PRODUCTION TECHNOLOGIES OF KOKUM

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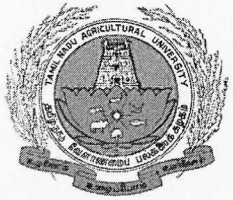

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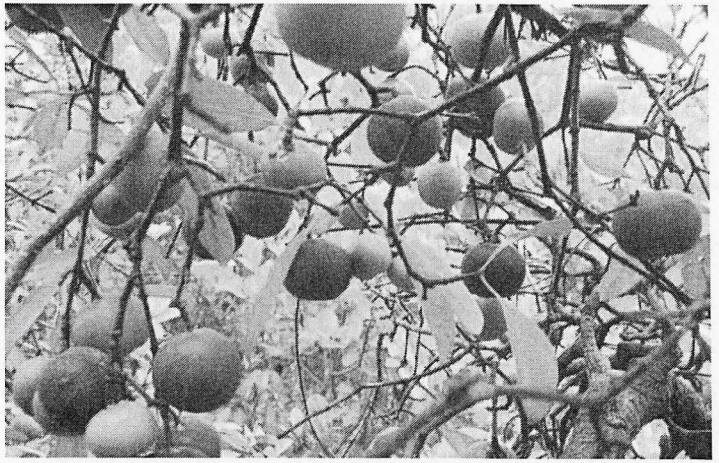
KOKUM (*Garcinia indica*) Family: Clusiaceae

Kokum indigenous to India, in which the sun dried rind of the fruits are the Kokum of commerce. It is an important tree spice mainly grown in the South Konkan region of Maharashtra, Western Ghats, Coorg, Wynad, Goa, evergreen forests of Assam, Khasi and Jaintia hills, West Bengal and Gujarat. Kokum plant grows widely in the tropical forests of Western Ghats of India. In the Konkan region, kokum trees are scattered over backyards, river and stream sides, waste lands and also in coconut and arecanut gardens. No reliable statistical information is available as to how much kokum is available in India. However, in the konkan region alone about 4,000 t are produced. A survey report has indicated that Western Ghat region contains about 15 lakh trees.



Kokum fruit has several uses. It serves as a flavouring substitute and is being used as a fish preservative. It contains substantial amount of malic acid

and very small quantities of tartaric and citric acids. The ripened rind and juice of kokum fruit are commonly used in culinary for preparing 'Solkadi' which is a house hold preparation in Konkan region. Kokum syrup popularly called as 'Amrit Kokan is commercially prepared from ripened fresh fruits and the syrup has potential demand in the market. The dried and salted rind (Ansol) is being used as spice in curries. Kokum seeds also have good commercial value. The kokum fat popularly known as "kokum butter' is being prepared from seed kernels. The seed contains about 32 to 35 per cent fat. It is edible, nutritive, demulcent, astringent emollient. Kokum fat is also used for local application to ulcerations fissures of lips, hands etc. It is used in pharmaceutical preparations and cosmetic products. Most of the kokum fat produced in the country is exported to Netherlands, Italy, Japan, Singapore, UK a Malaysia. Kokum fat has been reported to be used in chocolate and confectionery preparations. It is also used in the manufacture of soap, candle and ointments. Kokum rind is the richest source of natural red pigment (Anthocyanin, 2-3 %). A new fat soluble yellow pigment, garcinol has been isolated from the fruit rind.

Growth Habit

Kokum is a slender, evergreen tree with drooping branches which attain a pyramidal shape on maturity. Kokum is said to be dioecious, but seems to be highly variable in sex. Flowers are axillary or terminal, solitary or fascicled having 2 to 8 buds. Bud is 1.4 to 1.6 cm long and 0.7 to 0.8 cm broad. Flower is tetramerous and hypogynous. The calyx is sepaloid, consisting of four sepals arranged in decussate pairs, the inner pair being

broader than the outer one. The corolla consists of four petals slightly larger than sepals and yellow to pink dorsally and dark pink ventrally. The male flower has generally long pedicel and numerous stamens forming short capitate column or collected in a ring surrounding the rudimentary pistil. Anthers are oblong, on short thick filaments, adnate, four celled and very rarely two celled. The female flower has short pedicel, staminodes are arranged in four tufts and very rarely in two tufts round the pistil. Stigma is sessile, radiate, each ray with two lines of tubercles. Ovary is two to eight celled, ovules solitary with axile placentation. The bisexual flower has long pedicel, four tufts of stamens surrounding the pistil. The stigma is sessile or sub-sessile. The flower is morphologically analogous to the female flower.

Anthesis occurs mainly between 6 am to 8 am. Anthers dehisce just before anthesis. Stigma attains maturity one day before anthesis (12%) and the receptivity remains (80%) on the day of anthesis. Hand pollination resulted in 78 per cent and open pollination (natural cross) gave 68 per cent fruit set.

Flower types: Different flower types were observed based on the function of the pistil and the stamen and are classified into 11 distinct types.

Sex types: The trees could be designed into the following types on the basis of preponderance of particular type of flowers and the bearing tendency of individual tree.

Tree type-I-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: The young fruits produced in such trees 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: The 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. The 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.

Crop Improvement

Among 36 Kokum genotypes maintained and evaluated at Ratnagiri, five promising selections viz., S1, S3, S8, S11 and S14 were identified and growth, flowering, fruiting and quality aspects were studied. The Kokum types varied considerably. Variation in height was 6.75 to 10.40 m whereas the crown volume ranged between 29.74 and 111.56 m^2v^3. The flowering initiated during October-November. The fruit retention ranged between 10 and 26 per cent. Harvesting period required was 78 to 91 days. Variation in fruit shape ranged from round to pear shape. The fruit parameters also varied considerably. The average weight of fruit ranged between 28.10 and 34.95 g. All the kokum types varied remarkably for yield. The average yield after seven years ranged from 29.00 to 138.28kg.

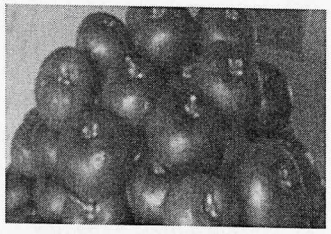
Varieties

'Konkum Amritha' is a clonal selection which is early bearing and having short harvesting period (78 days). The yield is high (138.28) with medium

sized fruits (34.45 g) having rind of 17.55 g. Filled seeds were 3.55 per fruit. This variety is a pure female.

There are two released varieties of kokum (Konkum Amruta (S-8) and Konkan Hatis). However, there are other high yielding and early fruit bearing cultivars available in the Indian market.

Konkum Amruta (S-8)

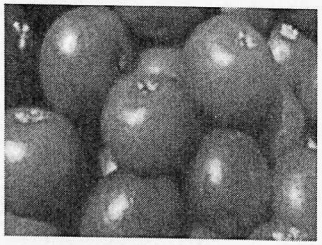


Year of release: 1997

Yield (q/ha): 135kg/tree

Salient features: Early types, requires minimum number of plucking, long shelf life of fruits, apple shape fruits

Konkan Hatis

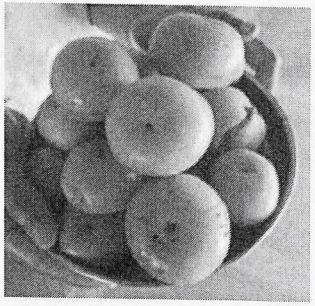


Year of release: 2005

Yield (q/ha): 250kg/tree

Salient features: High yielding (250kg/plant), Bold size fruit (91.59g), thick rind.

Yellow kokum



A unique variety of kokum in Uttara Kannada dist. It is locally called as bili murugalu though the colour is yellow. It is belived to posses more medicinal properties. Skin will turn yellow at the time of ripening.

Kokum is one of the important non timer forest produces (NTFPs) collected from the western ghats of Karnataka. Variety Konkan Amritha was developed by clonal selection. This variety is considerably early having short harvesting period (78 days) with a few plucking. The yield is high (138.28kg) with medium sized fruits (34.45g) having rind of 17.55g. filled seeds were 3.55 per fruit. This variety is a pure female.

High yielders: Pednem Keri 1, Kasarpal 5, Kharekhazan 1, Borim 2 and Parashte 3.

Early fruit bearers: Gola 17, Savoi Kaminil, Mashem 4, Hedode 1, Parashte 3, Pednem Keri 1 and Hedode 1.

Crop Production

Soil and Climate

Kokum tree is very strong and sturdy in growth. It grows on a wide range of soils, from marginal to deep alluvial, which are well drained. Lateritic soils of the Konkan belt are very much suitable for its cultivation. Soils having good moisture retention capacity are the most favourable ones. The most favourable regions for kokum cultivation are warm and moderate humid zones. The temperature ranges from 20°C to 35°C, 60 to 80 per cent humidity, well distributed annual rainfall ranging from 2500 to 4000 mm seem to be ideal for this crop. Extreme acidity is harmful to the crop.

Propagation

Seed

Propagation of Kokum by seed is the prevailing practice. For raising of seedling, bigger sized fresh seeds from high yielding and regular bearing

plants should be cleaned with water and then sown in polythene bags (12.5 x 20.0 cm) containing potting mixture. Two days prior to sowing, seeds should be soaked in water, which gives early and better germination (up to 90%). One year old seedlings should be used for planting in the field.

Vegetative Propagation

Soft wood grafting technique has been found successful. October was the best season for soft wood grafting and grafts could be successfully maintained either in glass house or under open sun. The mature scion stick of 5-6 months age can be preferred for soft wood grafting. Pre curing is not a pre requisite for soft wood grafting in kokum. The age of root stock should be more than 22 weeks. The retention of leaves on rootstock did not influence success of grafting. The length of scion stick from 2.5 cm to 15 cm did not exhibit any significant influence on survival of graft. The scion stick could be stored successfully in poly bag or sphagnum moss for seven days. To achieve maximum percentage of survival at the establishment stage, grafting operation should be performed in situ.

Sexual Propagation

Kokum fruit generally contains 4 – 8 seeds. For propagation seeds are collected from fully ripe fruits of early and high yielding kokum tree, having good quality. Seeds are extracted and spread on floor under shade. The seeds are allowed to soak in rains for germination. Pre sowing treatment of seed with wet packing or drying with coal ash is recommended for good germination. The seeds can be sown on raised bed or in polybag. Seed germination is not a hurdle in kokum. The seeds germinate without any

treatment. 90 to 100 per cent seed germination is reported in kokum. However, the seed treatments such as soaking in water, cycocel 500 ppm have shown promise. After germination the seedlings are transplanted in polythene bags of 10 X 15 cm size containing potting mixture of soil and FYM in the ratio of 3:1. The initial growth of kokum seedling is very slow. For planting in the field, 12 – 14 month old seedlings are preferred. The experience of farmers suggests that bigger size seedlings suffer less mortality in the field.

Removal of Male Plants

The kokum plant is dioecious in nature. If orchard is established by using seedlings, only after flowering, the male and female plants can be identified. It is advisable to remove excess number of male plants. For ensuring adequate pollination, better fruit set and higher yield, it is desirable to maintain 10 per cent male plants in the orchard. By top working technique, the extra male plants can be converted into bearing female plants.

Planting:

Kokum can be planted as a monocrop or as a mixed crop in coconut and arecanut plantation and can also be planted in a kitchen garden. Considering the growth habit spacing of 6 X 6 m is recommended for sole plantation of kokum. In an established coconut plantation planted at 7.5 to 8 m spacing, Kokum can be planted in the centre of 2 coconut palms. 300 kokum plants can be accommodated per hectare as a mixed crop in coconut plantation. Planting of kokum as mixed crop has proved to increase the coconut yield by 34 per cent. In an arecanut plantation planted at 2.7 X 2.7 m,

kokum can be planted at the alternate centre of four arecanut palm planted. When grafts are used for planting the spacing can be reduced to 5 m. While planting in kitchen garden, kokum should be planted at least 4 to 5 m away from other tall plants. A pit of 60 cm3 is prepared before monsoon and filled with a mixture of top soil, 10 kg FYM and 1 kg Single Super Phosphate. When grafts are planted, periodical removal of suckers below graft joint is essential.

Age of planting material: One year old seedling or grafts.

Field Preparation and Planting

Before planting, all bushes, trees and stumps should be removed. Planting should be done at 6 m x 5 m spacing (333 plants/ ha). Pits of size 60 cm x 60 cm should be dug out. The pits should be filled with well decomposed farm yard manure and soil. Sevin @100 g/pit should be mixed in soil to protect the young plants from termites and also 1 to 1.5 kg single super phosphate per pit should be mixed in soil while refilling the pits. Planting should be carried out with the onset of monsoon. Strong and healthy seedlings year old grafts should be used for planting. Immediately after planting or one staking should be given.

Weeding:

Weeding as and when required to keep field clean.

Irrigation:

Irrigate once in 5-6 days. It helps for better establishment of garcinia plant. Initially 15 L of water per week in winter and twice a week in summer

is advised in Konkan region of Maharashtra. Mulching helps to retain soil moisture. The weed near plant should be removed and used for mulching.

After care

The young plants should be provided with partial shade in winter and summer months and should be irrigated at least once in a fortnight during winter and summer months, for better establishment in field. Orchard should be kept clean by removing weeds, grasses and bushes. Adequate supply of moisture in soil helps the bearing trees for producing higher yield.

Manures and Fertilizers

The farmers do not generally manure Kokum trees, and hence production is very low. As the kokum tree is an evergreen plant and survives for many years and yields every year, it should be manured regularly for healthy and vigourous growth and for higher yield.

For one-year-old plant, 5 kg FYM or green manure and 50 g N, 25 g P_2O_5 and 25 g K_2O per tree every year. For ten year old onwards, 5 kg FYM or green manure, 500 g N, 250g K_2O should be given per year. The fertilizers should be applied in the month of August after heavy rains are over. A circular trench of size 30 cm depth and 30-45 cm width should be dug out below the tree canopy. The manures and fertilizers should be incorporated in the trench and refilled with soil.

Intercrops

Rainfed crops like cucurbitaceous vegetables, okra, sweet potato, etc. can be successfully grown in between two rows of kokum.

Crop Protection

There are no serious diseases or insect pests damaging the plant. Among insect pests, leaf miner is important, which causes damage to tender leaves. Spraying with 0.03 per cent phosphomidon or 0.03 per cent dimethoate are effective for its control.

Insect pests

Insect	Symptom	Monitoring
Red-banded thrip (*Selenothrips rubrocinctus*)	Infests flowers and damages the fruit skin, leaving a brown rusty appearance on the fruit	Monitor newly emerged flower panicles for thrips on 10-20 trees/ha with a x 10 handlens. If 50% of trees have thrips spray with registered chemical. Critical monitoring period is prior to flowering
Fruit-spotting bug (*Amblypelta lutescens lutescens and Amblypelta nitida*)	Insects cause damage by feeding on newly developing fruit and foliage. Feeding damage can be seen as black / brown sunken spots on the fruit and leaves	Spot spray affected trees with registered chemical if damage is observed
Larvae of leaf webber (*Pyralidae*)	Chewing damage to foliage, flowers and fruit	• Not normally needed • Spray with *Bacillus thuringiensis* if fruit damage is observed

Insect	Symptom	Monitoring
Red shouldered leaf beetle (*Monolepta australis*)	Chewing damage to foliage, flowers and fruit	Spot spray trees with registered chemical if beetle numbers are higher then 10 adults
Flat mite (*Brevipalpus* sp.)	• Leaf damage • Mottling of foliage • Defoliation in severe cases	Not needed in north Qld
Citrus mealy bug (*Planococcus citri*)	Sap sucking honey dew producing insect which can cause sooty mould on the fruit and leaves. Usually farmed by ants.	Control ants and release the mealybug predator *Cryptolaemus montrouzieri*
Green tree ant (*Oecophylla smaragdina*)	Farms citrus mealybug and are very territorial and aggressive if disturbed making harvesting of fruit difficult. These insects will web the fruit together to protect mealybug colonies	Inject ant nests with appropriate registered chemical
Larvae of the *Tortricidae* moth.	Chewing damage to foliage flowers and fruit	• Not normally needed • Spray with *Bacillus thuringiensis* if fruit damage is observed

Disease

Kokum is relatively free from pests and diseases. The major insect pests are the leaf eating insect (*Stictoptera* sp) which feeds on the young leaves and shoots, the leaf miner (*Phyllocnictis citrella*) which bores into the leaves, and beetle which lays eggs on the fruit and its larvae feeds on the flesh and seeds. The first two insect pests can be controlled by using Methamidophos and Fenthion, while the third, by destroying all infested fruits. The diseases include canker (*Zignoella gorcirea*), which affects the branch resulting in defoliation and death of the tree, and pink disease (*Corticium salmonicolor*) that infects the trunk and branch causing wilting and leaf drop.

Disorder/disease	Symptom	Control procedure
Gamboge/gummosis	• Yellow exudate on fruits and branches	• Avoid injury • Avoid fruit dropping on ground during harvest
Translucent flesh	• Flesh becomes watery translucent - inedible	
Pestalozzia blight and stem canker (*Pestalotiopsis* sp. associated)	• Branch splitting • Gummosis and blistering • (Especially during stormy and windy conditions)	• Spray with copper oxychloride • Sun protection essential • Plant windbreak early

Disorder/disease	Symptom	Control procedure
Pink disease (*Corticium salmonicolor*)	• Infected area (stem/branch) covered with pink mycelium • Wilting of leaves and shoots	• Proper and appropriate pruning • Spray with copper oxychloride

Physical and Physiological disorder: A major physiological problem called "gamboge" is evidenced by the oozing of latex onto the outer surface of the fruits and on the branches during periods of heavy and continuous rains. Fruits exposed to strong sun may also exude latex.

Gamosis also occurs inside the fruit whereby the affected fruits become harden and the flesh tastes bitter. In most instances gamosis is the result of physical injury thus affecting eating quality. For example, mangosteens produced in Honduras often have crystal-like "stones" in the flesh and they may render the fruit completely inedible.

In another situation, fruit-cracking may occur because of excessive absorption of moisture. In cracked fruits the flesh will be swollen and mushy. Bruising caused by the force of storms may be an important factor in both of these abnormalities. Mangosteen fruits stored at low temperatures result in hardening of the pericarp. This condition reduces acceptability of the fruits due to difficulty in opening them.

Problems and prospects

(i) Pressures on land, (ii) size reduction of holdings and (iii) the popularization of tree spices and coconut in homesteads have, over the years, pushed Garcinia and many other useful plants to the background of our agriculture. Further (iv) variations in yield, (v) the dense shade of foliage and (vi) the belief that it is a heavy feeder, tends to make farmers regard this crop as a liability.

Harvest and Yield

Kokum seedling raised tree commences bearing after 7 to 8 years of planting whereas grafted tree starts bearing 5 to 6 years of planting. Flowering starts from October-November and continues upto February under the agro-climatic conditions of the Konkan region. Harvesting of fruits commences from March and continues upto the first fortnight of June. The peak period of harvesting is April-May. At fruit maturity, colour changes from green to red. The ripened fruits are harvested frequently by using harvester.

Yield potential in different kokum genotypes ranged from 30.60 kg to 173.00 kg per tree per year with the productivity of 9.27 t to 51.90 t per ha. It shows that there is tremendous yield potential for the multipurpose fruit crop. Further, the establishment of kokum orchard with vegetatively propagated trees (grafted) is ideal and most beneficial from the view point of higher yield and returns.

Post harvest Handling and Processing

Grading/Standards

No standards have yet been laid for kokum under the Agmark, ISI or PFA.

Composition

The composition of fresh kokum rind comprising 50-55% of fruit is as follows:

All values are in percentages on 'moisture free basis'

Moisture: 30%; protein (N: 6.25) 1.92; crude fibre: 14.28; total ash: 2.57; tannins (polyphenols): 2.85; pectin: 5.71 per cent; starch 1.00 per cent crude fat (hexane extract): 10.00; total acidity (as hydroxy-citric acid): 22.80; pigment (total anthocyanins): 2.40 ascorbic acid: 60mg/100g (0.06%); carbohydrates (by difference, excluding starch and pectin): 36.40.

Kokum seeds (comprising 8-10 per cent of the whole fruit) contain about 25-30 per cent fat which is greasy and whitish yellow.

Packaging and Storage

It is packed in cardboard boxes. The life of fresh fruit is about 5 days at room temperature. Hence, sun drying is practiced for its longer storage/ preservation.

Processed products

Kokum of Commerce

For sun drying of kokum rind, the fresh fruits are cut into halves and the fleshy portion containing seeds (8-10 per cent) is taken out. The rind constitutes about 50-55 per cent of the whole fruit. The rind contains about 15 per cent acid (hydroxy-citric acid). The kokum of commerce is prepared by sun drying the rind (skin) of the ripe fruits after repeatedly soaking it in the juice of the pulp. The product so dried constitutes as the unsalted kokum of commerce. Sometimes, after treatment with common salt during soaking and drying, the salted kokum is produced. About 6-8 days are required for complete sun drying. Kokum seed is a good source of fat (about 25-30 per cent), which is known as 'Kokum butter' in commerce and is described as follows.

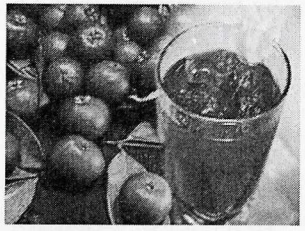
Kokum Butter

The seeds of the fruit yield (25-30 per cent) fat on the basis of weight of seeds or about 45 per cent on the weight of kernels, it is a valuable edible fat known in commerce as 'kokum butter'. It is extracted mostly on a cottage industry basis by crushing the kernels, boiling the pulp in water and skimming off the fat from the top; or by churning the crushed pulp with water. Nowadays, oil is obtained by solvent extraction of seed-kernels (after decortication of seeds) in mechanical or motorized decorticators.

The characteristics of the fat are: refractive index at 40° C: 1.4575; saponification value: 187-191.7; iodine value: 25-36; unsaponification matter: 2.3 per cent; RM value: 0.1-1.0; and melting point 40-43° C.

Stearic Acid from Kokum Fat

Kokum butter, like other Garcinia fats, is rich in combined stearic and oleic acids. It contains about 75 per cent of mono-oleo disaturated glycerides. A method has been developed for the production of stearic acid from the fat with a yield of 45.7 per cent.



Kokum Syrup

Kokum syrup is prepared from kokum pulp/juice by mixing sugar and water and is used in medicine.

Kokum Concentrate

A process has been standardized at the CFTRI, Mysore, for making kokum concentrate which, like tamarind concentrate, can be used as an acidulant in various food preparations, curries, chutney, etc.

Kokum Rind

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.

Kokum Rind Acid

The isolation of the hydroxy- citric acid (15 per cent) in the pure form has been carried out on a small scale. Scaling up of the process is in progress at the CFTRI. The pure acid finds a potential application in medicine.

Kokum Colour

Kokarn rind contains 2-3 per cent anthocyanin pigments, which constitute a promising source of natural colour for acidic foods. The process for extraction of colour and purification of the colour pigment concentrate for colouring of foods and beverages has also been standardized at the CFTRI, Mysore.

Ointment for Treating Carbuncles

An ointment made out of kokum fat, 'white dammar resin' (exuded by *Vateria indica* tree) and wax is said to be effective in treating carbuncles.

Gamboge

The commercial gamboge is a resin prepared from kokum rind, which was used extensively in the past in paints and varnishes.

Uses

As Food Flavourant

The fruit has an agreeable flavour and a sweetish acid taste. It is traditionally used in Konkan area, chiefly in the form of kokum prepared by

drying the outer rind, soaking it repeatedly in the juice of the pulp and sun-drying it. Kokum contains about 10 per cent malic acid and a little of tartaric or citric acid. It contains 15 per cent hydroxy-citric acid. It is used as a garnish to give an acid flavour to curries and also for preparing cooling syrups during hot months. Kokum is reported to have been imported earlier into Zanzibar from India during sixties. Besides, Italy and other foreign countries are also importing kokum butter from India for use in confectionery.

In Medicine

The fruit is anthelmintic and cardiotonic and useful in piles, dysentery, tumours, pains and heart complaints. Syrup from the fruit juice is given in bilious affections. The root is astringent.

As Kokum Butter

Kokum butter is considered nutritive, demulcent, astringent and emollient. It is suitable for ointments, and other pharmaceutical purpose. It is used as a local application to ulcerations and fissures of lips, hands, etc. Kokum butter, as sold in the market, consists of egg-shaped lumps or cakes of light grey or yellowish in colour with a greasy feel and a oily taste.

Adulterant Tree Spices - Kokum

Edible fat; it is also used as an adulterant of ghee. As ordinarily met with, it contains seed particles as impurities. Refined and deodorized fat is white and compares favourably with high class hydrogenated fats. Kokum butter is suitable for use as confectionery butter. However, as it solidifies

with a rough surface, addition or blending with another fat is necessary to correct the defect. It is also suitable for candle and soap manufacture.

Chemical Constituents

The dried rind of kokum (*Garcinia indica*) fruit contains three important constituents, viz. anthocyanin pigments, hydroxycitric acid and garcinol. Garcinol, a polyisophenyl phenolic pigment, is present to the extent of 2-3 per cent in the dried rind of kokum.

Future Strategies

Mass multiplication of elite planting materials should be taken up on up on priority by resorting to softwood grafting as well as approach grafting and micro-propagation. Possibility and prospects of cultivation of Kokum as a mixed crop with cashew, arecanut, coconut etc., which is an important commercial plantation crop. Concerted efforts are needed to establish large-scale commercial plantations. Kokum based soft drinks need to be popularized among international and domestic tourists alike as health drink.