western India. Kokum sherbet or kokum-infused water is a refreshing summer drink that helps cool down the body and quench thirst. It has a tangy and sour flavor, making it a delicious and refreshing beverage option. Kokum beverages are also believed to aid digestion and promote overall well-being.

Kokum as Amsul: Amsul, also known as Kokum or Kokum extract, is a traditional souring agent used in Indian cuisine. It is made by drying and preserving Kokum fruit rinds, which are then used to add a tangy and sour flavor to dishes. Amsul is commonly used in curries, soups, chutneys, pickles, and beverages. It imparts a unique taste to dishes and is a popular alternative to tamarind or lemon juice as a souring agent. Additionally, Amsul is believed to aid digestion and provide various health benefits.

Culinary Purposes: Kokum is a popular ingredient in Indian cuisine, especially in the coastal regions of Western India. Its tangy and sour flavor adds a unique taste to dishes. Kokum is often used in curries, soups, chutneys, pickles, and beverages like sol kadhi. It is also used as a natural souring agent in place of tamarind or lemon juice.

Digestive Aid: Kokum is known for its digestive properties. Consuming Kokum-based beverages like sol kadhi after meals is believed to aid digestion and relieve digestive discomfort. It helps stimulate the secretion of digestive enzymes and promotes better absorption of nutrients.

Cooling Agent: In tropical regions, Kokum is used as a natural coolant to beat the heat. Kokum sherbet or kokum-infused water is a refreshing summer drink that helps cool down the body and quench thirst. It is also believed to reduce body heat and prevent heat-related ailments.

Weight Management: Kokum is low in calories and contains hydroxycitric acid (HCA), which may help suppress appetite and inhibit the conversion of carbohydrates into fat. Including Kokum in the diet may aid in weight management by promoting satiety and reducing calorie intake.

Skin Care: Kokum butter, extracted from Kokum seeds, is a rich emollient used in skincare products like moisturizers, lotions, and creams. It has excellent moisturizing properties and is beneficial for dry and sensitive skin. Kokum butter helps hydrate the skin, improve skin elasticity, and soothe irritation.

Hair Care: Kokum butter is also used in hair care products such as shampoos, conditioners, and hair masks. It helps nourish the scalp, moisturize the hair, and prevent dryness and breakage. Kokum butter is particularly beneficial for maintaining soft and healthy hair.

Kokum can also be used in the following ways:

- **Food:** Add Kokum to curries, soups, chutneys, and beverages for its tangy flavor.
- **Skincare:** Use Kokum butter in moisturisers, lotions, and creams to hydrate and nourish the skin.
- **Beverages:** You can make Kokum sherbet by mixing Kokum syrup with water for a refreshing drink.

Health Benefits (Miguel *et al*., 2012)

- 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.
- Potential Benefits of Kokum are Anti-viral, Anti-bacterial, Free radical fighter, Cardio support, Immune system Enhancer, Powerful antioxidant, Skin rashes, infections and wounds, Diarrhea, Anti-inflammatory and Vasorelaxant.
- 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 jiggery (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.

Health Benefits: 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). It has been used in culinary and industrial applications for a variety of purposes, including acidulant in curries, pickles, health drinks, wine, and butter. In particular, G. indica has been used in traditional medicine to treat inflammation, dermatitis, and diarrhea, and to promote digestion (Kampa, 2024). The outer cover of fruit is dried in the sun to get *aamsul* or *kokam*. It is used as a souring agent typically in Maharashtra, Assam, Karnataka, Goa, Gujarat. Kokum yields a distinctive flavour and deep-red colour. As a souring agent, it is used as an alternative to tamarind in curries and other dishes from south India. It is also used in cuisine from Gujarat, where it is frequently used to add flavor and tartness to dal (lentil soup) for flavor balance. It is extensively used in Assamese cuisine in many dishes like *masor tenga* (sour fish curry) and *tenga dali* (sour dal). The fresh fruit is preserved with sugar to make bright-red squash that is diluted with water and bottled for sale as a beverage called Kokum Sarbat. The extract of the fruit is called *aagul* in Konkani and Marathi. It is added during the preparation of *solkadhi*, which may also include coconut milk, coriander and garlic (Wikipedia, 2024). The seed of *Garcinia indica* contains 23–26% Kokum butter, which remains solid at room temperature. It is used in the preparation of chocolate and sugar confectionery (Wikipedia, 2024). The oily extract called Kukum butter is used in ointments and suppositories.[5] It has application in skin and hair products, acne products and skin tonics.The rind of the fruit is a good source of hydroxycitric acid which has been claimed to modify lipid metabolism (Wikipedia, 2024). Kokum butter is non-greasy and gets absorbed into the skin once it is applied. It is often used as a substitute for cocoa butter due to its triglyceride composition. Kokum butter has emollient properties and good oxidative stability, which can assist emulsion integrity. With its relatively higher melt point, it melts slightly at skin temperatures, making it ideal for lipsticks and balms. It is also added in the making of bar soaps and skin lotions (Wikipedia, 2024a).

Health Benefits

Rasa (Taste): The primary characteristic of *Garcinia indica* is its sour taste, a quality that is closely linked to its digestive and stimulating properties in Ayurveda. This sour taste is believed to balance Vata dosha, although excessive use can sometimes aggravate Pitta (Ayurveda, 2024).

Guna (Quality): Additionally, Garcinia's qualities of being light and dry (laghu and raksha) further support its role in reducing kapha, promoting lightness, and reducing excess heaviness in the body (Ayurveda, 2024).

Virya (Potency): Its potency, or virya, is ushna (heating). This heating effect stimulates digestive fire (Agni), aiding food breakdown and promoting metabolism (Ayurveda, 2024).

Vipaka (Post-Digestive Effect): The vipaka, or the taste after digestion, is often understood as sour, aligning with its initial rasa and enhancing its effects on metabolism and digestion. Sour vipaka is associated with tonifying and energising the tissues (Ayurveda, 2024).

Prabhava (Unique Effect): Garcinia's prabhava is linked to its unique ability to regulate appetite and support fat metabolism, which is why it's traditionally used in Ayurvedic weight management. This fruit's unique effect, a fascinating aspect, helps curb cravings and supports balanced digestion, aligning with its broader uses in traditional and modern health practices (Ayurveda, 2024).

Health Benefits (Ayurveda, 2024).

HCA: The most prominent and studied component of Garcinia is Hydroxycitric Acid (HCA), found in the fruit's rind. HCA is believed to inhibit an enzyme called ATP-citrate lyase, which plays a role in fat synthesis. This compound is also thought to help control appetite and support metabolism, making it a popular choice for weight management.

Garcinol: Another essential component is polyisoprenylated benzophenone, which has antioxidant and anti-inflammatory properties. Garcinol may support digestive health by reducing oxidative stress in the gastrointestinal system.

Xanthones: Garcinia contains several xanthone compounds with antioxidant and anti-inflammatory properties. These compounds contribute to Garcinia's overall health benefits, supporting cellular health and potentially aiding in inflammation management.

Polyphenols: Polyphenols are plant-based antioxidants that help protect the body from free radicals. Garcinia contains polyphenols, which contribute to its anti-inflammatory and antioxidant actions.

Flavonoids: These compounds, commonly found in plants, also have antioxidant properties and help protect cells from oxidative stress. They may also support cardiovascular health and improve general wellness.

Benzophenones: In addition to garcinol, Garcinia contains other benzophenones with antioxidant properties. These compounds contribute to its traditional use in supporting digestive and metabolic health.

The seed yield 25 to 35% of an edible, white or pale yellow buttery fat known as ‘Kokum Butter’. It is produced by grinding, steaming and then pressing the seed to release the fat, which is then filtered and churned into a solid buttery mass. The leftover seed cake is high in protein and is used mainly as an ingredient in livestock feed. Kokum butter has a melting point of around 40°C (104°F), remaining solid at room temperature. Its melting properties and buttery consistency make it suitable for confectionery, including use as a Cocoa Butter Equivalent (CBE) to extend or replace Cocoa butter (from Theobroma cacao) in chocolate manufacturing. It is also widely used in its native range as a substitute for Gee, the clarified dairy butter common in Indian cooking. And it is an ingredient in cosmetics, especially skin moisturising, lip balm and lipstick products. The fruit rind is juicy with a sour flavour and is made into a syrup (cordial), beverage base, or dried as a souring agent. The syrup, known as ‘Kokum syrup’ is made by mixing the rind with cane sugar and packing the mixture into sealed drums left to stand. After standing for a week, the mixture is pressed and strained to produce the syrupy liquid, which is usually bottled. It is an intensely deep purple-red syrup with a pleasing fruity taste and is served diluted with tap or soda water to make a refreshing drink. Kokum rind is indispensable in making ‘Sol Kadi’, one of southern India’s most popular beverages. A vividly pink drink, it is made by soaking the rind in hot water to extract the colour and flavour, then mixing the resulting liquid with fresh coconut milk, salt, garlic and green chillies. Some of the rind is also usually reserved for drying (after brining) to make a souring agent known as ‘Malabar tamarind’, commonly used in southern Indian cooking, especially fish curries (Yogish, 2024).

The properties of the seed fat lend to its use as an ointment base for adding medicinal ingredients, such as liniment ointments for treating sore muscles and strains. It is also used in its pure form to soothe chapped or cracked lips, fingers and feet. The rind is rich in hydroxycitric acid, a biologically active plant metabolite sometimes touted as an anti-obesity drug, reportedly inhibiting the conversion of carbohydrates to fats (Yogish, 2024). Kokum is Anthelmintic, Cardiotonic, Fights dysentery, Reduces tumors, Alleviates pain, Astringent, Its juice aids digestion and wards off heatstroke, Its butter treats burns and various wounds, and Reduces biliousness. Ayurvedic practitioners use kokum to treat inflammatory issues, rheumatoid pain and bowel problems, intestinal parasites, delayed menstruation, dermatitis, ear infections and sores. Kokum’s rind possesses a compound called hydroxycitric acid. This substance has a number of benefits including reducing the appetite, improving heart health and the immune system, lowers fat formation and stabilizes cholesterol levels (Yogish, 2024).

Health Benefits (Ayurveda, 2024).

Weight Loss and Management: Garcinia is renowned for its weight management benefits, primarily through Hydroxycitric Acid (HCA), which may inhibit fat production, promote fat burning, and suppress appetite.

Improved Digestion: It enhances digestion by stimulating digestive fire, improving food breakdown, relieving indigestion, and promoting regular bowel movements while reducing bloating.

Appetite Suppression: Garcinia may help control hunger by increasing serotonin levels and reducing emotional eating and sugar cravings.

Metabolism Regulation: It boosts metabolism and fat burning, enhances energy levels, and may help regulate blood sugar and insulin levels.

Cholesterol and Lipid Regulation: Garcinia supports healthy cholesterol levels by lowering LDL cholesterol and triglycerides while potentially increasing HDL cholesterol, benefiting cardiovascular health.

Detoxification and Liver Repair: Its detoxifying properties cleanse the digestive system and support liver function, and its antioxidants protect the liver from oxidative stress.

Side Effects: You should be aware of the potential Kokum juice side effects. Kokum is a wonderful natural gift from nature to humans. It has some adverse effects if used incorrectly. People with serious skin problems should avoid consuming kokum butter, despite the fact that it is used to treat skin disorders. The irritation on the skin is made worse as a result of this. A higher-than-normal level of serotonin improves mental capacity and reduces despair and anxiety (Singh, 2025).

CULTIVATION

Propagation: Kokum is traditionally propagated by sexual means however recently it is also propagated by the vegetative method like softwood grafting (Haldankar *et al*., 2012). 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 (Korikanthimath and Desai, 2021). Kokum may be propagated by seed, grafting and root suckers (Tripathi, 2021).

Cultivation: Kokum grows naturally in humid subtropical and tropical lowland to mid-elevation climates, generally frost-free areas with annual lows of 18 to 25°C annual highs of 27 to 35°C, annual rainfall of 2000 to 5000 mm and a dry season of 7 months or less (Yogish, 2024). It can be grown in a variety of soil and in different agro-climatic conditions. It can be cultivated by soft wood grafting and planted in the month of July-August. Weeding and thinning of the plants may be done as and when required usually after 15-20 days. The medicinal plants have to be grown without chemical fertilizers and use of pesticides. Organic manures like, Farm Yard Manure (FYM), Vermi-Compost, Green Manure etc. may be used as per requirement of the species. To prevent diseases, bio-pesticides could be prepared (either single or mixture) from Neem (kernel, seeds & leaves), Chitrakmool, Dhatura, Cow's urine etc. Normally grown as rainfed crop. Hence regular irrigations is not in vogue for grown up orchards. Harvesting is done in March-April. Fruits and Bark are removed and dried in shade. Ripe fruit 8.5 ton per hectare. Expenditure per ha. Rs.13,000/-. Return per ha. Rs. 47,300/- and Net income Rs. 34,300/- (Kampa, 2024). New plants are usually started from seed and cuttings, with cuttings from known female and male trees considered best practice to establish a good male to female ratio for successful pollination and fruit production. The seed are very slow to germinate, and seedling trees only start to flower and bear fruit at about seven to eight years old. Yields vary considerably but average around 12 kgs (26 lbs) of fruit per tree per year. Performs best on free- to slow-draining clay and loam soils of a moderately acid to neutral nature, generally with a pH of 5.0 to 7.5, and on sites with full to partial sun exposure. It has good tolerance to permanently wet or waterlogged soils (Yogish, 2024). Kokum is an important fruit /spice tree crop native to India. It is a crop of humid and tropical region.It can thrive well in extreme rocky to good lateritic soil, withstanding drought to water logging conditions. It bears fruits from April to June. Field should be ploughed thoroughly and pits of size 60 cu.cm should be dug out. After weathering, pits should be filled with top dug out soil along with 10kg FYM. Planting is normally done at the onset of

monsoon and due care should be taken so that the graft joint is at least 15 cm above the ground level. After planting, the soil around the roots is firmly pressed and the grafts have to be staked using two strong pegs and a rope. Grafts should be planted at a spacing of 5-6m between plants and rows.Seedlings can be planted at a spacing of 4 x 4 m spacing. Konkan Amruta and Konkan Hatis are two released varieties of kokum. Promising lines identified at ICAR RC for Goa are High yielders: Kharekhazan, Borim, Kasarpal, Parashte, Pednem Keri; and Early bearers: Savoi Kamini, Mashem, Hedode, Parashte, Pednem Keri, Gola (CCARI, 2024).

Bearing: The seedlings start flowering 7 to 8 years of planting whereas grafted plants starts flowering after 3-4 years. Generally kokum plant flowers during December to February depending on the climatic conditions. The fruits are harvested after about 120 days of fruit set. Kokum fruits are ready for

harvesting from the month of April to May. Generally a 15 year old seedling plant produces 30-50 kg fruits/ plant (Tripathi, 2021).

Shelf life: The shelf life of kokum fruits is 4-5 days under ambient temperature. It can be extended up to 28 days if stored at 13°C and 86% relative humidity (Tripathi, 2021).

Harvesting of Seeds: Fruits are collected manually by handpicking. The tree branches are shaken with long sticks and fallen fruits are collected. The fruits are broken by sticks to
separate the seeds, which are picked up by hand. Then the separated seeds are dried to reduce their moisture content (Handwiki, 2024).

Properties of Oil: Kokum oil or kokum butter is light gray or yellowish in color. After refining, the kokum fat is equivalent to vanaspati ghee. Kokum oil contains up to 60-65 percent saturated fatty acid, making it solid at room temperature, so this oil is known as kokum butter or kokum fat. Its triglyceride composition is uniform and consists of up to 80% of stearic-oleic-stearic (SOS) triglycerides. The butter melts readily on contact with the skin (Handwiki, 2024).

Uses of Oil: Kokum butter is non-greasy and gets absorbed into the skin once it is applied. It is often used as a substitute for cocoa butter due to its triglyceride composition. Kokum

butter also contains antioxidants and vitamin E. Kokum butter exhibits excellent emollient properties and high oxidative stability, which can assist emulsion integrity. With its relatively higher melt point, it melts slightly at skin temperatures, making it ideal for lipsticks and balms. It is also added in the making of bar soaps and skin lotions.[9] Kokum butter is also used to treat dry lips, chapped hands and soles of the feet (Handwiki, 2024).

Plant protection: Major diseases and pests are not noticed in kokum. Sometimes 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 (Haldankar et al., 2012).

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 C + 10 c and 86 per cent RH and Waxol 3 per cent. CFB boxes and paddy straw are good packaging material for kokum (Haldankar *et al.,* 2012). 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 (Korikanthimath and Desai, 2021).

Standardized Products from Kokum

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 (Thakor *et al*., 2012).

Kokum fruit juice is sweet and sour in taste and thus liked by many. In traditional method kokum rind is separated by removing fruit pulp and seeds. Equal quantity of sugar mixed with kokum rind in a wide mouth vessel. This mixture of sugar and kokum kept open for sun rays up to eight to ten days. In this process juice comes out from kokum rind and already sugar is mixed with juice. Filter juice and rind with help of a cotton cloth. This clean Kokum Syrup is to be filled in clean glass bottle. For long term preservation these filled bottles again kept on sun light for another ten days without capping. You have to cap the bottles at end of process (Chate *et al*., 2019). The products such as kokum syrup, salted kokum syrup and dried rind are traditionally prepared from rind of fruit and oil is extracted seeds in Konkan region of Maharashtra and coastal region of Karnataka. Dried rind is prepared by sun drying (Tripathi, 2021).

Kokum Aamsul (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 (Thakor *et al*., 2012). Aamsul is manufactured from the peel of the Kokum fruit. Aamsul is a fine ingredient in vegetarian dishes and curries for the sour taste (Chate *et al.,* 2019).

Kokum Juice or Kokam Sharbat: Basically, a healthy and refreshing cool drink or beverage prepared mainly from the kokum fruit or Garcinia Indica. it is a simple drink to prepare and involves preparing the concentrated kokum syrup for future use. later the syrup is diluted with water as per the preference and served with cold ice. The summer season can be daunting with the heat and humidity making it very uncomfortable for everyone. evidently, we resort to refreshing and chill juice recipes which can be either store-bought or natural and organic homemade recipes. kokum juice or kokum Sherbet is one such healthy recipe prepared with dry kokum fruit / fresh kokum fruit**.** There are a couple of juice recipes, that is nostalgic to me and kokum juice recipe and kokum fruit is one among them. I personally, big fan of kokum fruit and especially the sour leaves from the kokum tree. back then, my first preference was eating the fruit as it rather than converting it to juice and the consume it. moreover, even the leaves are edible and I used to love the combination of sour leaves with sweet ripe fruit. but things changed gradually and I hardly find any trees left now and we can only fetch these awesome fruits via stores. and most of the time it would be sun-dried which can only be used for juice and Rasam (Yogish, 2024).

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 (Thakor *et al.,* 2012). Health benefits of kokum juice are which is naturally cool and refreshing, can help prevent dehydration and sunstroke by hydrating the

body. In addition to improving the digestive system, it is utilised as a natural cure for a variety of stomach and liver conditions. Kokum juice, which is naturally cool and refreshing, can help prevent dehydration and sunstroke by hydrating the body. In addition to improving the digestive system, it is utilised as a natural cure for a variety of stomach and liver conditions. The Kokum fruit is used to make juice, which can be eaten year-round due to its digestive benefits. Kokum drink has Ushna (hot), Deepana (appetiser), and Pachan (digestion) qualities that serve to stimulate the digestive fire (Agni) and aid digestion. Kokum juice benefits the Property of antifungal and anti-oxidant- The antifungal and antioxidant properties of Kokum aid in the prevention of infections. As a preservative, the fruit is also an option. Kokum juice benefits a lot of nutrients-Kokum is a nutritional and vitamin powerhouse in the human body. carbohydrates, malic acid, and citric acid are all present in this food Ascorbic acid, manganese, potassium, dietary fibre, and garcinol are all found in this product, which is a good source of B-Vitamins. Kokum juice benefits for Digestion-When it comes to digestive disorders, Kokum may be able to aid. Kokum is an excellent remedy for conditions such as dysentery and constipation. Kokum juice benefits for Anti-ageing-Kokum's antioxidants aid in the improvement of hair and skin texture. It aids in cell repair and regeneration, making it an anti-ageing agent. Analgesic and anti-inflammatories-The excellent anti-inflammatory effects of Kokum are just one of its many health advantages. Sores can be treated with the fruit, or they can be applied directly to allergies, rashes, and burns to alleviate them.

Ayurveda-Kokum is used to treat cracked heels in Ayurveda. Pain associated with rheumatoid arthritis may be reduced by using this product. A wide range of ailments can be alleviated by taking Kokum supplements. These include ear infections, ulcers on the skin, menstrual delays, and intestinal parasites. Cholesterol control and weight reduction-Kokum drink is minimal in calories and has no saturated fats. Cholesterol levels are regulated by the health advantages of kokum in the body. Those with a cardiac condition can benefit from it. The fruit's anti-obesity properties help people lose weight by preventing fat from being produced. Kokum sharbat benefits are Thermodynamics-Because of its cooling characteristics, the kokum fruit is ideal for enjoying in the sweltering heat of summer. Dehydration and stroke are two common health problems that can be avoided with the use of kokum. Kokum sharbat benefits for Indigestion-Kokum juice relieves indigestion. Indigestion is defined as inadequate digestion in Ayurveda. Indigestion is caused by exacerbated Kapha, causing Agnimandya (weak digestive fire). Taking kokum juice improves Agni (digestive heat) and aids digestion. Kokum sharbat benefits for Diarrhea-In Ayurveda, diarrhoea is called Artisan. Inappropriate food, water, pollutants, mental stress, and Agnimandya cause this (weak digestive fire). These elements aggravate Vata. Kokum sharbat benefits for Immunity Booster-This fruit's anti-bacterial and anti-viral characteristics make it an important actor in the fight against bacterial and viral infections. This is true for both topical and oral use. Kokum sharbat benefits for Reducing Cancer Risk-Kokam is an antioxidant that protects against cancer. Its anti-carcinogenic qualities scavenge free radicals, protecting us against cancer (Singh, 2025).

Ready-To-Serve (R.T.S.)

The T.S.S. and acidity of different juice are observed, then required quantity of citric acid and sugar was added to raise its ^{0}Brix and acidity to 20^{0}Brix and 0.3 per cent respectively (Thakor *et al*., 2012).

Squashes: The T.S.S. are noted and further required of sugar are added to juice to raise its ^{0}Brix to 45^{0}Brix. Various parameters with the quantity required for Squash from Kokum (Thakor *et al*., 2012).

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 day 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 (Thakor *et al*., 2012). Kokum butter is obtained from the seed of kokum. It is a solid, stable hard butter. It is used in preparation of cosmetics, bar soaps and skin lotions (Chate *et al.,* 2019). Kokum butter is obtained from the seed of kokum. It is a solid, stable hard butter. It is used in preparation of cosmetics, bar soaps and skin lotions (Tripathi, 2021).

Kokum Beverages: Kokum extract is having approximately 4% sugar which can be fermented to produce high quality red wine. The extract from kokum fruit can be converted to many health beverages with addition of sugar (Chate *et al*., 2019).

Kokum Vodka Punch: This recipe is special as it was shared with me by my friend Gaurav Pandey. This cocktail is sure to kill your heat with a buzz. All you have to do is in a cocktail shaker add some chilled water, vodka and ice. After that add some kokum syrup to it. Squeeze in some lemon juice and add some salt, and shake well. Pour the cocktail into a glass and enjoy your summer evenings (Yogish, 2024).

Kokum Stings: Kokum Stings, a drink inspired from Pedro's jaunts to the sea, this concoction is a tribute to the beautiful jellyfish and love for Goa's favourite sour fruit (Yogish, 2024).

Wine and Kokum: Summer in India is famous for Kokum Sherbet. This drink is a flaming red fusion of sweet, spicy, and sour flavors made with lychee, kokum, roasted cumin, lime, and sparkling wine. The wine is added to bring the flavours together. Mix the ingredients well and serve it in a tall wine glass (Yogish, 2024).

White Rum Kokum: Try pairing kokum sharbat with white rum and you will see the magic happening. In a cocktail shaker add the kokum sharbat, white rum, ice cubes and crushed mint leaves. Shake the ingredients well. Garnish it with some fresh mint leaves (Yogish, 2024).

Gin and Kokum: In a cocktail shaker add some Gin, lime juice, kokum sharbat, rose syrup and salt. Shake the ingredients well. Add some ice cubes and mix the cocktail well. Pour it into a cocktail glass and garnish it with some dried rose petals (Yogish, 2024).

Frozen Kokum Margarita: Frozen margaritas are everyone's favourite. In a blender add some ice cubes, vodka, tequilla and kokum sharbat. Blend it until you it gets slushy. Make sure not to ver blend it as it may melt the ice. Pour the slushy margarita into a glass and freeze it for 10 minutes. Your frozen kokum margarita is ready to blow away your summer glooms (Yogish, 2024).

Fruits	**Peel**	**Peel**
Peel	**Dried Peel**	**Jam**
Juice	**Juice**	**Juice**
Syrup	**Lip balm**	

Fig. 3: Products

Flavor Complements: Purple mangosteen, cambogia, cochin goraka, elephant apple, mango, tamarind, tangerine, coconut, lime, lemon, kiwi, orange, grapefruit, pomelo, sweet lime, pineapple, butterfruit, bael, wood apple. Herbs, spices, and oil: green chili, coriander, rock salt, black pepper, cumin, turmeric, mustard seed, salt, lemon juice, limejuice, citrus rind, sugar, jaggery, coconut milk, coconut oil, vinegar, tamarind paste (Yogish, 2024).

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 (Haldankar *et al.,* 2012).

Storage: Keep kokum at room temperature and enjoy within a few days of ripeness. In the refrigerator, the fruits will keep up to one week. Do not freeze kokum, as their flavor and texture are adversely affected. Place dried Kokum in an airtight container to avoid moisture. Refrigeration is not required, as the fruit keeps for years on kitchen countertops (Yogish, 2024).

Risks (Ayurveda, 2024)

Pregnancy and Breastfeeding: Due to insufficient safety research, Garcinia is not recommended for pregnant or breastfeeding women.
Children: Due to safety concerns, it is not advised for those under 18 unless prescribed by a healthcare professional.

Gastrointestinal Issues: May cause mild digestive upset in sensitive individuals. Caution is advised for those with gastrointestinal conditions.

Diabetes and Hypoglycemia: Can affect blood sugar and insulin sensitivity. Consult a healthcare provider before use if you have diabetes or hypoglycemia.

Liver Disease: Potential liver toxicity in excess use. Those with liver conditions should avoid it or consult a professional.

Allergic Reactions: It may rarely cause skin rashes or other allergic symptoms. Discontinue use if allergic reactions occur.

Drug Interactions: Prescription medications for blood sugar, cholesterol, and liver function can interact. Consult a healthcare provider if you are taking medications.

Serotonergic Drugs: Use cautiously with serotonergic medications due to the risk of serotonin syndrome.

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