



Research Article

KOKUM (*GARCINIA INDICA*) - ITS STATUS, PROBLEMS AND PROSPECTS OF CULTIVATION AND PROCESSING

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Abstract: The Kokum tree has great potential in commercial cultivation. This very useful and beautiful tree is ideal for planting in parks and gardens, roadsides and in the compounds of houses and public institutions. The organoleptic analysis results revealed that the carbonated kokum was tastier and highly refreshing than the normal kokum drink.

Keywords: Kokum (*Garcinia indica*), Organoleptic analysis

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Introduction

G. indica Choisy (Syn. *G. pumila*) is a beautiful evergreen tree popularly called 'Kokum', found in the Western Ghats, along the west coast of Konkan, Goa, Karnataka and north Malabar. The tree reaches a height of about 10-15m. Its dark green foliage, drooping branches and pyramidal shape make this slender tree very graceful in the forest or garden. The tree comes to bloom after about 7-8 years of general pre-bearing period during November to February and fruits ripen in April-May. The fruit-bearing tree is very attractive. The fruits are usually deep purple to pink, occasionally yellow in colour (called white-kokum). The size of the fruits varies from 25-60 g. Fruit with 85g are also found rarely. Each fruit contains up to eight seeds. About 700g seeds are obtained per kg of fruit. The seeds yield about 23-26 percent oil, which is called as 'Kokum butter'. It is an important species that has culinary, pharmaceutical and industrial uses. The fruit rind is used in preparation of syrup, which is used in production of popular drink 'kokum juice'. The kokum butter remains solid at room temperature and is used in the preparation of chocolates, skin care medicines, cosmetics, etc. A group of scientists from Indian Institute of Science, Bangalore have also found that it is possible to solidify petrol using a compound extracted from kokum butter and are in the process of patenting their findings. The fresh fruit rind contains anthocyanin (2-3%), which is a natural food colour. The natural colour obtained from its fresh rind is stable under acidic conditions hence suitable for food prepared in acidic medium. There is good demand for this natural colour in European market. The unique environmentally friendly characters and non-toxic nature of its products have opened new avenues for export also.

(-)-Hydroxy citric acid [(-)-HCA]:

The dried rinds of the species are reported to contain (-)-HCA up to 37.4 percent. The (-)-HCA is proved to be an alpha-hydroxy tribasic acid. It is chemically 1, 2-dihydroxypropane-1, 2, 3-tricarboxylic acid. Being a gamma-hydroxy acid, it cyclizes readily to the corresponding lactone [1]. It is found that (-)-HCA strongly inhibited fatty acid synthesis in living systems. Fatty acid and cholesterol synthesis were blocked significantly in test animals which were given (-)-HCA [2]. The (-)-HCA lowered body fat level with no loss of body protein or lean mass in test animals that had been experimentally made obese [3]. It inhibits lipogenesis, lowers the production of cholesterol and fatty acids, increases the production of glycogen in the liver, suppresses appetite, and increases the body's production of

heat by activating the process of thermogenesis [4]. It is found to be a potential dietary supplement for weight loss and appetite control. Industries are extracting (-)-HCA from the rind of the fruits. Several products of (-)-HCA like Citrin, Citrimax, Garcinia spray, Garcinia puff, Garcinia soap, etc. are available commercially in the market [5]. They are gaining popularity as drugs for weight loss [6]. Stable salts of calcium or potassium of (-)-HCA has become an important export commodity in India [7]. Garcinol, a derivative of *G. indica* has interesting features of cancer management. In the world, the Indian and the Tai people have the lowest overall rates of cancer. The total area in which the species is spread is about 1200ha [8]. On an estimate about 8,000-10,000 tons of kokum dried rind is produced annually in Karnataka alone. When kokum trees were abundant in Western Ghats, native people used to extract butter in every household from its seeds by crushing and boiling in water for a long period. It is a cumbersome process only aged people used to prepare this. The butter was used in food preparations like in Dosa, Sweets, etc. that used to give characteristic odour to dosa. Apart from this, butter has very good medicinal property, mainly for diarrhoea and dysentery. Now the preparation of kokum butter locally is stopped due to its difficult process of extraction. In Uttara Kannada district of Karnataka alone an estimated 500 quintals of seeds are collected every year. It is mainly used for local pharmaceutical industries in preparation of skin care ointments. In spite of its multifarious usage the crop could not attain commercial status. The reasons may be,

1. No organized production of kokum from the cultivated sources is available. Only wild collection is being done from wider area and hence the cost of production is increased.
2. Very short period of fruit ripening (about six weeks) in a year. The collection and processing of large quantity is very difficult as the fruits are highly perishable and are acidic in nature. This will discourage the manufacturers who are normally small entrepreneurs.
3. The refreshing drink prepared by fresh fruits is highly superior to the RTS prepared by the dried rinds. The preference for the latter is less though the drink is superior to many synthetic drinks.
4. This natural drink is little known to the people out of western ghat region hence the demand is regional and seasonal and did not attract the bigger manufacturers.

- Being the crop of hilly area, the transport of fruits to bigger market is difficult and also cost of transport is high. Labour scarcity, high wage rate adds to the woe.
- Un-organized market, season bound production, poor research back up are the other problems in the business chain.
- Non-availability of planting materials of high yielding varieties for commercial plantations to be established.
- Manual harvesting by climbing trees is tedious and a skilled and life-risk job. In many cases the fruits will be wasted without harvest.

Furthermore, the plant has certain inherent limitations due to which there is slow development in harnessing its full potential.

- Dormancy of seeds.
- Slow growth of seedlings.
- Long juvenile period of about 8-10years.
- Lack of reliable method of propagation.
- No large scale availability of genuine planting materials.
- Dioecious nature of the crop.
- Yield variation in seedling population.

There are several attempts made to address these problems in order to make the crop more viable and attractive.

Research achievements made so far

Survey and Evaluation of genetic variability

The collection and conservation of *Garcinia* sp. is reported from Agricultural University and also NBPG regional station in Kerala. However, the extensive literature survey revealed that some efforts are being made in *G. indica* at Konkan Krishi Vidya Peetha, Vengurle (Maharashtra) where 36 high yielding early types are evaluated [9]. Five promising selections studied further and among them S8 exhibited consistently high yields over seven years with a short harvesting period (78days) and minimum number of harvests (3nos.), highest average weight of 34.45g. Fruits also had the longest shelf life of 15 days. A sample survey was conducted during 2002-03, in Western Ghats of Karnataka and parts of Kerala to study the diversity for morpho-economic characters in this species. An extensive survey was conducted in Western Ghats of Karnataka to study the diversity for morpho-economic characters and (-)-hydroxycitric [(-)-HCA] content in *G. indica*. Wide morphological variation was observed for fruit shape, colour and size. Varied shapes like round, flat, pear shaped with or without prominent navel fruits were seen. Fruit colour varied from dark red to crimson and also pure yellow. Other fruit characters also showed significant variation. They were, horizontal fruit diameter (3.22-4.90 cm), vertical diameter of fruits (2.78-4.74 cm), fresh weight of fruit (16.24-51.00 g), fresh weight of rind (9.40-26.22 g), number of seeds per fruit (2.60-7.00), fresh weight of pulp (6.04-26.56 g) and dry weight of rind (1.52-4.54 g) (Table 1) [10].

Table-1 Quantitative Characters in *G. indica* collections

SN	Character	Range	Collection No.
1	Horizontal fruit dia. (cm)	3.22 - 4.90	GIDG-8-GIDG-1
2	Vertical dia. (cm)	2.78 - 4.74	GIDG-8-GID-2
3	Fresh weight of fruit (g)	16.24 - 51.00	GIDG-8-GID-2
4	Fresh weight of rind (g)	9.40 - 26.22	GID-14-GIDG-1
5	Fresh weight of pulp (g)	6.04 - 26.56	GID-16-GID-25
6	No. of seeds per fruit	2.60 - 7.00	GIDG-8-GIDG-13
7	Dry weight of rind (g)	1.52 - 4.54	GIDG-8-GID-2

Yellow kokum: It is a unique type of kokum, mainly found in Karnataka (particularly Uttar Kannada dist.) kokum belt. It is normally called as 'bili murugalu' (white kokum). Though it is called as 'white kokum', but its rind colour is yellow. About 10-12% of the total population of kokum is yellow fruited type. The trees of white kokum are comparatively lower in height. It is believed that the fruits of this type are superior in medicinal properties. The survey of kokum population of U. Kannada and Udupi districts of Karnataka was undertaken and it revealed that out of 40 promising samples evaluated, a sample from Udupi district showed promising results for fruits and seed qualities [11].

Table-2 Variability in fruit and seed quality characters

SN	Character	Range	Mean value
1	Fruit length (cm)	2.43-4.91	3.37
2	Fruit width (cm)	2.8-4.90	3.44
3	Seed length (mm)	19.63-12.63	15.98
4	Seed width (mm)	11.23-6.73	9.51
5	100 seed weight (g)	87.9-28.91	50.6
6	Oil content (%)	23.73-12.25	16.36

They concluded that the sample no. CPTDK -31 was superior for fruit, seed and seed oil qualities.

Variability for (-)-HCA content

The chemical analysis of fruit rind through HPLC revealed that the (-) -HCA content ranged from 7.0 to 13.0 percent among higher fruit yielding trees. The lactone content was 4.9 to 10.5 percent and citric acid content ranged from <0.1 to 2.8 percent. In the case of white fruit rind type (-) -HCA content ranged from 9.0 to 11.9 percent. Among general collections the (-) -HCA content was in the lower range (6.5-11.5%); however there was no much difference in lactone (5.0-9.4%) and citric acid (<0.1-2.7%) contents.

Table-3 Qualitative characters in *G. indica* collections

SN	Character	Range	Collection No.
In Red fruit type			
1	(-) - HCA content	7.0 - 13.0%	GIDG-9-GID-15
2	Lactone content	4.9 - 10.5 %	GID-9-GID-24
3	Citric acid	<0.1 - 2.8%	GID-20, 21- GID-2
In white (yellow) fruit types			
1	(-) - HCA content	9.0 - 11.5%	GIDW-2-GIDGW-2
2	Lactone content	7.2-9.1%	GIDW-2-GIDW-1
3	Citric acid	0.8-1.6%	GIDW-2-GIDGW-2

The results also showed that there was no significant variation in major constituents between red and yellow types. There is lot of variation in the yield of fruits of wild grown plants due to dioecious nature. Male, female and hermaphrodite flowers are produced and they reproduce invariably throughout-breeding. Therefore, it is suggested to maintain 20:1 female to male population in the commercial gardens to maintain uniform yield. The DNA extraction from the leaves has been standardized through RAPD analysis in order to study the diversity in selected types [12]. A high fruit yielding variety 'Konkan Amrita' is developed through selection. It is early maturing with average fruit yield of 138kg/tree. Average fruit weight is 35g and has good shelf life [13]. Recently, a bold fruited type with increased shelf life, 'Konkan Hatis' is released from BSKKV, Dapoli [14].

Konkan Amrita: This is the first improved variety released in this crop. The flower initiation takes place during the 2nd week of Nov. and first harvesting can be taken up during the first week of March. March-April will be the harvesting period. On an average about 138kg fresh fruits can be harvested having the average individual fruit wt. of 34.5g. The rind thickness will be about 4.5mm. The shelf life of the fruits is 15days.

Konkan Hatis: This is recently released variety with big fruited type. The flower initiation starts from the 2nd week of Dec. and the first harvesting will be expected from 2nd week of April. The harvesting period will be between April-May. Average yield of fruits is about 250kg with the average individual fruit size of 91.5g. The fruit rind thickness is about 5.6mm. The shelf life is around 18days.

Standardization of propagation

Two vegetative propagation methods, air layering or grafting on to 'rajapuli' (*G. tinctoria*) root stocks (3-month old seedling) were tried. No plants were produced through layering and about 66% success had been reported through grafting [15]. Grafted plants in Kokum will have several advantages:

- Tree size (dwarf plants) and shape can be regulated
- Variation due to out-breeding will be minimized, as it is difficult to identify only female/hermoprodite types at seedling stage.
- Pre-bearing age will be reduced considerably; plants start yielding from 3rd year onwards.
- High density planting can be followed.

Softwood grafting is made in individual trees and ex-situ gene bank is established. Initial 70% graft success is observed [12]. Grafted plants with the roots stocks of different related species will be of special benefits. The plants will be vigorous and yield better due to the improved uptake of nutrients and water. It will also show resistance to different biotic and abiotic stresses. The maintenance cost will be reduced. Different types of grafting in kokum were tried using the same species as root stock. Different types of grafting were done on one-year old stock plants using scion of 5-8cm long from selected female trees. They reported cleft and whip grafting were superior to other methods of vegetative propagation based on the survival percentage of grafts.

Table-5 Effect of types of grafting on survival and growth of kokum seedlings

SN	Type of graft	Survival percentage	No. of sprouts	No. of leaves/plant
1	Cleft	92.5	5.07	12.02
2	Whip	87.5	3.99	8.59
3	Whip & Tongue	82.5	5.04	11.72
4	Epicotyle	47.5	2.97	5.81
Mean		77.5	4.27	9.53

It is estimated that the kokum high-density plantation grown only for fruits can fetch a net returns of over Rs. 30,000 /acre/year. Therefore, kokum can be a good alternate crop for the hilly zone areas if the butter production is also included additionally.

Product development

At present the fresh and dried rinds are used for the production of health drinks. The sugary syrup, called as 'Amruth kokum' is extracted from the fresh rind and pulp to prepare ready-to-serve (RTS) beverages. At present kokum concentrate, rasam, sherbet, etc. are prepared. Kokum amsol, a traditional product and a substitute for tamarind is a popular product in Maharashtra. Attempts have been made to standardize of these traditional products. In order to improve the acceptability of the fresh drink an attempt is also made to produce carbonated kokum drink. Among different concentrations of carbonation tried, carbonation with 13% juice was more acceptable and the bottles could be stored safely. The organoleptic analysis results revealed that the carbonated kokum was tastier and highly refreshing than the normal kokum drink.

Conclusion

There is enormous potential for raising beautiful avenues of kokum trees alongside of roads. It is also suggested to plant this tree along the sides of newly laid Konkan Railway tract, which passes through almost 750km length in coastal hills and valley, as it provides a promising habitat for raising thousands of kokum trees. No attempt is made so far to commercialize the natural dye contained in its rind. There needs to be evaluated the diversity to isolate the higher anthocyanin containing genotypes in the natural population. Further, the edible butter is also another pharmaceutically important component. Research efforts need to be focused in the future programmes.

With the limited availability of research findings one can find new avenues for future research in the crop.

- Higher fruit yielding types may be selected from entire kokum growing areas.
- Early flowering and fruit ripening types have to be selected.
- Small and medium sized tree stature may be identified.
- Fruits with thicker rind are preferred.
- Higher (-)-HCA containing fruit yielding trees may be identified.
- Higher carotene containing fruits, as the demand for natural dye is increasing.
- More research is needed for yellow fruited kokum.
- Extensive evaluation for higher edible oil or butter yielding trees.
- Genotypes which respond to intensive in puts application may be identified.
- Response of kokum trees under existing cropping systems in the traditional kokum growing areas may be tried as the land holding is very limited for the farmers of hilly zone.
- Processing of kokum has another avenue which still not been tapped fully. Preparation fruit jams, blending with other locally available fruits, etc. may be tried.

Application of research: The study gives an insight in to the potential of untapped forest resources on a commercial plantation scale. The idea proposed in the paper for its un-tapped potential will be a good guideline for future researchers.

Research Category: Hydroxy citric acid, white kokum, propagation

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Cultivar / Variety name: Kokum (*Garcinia indica*)

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