

Proceedings and compendium
Second National Conference on Kokum
Goa University, March 4-5, 2005

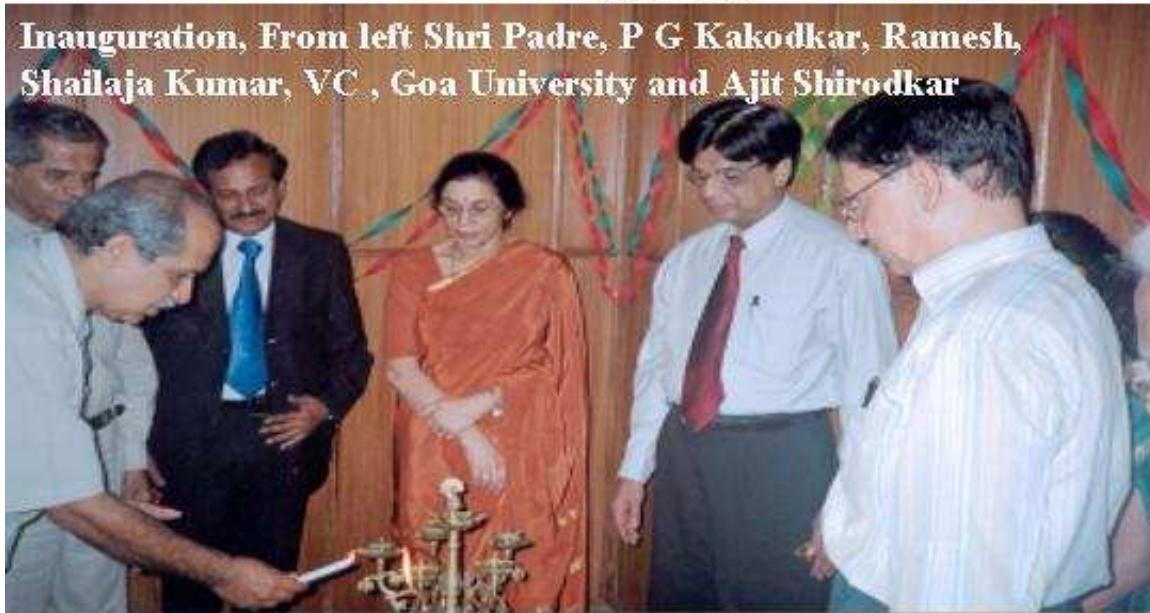




**Second national seminar,
inaugural session snapshots**



**NABARD chairperson
speaking**



**Inauguration, From left Shri Padre, P G Kakodkar, Ramesh,
Shailaja Kumar, VC , Goa University and Ajit Shirodkar**

Proceedings and compendium Second National Conference on Kokum

Goa University, March 4-5, 2005

**Organized by
Western Ghats Kokum Foundation
&
Goa University**

**Supported by
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Sesa Goa**

Editor

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**Part A :- Western Ghats Kokum Foundation
and its' work**

1. WESTERN GHATS KOKUM FOUNDATION AND ACTIVITIES

Till recent past, there had been no specific and systematic efforts to promote cultivation of Kokum throughout the coastal regions of Maharashtra/Goa/Karnataka/Kerala. Whereas considerable attention was paid in promoting mango and cashew along with existing coconut, with various subsidized schemes, as Major Fruit Crops of the region, Kokum was conveniently relegated to the status of Minor Fruit Crop and thus neglected. It was the farming communities of Ratnagiri/Sindhudurg districts of Maharashtra, Sahyadri adjoining talukas of Goa, Sirsi/Puttur and surrounding areas of Karnataka whose livelihood depended on it kept the natural cultivation and processing going.

The Western Ghats Kokum Foundation (WGKF) was established with a mission to promote and establish globally Kokum (*Garcinia indica Choicy*) as the Commercial Medicinal Fruit Plant of the Western Ghats region, and in turn assist in bringing additional 50,000 hectare land under Kokum cultivation by year 2010, Western Ghats Kokum Foundation (WGKF) was formed by a group of horticulture enthusiasts of the region and was registered as an Agro–Eco Promotion Society (NGO) in Goa in 2001.

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

In the last two years, the governments, both at the center and the state levels have taken notice of the potential of Kokum cultivation and processing in the region and have accordingly initiated implementing various schemes through District Rural Development Agencies, Agriculture and Forest Departments, Selfhelp Groups, etc.

The specific objectives of the Society are:

1. To promote research and development in propagation, cultivation and commercial exploitation of Kokum, particularly throughout the Western Ghats of India and in general around the country.
2. To develop and standardize crop improvement methods, propagation, production and post harvest technologies and medicinal value of Kokum.
3. To interact with farmers, local government, local bodies to encourage cultivation of Kokum and produce value added traditional/non traditional products.
4. To interact with institutions, local / national / international, government and non-government organizations in promoting research and development in all aspects of Kokum cultivation and commercial exploitation.
5. To build up and mobilize high quality scientific and technical manpower to undertake modern horticultural practices for Kokum.
6. To develop intellectual property on Kokum and enjoy the benefits from it for the agricultural community at large and
7. To bring WGKF to the level of an apex body in Kokum.

The WGKF launched its activities immediately by organizing the 1st National Seminar on Kokum in May 2001 at Regional Fruit Research Station Vengurle, Sindhudurg district, Maharashtra. A brief report of this event follows.

2. BRIEF REPORT OF THE FIRST NATIONAL SEMINAR ON KOKUM

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

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

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

The main persons behind organizing this seminar were Dr. B. P. Patil, Associate Director of Research and his colleagues; Regional Fruit Research Station, Vengurle; Dr. P.

G. Kakodkar, Chairman; State Bank of India and Dr. Ajit Shirodar, President, Western Ghats Kokum Foundation, Goa.

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

- ❖ Crop improvement.
- ❖ Propagation technology.
- ❖ Production technology and economics.
- ❖ Post harvest technology and uses.

A total of 27 technical papers contributed by 34 experts were presented which covered the above 4 mentioned aspects. Some notable papers included from Maharashtra: Variability fro morpho -physical properties on fruits on Kokum; *Garcinia* a unique genus for coming decade, Graft induced modification in plant architecture of Kokum; Effect of shade and season on success on soft wood grafting on Kokum, Performance of Kokum graft and seedlings during initial years, Studies on pest infesting Kokum, Economics of establishing Kokum plantation, Home scale preparation of Kokum products, Economics of processing of Kokum fruits at household level, Economic analysis of Kokum fruit processing units, Problems and future thrust areas in Kokum. From Kerala: Collection and conservation of *Garcinia* germplasm at Indian Institute of Spices Research, Calicut; Kokum –neglected fruit for a bright tomorrow. From Karnataka Kokum the future crop and *Garcinia*- a gold mine in the forest. From Goa, some medicinal uses of *Garcinia indica*.

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

The 1st seminar generated tremendous enthusiasm among the cultivators and the Kokum processors. For the first time it brought together people from the Western Ghats states on a single platform for a common cause. It helped in networking the various role players in the

four states. The experienced gained from this seminar was useful in conceptualizing the 2nd National Seminar.

Conceptualization of the 2nd National Seminar

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

The Organising group

The preparations for the second national seminar were launched by forming an organizing group with the Vice Chancellor of Goa University, Prof. P.S. Zacharias and the then Chief secretary of Goa, Dr. D.S. Negi, IAS as patrons. The head of department of Botany Prof. D.J.Bhat, the former chairman of State Bank of India Mr. P.G. Kakodkar and the President of WGKF Dr. Ajit Shirodkar were the convenors. Dr. Nandkumar Kamat was nominated as organizing secretary. Strategic support was extended by Dr. Prabhakar Bhat, Karnataka, Shri Shri Padre, Kerala, Dr. B.P.Patil, Maharashtra, dr. sangam Kurade, Dr. V.S. Korikantimath , Shri Kalidas Savoikar, Smt. Ujjvala Shilkar, and Shri Satish Tendulkar from Goa. Treasurer of WGKF Shri Ashok Joshi was entrusted the task of looking after the accomidation and catering and Mr. Miguel Braganza was entrusted with the task of giving adequate publicity. Mr. Sharad Joshi of Goa Bagayatdar Sangha shouldered the responsibility of mobilizing the farmer delegates. From the local mediapersons Shri Prakash Kamat, Frederick Noronha and Jagdish wagh provided the support. The student and staff of the department of Botany and the university administration extended excellent support for the successful organization.

The seminar highlights

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

Part B:- Proceedings of the Second National Seminar On Kokum

The programme of second national seminar on Kokum

2nd NATIONAL SEMINAR ON KOKUM Kokum Cultivation in Western Ghats for Prosperity and Health Care March 4-5, 2005 Conference Hall Goa University.

Programme

4th March

Inaugural ceremony

10:00 a.m.: Ganesh Vandana- Invocation Song.
10:05 a.m.: Welcome address by Dr. Ajit Shirodkar.
10:15 a.m.: Welcoming the dignitaries.
10:20 a.m.: Inauguration by lighting the traditional lamp followed by the release of the 'Preview' volume.

10:25 a.m.: Address by Prof. P.S. Zacharias, Vice Chancellor, Goa University.
10:35 a.m.: Address by Shree Padre.
10:45 a.m.: Address by the Guest of Honour, Mr. A. Ramesh Kumar, Chief Manager.
10:55 a.m.: Introduction of the Chief Guest and address by Shri. P. G. Kakodkar.
11:05 a.m.: Keynote address by Smt. Ranjana Kumar, Chairperson, NABARD.
11:25 a.m.: Vote of thanks by Prof. D. J. Bhat, Department of Botany, Goa University.
11:30 a.m.: Tea break.

12:00 p.m : Technical session 1.
(Chairperson: Prof. D. J. Bhat)
1. **Status of Kokum in Goa**-V. S. Korikanthimath & A. R. Desai.
2. **Status of Existing Kokum Plantation in Maharashtra**- B. P. Patil *et al*
01:30 p.m.: Lunch break.
02:15 p.m.: Technical session 2
(Chairperson: Prof. Chautha)
1. **Status and Prospects of *Garcinia indica* in Uttar Kannada, Karnataka**- Prabhakar R. Bhat.
2. **Status of Existing Kokum Plantations/Cultivation in Karnataka and North Kerala**-Shree Padre.

03:45 p.m.: Tea break.

04:00- 05:30 p.m.: Technical session 3
1. **Cultivation of Kokum Amruta and Search for Elite Varieties**-B. P. Patil *et al*.
2. **Kokum in Forest lands of Western Ghats**- Dr. D. Pandey.

5th March

10:30 a.m.: Technical session 4

1. **Prospects of Kokum as an Intercrop/Bordercrop in Mango Orchards**- K. H. Pujari *et al*.
2. **Traditional Methods of Kokum Fruit Processing**- Dr. G. D. Joshi.

11:30 a.m.: Tea break.

11:45a.m: Technical session 5

- 1. Non-Traditional Products from Kokum Inland and Global Opportunities-**
Dr.Nandkumar Kamat.
- 2. Credit Support from NABARD for Development of Kokum in India-** R. N. Hegde

01:15 p.m.: Lunch Break & submission of suggestions.

Panel Discussion

02:15-04:00 p.m.: Panel Discussion (S.P. Tendulkar, M. J. Bhat, B.P. Patil, Dr. Ajit Shirodkar, Jagdish Wagh, Frederick Noronha, Prakash Kamat, Mr. Sadanand Tendulkar)

Valedictory function

***Compere**- Dr. Nandkumar Kamat, Organising Secretary.

The proceedings of the 2nd National Seminar on Kokum

The Second National Seminar on Kokum (*Garcinia indica* Choisy) was jointly organized by the Western Ghats Kokum Foundation and Goa University, Goa at the Conference Hall, Goa University on the 4th and 5th of March 2005.

The inaugural session

The seminar was inaugurated on 4th March 2005 by Smt. Ranjana Kumar, Chairperson of NABARD in the presence of Shri. Ramesh Kumar, Chief General Manager of State bank of India; Shree Padre, progressive agriculturalist from Kasorgod, Kerala; Prof. P. S. Zacharias, Vice Chancellor of Goa University; Dr. Ajit Shirodkar, Chairman of west Coast Kokum Foundation and Shri. P. G. Kakodkar, former Chairman of SBI and a lover of Kokum.

The gathering was addressed by Dr. Ajit Shirodkar. This was followed by lighting of the traditional lamp and the inauguration of the seminar by Smt. Ranjana Kumar, Chairperson, NABARD and release of the “Preview” volume. Then Prof. P. S. Zacharias in his speech put forth an offer to the foundation that a vast stretch of open land in the University campus could be used for the cultivation of Kokum, as a demo project which would also provide opportunities for the University science departments to conduct needful scientific experiments. Then two eminent personalities Shree Padre from Kerala and Shri. Ramesh Kumar from SBI addressed the gathering. Then Shri. P. G. Kakodkar introduced the Chief Guest and addressed the participants.

Key note address by chairperson, NABARD

In her key note address Smt. Ranjana Kumar, Chairperson, NABARD:

Kokum (*Garcinia indica*) which is the hitherto considered to be a minor fruit crop and grown locally in the Western Ghats of India possess all the potential to become a major fruit crop to make its presence globally.

She said that its quite amazing to know that a little known fruit has such enormous utility with diverse range of products. The important products such as Kokum syrup with variants like Amrut Kokum and dried kokum rind (known as Amsul) are prepared from Kokum rind. Kokum butter is extracted from Kokum seed, which contains about 25% fat, which remains solid at room temperature.

The seedling fruit tree itself, due to its upright growth and pyramid shape, is an excellent avenue tree and a good substitute for the Ashoka tree in big cities.

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

She further stated that in recognition of its immense medicinal properties the National Medicinal Plant Board has identified 'Kokum' as one of the 32 prioritized species of plants for promotion and development. Inspite of its many virtues, no systematic effort has been reported to popularize the fruit to harness its commercial potentials till the 1st National Seminar on Kokum was organized in 2001, at Sindhudurg. The need of the hour is to give

pointed focus to every detailed development of the fruit with regard to its production, processing and marketing.

Then she enlisted the challenges for development of Kokum

- Unorganized and scattered plantation leading to poor collection of fruit.
- Only 20% of the present production is processed and the rest is wasted.
- Harvesting time is extremely limited and coincides with the rainy season.
- Absence of any post harvest technology for drying of rind, cutting of fruits or preparation of kokum drink leading to poor quality product.
- Lack of generic promotion of Kokum about its high medicinal value.
- Lack of awareness about its medicinal virtue.
- Very narrow band of market
- Absence of a specific Nodal dept.-till recently there was no nodal department of state Govt. for the promotion of this crop.

By doing this a road map for the development of Kokum can be constructed by working towards the following points:

- Awareness creation among farmers, processors and consumers about its economic and medicinal value.
- Developing pre- and post- harvest techniques.
- Identification and dissemination of good agricultural practices and best processing techniques.
- Standardization of processing protocols.
- Linkages with major Ayurvedic industry.
- Patenting for geographical indication.
- Strong advocacy for inclusion of this crop under National Horticulture Mission (Technology Mission).

She further said that NABARD would create an environment for the development of this crop. Already some beginning has been made in this path:

- Pre-investment study was conducted during 2001-02. This led to the fixation of unit cost for Kokum plantation for the first time and it was duly approved in the State Unit Cost Committee for financing Kokum plantation by banks.
- During 2004, a detailed study was conducted and a Business model evolved for Kokum processing involving SHG, NGO and consortia of processor in collaboration with UNIDO (working at Sindhudurg for cluster development).
- Two rural Entrepreneurship development programmes were conducted through MCED (Maharashtra Centre for Entrepreneurship Development) for capacity building of the prospective entrepreneurs.

Lastly she proposed the initiatives of NABARD:

- An area development programme for Kokum plantation may be formulated by NABARD to be implemented by the banks operating in identified districts.
- NABARD would assess the credit need for Kokum processing industry and arrange to provide the requisite financial assistance to small and medium entrepreneurs (SMEs) through banking institutions. Provide intensive training to prospective SMSs for processing of Kokum and developing new products through rural Entrepreneurship development programme (REDF).
- It would support NGOs/processors for undertaking capacity building measures such as exposure visits to research institute/good Kokum orchard or to an ideal processing unit of Kokum grower/processor for adoption of technology, awareness camps for farmers and sensitization programmes for bankers.
- It will strengthen the functioning of existing farmers clubs and SHGs to promote Kokum cultivation and its processing.
- Possibilities of contract farming would be explored.
- It would further facilitate the convergence of various subsidy schemes of GoI and State Govt. like KVIC scheme for SSI unit, NMPB's scheme, Horticulture Dept. scheme for EGS.
- NABARD will interface with proposed National Horticulture mission of GoI to give a special focus on development of Kokum. NABARD may consider extending grant support to university or research Institutions to undertake any operational research on Kokum fruit.

Before concluding she congratulated the Western Ghats Kokum Foundation and Agricultural University, Dapoli for organizing this seminar which would provide an excellent platform for the intellectual interaction of various stakeholders on the vital issues related to the development of Kokum. She further said that this seminar should come out with short term and long-term strategies that need to be implemented by each stakeholder with a definite time frame.

The technical sessions

In all ten review papers were presented in six technical sessions. Technical sessions 1, 2 and 3 took place on March 4 th and the rest on March 5 th.

The following papers were presented using MS-Powerpoint based media. Each session was chaired by a chairperson. Written questions were invited from the delegate on a printed question slip. These were then sorted and the appropriate questions were answered by the concerned speaker. At the beginning of each session, the chairperson and the speakers were introduced. The chairperson made a few opening remarks and after the discussion was over concluded the session.

1. Status of Kokum in Goa-V. S. Korikanthimath & A. R. Desai.
2. Status of Existing Kokum Plantation in Maharashtra- B. P. Patil *et al.*
3. Status and Prospects of *Garcinia indica* in Uttar Kannada,Karnataka Prabhakar R. Bhat.
4. Status of Existing Kokum Plantations/Cultivation in Karnataka and North Kerala-Shree Padre.
5. Cultivation of Kokum Amruta and Search for Elite Varieties-B. P. Patil *et al.*
6. Kokum in Forest lands of Western Ghats- Dr. D. Pandey.
7. Prospects of Kokum as an Intercrop/Bordercrop in Mango Orchards- K. H. Pujari *et al.*
8. Traditional Methods of Kokum Fruit Processing- Dr. G. D. Joshi.
9. Non-Traditional Products from Kokum Inland and Global Opportunities- Dr. Nandkumar Kamat.
10. Credit Support from NABARD for Development of Kokum in India- R. N. Hegde

The text of each of the paper alongwith statistical and graphical data and the important questions which were asked are given hereafter. The responses wherever recorded have been included and those which were later incorporated in recommendations have been ommitted.

Day One- March 4, 2005,

Technical session 1: (Chairperson: Prof. D. J. Bhat)

1. Status of Kokum in Goa-V. S. Korikanthimath & A. R. Desai.
2. Status of Existing Kokum Plantation in Maharashtra- B. P. Patil *et al.*

Status of Kokum (*Garcinia indica* Choisy) in Goa

V. S. Korikanthimath and A. R. Desai

ICAR Research Complex for Goa, Ela, Old Goa – 403 402

Introduction

Garcinia species are distributed widely throughout the tropical Asian and African countries and have tremendous potential, both as spice and medicinal plants. They comprise a large genus of evergreen trees, shrubs and herbs. *Garcinia* belongs to the family Clusiaceae. Some of the species in this family possess medicinal properties, whereas most of the plants are known for their oil glands or secretary canals or cavities. The genus *Garcinia* includes 200 species, of which about 30 different species are reported to be grown in Andaman Islands, North East Hill region, West Bengal, Orissa, Bihar, Western Ghats covering Maharashtra, Goa, Karnataka, Kerala and Nilgiri hills in India (Rema and Krishnamurthy, 2000). *Garcinia indica* (Kokum), *G. gummigutta* (Kodampuli), *G. mangostana* (Mangosteen), and *G. spicata* are widely distributed in the Western Ghats, of which the former two are the most wildly spread species in Goa region of Konkan belt and northern part of Kerala respectively, with tremendous natural variability. The typical features of *Garcinia* species include monopodial growth.

Recently *Garcinia* excited the scientific world for possessing properties that regulate obesity. Though commercially important, these species remained neglected and not much attention was given for their research and development. Present production level of kokum is estimated at 10,200 tons from 1200 ha. (Table 1). However, there is a continuous increase in its demand as is evident by the market trends and export scenario (Table 2).

Table 1: Kokum at glance

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

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

Table 2: Market – demand and export scenario

1. Estimated domestic demand (tonnes):
<u>1999-2000</u> <u>2001-02</u> <u>2004-05</u>
272.30 466.60 1046.50
2. Estimated demand value wise (in lakhs @ Rs. 30,000/- per ton):
<u>1999-00</u> <u>2001-02</u> <u>2004-05</u>
81.27 140.00 314.00
3. Estimated demand supply gap:
2001-02 194.30 tonnes
2004-05 774.20 tonnes
4. Export scenario
Exported quantity and value
1996-97 1997-98
Quantity (in tonnes) 4.22 31.32
Value (in lakhs) 9.32 150.25
Export price realized (Rs. per kg.):
1996-97 220.94
1997-98 479.59
Its seed fat is being exported to Netherlands, Italy, Japan, Singapore, UK, Malaysia, China, Taipei, Korea Republic & Spain.

Composition and uses of Kokum

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

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

Table 3: The composition of fresh Kokum rind

Moisture (%)	80.00
Protein (6.25)%	1.92
Crude fibre (%)	14.28
Total ash (%)	2.57
Tannin (%)	2.85
Pectin (%)	5.71
Starch (%)	1.00
Crude fat (%) (Hexane extract)	10.00
Acid (as hydroxy citric acid)	22.80
Pigment (%)	2.40
Ascorbic acid (%)	0.06
Carbohydrates by difference (%)	35.00
(Values are expressed on moisture free basis)	

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

Botany of *Garcinia* species

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

Species of *Garcinia*

Garcinia is a rich genus having more than 200 listed species. Of the 30 species available in India, important ones are *G. indica*, *G. gummigutta*, *G. mangostana*, *G. tinctoria* (*G. xanthochymus*), *G. morella*, *G. cowa* and *G. hombroniana*

***Garcinia indica* Choisy**

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

Distribution and climate

Kokum (*G. indica*) is an evergreen tree occurring up to an elevation of about 800 metres from sea level. It is abundant in Western India and is distributed throughout Konkan, Goa, North Kanara, the Western Ghats, South Kanara and in areas in west of Bombay. It is found in tropical rain forests of Western Ghats, North Malabar, Coorg and Wynad as well as in West Bengal and Assam.

***Garcinia* species in Goa / Konkan region**

Species	Remarks
<i>Garcinia indica</i>	Fruits and seeds multiple uses
<i>Garcinia gummigutta</i>	Fruits & seeds
<i>Garcinia mangostana</i>	Dessert fruits
<i>Garcinia spicata</i>	Wood & bark, timber, dye & medicinal value
<i>Garcinia morella</i>	Camboge, seed & stem

Description, flowering and fruiting

It has dark green and drooping foliage. The tree flowers in November -February and fruits ripen in the April-May. The flowers, which can be axillary or terminal, exist in solitary form or as spreading fascicles. The sepals are decussate, thick and fleshy. Four thick petals extend in length slightly beyond the sepals. Male flowers are characterized by numerous stamens and two celled anthers with 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.

Kokum in Goa

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

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

SR. NO.	VARIABLES	RANGE OF VARIABLES	REMARKS
1.	Tree habit	Tall & conical, pyramidal, domeshaped, spreading type	-
2.	Branching pattern	Erect, spreading, drooping	Tall & dwarf nature
3.	Tree height (m)	6 – 12 m	Tall & dwarf types
4.	Fruiting season	Very early (Feb-March) to Late types (May-June)	Early & mid season types preferred
5.	Fruit yield (adult tree)	50 to >350 Kg / tree	
6.	Fruit size	21 g - 85 g	
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 Degree Brix	Sweet & sour types present
13.	Acidity (%)	1.1 – 3.2	Sub acid to very acidic types
14.	Kokum fat (in seeds)	20 -26 % (as reported by Karnik et al., 2001 Konkan region)	

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

Table 5: Fruit characters of some promising Kokum accessions of Goa.

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

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

Propagation

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

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

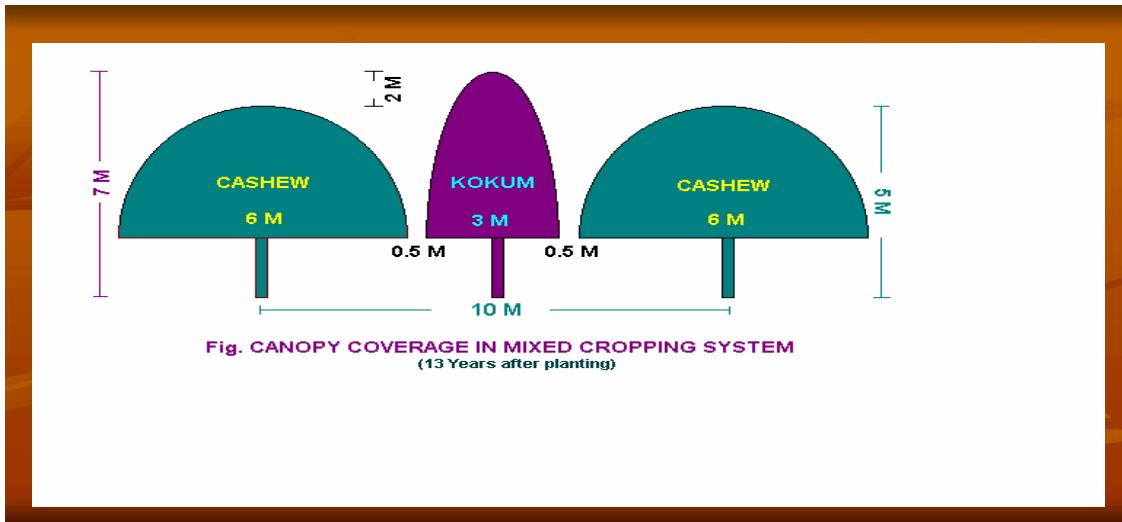
Higher productivity

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

Prospects of cultivation of Kokum as a mixed crop with cashew

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

Figure 1: Planting Plan



Considerable increase in income can be realized from cashew + kokum mixed cropping system (Table 6). Kokum can also be planted advantageously and comfortably on all the borders of coconut gardens (Korikanthimath, 2003). Further, crop compatibility studies will help in appropriate incorporation of this crop in different farming systems for sustainable production diversified farming systems.

Table 6: Effect of mixed cropping on main and mixed crop yield (kg/tree)

Treatments	12 YAP		Cumulative yield (4 to 12 years)	
	Main crop	Mixed crop	Main crop*	Mixed crop#
Cashew (monocrop)	6.5	-	41	-
Cashew + Kokum	6.0	30	34	120

* Total yield -10 harvests for Cashew,

Total yield – 6 harvests for Kokum

Post harvest handling

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

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

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

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

B] Dry Seed

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

Oil

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

Medicinal values of *Garcinia indica*

Raw fruits are used as antihelmintic, 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).

Constraints of kokum processing units

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

Future Strategies

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

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

- Identification of plus trees for higher yield, earliness, regular bearing and good fruit quality.
- Commercialization of tissue culture technology for production of elite plants.
- Standardization of nutritional requirements and cultural practices.
- Mechanization of post harvesting operations with emphasis on hygienic processing.
- Development of more value added products.
- Considerable Wasteland available in Goa and adjoining areas may be very well utilized for profitable cultivation of kokum.
- Similar to cashew, kokum can be a brand product of Goa.

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Questions:-

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

1. Is there any reputed Govt/private nursery for Kokum grafts? If yes, how many grafts can be available per year for plantation. If no, what measures are adopted by universities for availability of Kokum grafts?
2. Is there any special technique to maintain male/female ratio in Kokum trees before planting?
3. What is the water requirement for the plant to grow? Any measures like irrigation are to be taken?
4. Where can we get the details of the technology for processing of kokum (khajur, wine, powder, etc. to import it to our farmers in our region for popularizing the use of the same?
5. Is there any harm for inter- or mixed- cropping of Kokum with mango, awala, bamboo, coconut, vegetables, etc? If yes, please give the control and if no, then why the university is not recommending the Government to include Kokum as an inter/mixed crop under 100% employment guarantee scheme?
6. Who exports Kokum seeds and what is the rate per kg in the Konkan?

7. Can Vanilla be planted in kokum areas as a support tree?
8. Is there any special cultivation practices for Kokum to get early maturity or tell us about early yielding Kokum varieties?
9. In mixed cropping of cashew and Kokum, there appears some crowding in the plantation area? Whether any pruning is required and if so how does Kokum respond to pruning?

The second presentation was made by the scientists of RFRS-vengurle.

Status of Existing Kokum Plantation in Maharashtra

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Introduction

The genus *Garcinia* belongs to the family Clusiaceae. Over 400 species of the *Garcinia* have been identified and 40 edible *Garcinia* have been listed (Karnik *et al.*, 1978). About 30 species occur in India. Amongst these *G. cambogia*, *G. morella* and *G. indica* yield non-drying edible fat. A feature of this genus is yellow or white latex present in most of parts of the plant. Out of thirty species occurring in India, species *indica* is confined to India and ShriLanka only. It is found in the tropical humid, evergreen forest of western Ghats extending from Surat district in the state of Gujarat to Coastal (Konkan) belt in the state of Maharashtra, state of Karnataka (North and south Canara, Udupi and Shimoga) and state of Kerala.

Area and production

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

Morphological features of Kokum

A full-grown tree of Kokum attains a height of about 16 to 20 meters. The tree itself is ornamental with a dense canopy having lush green leaves with red tinged tender emerging leaves. Being a pyramid shaped handsome evergreen tree, it is a good choice for growing along the roads and railway tracts. The leaves are ovate to oblong, lanceolate, broad, dark green above and pale beneath. Kokum is predominantly a dioecious plant and cross-

pollination of the flowers on female tree is very essential for fruit set. Karnik *et al* (1978) observed substantially high fruit set in both open (natural cross) and hand (artificial cross) pollination in Kokum which could be due to large number of pollen grain produced by Kokum trees and role of wind in pollinations as judged by the atmospheric pollen.

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

Processing of Kokum

The products such as Amrit kokum (Kokum syrup) and Amsol (dried kokum rind) are prepared from kokum rind. South Konkan of Maharashtra state where kokum is grown as an important other major fruit crop and its products are commercially processed at household level has been the traditional kokum pocket. Wadkar *et al* (2001) mentioned in their survey report that the quantities of product prepared per house hold varied from product to product when data were collected by survey method of 60 respondents in the year 1995-96 for testing of economics of processing of kokum fruits at house hold level. It is also reported that in South Konkan, it was estimated that 1674 MT of fruits were used for dried kokum rind, 757 MT for preparation of Amrit Kokum and 40 Mt for Kokum butter.

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

Constraints in production and processing

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

Kokum Promotion Strategies

In order to promote kokum plantation on massive scale it is necessary to provide liberal funding and subsidies for its inter planting in coconut, cashewnut and mango orchards as well as its border planting around these gardens and field bunds.

Similarly, funding and subsidies may be provided to the farmer processors for an integrated package of Kokum production and primary processing of Kokum fruits.

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There were no relevant questions on this paper.

Day One , Technical session 2: (Chairperson: Prof.Chautha)

In this session two papers were presented

- 1.Status and Prospects of *Garcinia indica* in Uttar Kannada, Karnataka-** Prabhakar R. Bhat.
- 2.Status of Existing Kokum Plantations/Cultivation in Karnataka and North Kerala-** Shree Padre.

Status and prospects of *Garcinia indica* (Kokum) in Uttara Kannada, Karnataka

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Introduction

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

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

Forests of Karnataka

Karnataka is endowed with some of the most magnificent forests in the country ranging from the majestic evergreen forests of the Western Ghats to the scrub jungles of the plains. The forests comprise of several types ranging from fragile coastal mangroves along the coastlines to tropical wet evergreen forests all along the Western Ghats. The total forest cover of Karnataka is 36991 square kilometer representing around 19.3 percent of the total geographical area of the state and 5.5% of the country. Forests in Karnataka are classified in to reserve forests, protected forest, village forests, unclassified, and private forests (Table 1.). The area under dense canopy cover (canopy density more than 40%) is nearly 13.6 percent of the total geographical area of the state while 5.6 percent falls under open forests (canopy density between 10 to 40 percent) and 3245 square kilometer of scrub (canopy density less than 10 percent) (Table 2 and Fig 1).

Table 1. Classification of recorded forest area in Karnataka on the basis of legal status

S. No.	Legal status	Area (Sq. Km)	Percent
1	Reserved forests	28,689.97	74.94
2	Protected forests	3,930.70	10.27
3	Village forests	124.20	0.32
4	Unclassified forests	5,230.99	13.66
5	Private forests	308.42	0.81
	Total	38,284.28	100

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

Table 2. Forest cover and forest types in Karnataka and their extent

Forest cover of Karnataka in Sq. kms	Forest types
Dense forests	Evergreen 4,350 (11.36)
Open forests	Semi-evergreen 1,450 (03.79)
Total	Moist deciduous 5,780 (15.10) Dry deciduous 7,270 (18.99) Thorn forests 8,340 (21.78) (Scrub) Un-wooded 11,094 (28.98) (Number in parenthesis is percent)

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

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

District of Uttara Kannada

Uttara Kannada district ($13^{\circ}52'$ to $15^{\circ}31'N$ and $74^{\circ}9'$ to $75^{\circ}10'E$) is the northernmost coastal district of Karnataka. (Fig 2). It has a total geographical area of 10,291 km² and accounts for 5.4% of the total area of the state. The district has lot of ecological significance with its location at the centre of Western Ghats. The district is divided in to characteristic four distinct regions depending on the physical features and natural resources available. They are Coastal region, Foothills of Western Ghat, Hilly region, Eastern transition region. The Western Ghats covers a substantial portion of the district. The hills rise to 600–700 m above msl. The average annual precipitation is 2742 mm ranging from 1000 mm in the eastern transition area to 5000 mm on the coast.

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

Forest Resources of Uttara Kannada

Uttara Kannada is endowed with rich forest wealth. Total forest cover is 781,600 ha, which accounts for nearly 76% of the total geographical area of the district. The district has an undulating terrain with a long contiguous tract of tropical forests. The major forest types found here are tropical wet evergreen forest (14%), semi-evergreen forest (25%), moist-deciduous (35%), dry deciduous (26%) and mangrove forests. These forests are categorized into different forests according to the ownership pattern (Table 3.). State Forest Department manages the most part of the forests in the district.

Table 3. The legal classification of forest lands and area in Uttara Kannada

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

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

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

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

concentrated is tendered for auction by the Forest Department in the name of amsol or bhirand (Table 4).

Table 4: Quantities of murgalu (amsol and bhiranda) extracted by MFP contractors in Uttara Kannada

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

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

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

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

Some observations related to *Garcinia indica* in Uttara Kannada

Distribution: Trees of *Garcinia indica* are distributed in nine Western Ghats taluka of the district.

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

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

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

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

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

Kokum butter is mainly used at the household level.

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

Future Prospects

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

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

Questions:-

This is a list of questions which were put forward by the participants and were simultaneously answered by the speaker of the paper. A few responses are included wherever transcript was available.

1. Whether any efforts are made for organic certification of Kokum plantation? Whether it is viable to have this certificate for any private plantation of the farmer?

2. How are Kokum crops inside wildlife sanctuaries exploited?

3. Why do you think people are not growing 'Murgalu' on a large scale?

Response:--The speaker said that since cardamom and other spices are grown on a large scale no much consideration is shown towards the large scale cultivation of Kokum. Kokum is only planted in backyards and private lands on a very small scale and farmers are growing *Garcinia* plants only along the coastline.

4. What are the local uses of Kokum in Uttar Kanada district? Give detailed information.

Response:--In Uttar Kanada, kokum is mainly used for 2 purposes namely, seeds are separated from the rind and oil is extracted from it which is mainly used for frying and healing the cracks on the feet in winter. Secondly, the rind is dried and mainly used in the preparation of curries, concentrated syrups, etc.

5. There is no authenticated data available with regards to the total area under cultivation, yield, practices followed in harvesting in different areas/states. Can this work be taken up by the foundation especially by involving the educational institutes of the regions?

6. Does the center for Eco- Sciences have website/interactive mail list? What are the preliminary findings of the multi-location yield analysis in *Garcinia*?

The next presentation was made by Shri Padre from Kerala.

Status of Existing Kokum Plantations/Cultivation in Karnataka and North Kerala

Shree Padre, Journalist

Post Vaninagar Via: Perla 671 552 Kerala

Introduction

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

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

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

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

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

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

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

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

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

There are more reasons than one why Kokum enjoys top priority among these small-holders. It doesn't require irrigation, maturing or pesticides. It's a typical zero cultivation. Only agricultural practice required is harvesting, cutting & drying. But summer rains play a villain to local economy. If rain falls on fruits, worms develop in it, turning the fruits useless.

Take for example the case of Shri Toku Naik of Kadakaar. He has 4 acres of paddy fields. Paddy is rainfed. The torrential rains take good amounts of nutrients from the paddy

fields. He is continuing paddy cultivation only for the sentimental reasons. From 4 acres he gets an average of 20 to 25 bags of paddy. That is about 1.25 to 1.5 tonnes. After deducting the expenses of manuring, tilling, replanting, harvesting etc it is a literal loss for him. But “quite in contrast”, he says, lions-share of the amount he earns from Kokum trees is a net savings.

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

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

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

Value Addition

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

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

Yet, a lot of R & D and promotional work is needed to be done in the selection, breeding and value addition front of Kokum. Kokum Jam, Soup ready-mix are two concepts that need to be worked. Another possibility is providing Kokum as a healthy drink by blending it with other nutritious and products like honey or buttermilk. Kokum makes a very good combination with these products. This health-drink can be packed in tetrapacks and sold as a zero-chemical drink.

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

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

Farmers Viewpoint

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

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

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

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

Reference

Paschima Ghattadalli Monoculture Mahayana, collection of features by Shivananda Kalave. 2003. Published by Shivarama Karantha Adhyayana Kendra, Puttur 574 203.

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

Questions:-

1. What farmers, cooperatives and NGO's could do to promote Kokum? Can you give specific suggestions?
2. Is there any problem to Kokum from wild animals?
Response:-- Kokum has no significant problems from wild animals
3. Systematic documentation of medicinal properties with clinical trials, etc are essential to make it acceptable to the international community, developing new product ranges. Any effort in this direction?
Response:--This question was answered by Sarita Hegde working with Shree Padre. She said that they were collaborating with NGO's like IAD with the help of team of doctors on the concept of "Comparison of efficacy of Kokum butter with standard emollient of biomedicine in the treatment of keratoderma".she furter stated that the research is in progress and they will come with results in the coming year.
4. Which part of Kokum fruit is having more medicinal properties?

Day One, Technical session 3:

There were two presentations

1. **Cultivation of Kokum Amruta and Search for Elite Varieties-**
B. P. Patil *et al.*
2. **Kokum in Forestlands of Western Ghats-** Dr. D. Pandey.

The second paper was revised by Mr. R.K.Singh and the new version is included in the present proceedings.

Cultivation of Konkan Amruta and Search for Elite Varieties

B. P. Patil, M. S. Gawankar, D. S. Sawant, K. H. Pujari and N. D. Jambhale

Regional Fruit Research Station, Vengurle, 416 516 (M.S.)

Kokum (*Garcinia indica* Choisy) is one of the native plants found only in our country and that too on the West Coast of India. At present, its cultivation is confined to the coastal hilly regions of Maharashtra, Goa, Karnataka and north Kerala. It is the most important fruit crop among the other major fruit crops. The tree architecture provides scope for landscape designing. Kokum fruits have medicinal properties and fat extracted from kernel is used in confectionery preparations, cosmetics and manufacture of soaps and candles. Dried fruit rind (Amsol) is used in culinary purposes especially, in fish curries instead of tamarind. Fresh rind is an antidote against bilious affections and syrup (Amrit kokum) is prepared by using fresh rind pieces and sugar in 1: 2 proportion. Kokum syrup on dilution is a cooling and refreshing natural drink. Hydroxy Citric Acid which is anti obesity (antifatness) agent can be extracted from the ripe rind. The ripe and unripe fruits, the kokum butter and leaves have been reported to posses medicinal properties for improving appetite, controlling piles, dysentery, tumors etc, (Karnik *et al.*, 2001).

Distinct agro-climatic conditions of the coastal zone to which Kokum is adapted impose limitation to extend the area under Kokum cultivation. Because of dioecious nature of the plant, surplus and unproductive maleness, large genetic variability, slow growth, late

bearing and prolonged harvesting, lack of rapid, easy and cheapest propagation technique are some of the constraints for its rapid spread as commercial crop.

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

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

Characteristic of the Variety “Konkan Amruta”

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

Table 1 Morphological and physicochemical characters of the variety Kokum Amruta

A)	Distinguishing morphological characters
a)	Growth characters of the tree
i	Height (m) : 10.30
ii	Trunk girth at base (m) : 1.05
iii	North – south spread (m) : 3.10
iv	East – west spread (m) : 2.90
v	Volume of the tree (m) : 48.58
vi	Growth habit : Erect with narrow oblong type crown
b)	Flowering and fruiting pattern
i	Flower bud appearance (date) : 5 th October
ii	Initiation of flowering (date) : 10 th 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) : 138.28 kg
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

B)	Chemical Analysis
i	Moisture (%) :
ii	T.S.S. (%) : 9.08
iii	Reducing sugar (%) : 2.41
iv	Total sugar (%) : 4.52
v	Acidity (%) : 5.12
vi	pH : 1.81
C)	Agronomic features
i	Spacing : 5 X 5 m (Grafts)
ii	Season of planting : June to September
iii	Manures and Fertilizers
a	First year : 2 kg FYM, 50 g N, 25 g P ₂ O ₅ , 25 g K
b	Tenth year and above : 20 kg FYM, 500 g N, 250 g P ₂ O ₅ , 250 g K
iv	Major pest and disease : Incidence of any major pest and disease were not noticed

Identification of Elite type:

Though Konkan Amruta is the first variety released by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli and recommended for planting in the Konkan region. Nevertheless, lot of scope still exists for selection of superior seedling from the natural variation. With this view, selection of high yielding types with bold fruits and early ripening characters were made from Ratnagiri and Sindhudurg district of Maharashtra and grafts prepared from such seedling types were planted in Germplasm block at Regional Fruit Research Station, Vengurle and Agricultural Research Station, Mulde during the year 1990 to 1996 for further evaluation. Fourteen types planted in Germplasm block at Agricultural Research Station, Mulde were evaluated in the year 2002 and reported by Gawankar *et al.*, (2004). Study revealed that genotype MLDK – 5, MLDK - 2, MLDK – 3, MLDK – 10 and MLDK – 4 were precocious genotypes and their yield ranged from 11.0 kg to 2.70 kg at the age of 6 years which needs further evaluation to confirm their consistency and stability in performance with regard to early ripening, fruit weight, yield and quality parameters before considering it for releasing as new variety.

Gawankar *et al.*, (2003) in another study on screening of seedling kokum types reported that high variability existed among the different kokum types under study in respect of fruit weight, rind recovery, shelling percentage and quality parameters which indicates that still there is a scope for effective improvement in kokum by simple selection. Overall survey study identified KK- 40, KK-18, KK-17, KK-9 and KK-19 were elite and superior for fruit weight, which ranged between 77.3 g to 63.0 g

Similarly, study on screening of fifteen seedling genotypes at Agricultural Research Station, Mulde Tal: Kudal showed promising results and needs further evaluation. Year wise yield data of different genotypes are given below.

Table 2 Year wise yield data of different genotypes

Genotype	Tree No.	Yield Kg/plant				Cumulative yield Kg/plant 1999 to 2004
		2001	2002	2003	2004	
MLDKS- 3	40	0.30	12.0	43.65	44.19	100.14
	37	5.41	1.0	31.73	29.40	67.56
	32	2.97	8.00	19.05	29.39	59.41
	43	1.31	2.80	32.23	18.10	54.44
MLDKS- 1	2	0.69	9.00	17.22	37.03	63.93
	11	-	1.50	10.23	14.20	25.75
MLDKS- 2	27	1.13	-	23.62	21.28	46.03
	30	-	-	8.56	15.19	23.75
MLDKS- 5	72	-	1.50	23.64	27.80	52.94
MLDKS- 6	85	-	-	8.76	11.30	20.06
MLDKS- 15	215	-	-	23.35	35.80	59.15

Kshirsagar *et al.*, (2003) collected and assessed 108 elite type of Kokum at the Regional Fruit Research Station, Vengurle for fruit colour, fruit weight, pulp weight, seed weight, pulp to fruit ratio etc., On the basis of these characters ten promising types have been identified and relevant data are presented in Table 3.

Table 3. Physical characters of promising Kokum types

Accession No.	Average Weight of the fruit (g)	Average Peel weight/ fruit (g)	Average Seed weight / fruit (g)	Peel: fruit ratio	Seed : fruit ratio
VGL 01133	83.33	46.67	36.00	0.6	0.4
VGL 01021	83.20	44.80	36.60	0.6	0.5
VGL 01072	67.20	30.40	36.80	0.5	0.5
VGL 01136	59.60	37.60	20.00	0.6	0.3
VGL 01189	54.40	21.20	32.40	0.4	0.6
VGL 01170	58.40	30.00	27.20	0.5	0.5
VGL 01058	48.80	18.80	28.80	0.4	0.6
VGL 01130	57.00	27.50	29.50	0.5	0.5
VGL 01005	49.60	28.80	20.30	0.6	0.4
VGL 01162	35.20	25.60	9.20	0.8	0.3

The present research programme on this versatile crop at the various research centers under Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli will undoubtedly help in conserving and utilizing the existing Kokum bio-diversity to a great extent and will benefit in promoting the crop in Konkan for its commercial plantation.

Reference

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

The next paper was presented by the ex-chief conservator of forests, Government of Goa, Dr. Pandey. Later it was revised by the dy. Conservator of forests, Mr. RK.Singh and the revised version is included here.

Garcinia indica – efforts for development by Forest Department, Goa

R.K.Singh, IFS

Dy. Conservator of Forests, North Goa Division, Ponda – Goa

(The original presentation on a related theme was made by the former CCF, Dr. Pandey)

Introduction

Garcinia indica is popularly known as kokum or bhirand and is also stated to have been known as kokum butter tree or Indian butter tree. It belongs to the family *Guttiferae* and it is a slow-growing slender tree of moderate size, having a beautiful conical shape. It bears fruits with arillate seeds, which are spherical in shape and are as large as a small orange, green in beginning and turning to bright purplish red when fully ripe. Its horizontal, drooping branches have leaves that are simple, bright, oval or elliptical and dark green in colour, juvenile being red and membranous.

It is endemic to the evergreen forests of Western Ghats, mainly to Konkan region. It is found up to an elevation of 1800 m above the sea level and is suitable for forestland, wasteland and farmbunds. It is also reported to be there in South Gujarat, Assam and West Bengal. In Goa, it is mainly found in Quepem, Sanguem, Ponda, Canacona, Pernem, Bardez

and Sattari. It grows well on well-drained sandy loam, light soils and requires a temperature in the range of 15°-35° C and average rainfall of about 3000 mm.

Uses

- (1) It is commonly used as a souring agent in food and the rind of the fruit is used as daily food item in Konkan areas (commonly known as Kokum or Sol curry).
- (2) A sugary syrup is extracted from the pulp to make “sherbet”. It is a popular drink during summer months, as it is known to provide relief from the sweltering sun.
- (3) Kokum has outstanding medicinal properties and is used as an acidulant. The bark and young leaves act as astringent. The leaves are used as a remedy for dysentery. A decoction is given in cases of rheumatism and bowel complaints. It is useful as an infusion, or by direct application, in skin ailments such as rashes caused by allergies. It is also used for control of cholesterol and reduction of obesity.
- (4) Butter is extracted from the seeds, which is an emollient and is helpful in the treatment of burns, scalds and chaffed skin. It is used to cure the cracks on the foot, fissures of lips and hand etc. It is used in cosmetics as a base. Butter is used for preparation of food also.
- (5) Wood is used as firewood and also as poles since it is not attacked by ants.

Status of *Garcinia indica* in Goa

Garcinia indica (Kokum or Bhirand) is a tree, which is put to use by almost every person in Goa, mainly as a daily food item. Because of this reason, it is planted by many, either in their back yard or in their agricultural fields. Thus, kokum tree is available in almost every part of the Goa State. Some of the progressive farmers have taken up plantation of kokum trees in their agricultural fields. People in Goa are every year planting a large number of kokum saplings and grafts, either on their own or with the help of the forest and agriculture department.

Apart from the private areas, kokum tree is available in quite a good number in the forest areas of Goa. It generally is available in the western ghat areas, in semi-evergreen and evergreen forests.

Works by the Forest Department, Goa:

Forest Department, Goa is associated with the development of kokum since long-long back. Saplings of kokum are raised since beginning in the various nurseries spread all over the State. These saplings are distributed and sold to public and are also used for plantation purposes. Works of the forest department can be described as follows –

(1) Nursery raising:

Saplings of kokum are raised in almost all the nurseries since beginning. During the past five years, saplings not less than 25,000 per year have been raised by the forest department. These saplings in general have been raised in poly bags and with the advancement of technology; they have been raised in root trainers also lately. Forest department has followed the practice of selection of plus trees and collection of seeds from there for nursery raising. Thus, saplings raised in the nurseries of the forest department are quality saplings. The saplings so raised are distributed to people and are also utilized for plantation work of the department. Same saplings are utilized for preparation of kokum graft also.

(2) Plantation:

Main activity of the forest department is plantation in forest areas. Since beginning, plantation activity in the State is taken up by the department and kokum is planted in the plantations almost every year since then alongwith the other species, though the number planted every year will vary and not many trees were planted. However, planting kokum in forest areas have continued and it is being planted at present also and considerable area is brought under kokum plantation. Notable plantations exclusively of kokum are of Patradevi and Kodal. Plantation at Patradevi was raised some ten years before; plantation at Kodal is raised two years before only. New areas are being added every year and in the coming years, lot of kokum trees will be visible all round the State, once they become matured and start bearing fruits.

(3) Plantations in areas other than forests:

Besides forest areas, forest department has also taken up plantation of kokum in small scale in its Satpal Arboretum; Medicinal Plants Demonstration Plots at Valpoi and Valkini – Sanguem; Medicinal Plants garden at Tisk Usgao and at Aushadhi Vatika at Raj Bhavan. These plantations are basically raised to demonstrate the kokum plant and inform people about its uses and its cultivation practices.

(4) Damage to plantations:

It is observed that raising kokum plantation in forest areas is not an easy job to handle. There are many factors, which adversely affect the efforts of the forest department. Major of it is the damage to tender leaves and twigs by man and animals. Tender leaves of kokum have a pleasant sweet-sour taste and are liked by man and animal equally. Monkeys are the animals, which cause maximum damage to the saplings and they never allow it to grow. Deer and other herbivorous animals including bison cause considerable damage and even pole size crop is found to have been damaged by them. Damage due to other factors as insects and fungus is not observed much. All efforts are made by forest department to protect the plants by putting brushwood fence for individual plants, barbed wire fence for plantation areas, deployment of watchers etc.

(5) Preparation of kokum grafts:

Forest department is preparing kokum grafts for the last two years and three varieties have been developed at Ghotmode nursery and one at Valkini-Sanguem nursery. The work of preparation of kokum grafts is being extended in the coming year and more varieties will be developed at Tisk Usgao and Veluz, Valpoi nursery. Care is taken while developing the graft that the varieties developed are of high yielding and early fruiting only. Besides, size of fruit and quantity of pulp is also to be taken into consideration while developing the new varieties. Grafts so developed are being planted by forest department and are also being provided to the people for planting. Thus, forest department has gone quite far in development of kokum and the grafts, which till now were available at Vengurla Research Station, Maharashtra, are now available locally for the people and there dependence on Vengurla in future may come to a complete end because of the efforts of the forest department, Goa.

Thus, forest department, Goa has done lot of work towards development of *Garcinia indica* (Kokum) in the State and its efforts are continued. Forest Department has many plans in offing for covering more area of the State, forest area as well as private area, with *Garcinia indica* so as to provide sufficient raw material to the people of the State for further use by them. Establishment of a kokum processing plant and plantation of kokum grafts and development of kokum gardens is also in the pipeline and may be reality in the time to come. In all, it can be said that forest department, Goa is making all out efforts for development of kokum due to its multiple and regular use by the people and also for providing raw material to the industry for obtaining its medicinal benefits.

The first day's programme was over after Dr. Pandey's presentation. The above paper presents the latest knowledge as compiled by Mr. R.K.Singh on the topic.

Day two, March 5, 2005

Technical session 4:

- 1. Prospects of Kokum as an Intercrop/Bordercrop in Mango Orchards-** K. H. Pujari *et al.*
- 2. Traditional Methods of Kokum Fruit Processing-** Dr. G. D. Joshi.

Prospects of Kokum as an intercrop/Border crop in mango orchards

K. H. Pujari, B. P. Patil, R. S. Patil, S. S. Wadkar, P. B. Sanap and T. N.Thorat

Regional Fruit Research Station, Vengurle Dist. Sindhudurg.

Introduction

Kokum (*Garcinia indica* Choisy), indigenous to western Ghat, is an important fruit tree having culinary, pharmaceutical and industrial uses. Konkan region in general and Ratnagiri and Sindhudurga district in particular is famous for rich biodiversity. Kokum is one of the rare species which is adapted to the specific climate and geography of konkan. The traditional cultivation of kokum is done in the premises of the houses,coconut and arecanut gardens, along the banks of rivers, streams and nallas and waste lands. Under the World Trade Organization (WTO) and globalization, the kokum is crossing continents and generated interest among the people from outside the region of the country. Also it has paramount importance in the international market from medicinal point of view. The multifaceted kokum recently proved its potential in national and international markets. Scientific cultivation of this crop has therefore been introduced recently with improved varieties, propogation techniques and package of practices developed and standardized by the Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. The kokum fruits are used to prepare fruit syrup i.e. Amrit Kokum, Solkadhi, , Amsol(Dry rind) and Agal, Kokum powder etc. The oil of kokum seed has tremendous export value. Considering the importance of this crop, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli has released the "Konkan Amruta"the first ever variety of kokum as well as standardized the soft woodgrafting technique for preparing kokum grafts. In view of numerous medicinal properties, other major economic potential and future importance of kokum crop this crop can be grown as intercrop in mango orchard for more profitable and sustainable farm business. Being a rainfed crop, there is vast scope for expansion of this crop in near future. This promising crop has good potential to change the economy of Konkan region by providing avenues for income generation and employment opportunities through increased production by taking intercrop in mango and other rainfed orchards. The processing sector will consume increased production. The processed products of kokum have domestic as well as international market. Eventually, this crop has good potential to compliment the established crop that is mango, in foreign exchange earnings.

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

Methodology

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

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

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

Results and discussion

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

Table 1: Per hectare cost of establishment of kokum upto the year

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

- First year cost includes value of land.

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

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

Table 2: Economic Viability of Kokum crop

Sr. No.	Criteria	Particulars
1	Pay back period	9 years
2	NPV at 14% discount rate	135351
3	B.C. Ratio at 14% discount	2.75
4	I.R.R.	28.97

The per hectare cost of production is given in Table 3. The total cost of production was Rs. 42500 while cost of input was Rs. 15,500. Cost benefit ratio was 2.32 at the total cost level, while at input cost level, it was 6.39. In both the cases, it is more than one, indicating that kokum plantation is profitable one and can be considered favourably. The per kg. cost of producing kokum is Rs. 2.58 having Rs. 3.42 profit for the grower at present price of Rs. 6/kg. kokum.

Table 3: Economics & Annual Production of Kokum

Sr. No.	Particulars	Value
1	Yield /ha in kg.	16500
2	Gross value (Rs.) @ 6/kg	99000
3	Input Cost (Rs.)	15500
4	Total Cost (Rs.)	42500
5	Net return at input cost (Rs.)	84000
6	Net return at total cost (Rs.)	56500
7	Output-input ratio	6.39
8	Cost Benefit Ratio	2.33
9	Cost per kg. (Rs.)	2.58

Table 4: Cost of establishment of kokum grafts planted in mango orchard as border row (upto 7th year) (64 grafts)

Year	Amount (Rs.)
First	6575.00
Second	880.00
Third	904.00
Fourth	851.00
Fifth	1088.00
Sixth	1305.00
Seventh	1596.00
Total	13186.00

Table 5: Cost of establishment of kokum grafts planted in mango orchards border rows as well as roadside avenue. (upto 7th year) (124 grafts)

Year	Amount (Rs.)
First	12738.00
Second	1705.00
Third	1751.00
Fourth	1648.00
Fifth	2108.00
Sixth	2526.00
Seventh	3092.00
Total	25568.00

Table 6: Per hectare cost of establishment of mango upto 7th year

Year	Amount (Rs.)
First	29617.00
Second	9223.00
Third	8195.00
Fourth	4735.00
Fifth	5861.00
Sixth	6935.00
Seventh	8145.00
Total	72711.00

Table –6 revealed that cost incurred for establishment of mango orchard comes Rs. 72,711. The maximum expenditure is incurred in the first year. The annual expenditure is found to be declining upto fourth year and from the fifth year it increase when trees start bearing.

The economic viability of investments in mango according to different criteria is given in Table 7.

Table 7: Economic viability of investment in Alphonso Mango.

Sr. No.	Criteria	Particulars
1	Pay back period	15 years
2	Net present value at 14% discount rate	66080.00
3	B.C. ratio at 14% discount	1.38
4	Internal rate of Return %	19.68

The pay back period is found to be 15 years for mango. It meant that capital cost in mango orchard would be recovered within a period of 15 years. The benefit cost ratio at 14% discount is 2.53. The internal rate of return is 19.68% per annum. The benefit cost ratio is more than unity and internal rate of return is more than the prevailing borrowing interest rate, indicating that the investment in mango orchard is economically viable and worthwhile.

The economics of annual production of mango crop is given in Table8. Per hectare total cost incurred for mango orchard worked out to Rs. 54439.00. Per hectare yield obtained is 5000 kg and the gross returns are Rs. 7500.00 leaving net profit of Rs. 45762.00. The output: ratio is 1.38.

If kokum grafts are planted in mango orchard as border (64 grafts/ha), per hectare total cost incurred for kokum grafts worked out to Rs. 9891.00 and per hectare yield obtained is 3840.00 kg. The output input ratio is 1.49, which is significantly higher than mono cropping of mango orchard. And if kokum grafts are planted in mango orchard as border rows as well as roadside avenue (124 grafts/ha), then per hectare total cost incurred for kokum grafts worked out to Rs. 193119.00 and per hectare yield obtained is 7500.00 kg. The output input ratio is 2.91 which is higher than mono cropping of mango orchard as well as kokum grafts planted in mango orchard in border row only indicating

that the kokum as inter crop in mango orchard is economically more viable and worthwhile.

Table 8: Per hectare cost of cultivation of mango by following recommended package of practices

Sr. No.	Particulars	Quantity/Unit	Rate (Rs.)	Amount (Rs.)
1	Labour – Male Female Bullock	169 days 80 days 9 p. days	67.00 67.00 125.00	11323.00 5360.00 1125.00
2	F.Y.M.	30 C.L.	175.00	5250.00
3	Fertilizers 1) Urea @ 100kg.n/ha 2) Single superphosphate 50kg P2O5/ha 3) Muriate of Potash (50kg K2O/ha)	326 kg 313 kg 84 kg	5.02 3.14 4.62	1637.00 983.00 388.00
4	Plant Protection 1) Cypermethrin 2) Endosulfan 3) Rogar 4) Quinolphos 5) Wettable sulphur	600 ml. 3 lit. 2 lit. 4 lit. 4 kg.	340.00 260.00 238.00 368.00 60.00	204.00 780.00 476.00 1472.00 240.00
5	Depreciation on implements and machinery Land revenue and other cesses Interest on Working Capital @ 13% for 12 months Interest on Fixed Capital @ 10% Rental value of land (1/6 th of the gross value of land revenue) Supervision charges @ 10% input cost Amortization value	- - - - - - -	- - - - - - -	500.00 50.00 3801.00 500.00 12450.00 2924.00 4976.00
	Total cost			54439.00

Yield and gross returns			
1) Main product	50Q.	1500.00	75000.00
Gross returns			75000.00
Net returns at			
1) Input cost			45762.00
2) Total cost			2056.00
Cost benefit ratio			1.38
Cost per Quintal			1089.00

Table 9: Economics & annual production of kokum grafts planted in mango orchard as border rows. (64 grafts)

Sr. No.	Particulars	Value
1	Yield/ ha in kg	3840.00
2	Gross Value (Rs.) @ Rs.6/kg	23040.00
3	Input Cost (Rs.)	3607.00
4	Total Cost (Rs.)	9891.00
5	Net returns at input cost (Rs.)	19550.00
6	Net return at total cost (Rs.)	13149.00
7	Output –Input ratio	1.49
8	Cost Benefit ratio	0.49
9	Cost per kg (Rs.)	0.61

Table 10 - Economics & annual production of kokum grafts planted in mango orchard as border rows as well as roadside avenue (124 grafts)

Sr. No.	Particulars	Value
1	Yield/ ha in kg	7500.00
2	Gross Value (Rs.) @ Rs.6/kg	45000.00
3	Input Cost (Rs.)	7046.00
4	Total Cost (Rs.)	19319.00
5	Net returns at input cost (Rs.)	38182.00
6	Net return at total cost (Rs.)	25682.00
7	Output –Input ratio	2.91
8	Cost Benefit ratio	1.06
9	Cost per kg (Rs.)	0.46

Economic viability of integrated plating of kokum with mango as border crop provides ample evidence to the fact that kokum can find economically and ecologically viable place in rarified orchards of Mango.

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

Dr. G.D. Joshi then made his presentation.

Traditional methods of Kokum (*Garcinia indica* Choisy) fruits processing

Dr. G.D. Joshi

Head,

Department of Horticulture,

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

Introduction

Kokum is an evergreen tree found in the tropical forests of India, particularly in Maharashtra, Karnataka, Kerala, West Bengal and Assam. The important producing areas are Western Ghats, Coorg, Wyand and Ratnagiri. No reliable statistical information is available as to how much Kokum is available in India. However, in the Konkan region alone about 4,000 tonnes are produced. One survey report has indicated that Western Ghats region contain about 15 lakhs trees and the estimated yield is 10,000 bags each with 100 seers of seeds. The tree flowers in November-February and fruits ripen in April-May.

Processing of kokum fruits

Traditionally, fresh fruits are collected from the forest areas and are pooled and marketed when freshly harvested, the fruits are reddish green in colour and turns into full-red-purple colour in a day or two. The fruit has an agreeable flavour and sweetish acid taste. The normal shelf-life of the fresh fruits is about 5 days. Hence sundrying is practised for preservation. For sun drying, the fresh fruits are cut into halves and the fleshy portion containing the seeds is removed. The rind which constitutes about 50-55% of whole fruit is repeatedly soaked in the juice of the pulp during the sun drying. About 6-8 days are required for complete drying. The product so dried, constitutes the unsalted Kokum of commerce. A salted variety, where common salt is used during soaking and drying of the rind is also marketed. Lonavala kokum, Pakali kokum, Khanee or edible kokan and Khoba kokum are some of the trade varieties.

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

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

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

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

Selection of fruits

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

Raw kokum juice extraction

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

Preparation of R.T.S.

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

Parameters	Quantity
Juice	20 per cent
T.S.S.	20 per cent
Acidity	0.3 per cent
Water	Remaining

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

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

Preparation of squashes

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

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

Preservative sodium benzoate @ 610 mg/kg of final product. After adding the necessary quantity of sugar the product was boiled to dissolved the ingredients. The preservative sodium benzoate for coloured are added @ 610 mg/kg of final product. The final product was filled immediately into the presterilized glass bottles, further the bottles are sealed immediately with the crown corks and are pasteurised for 30 min. in boiled water. The filled

bottles are then removed, cooled labelled and stored at cool and dry places at ambient temperature.

Preparation of Syrup (Amrut Kokum)

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

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

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

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

Ripe kokum rind powder

Selection of fruits ripe, fresh and sound kokum fruits are selected. The fruits are cut into pieces. Inner pulp and seeds are removed. The pieces are dried in cabinet drier at 50-55°C and after drying, powdered in electrically operated grinder. The powder is then sieved through 1 mm mesh sieve and then packed in polythene bags and kept in a cool and dry place at ambient temperature conditions.

Brined kokum juice (Agal)

The fruits are cut into pieces and inner pulp and seeds are utilized. The pulp along with the seeds are taken into a big stainless steel vessel. The salt at the rate of 160g per kg pulp was added. The mixture was stirred daily for seven days. After seven days the whole mixture was strained through stainless steel sieve. Thus, brined juice was then filled in presterilized bottles.

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

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

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

Chemical characteristics of the fat

Melting point	39° - 43°C
Sap value	189
Iodine value	34.7 to 36.7
Unsap matter (%)	1.4%

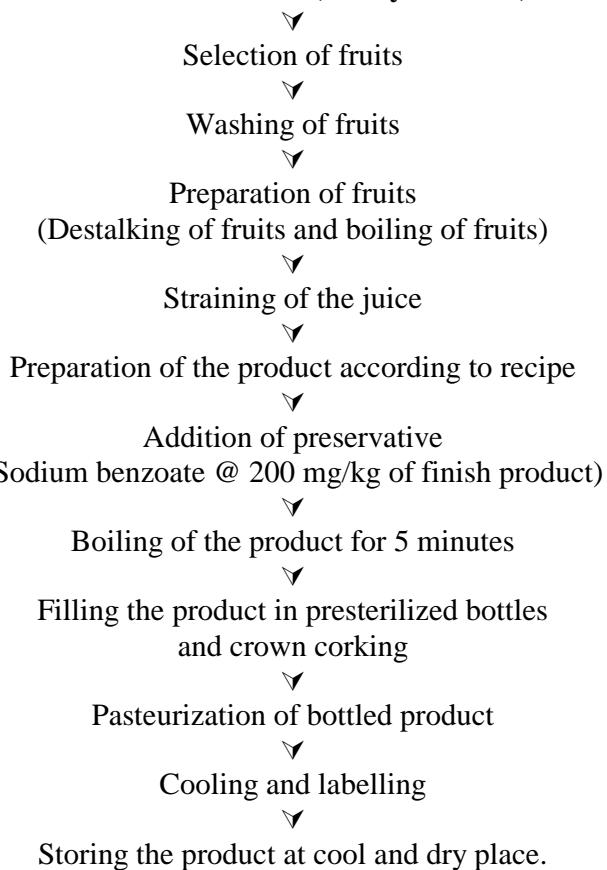
The component fatty acids percent by wt. are

Myristic	0 – 1.2
Palmitic	2.5 – 5.3
Stearic	52.0 – 56.4
Oleic	39.4 – 41.5
Linoleic	1.7

Kokam fat has been reported to be used in chocolate and confectionery preparation. It is also used in the manufacture of soap, candle and ointments. An ointment made out of kokam fat, white dammar resin (resin exuded by Vateria Indica tree) and wax is said to be effective in treating carbuncles". It is reported that Italy and some other foreign countries are importing kokam fat from India. For use in confectionery preparations.

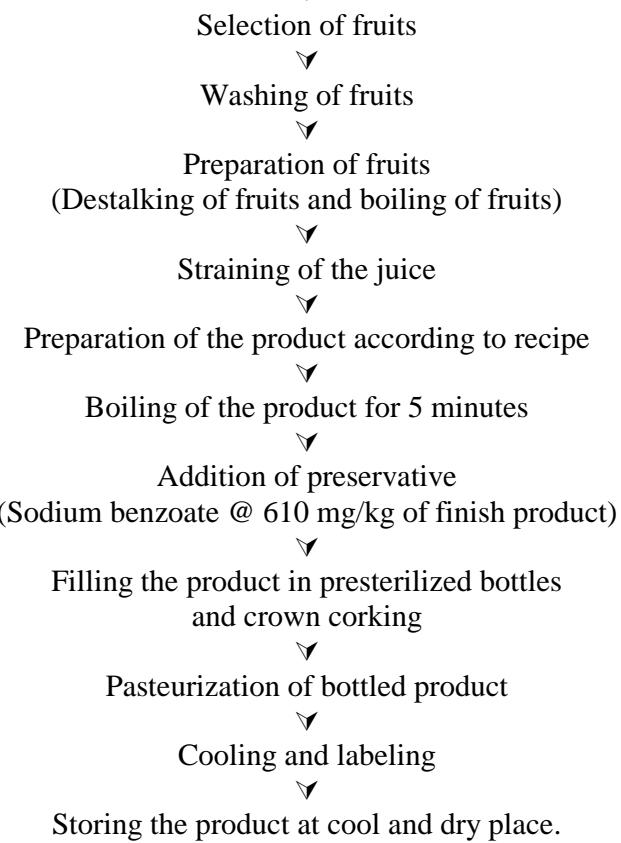
Flow sheet 1

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



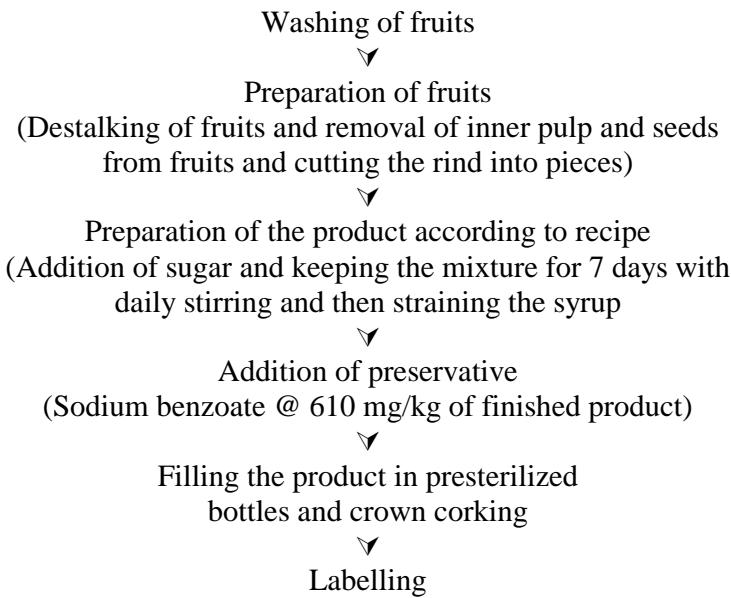
Flow sheet 2

Raw kokum squash



Flow sheet 3

Ripe kokum syrup (Amrut Kokum)



▼
Storing the product at cool and dry place

Flow sheet 4
Brined Kokum Juice (Agal)

▼
Selection of fruits
▼
Washing of fruits
▼
Preparation of fruits
(Destalking of fruits and separation of inner pulp)
▼
Preparation of the product according to recipe

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

▼
Straining of pulp
▼
Filling the product in presterilized
bottles and crown corking

▼
Labelling
▼
Storing the product at cool and dry place

Flow sheet 5
Ripe Kokum Rind Powder

▼
Selection of fruits
▼
Washing of fruits
▼
Removal of inner pulp and seeds from rind
▼
Drying the rind in cabinet drier at 50-55°C
▼
Grinding the dried rind into fine powder

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

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

Questions:-

1. In the conventional method of harvesting, damage to fruits is unavoidable leading to poor shelf life. Is any technology available for improved harvesting with minimal injury?
2. Do we have a Kokum Website? What is the advantage of raw Kokum squash in comparison to the ripe kokum syrup (Amrut Kokum) not one for WGKF?

3. Can we blend kokum juice with other fruits? Can you give the procedure for he same? Can we do Kokum RTS? Can jams be prepared?
4. What about the metal used in the production and storage, as HCA is highly corrosive?
5. What is the procedure for collection of Kokum butter? Whether there is any difference between oil content of the mature greenish red Kokum and ripe Kokum?
6. There are many traditional ways in Maharashtra of preparing juice, jams and value added products. Do you have studied or have any knowledge about value added products?
7. Drying Kokum rind at 50-55°C does this retain the quality of Kokam amsul dried in the sun?
8. In case of kokum rind powder, is it possible to sundry the rind?

Day two, technical session 5:

Chairperson:-Mr. S.D. Tendulkar

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

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

The first paper of this session was presented by Dr. Nandkumar Kamat, Goa University. The revised version of his paper is presented here.

Non-traditional products from Kokum: inland and global opportunities

Nandkumar M. Kamat

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Introduction

Kokum or *Garcinia indica* Choisy is one of the 200 species in the genus *Garcinia* found in the Afro-Asian countries and one of the 30 species found in India. The *Garcinia indica* bioresource base may include the primary products like the fruit with the rind, pulp and the seeds, the flowers, the floral nectar, the pollens, the leaves, the wood and the roots and the associated microflora. The ecological anthropology of traditional *Garcinia indica* products shows that the useful properties of edible parts were discovered by the local communities by ‘trial and error’ and ‘cause and effect’ strategies perhaps during the food gathering stages. Products like food colourants, juice, brined solution, butter and oil were prepared without understanding their chemical and biochemical composition. These traditional products and the local knowledge about their properties could have provided the important biological leads to the chemists searching for novel biomolecules. So, we can say that the age of “Kokum bioprospecting” has now begun. This age would see discovery of many novel biomolecules from Kokum. Several of these would be tested for their useful bioactive, pharmacological, medicinal properties and potential application in food industry. Table 1 gives the list of major biomolecules and their percentage weight per unit fruit biomass. Such research and development would open many opportunities for the Kokum producers to supply best quality fruits or any other plant part in demand. Value addition of primary products is another opportunity for kokum producers. Natural food colourants can be extracted from the red and

yellow pigments, which constitute 2.4% of the fruit biomass. The kokum juice can be fermented to produce high quality fruit wine.

Table 1 major biomolecules from *G. indica* fruits

Biomolecules	Percentage weight
Proteins	1.00
Tannin	1.70
Pectin	0.90
Fats	1.40
Total sugars	4.10
Pigments	2.40
Organic acids	5.10

Non-traditional products: - the present knowledge

February 2005

As on February 20, 2005, search with Google returned 17400 entries for Kokum and 212,000 for *Garcinia* and only 688 entries for *G. indica*. Only five entries were found under ‘kokum products’ and 78 under *Garcinia* products.

November 2005

As on November 30, 2005, search with Google returned 51700 entries for Kokum and 624000 for *Garcinia* and only 862 entries for *G. indica*. There was no change for entries under ‘kokum products’. However under *Garcinia* products 2840 entries were found.

Scientific research

February 2005

A search on Scirus website, which searches only technical papers returned 17 journal entries and 283 web entries fro Kokum. The Pubmed database of National Library of Medicine, USA showed only a single entry under Kokum, 195 under *Garcinia* and 8 under *G. indica*. The scholar.google search engine which returns only scientific papers showed 40 entries under Kokum, 1050 under ‘*Garcinia*’, and 40 under *G. indica*. These results point to Kokum bioprospecting as a relatively novel field.

November 2005

Scirus website returned 19 journal and 312 web entries for ‘kokum’. Pubmed database showed two entries under ‘Kokum’, 237 under *Garcinia* and 12 under *G. indica*. The scholar.google.com search engine returned 80 entries under ‘Kokum’, 1710 under ‘*Garcinia*’ and 492 under *G. indica*.

A comparison of the above search data clearly shows the growing scientific importance of Kokum.

Patent databases searches

The United states patent database (uspto.gov) is the largest in the world and has entries from 1790. It showed 40 US patents under ‘kokum’ (44 in November 2005) and 21 under ‘Kokum products’ (35 in November 2005). Data from February 2005 is listed in Annexure 1 and 2. An analysis of the patents showed that USA, India, Japan and France are main players in Kokum bioprospecting. The patents refer to use of Hydroxycitric acid, various methods of producing its’ alkaline and metallic salts, the large scale isolation of *Garcinia* acid and various processes and formulations in food, chocolate, confectionary industries. Novel uses

of *G. indica* fat for solidification of organic liquids is another application for which an Indian team (Daniels, 2003) has got patent.

Some useful non traditional products

1. **Hydroxycitric acid (HCA)** also known as *Garcinia* acid has found many commercial applications. It may inhibit the body's ability to store fat, possibly causing more fat from foods to pass through the body without being stored. It is suggested that, HCA may cause the body to use existing body fat for energy during prolonged exercise. HCA is being promoted as an ingredient of anti-obesity formulations. A GOOGLE search returned 894 entries for 'HCA and *Garcinia*'. The physiological and biochemical effects of (-)-HCA have been studied extensively for its unique regulatory effect on fatty acid synthesis, lipogenesis, appetite, and weight loss. The derivatives of (-)-HCA have been incorporated into a wide range of pharmaceutical preparations in combination with other ingredients for the claimed purpose of enhancing weight loss, cardioprotection, correcting conditions of lipid abnormalities, and endurance in exercise.

2. Benzophenone derivatives

Kokum fruit rind contains 2-3% Garcinol, a polyisoprenylated benzophenone derivative, a yellow pigment by weight. It has some antibiotic properties and has been found to be a potent inhibitor of histone acetyltransferase and is considered as a potential anti-cancer agent. Yamaguchi et.al., 2000 reported antioxidative activity, chelating activity, free radical scavenging activity, and anti-glycation activity. They have suggested that garcinol might be beneficial as a potent antioxidant and a glycation inhibitor under specified conditions. Garcinol has also shown *in vivo* cancer chemopreventive activity against colonic aberrant crypt foci in an animal model. Therefore, the Japanese research group regards, benzophenone derivatives as useful candidates for drug development including anti cancer agents. They confirmed that garcinol has potent free radical scavenging activity in three kinds of free radical generating systems. Hydroxyl radical is regarded as the most dangerous ROS, and, therefore, garcinol is expected to be useful for preventing diseases caused by that radical, such as stress-induced gastric ulcer and nonsteroidal anti-inflammatory drug-induced gastric. These results suggest that garcinol, a free radical scavenger, may have potential as an antiulcer drug. Although the mechanism of its antiulcer activity is not yet understood, garcinol may scavenge reactive oxygen species on the surface of gastric mucosa, thus protecting cells from injury.

Some useful non traditional properties

1. **Organogelation:** - Rajasekharan and Daniels from Indian Institute of science, Bangalore, used Kokum fat to solidify organic liquids in 12 hours at room temperature and in just 1 hour at 4°C. Further experiments showed that any saturated fatty acid that has between 10 and 31 carbon atoms can perform the same trick, although the gelling efficiency was more efficient with smaller molecules. Moreover, saturated wax esters--a certain type of derivative of fatty acids used to make cosmetics--were just as efficient. Data in Table 2 and 3 has been taken from their US patent.

TABLE 2
Fatty Acid Composition of Triacylglycerols in Mature Seeds of *G. indica*
Fatty Acid Composition

Age of Seeds (DAF)	(Percentage by Weight)				
	C16:0	C18:0	C18:1	C18:2	C20:0
120	4.6	59.3	35.3	0.1	0.7

TABLE 3
Percent Kokum Fat Required for Solidification of Organic Liquids at Four Degrees Celsius

Percent Kokum	
Organic Liquid	Fat
Sunflower Oil	10
Lavender Oil	15
Petrol	20
Kerosene	20
Acetone	20

This property definitely has a wide range of commercial and industrial applications.

Some useful non traditional products:

1. **Kokum wine-** The red Kokum juice has about 4 percent sugars and can be fermented to produce wine. Kokum wine is prepared in Goa using the traditional method (Saladnha, 1995) with commercial bakers' yeast. However this method has been found to give wine of poor quality. An improved method was developed by us at our department using a strain of natural wild *Saccharomyces* sp. and fresh juice. Bottled juice/syrup with preservative or brined Kokum extract was not found to be ideal for fermentation.
2. **Kokum honey-** Honey is concentrated floral nectar. So far no efforts are reported to establish apiculture units in a kokum plantations but if this is done then 'Kokum honey' can be obtained with excellent medicinal qualities.

Some novel applications under research in our laboratory-

3. Kokum based sunscreens- The acidic juice contains pigments which strongly absorb in the DNA damaging Ultraviolet range. This property is useful in producing sunscreens in cosmetics industry (Kamat & Phadte, 2005).
4. Kokum pigment based pH indicators and biosensors- We have recently reported that increasing alkaline conditions affect the colour of the fresh juice and this property can be utilized to develop pH indicators and pH sensitive biosensors for a pH range of 3-13.

The unexplored potential-

There is very little knowledge about various amino acids, vitamins, proteins, enzymes, glycoconjugates, lectins, polyphenolics etc, from *G. indica*. Perhaps more directed efforts of Kokum bioprospecting and chemical screening may yield novel compounds with useful properties.

Inland opportunities-

1. Opportunities in R & D: -These would exhaustively analyse all the chemical components of *G. indica* and prepare a chemical and biochemical database.
2. Opportunities to create Kokum based IPRs: - Already India has scored well to obtain US patents on various Kokum ingredients, products and processes. This can be further promoted through targeted screening.
3. Opportunities to assess and evaluate Kokum microbiodiversity: - Already a few bacterial, fungal and yeast species from Kokum have been documented. This has to be expanded to cover different cultivars. The ecological and biological role of these species would have to be explored. A few microbial species may be biochemically creative.

4. Opportunities in HCA and Garcinol based products and derivatives: - the local industry can extract and supply these ingredients in bulk and also produce a new line of formulations.
5. Organogelation: - This property can be further explored by the oil and fat industries for solidification of the oils.
6. Extraction of edible pigments: - Kokum pigments can be extracted and used as natural food colorants.
7. Wine production: - This would add value to the juice. Quality wine can be branded and marketed as organic and medicinal wines.
8. Kokum honey production: - Kokum honey would have great demand.

Global opportunities:

1. Supply of the raw material (kokum rind) to extract HCA and Garcinol
2. Bulk supply of crude or pure HCA and Garcinol or their derivatives
3. Export of Kokum wine

Conclusions:

The recent research establishes *Garcinia indica* as biochemically one of the most creative plant species. Appropriate utilization of the non-traditional products like HCA, Garcinol, wine, Purified pigments and processes such as organogelation would create more domestic and International demand. As research progresses, Kokum would attract worldwide attention and the Indian Kokum cultivators could expect to benefit from the R & D leads. For raw material, crude products and purified substances, the demand may increase in future. To meet it, Kokum cultivators would have to be ready to produce surplus marketable crops.

Annexure I

United States Patent databases: -List of Patents granted from 1976 on *Garcinia indica*

PAT. NO.	Title
1 <u>6,818,234</u>	<u>Dietary food supplement containing natural cyclooxygenase inhibitors and methods for inhibiting pain and inflammation</u>
2 <u>6,780,440</u>	<u>Herbal compositions and methods for diabetes and weight loss management</u>
3 <u>6,770,782</u>	<u>Process for the production of potassium hydroxy citric acid, and compositions containing the potassium hydroxy citric acid</u>
4 <u>6,706,899</u>	<u>Acyclic chiral compound from garcinia acid and process for preparing the same</u>
5 <u>6,489,492</u>	<u>Chiral derivatives of Garcinia acid bearing lactone ring moiety and process for preparing the same</u>
6 <u>6,395,296</u>	<u>Soluble double metal salt of group IA and IIA of hydroxycitric acid, process of preparing the same and its use in beverages and other food products without effecting their flavor and properties</u>
7 <u>6,391,928</u>	<u>Process for preparing a novel synergistic solid/semi-solid organic composition</u>
8 <u>6,294,190</u>	<u>Antibiotic agent containing procyanidin as the active ingredient</u>
9 <u>6,221,901</u>	<u>Magnesium (-)hydroxycitrate, method of preparation, applications, and compositions in particular pharmaceutical containing same</u>
10 <u>6,217,898</u>	<u>Pharmaceutical composition comprising carnitine or alkanoyl L-carnitine, for the prevention and treatment of diseases brought about by lipid metabolism disorders</u>

- 11 6,160,172 Soluble double metal salt of group IA and IIA of (-) hydroxycitric acid, process of preparing the same and its use in beverages and other food products without effecting their flavor and properties
- 12 6,147,228 Convenient method for the large scale isolation of garcinia acid
- 13 6,126,950 Composition useful for healing and protecting skin
- 14 6,113,949 Weight control product and method of treating hyperlipidemia and increasing vigor with said product
- 15 5,972,357 Healthy foods and cosmetics
- 16 5,783,603 Potassium hydroxycitrate for the suppression of appetite and induction of weight loss
- 17 5,656,314 Hydroxycitric acid concentrate and food products prepared therefrom
- 18 5,536,516 Hydroxycitric acid concentrate and food products prepared therefrom
- 19 4,594,194 Fat fractionation
- 20 4,348,423 Method of preparing a cocoa butter substitute
- 21 4,157,405 Cocoa butter substitutes and their preparation

Annexure 2

US Patent database: -List of Patents on “Kokum” granted since 1976

- | PAT. NO. | Title |
|---------------------|--|
| 1 <u>6,822,141</u> | <u>Diacylglycerol acyl transferase proteins</u> |
| 2 <u>6,818,234</u> | <u>Dietary food supplement containing natural cyclooxygenase inhibitors and methods for inhibiting pain and inflammation</u> |
| 3 <u>6,770,782</u> | <u>Process for the production of potassium hydroxy citric acid, and compositions containing the potassium hydroxy citric acid</u> |
| 4 <u>6,713,117</u> | <u>Vegetable oil having elevated stearic acid content</u> |
| 5 <u>6,649,781</u> | <u>Recovery of minor components and refining of vegetable oils and fats</u> |
| 6 <u>6,517,883</u> | <u>Satiety product</u> |
| 7 <u>6,444,876</u> | <u>Acyl CoA: cholesterol acyltransferase related nucleic acid sequences</u> |
| 8 <u>6,395,296</u> | <u>Soluble double metal salt of group IA and IIA of hydroxycitric acid, process of preparing the same and its use in beverages and other food products without effecting their flavor and properties</u> |
| 9 <u>6,391,928</u> | <u>Process for preparing a novel synergistic solid/semi-solid organic composition</u> |
| 10 <u>6,160,172</u> | <u>Soluble double metal salt of group IA and IIA of (-) hydroxycitric acid, process of preparing the same and its use in beverages and other food products without effecting their flavor and properties</u> |
| 11 <u>6,103,292</u> | <u>Food products containing structured triglycerides</u> |
| 12 <u>5,972,357</u> | <u>Healthy foods and cosmetics</u> |
| 13 <u>5,783,603</u> | <u>Potassium hydroxycitrate for the suppression of appetite and induction of weight loss</u> |
| 14 <u>5,679,393</u> | <u>Method of preparing fat fractions of vegetable origin enriched with unsaponifiable materials and use of said fractions for preparing cosmetic and/or pharmaceutical compositions, in particular dermatological compositions</u> |
| 15 <u>5,135,769</u> | <u>Fat and oil composition</u> |
| 16 <u>5,111,860</u> | <u>Compression log debarking apparatus</u> |
| 17 <u>5,023,101</u> | <u>Shortening for hard butter product and process for producing hard butter product</u> |
| 18 <u>5,022,446</u> | <u>Compression log debarking apparatus</u> |

- 19** 4,956,287 Process for producing oleaginous composition
20 4,948,618 Process for tempering edible plastic fat products
21 4,940,845 Esterification process of fats and oils and enzymatic preparation to use therein
22 4,910,037 Tempering accelerator and use thereof in chocolate
23 4,880,658 Obtaining a fat fraction with azeotropic solvents
24 4,877,636 Chocolate and chocolate additive
25 4,875,511 Apparatus for removing bark from logs
26 4,874,699 Reaction method for transesterifying fats and oils
27 4,844,940 Hard butter
28 4,839,192 Hard butter composition containing triglycerides, and process for production thereof
29 4,839,191 Fat fractions and mixtures thereof
30 4,735,900 Enzyme preparation for interesterification
31 4,613,514 Cacao butter substitutes and chocolates containing the same
32 4,601,857 Process for fat fractionation with azeotropic solvents
33 4,594,194 Fat fractionation
34 4,420,560 Method for modification of fats and oils
35 4,348,423 Method of preparing a cocoa butter substitute
36 4,308,350 Method for producing cacao butter substitute
37 4,276,322 Chocolate having defined hard fat
38 4,219,584 Hard butter composition
39 4,157,405 Cocoa butter substitutes and their preparation
40 4,032,405 Method for producing cacao butter substitute

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

Questions:-

1. In making wine of Kokum syrup, HCA being a stabilizer it is preventing the fermentation process? If we add monomeric sugars at the rate of 10% to Kokum syrup and then ferment, will it ferment completely to form wine?

Response:- knowledge of sugar concentration is a very important parameter in Kokum wine making, since oxygen tension is lowered by the formation of carbon dioxide. He further said that by adding monomeric oxygen, the wine would not be of organic origin.

2. What are the ill effects of taking HCA for a long time?

-Response:- long time use of HCA is not life threatening and its ill effects are mild or idiopathic and research is still being done in this matter.

3. Where can we sample Kokum wine? After sampling, could a bottle be purchased?

- Response:- Possibly in Poinginium and Keri in the year 2006 if everything goes on well as planned. Kokum wine of good quality requires at least a year of maturity under low temperature. More the maturity, better would be the taste.

4. Does HCA naturally present in Kokum fruit has any side effect on the health on its constant use, as it is said that the tablets otherwise used on the same for reducing weight loss?

5. What is the alcohol percent in the wine?

Response:- In kokum wine, ethyl alcohol is present in about 7-9% (v/V).

The next paper was presented by Shri R.N.Hegde. The main points from his talk are outlined.

Credit Support from NABARD for Development of Kokum in India

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India is emerging as one of the fastest growing economies in the world. The progress of agriculture has been impressive in production terms over the years and the country ranks in the top position in terms of production for most of the agricultural items in the world, say first in pulses, milk, coconut, mango, cashewnut, ginger, turmeric, black pepper, second in fruits, vegetables, rice, wheat, groundnut, sugarcane, inland fish, fourth in case of coarse cereals and cotton, fifth in oil seeds and eggs, sixth in fish production and seventh in meat production.

Agriculture in India has been the preserve of small and marginal farmers (less than 2 ha land) who account for 78% of land holdings. Credit has played an important role in increasing agricultural production.

There has been an increasing trend in the flow of credit for agriculture at the grassroot level over the years from 18744 crore in 1994-95 to 69560 crore (details of disbursements made bank-wise, year-wise and sub-sector-wise give in Annexure-II).

The National Bank for Agriculture and Rural Development (NABARD) came into existence in July 1982. It is established for providing credit for the promotion of agriculture, small scale industries, handicrafts and other allied economic activities in rural areas with a view to promoting integrated rural development and security prosperity in rural areas.

NABARD provides refinance support for a broad spectrum of investment and production oriented activities in the rural sector sprawled over minor irrigation, animal husbandry, farm mechanisation, forestry, fisheries, land development, dryland farming, market yards and storage godowns, non-farm activities, rural industries, plantation and horticulture, medicinal and aromatic plants also get the attention of NABARD for credit support under horticulture sector. Kokum is also one of the important crops of the Western Ghats, which is being supported by NABARD.

Present status of Kokum

Kokum (*Garcinia indica* Choisy) is an economically important, but neglected fruit, medicinal and spice tree of Western Ghats of India. Traditionally the tree is grown as homestead tree.

The tree itself is ornamental with handsome evergreen dense canopy having lush green leaves with red tinged tender emerging leaves. Being pyramid shaped, also makes a good choice for growing on roadside as avenue tree. It belongs to the family Guttiferae. It is wildly grown in tropical humid forests of Western Ghats of Maharashtra (Konkan), Goa and parts of Karnataka and Kerala, Gujarat and also in Andaman Islands. Recently Kokum is gaining importance because of its medicinal uses. Its every part is utilised. Recent discoveries on the anti-obesity factor in *Garcinia* sp. has kindled great interest worldwide and there is a need to promote this tree as a commercial fruit. It is prescribed in Ayurveda for ailments as varied as rheumatism, rickets, enlargement of spleen, uterine complaints and in animal disorders. The translucent yellow resin is used as a purgative. The rind is a rich source of para hydroxy Citric Acid (HCA). In future kokum can be used for extraction of HCA and food colour as rind yields natural red pigments. It could be ideal substitute for grapes in the wine industry. As kokum reduces fat, cools body, purifies blood, fights cholesterol, it will attract health conscious people.

Kokum trees presently found in Konkan region are mostly of seedling origin. Farming community made no efforts for commercialization so far. It is seldom planted in the form of an orchard and generally scattered trees are found in coconut, arecanut, mango gardens and waste lands along with cashew.

Kokum is a unique food spice, which is covered by Spices Board, Government of India, for development. Kokum is also recognized as a medicinal plant by National Medicinal Plant Board, Ministry of Health and Family Welfare, Government of India.

Kokum products of commerce

Kokum juice (The Health Drink)

It is extracted from fresh ripened kokum rinds. This purple colour juice is sour in taste. It is used to prepare kokum syrup and kokum curry. The juice is used in obesity management. Kokum juice acts as anti cholesterol and is a popular remedy for stomach upset. Indian Kokum (*Garcinia Indica*) is one of the few Hydroxycitric Acid (HCA) yielding species in the world having the highest naturally occurring concentrations. HCA curbs appetite without negatively affecting the nervous system unlike other fat reducing drugs. It lowers the production of cholesterol, improves energy level and is cardio protective too. It is found to be completely safe and effective in weight management by the studies made by many reputed research institutes including Brandies University and Hoffman La Roche.

Kokum syrup concentrate

The concentrate is prepared from the juice of fresh ripen Kokum fruits. It has a slightly sweet and sour aroma and is of pink colour. 'Ready to Serve' beverage is prepared by adding

eight times cold water in the concentrate. Kokum syrup cools you and is commonly used in sunstrokes and bilious afflictions.

The concentrate is available in following two variants (i) Kokum Syrup with no preservatives, colour, salt or water, except sugar and (ii) Kokum Syrup with permitted preservatives and salt.

Kokum Amsol

Kokum Amsol, 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 vegetable dishes. Kokum is popularly used with fish curries; three or four rinds are enough to season an average dish.

Kokum Butter

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 of cosmetics and ointments. It is nutritive, demulcent, astringent and emollient and is helpful in skin ailments such as rashes, allergies, burns, scalds and chaffed skin. The kokum butter is used for manufacture of cosmetics, creams, soaps, confectionery, candles, etc.

Kokum fruit is gaining substantial importance next to mango and coconut in south coastal Konkan tract of Maharashtra. The crop has tremendous potential for its value added products and medicinal importance.

Though almost all farmers have a few plants of kokum fruit trees in their backyards, but there is no organized plantations of kokum in the country, hence, the area under its cultivation is not properly estimated anywhere. In Maharashtra, though Kokum is included in Employment Guarantee Scheme (EGS) since long back, farmers have not taken the advantage of the scheme for growing kokum as an orchard crop. The farming community made no efforts for commercialization so far. It is seldom planted in the farm of orchard, but generally scattered trees are found in coconut, arecanut, gardens and wastelands. The reason for not getting the attention of the farmers to take up kokum on a commercial scale could be attributed as below :

- ◆ Harvesting of kokum fruits coincides with the rainy season, as ripening of fruits takes place in May or the first week of June.
- ◆ Harvesting will be difficult due to lack of suitable harvesting device.
- ◆ Scattered planting makes it more difficult for collection.
- ◆ Very few alternative value added products have been found.

- ◆ Technology for processing is not upgraded.
- ◆ Kokum of commerce is prepared by sun-drying the rind (skin or husk) of the ripe fruits after soaking it in the juice of the pulp. But sun-drying is very difficult as the fruit gets infected in the rains.

Hardly 30% of the existing production is properly utilized. 70% is wasted due to rain or realization of poor price. While the farmer gets Rs.1 to 3 per kg, the processor gets 10 times more income because it is an industry. The major products from the kokum fruit are syrup, amsol (salted and dried rind) and butter. The fruit is very soft, similar to litchi, phalsa, strawberry, etc. It should be marketed within 24 hours.

Climate and soil

Native to the evergreen forests of the Western mountain range of India, it is found up to 1800 m above the sea level. It is suitable for forest land, wasteland or farm bunds. It grows well on well-drained sandy loam, light soils and requires temperature range of 15 degrees to 35 degrees C, in the regions enjoying rainfall over 4000 mm.

Varieties and Propagation

There are two types of kokum viz. red and another white variety. In the red variety, there are different types according to size, colour, yielding time and taste. Kokum is a highly cross-pollinated crop. Dioeciousness is a major problem in kokum cultivation. The plants multiplied from seeds produce male, female and bisexual progenies. The bisexual progenies are poor yielders. Only female plants can yield high, provided if they are elite types and the orchard is maintained with proper sex ratio. Dr. Balalasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, has developed an improved variety called 'Kokum Amrita' which was released for planting. The planting materials were developed by graft method, which gives 90% female plants and 10% male plants. But grafts were found to remain dwarf and yeild-less. To overcome this, it is suggested that seedlings should be planted. Since the kokum plants are dioecious in nature, two seedlings should be planted in each pit. Two seedlings will remain till flowering, say 5th or 6th year. Then only 10% male plant population should be kept. Suppose, assuming 50% female plants, then over 40% plants can be transformed through top working, taking shoots, from female plants, on the lines of cashew top working. Hence, it is observed that the Kokum Amrita variety can not be recommended for commercial plantation at present. Further research is necessary for varietal improvement in kokum.

Spacing and Planting

If the orchard is established with seedlings, a spacing of 7x7 meters could be given. The saplings should be planted at the onset of monsoon in July-August. Pits of 60x60x60 cms should be dug in summer itself and filled with well decomposed farm yard manure and top soil at a ratio of 1:3. At the time of planting, carbaryl dust (10%) should be mixed in each pit to avoid termite attack.

Care of young orchards

Young plants should be given support by planting bamboo stake near the main stem. The orchard should be kept free of weeds by regular weeding and hoeing. Short duration, low growing cowpea and vegetables can be grown during the first 4-5 years. Young saplings need irrigation during dry periods and summer months for the first 2-3 years. It is normally grown under rain-fed conditions and hence, regular irrigation is not required for grown up orchards.

Plant nutrition

A one-year plant can be given 2 kg farmyard manure, 100 g urea and 150 g single super phosphate per tree. This can be increased on the age of the plant. But, an adult 10 year old tree can be given 20 kg FYM, 1 kg urea and 1.5 kg single super phosphate.

Harvesting and yield

The flowering season is from November to February. Fruiting takes place in May and June. The seedling tree takes 6-7 years to flower and yield. The matured tree gives, on an average, 70 kgs of fresh fruits per tree, though higher yield can be expected in well maintained orchards.

Markets

Kokum products, viz, amsol, syrup and butter are marketed in Mumbai, Goa and local markets. Earlier, the products did not reach even in cities like Pune. There is vast untapped potential for these products in food, medicine, cosmetics and natural food colours industry. As kokum contains HCA, which is a natural fat reducer and antioxidant, it has got wide potential in the health care industry.

Kokum concentrate

Kokum concentrate has got traditional markets in Maharashtra. It is a health drink. The product is a special commodity in fairs. It is estimated that many Konkan regional fairs, like Malvani, are being held in Mumbai and sub-urban areas. Each fair attracts at least 1 lakh people. Even in some districts of Maharashtra alone, there are about 40 fairs conducted in a year. Each fair attracts at least 10 to 15 thousand people from the neighbouring districts. In addition, there are regular markets in Goa (a neighbouring State). This product is kept in grocery shops, cold drink houses in Pune, Kolhapur, Ratnagiri and Mumbai. The price of the product varies from Rs.40 to Rs.50 per litre. The demand for this product is throughout the year, except during the rainy season.

Kokum amsol

It is a traditional product and substitutes tamarind in curry preparation and has traditional markets in Maharashtra, Gujarat, Kerala and Karnataka. The market is unorganized. There are many traders who deal in kokum amsol. They send the kokum amsol to the Mumbai traders. The price of kokum amsol varies depending upon the quality. For instance; the price of single dried kokum varies from Rs.10 to Rs.15 per kg, if kokum is dipped in salt and water, it fetches Rs.15 per kg and if it is dipped in kokum agal (juice), the price is Rs.30 to Rs.35 per kg. The retail price of kokum amsol varies from Rs.60 to Rs.65 per kg. The existing product is unpacked and not even labelled and is crudely manufactured. There is a market for good hygienically prepared kokum amsol. The demand for this product is throughout the year.

Kokum seeds

There is an unorganized market for kokum seeds in Kokum growing regions. But, there are some kokum butter manufacturers in those districts, who process kokum seeds into kokum butter. The price of kokum seeds varies from Rs.15 to Rs.25/- per kg, depending upon the quality of seeds and production.

Forward and Backward Linkages

There are about 65 home scale cottage processing units existing in the coastal districts of Maharashtra, having FPO certification. Each unit is using its own technology. Kokum processing does not require heavy machinery and it is entirely done on manual basis using sugar or salt, which acts as a preservative agent and does not allow micro organisms to grow in the kokum products.

United Nations Industrial Development Organisation (UNIDO) in Sindhudurg district has done good work to help the kokum processors to upgrade their technology. Best practices of kokum processing were disseminated in Sindhudurg with the help of CFTRI scientists. UNIDO has facilitated the hiring of food technologists to bring about uniformity in processing of kokum. Further, in order to reach the organized markets, UNIDO is promoting “Common Branding” of kokum in Sindhudurg district.

There are good prospects for the expansion of area under kokum, as demand is likely to increase as kokum products are considered as natural health food items.

On-farm Semi processing through kokum cutting machine

Since the fruits are very soft and delicate, which will spoil within 24 hours, if not treated with salt or sugar, it is advisable to have semi-processed products on the farm itself. Hence, we may finance kokum cutting machines manufactured by local fabricators in Konkan region. The addresses of the manufacturers may be obtained from the Regional Fruit Research Station, Vengurle, of Dr. B.S. Konkan Krishi Vidyapeeth (Sindhudurg District, Maharashtra).

The advantages of kokum cutting machine are : (a) hygiene can be maintained, (b) the farmer can separate the rind and seeds and later he can dry the rind and seeds on the farm and store the produce for some more time instead of distress sale, (c) the value added products will fetch a better price, (d) the farmer can have more options to make products like juice, syrup or butter at a later period, a nearly 70% which is being wasted now could be brought for processing, (e) farmer's hoarding capacity will increase, (f) the terrain and topography of the kokum growing regions are full of hillocks and mountain ranges, the infrastructure such as roads and bridges are very poor and in the rainy season, it is very difficult to access the market. In such cases, the machine will help him to store the produce at the farm itself.

These cutting machines could be financed to the existing kokum growers who have yielding kokum trees. The banks may also finance these cutting machines even to the landless labourers who would like to collect kokum fruits from the forest or other farmers and who would like to semi-process in their house.

The ratio of fresh fruits into final products are viz. dried kokum rind, kokum syrup and kokum butter, is as below :

Product	Fresh fruits (kg)	Final product (kg)	Ratio
Dried kokum rind	100	19.61	0.20
Kokum syrup	100	18.73	0.19
Kokum butter	100	10.00	0.10

Unit cost

1) Establishing new kokum orchard

The indicative cost of cultivation of kokum as a pure crop has been worked out for a unit size of 0.4 Ha (1 acre with 80 trees). Banks may finance based on the number of trees with minimum 40 kokum trees ($\frac{1}{2}$ acres) in a mixed orchards of arecanut, coconut, cashew or mango or any other crops grown on a larger area in the Western Ghats.

Year	Cost / 0.4 Ha (Rs.)
1	5,000
2	3,000
3	3,000
4	3,000
5	3,000
6	3,000
Total	20,000

Mature maintenance cost from 7th year onwards : Rs.2,000/-per 0.4 Ha (details in the Annexure-III)

NABARD has fixed the unit cost for financing new kokum orchards looking to area expansion as pure crop yield of fresh fruits and farm gate price.

2) **Kokum cutting machine unit**

The unit cost has been indicated as Rs.20,000/-, (Rs.17,000/- for machine plus Rs.3,000/- for utensils). The machine could be purchased from local manufacturers (Annexure-IV), whose addresses may be collected from the Fruit Research Section, Vengurle, Sidhudurg district, Maharashtra State.

Yield and sale price

This model is prepared keeping in view of the development of kokum as a commercial crop by the farmers and value addition for their produce in their farm by semi-processing. Later, this produce is lifted by the processing industry in talukas and district headquarters to produce final products. Basic purpose of this model scheme is to get these industries a raw material produced in a hygienic condition.

Repayment schedule

1) **Kokum Orchard Loan** : The loan shall be repayable within 14 years, with a grace period of 6 years.

2) **Kokum Cutting Machine** : The loan shall be repayable in 6 years, with a grace period of one year.

Development initiatives taken by NABARD for promotion of Kokum in India

- Fixation of unit cost for investments required for kokum orchard establishment, machineries and other infrastructure activities.
- Preparation of model bankable projects for financing kokum orchards by banks.
- Extending both medium term and short term credit (crop loans, marketing credit depending on the need of the borrowers).
- Training of bankers and officials of the Department of Agriculture/ Horticulture for financing kokum orchards.
- Funding research and development projects in applied research in kokum.
- Financing of all-weather roads and bridges in major kokum growing regions of India under RIDF, which has facilitated in quick transit to the Mumbai markets and in reducing post-harvest losses.

- NABARD keeps close liaison with R&D institutions like Indian Council of Agricultural Research (ICAR), New Delhi; Indian Agriculture Research Institute (IARI), New Delhi and Central Food Technological Research Institute (CFTRI), Mysore, to know the latest technologies developed for promotion of quality products of kokum so that it could be brought under bankable scheme.
- NABARD is keeping close contact with UNIDO, which is helping the kokum processing units to upgrade their technologies. A number of training programmes were organized for the growers, processors, NGOs and banks in Kokum growing regions.
- NABARD has also conducted kokum development studies in Western Ghats of India.
- NABARD is involved in technology transfer to farmers through linkage with Krishi Vignan Kendras and farmers' clubs.

Constraints faced by financial institutions to extend credit for kokum development

- Ready information to bankers on kokum, say cost of cultivation in a unit area, economic size of the unit, gestation period, yield, farm gate price, economic life and market demand and supply position, which are the key factors to formulate credit projects to lend on a large scale, particularly for small farmers, is not available. Hence, the assessment of credit becomes very difficult.
- Non-availability of good quality planting materials, as the present research on varietal improvement in kokum is inadequate.
- Lack of awareness among the farmers to take up kokum crop as pure exclusive orchard. At present, it is taken as a mixed crop, only along with other crops like arecanut, coconut, cashew, mango or homestead.
- The present backward and forward linkages are not sufficient to promote cultivation of kokum on a large scale. It requires coordinated efforts by all concerned.

Conclusion

Considering the present status of kokum, multifaceted uses and scope in the international market, the kokum will undoubtedly prove unique for the forthcoming decade and therefore, deserves due attention by all concerned.

Day two, Panel discussion

There was an interesting panel discussion after the lunch in which a variety of issues were discussed. Most of these culminated in the formulating the recommendations, which are outlined hereafter under separate heading.

Valedictory Function

The short valedictory function was more focused in the presentation of the recommendations. Prof. D.J.Bhat and Dr. Ajit Shirodkar expressed their views in detail on the issues which were discussed in the seminar followed by vote of thanks from the organizing secretary.

Recommendations of the second national seminar

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

- I. Production or cultivation of kokum.
- II. Kokum Processing.
- III. Marketing of Kokum and Kokum products.
- IV. Studies, research and development.
- V. Awareness, education, training and extension.
- VI. General suggestions.

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

I Production or cultivation of kokum

1. Along with the hybrid varieties like Kokum amruta, elite grafts need to be used in the Kokum Plantation because this would solve the problems of dioeciousness.
2. Kokum needs to be promoted as an avenue tree for border plantations. It can also be used around the houses for protection against the sun.
3. Cultivators interested in planting Kokum as an intercrop or a multi-crop needs to be given necessary subsidies.
4. The cultivation package needs to focus on the spacing required for kokum plantations as inter- and multi-crop species.
5. Kokum can be domesticated for reclamation of wasteland, mining or as a homestead garden species.
6. Seedlings or grafts of early flowering varieties should be made available for field trials under different climatic and soil conditions.
7. Assistance needs to be given for raising specialized nurseries of Kokum, which could meet the demand from farmers. The universities then could transfer Kokum nursery technology to the nurserymen.
8. All along the Western Ghats states, the representative state revenue departments and agricultural departments must identify land available for raising Kokum plantations.
9. In each taluka, in the Western Ghats, the government could establish a demonstration farm for training Kokum cultivators. A beginning could be made in this direction by supporting Goa University to setup a model demonstration plantation in its campus.
10. In promoting Kokum as multi- or inter-crop species stress needs to be given on environmentally sound organic farming principles.
11. Through development of social forestry excess land in schools, except playgrounds, Kokum plantation can be undertaken. By this the government sponsoring these plantations can gain a small benefit.

II Kokum Processing.

1. Collection of Kokum seeds by collection vehicles or mobile collection centre is possible. Post harvest semi-processing at farm level and actual processing, packaging and marketing at a central place can be done to avoid losses; again standardized process for each level is needed. Cost of seeds should be finalized.
2. Arrangements should be made to provide dehumidifiers to dry rinds of fruits that ripen after the monsoons.
3. Collection centre involving NGO's could be setup to procure fresh Kokum fruits and products at village leveling the Western Ghats.
4. There is need to fix quality standards for Kokum cultivars and all Kokum products according to the grades remmulative prices should be fixed for the welfare of the cultivators. These prices have to be attractive till the time the market forces take the control of the pricing mechanism.

III Marketing of Kokum and Kokum products

1. Assure farmers or growers of marketing especially high-end marketing to encourage and promote greater participation and production.
2. The government of India as well as the State governments, departments, corporations, agencies, etc could adopt Amrut kokum or Kokum syrup as a state sponsored drink and promote it in all the canteens in public premises. The railway board on all railway stations can also promote Kokum drinks.

IV Studies, research and development

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

V Awareness, education, training and extension

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

VI General suggestions

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

Part C:- The world of Kokum and Kokum in the globalized world

Index

1. Facts on Kokum
2. Other *Garcinia* species
3. Global R & D on Genus *Garcinia*
 - I. A list of biomolecules from various species of *Garcinia* under research**
 - II. The progress of Scientific research since 1969**
 - III. Research on different species of *Garcinia*-a sample bibliography.**
 - IV. Present status of research on various aspects of species in Genus *Garcinia***
4. Names and addresses of some Kokum researchers from western ghat states
5. List of kokum processors from Dapoli, Maharashtra

Facts on Kokum

Dr. B. P. Patil

(revised version)

Introduction.

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

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

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

region of India. These plants prefer evergreen forests, but some also thrive in relatively low-rainfall areas.

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

The species found in India are *Garcinia ananamanica*, *G. anomola*, *G. atrovidis*, *G. cambogia*, *G. cornea*, *G. cowa*, *G. dulas*, *G. gummigutta*, *G. hanburyii*, *G. hombroniana*, *G. indica*, *G. kydia*, *G. lanceaefolia*, *G. mangostana*, *G. microstigma*, *G. morella*, *G. paniculata*, *G. pedunculata*, *G. pinctoria*, *G. spicata*, *G. stipulate*, *G. succifolia*, *G. travancorica*, *G. waghtii* and *G. xanthochy whole* (Roberts 1984). Of which only 4 species namely *G. gummigutta* (Koampuli), *G. indica* (Kokum), *G. mangostana* (Mangosteen), *G. morella* and *G. spicata* are restricted to the Western Ghats, of which the former two are the most widely spread species in Goa, Konkan belt and the Northern part of Kerala.

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

Botany of *Garcinia* species

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

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

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

***Garcinia indica* Choisy**

Garcinia indica Choisy is synonymous with *Garcinia purpurea* and is known as brindon in Goa, *bhirind or ansul* in Marathi and Konkani, *Murugal* in Kannada and *Punampuli* in Malayalam (Sullivan *et al.*, 1974). The tree is commonly known as kokum butter tree, mangosteen oil tree or brindonia tallow tree. Kokum is reported to be imported from Zanzibar to India (Williams, 1949).

Distribution and climate :Kokum (*G. indica*) is an evergreen tree occurring up to an elevation of about 800 metres from sea level. It is abundant in Western India and is South Kanara and in areas west of Bombay (Muhammed *et al.*, 1994). According to Krishnamurthy *et al.*, (1981) most of found in tropical rain forests of Western Ghats, North Malabar, Coorg and Wynad as well as in West Bengal and Assam.

Description, flowering and fruiting : The kokum tree reaches a height of about 10 to 15 metres. It has dark green and drooping foliage. Smaller than most of the species of the genus *Garcinia*, it is distinguished by oblong-lanceolate and glabrous leaves. The tree flowers in November – February and fruits ripen in April-May (CSIR 1956). The flowers, which can be axillary or terminal, exist in solitary form or as spreading fascicles. The scale- like bracts are deciduous or shed seasonally. 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 (Muhammed *et al.*, 1994; Subash Chandra, 1996).

Propagation and cultural practices of kokum: Kokum is propagated on large scale by seeds. However, due to its dioecious nature, about 50 per cent seedlings turn out to be males. Only female trees produce fruits. Besides it, being a very slow grower, takes about 7 to 8 years for first flowering. At present no method is available to detect the sex of plant in seedling stage and hence after retaining about 10% male plants, rest have to be culled or converted into female tree by side grafting. Further seed propagated plants show varying ability in cropping, fruit size, shape and time of harvest of fruits.

For raising seedlings, fruits are collected from early maturing, heavy yielding plants having bold size fruits. After extraction, seeds are washed thoroughly in water and dried for 3 to 4 days. Then seeds are sown in small polythene bags (5.0 x 7.0 cm) about 2 cm depth. For early germination, seeds may be soaked in water for about 2 days. Seeds germinate in about 12-15 days. These seedlings are nursed for one year before planting in the field.

Vegetative propagation: For ensuring female trees and uniformity in yield and quality of fruits different methods of vegetative propagation were tried.

It was found that inarch grafting is successful on 10 to 18 month old seedlings of Kokum, when done in the month of December-January. For grafting purpose about 3-4 months old up-right growing shoots from scion plant should be selected. If horizontal growing scion shoot is used, the graft will have straggling habit with top heaviness on one side. About 90% success is observed in inarch grafting method.

Recently soft wood grafting has been found to be successful and easier than inarching for soft wood grafting 9-12 month. Old seedlings and 3 to 6 month old scion are suitable. The method of grafting is similar to soft wood grafting in mango and cashew. The period from April-May is suitable. Graft union occurs within 2 months. About 80% success is observed in this method.

Preparation of land and planting: Before planting the area should be cleared by removing bushes and trees in the month of April-May. Pits of 60 x 60 x 60 cm are dug at 6 x 6.0 m spacing. At the end of May pits are filled up with good soil, about 10 kg F.Y.M. and 1.0 kg single super phosphate or bone-meal. In each pit about 100 g 50% B.H.C. powder may be added to protect the seedling from termite attack. Kokum can be grown as avenue tree or planted on the fence for beautification and as a source of income.

At the onset of monsoon, one year old vigorously growing seedling or graft is planted per pit. At the time of planting root ball should be kept intact. When graft is used. The care is taken to keep the graft union above the soil surface. Soil around the graft/seedling is firmly pressed and a support of split bamboo stick is provided.

After cares: After planting, seedlings/grafts are required to be protected from, stray cattles. In the first year, for protecting the young seedlings from, scorching heat, overhead shade is provided from October. Weeds should be removed from time to time for good growth of seedlings/grafts. For the initial two years, about 10 litres of water be given per week per plant during winter and summer months. Mulching of dry grass may be done around the basin of plant to conserve the soil moisture.

Manure and fertilizer application: At present, Kokum trees are rarely manured. Therefore, very low yields are obtained from them. No research work has been carried out on the manurial and fertilizer requirement of Kokum. As Kokum is a perennial crop-bearing crop every year, it is necessary to give manures and fertilizers for higher yields. On ad-hoc basis, Konkan Krishi Vidyapeeth has recommended following manure and fertilizer dose per year.

In the first year, each plant should be applied with 2 kg F.Y.M., 50 g, 25 g O₂O₅ and 250 g K₂O. This dose is increased every year and from, tenth year each plant may be given 20 kg F.Y.M, 500 g, 250 g P₂O₅ and 250 g K₂O. Manures and fertilizers are applied by ring

method under the canopy of the plant during the month of August, after the heavy rains are over.

During the early 10 to 12 years after planting, rainfed crops like sweet potato, vegetables, flowering annuals and stylo grass can be taken as inter crops.

After 7 to 8 years from planting, sex of the seedling plants is known. Keep only 10% of the male plants, well scattered in the orchard for the proper pollination and fertilization. Rest of the male plants can be converted into female trees by side grafting in the month of August- September. In side grafting about 70% success has been observed.

Harvesting: In Kokum flowering starts from October-November and continues upto February. Fruits are ready for harvesting during the months of March to June. When fruits turn from green to reddish in colour, they are plucked carefully by hand.

At present, most of the cultivated plants of Kokum are of seedling origin most of them are in neglected condition. Hence, there is wide variation in the yield, fruit shape, size, quality and time, of maturity. From, properly cared plantation from 15 year onwards about 30 to 50 kg fruit yield can be obtained

Post harvest handling and technology of Kokum

The ripe Kokum, fruit is dark purple coloured or red with yellow tinge. It contains 3-8 large seeds embedded in a red acid pulp. The ripe fruit, which contains substantial, amount of malic acid and a little tartaric or citric acid has a acceptable acidic taste. Though the plantations of Kokum are not systematic and on large scale, its fruits are commercially exploited for making Kokum, syrup ("Amrit Kokum,") which makes an excellent sharbat and is also useful in fever as cooling, refreshing drink and antidote against bilious affections. No reliable estimates are available as to how much Kokum is available in India. However, in the Konkan region alone about 4000 tonnes are produced (Sampathu and N. Krishnaswamy, 1982).

Very little systematic work on maturity indices and storage of Kokum is reported so far. The tree flowers in November – February and the fruits ripened in April and May. Traditionally, the fresh fruits are collected from forest areas and marketed in fresh condition. Nair (1986) while working on maturity indices and post-harvest technology of Kokum concluded that weight, volume, length, diameter and colour of the fruit could be considered as physical indices whereas moisture, T.S.S., sugars, acidity, pH, ascorbic acid and tannins as

chemical indices of maturity. Sampathu and Krishnamurthy (1982) have also reported the chemical composition of Kokum rind.

The cool chamber storage (Roy and Khurdiya, 1982) was found to be better for storage of mature green and ripe Kokum fruits than ambient temperature storage (Nair, 1986).

Different products like dried ripe Kokum rind, Kokum syrup, extraction of fat from seed etc. are made from Kokum (Sampathu and Krishmurthy, 1982). Nair (1986) reported that the products like dried mature green Kokum, dried ripe Kokum rind and Amrit Kokum could be successfully prepared (Nair, 1986). Kadrekar *et al.*, (1969) have also emphasized the importance of Kokum in the development of rural economy of Konkan region.

Kokum seed (8-10 seeds per fruit) is a good source of fat called as “Kokum Butter” in commerce. Kokum is a minor oil seed crop and butter has food and nonfood applications. The oil is traditionally extracted by boiling the kernel powder in water and the oil that is collected at the top is skimmed off. The yield of oil (fat) is about 25 to 30% (Khanvilkar, 1984). The fat is greasy to feel and whitish yellow in colour. Anon (1981) has emphasized the post-harvest handling of Kokum and extraction of Kokum oil.

A new fat-soluble yellow pigment namely garcinol has been isolated from the Kokum fruit rind.

The chemical characteristics of Kokum fat (Sampathu and Krishnamurthy, 1982) are as given below:

Melting point	39 - 43°C
Sap value	189
Iodine value	34.7 - 36.7
Unsap. matter (%)	1.4%
Free fatty acid –	
(%) As oleic	7.2%

The component fatty acids present by wt. are

Myristic	0-1.2
Palmitic	2.5 – 5.3
Stearic	52-56.4
Oleic	39.4 – 41.5
Linoleic	1.7

Kokum fat has been reported to be used in chocolate and confectionary preparations. It is also used in manufacture of soap, candle and ointments. An ointment made out of Kokum, fat, white dammar resin (resin exuded by *Vateria indica* tree) and wax is said to be effective in treating carbuncles. It is reported that Italy and some, other foreign countries are importing Kokum fat from, India for use in confectionary preparations.

Kokum fruit appears to be a promising industrial raw material for commercial exploitation in view of its interesting chemical constituents.

Processing

Freshly harvested fruits are reddish green in colour and turn into full reddish purple colour in a day or two (Fig. La). The flesh of the fruit is juicy and has a sweetish acid taste. The normal shelf life of fresh fruit is about five days. The common method practiced for preservation is sun drying. For this, the fresh fruits are cut into halves and the fleshy portion containing the seed is removed. The rind (skin) is then repeatedly soaked in the juice of the pulp during sun drying. The product obtained after sun drying is referred to as amsul or unsalted kokum in commerce. Salted kokum (agar) is also marketed; wherein common salt is used during soaking and drying of the rind. Lonavala kokum, Pakali kokum, Khane or edible kokum and Khoba kokum are some of the trade varieties (Sampathu & Krishnamurthy, 1982).

The seeds yield a valuable, edible fat known in commerce as kokum butter. It is extracted mostly as a cottage industry by crushing the kernels, boiling the pulp in water and skimming off the fat from the top or churning the crushed pulp with water. Presently oil is obtained by solvent extraction also. The yield of oil (fat) is about 25%. Kokum butter sold in market consists of egg shaped lumps or cakes of light gray yellowish colour with a greasy texture and a bland oily taste. It is used mainly as an edible fat and sometimes as an adulterant of ghee. Refined and deodorized fat is white in colour and compares favourably with high class hydrogenated fats (Nadkarni 1954; CSIR 1956).

Kokum rind contains 2- 3% anthocyanin pigments. It is a promising source of natural colourant for acid foods. Processing condition has been standardized at CFTRI, Mysore for commercial scale extraction and purification of the pigment concentration. Preliminary studies have shown that cyanidin-3-sambubioside and cyanin-3-glucoside as the major pigments present in the ratio of 4:1. Food applications for kokum colour are in the area of

processed fruit products, alcoholic and nonalcoholic beverages, preservatives and instant foods (Krishnamurthy *et al.* 1982).

Characteristics and composition of *G. indica* fat (kokum butter) (Jameisen *et al.*, 1943) are as follows:

<u>Character</u>	<u>Value</u>
M.P.	39.5– 40.0° C
Sap. Equiv.	299.5
Iodine value	37.4
Unsap. matter %	1.4
Free fatty acids (% as oleic)	7.2
Component fatty acids (% by weight)	
Palmitic	2.5
Stearic	56.4
Arachidic	-
Olein	39.4
Linolein	1.7
Component glycerides (% by mol)	
Tristearin	1.5
Oleodistearin	68
Oleopalmitostearin	8
Palmitodiolein	20
Triolein	2

The acid in kokum rind (dry) has been identified as hydroxycitric acid and is present to the extent of 15 percent. A new fat-soluble pigment namely, garcinol has been isolated from the fruit rind. Chemical identify of this pigment has been established by chemical and spectral studies (Krishnamurthy *et al.*, 1981).

The composition of fresh kokum rind is as follows (Sampathu & Krishnamurthy 1982):

Moisture (%)	80.00
Protein (Nx 6.25) %	1.92
Crude fibre (%)	14.28
Total ash (%)	2.57
Tannin (%)	2.85
Pectin (%)	5.71
Starch (%)	1.00
Crude fat (%)	10.00
(Hexane extract)	
Acid (as Hydroxy Citric Acid)	22.80
Pigment (%)	2.40
Ascorbic acid (%)	0.06
Carbohydrates by difference (%)	35.00

(Values are expressed on moisture free basis)

Uses

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 cooling syrups (CSIR 2956). 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. 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 (CSIR 1956). The sweet pulpy cover of the weeds is eaten or made into curries. The fruit is also pickled (Subhash Chandra, 1996).

Kokum butter is suitable for use as confectionery butter. It is also suitable for making candle and soap. It possesses properties similar to piney tallow (from *Vateria indica*) and may be employed in the sizing of cotton yarn (Williams 1950; CSIR 1956; Muhammed *et al.*, 1994).

The Kokum seed oil (fat) called as “Kokum butter” in commerce is very famous in cosmetic industries. 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 (CSIR 1956).

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. Various parts of the tree like root, bark and fruit and seed oil are used for treating piles, spruce and abdominal disorders (Subash Chandra, 1996). 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 cooling syrups (CSIR 2956).

The rawfruit of *G. indica* is used as anthelmintic, cardiotonic and useful for treatment of piles, dysentery, tumours and heart complaints. 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 application to ulceration, fissures of the lips and hands. Syrup from the fruit juice is given in biliary affections. The root is astringent (Krishnamurthy et al., 1981; Sampath & Krishnamurthy, 1982).

From ripe Kokum fruit rind a refreshing drink called as “Amrit Kokum” is prepared dried ripe Kokum rind known as “Amsol” is used in curry in the place of tamarind. The main produce of kokum is a juicy, citrus-like fruit of bright red colour. A soft drink (sherbet) is prepared with the juice of the fruit. The juice is sour, but a delicious drink can be prepared by adding sugar.

Considering all these benefits, it is not an exaggeration to say that the soft drink of kokum is a Health Drink. In fact, those who are familiar with the properties of this drink use it for health-improving purposes. Therefore, it has to be promoted widely as a health drink.

The kokum juice that is available in shops is usually in the form of a squash that may or may not have sugar added to it. The squash having sugar is the easy to use form that needs only dilution with water for the drink to be ready. Kokum squash may also be flavoured with cummin seed.

In spite of its appeal as a health drink, there are certain constraints in its production and marketing. The main limitation is that there is no organised production of kokum at present. Most homesteads have a few trees from which fruits are collected. As a result, collection is from a wider area and it adds to the cost of production.

In the Malabar and Konkan coast of the Indian peninsula the fruit rind of *Garcinia cambogia* and *Garcinia indica* is used as a substitute for tamarind to impart flavour, popularly known as Malabar tamarind, it is extensively used for culinary purposes, particularly in the preparation of fish curry.

The major organic acid component that imparts the savoury taste to these fruits is hydroxycitric acid (HCA). This is a structural analogue of citric acid commonly found in citrus fruits such as oranges. Studies with rats indicate that HCA is effective in lowering lipid levels. HCA, in fact, prevents the conversion of sugar to fat by inhibiting one of the enzymes involved in fat formation. This leads to an increase in the glycogen level in the liver, which sends a satiety signal to the brain resulting in appetite reduction. HCA consumption also leads to an increase in fat mobilization and fat burning. Even though *Garcinia* has long been used in food preparation, there have been no known manifestations of any toxic symptoms associated with such use. Moreover, the published toxicological data indicate that HCA is 200 times safer than citric acid. The medicinal properties of kokum juice are well known for long and are made use of in Ayurvedic therapy. It has a cooling effect on the body and gives a pleasant feeling if taken during the summer season. It is taken before meals as an appetizer. Because it helps in digestion, it is also taken after spicy or heavy meals. Kokum juice is also used as a natural remedy for stomach acidity and liver disorder. Acidity gets normalized if the sugarless juice is taken every morning.

The use of kokum drink is limited to the summer season in Maharashtra whereas it is hardly known in the rest of the country or elsewhere. Thus the demand for it is regional as well as seasonal at present. Kokum drink, a gift of nature, is superior to many synthetic soft drinks in the market today. A systematic promotion of kokum as a health drink, rather than a seasonal drink, will help widen its appeal and consumer base. It will also bring in economic prosperity to kokum growers and stability to manufacturers who have developed processing techniques with little or no external support.

KOKUM (*Garcinia indica* Choisy): INTRODUCTION, VARIETAL IMPROVEMENT AND PROMISING TYPES

Kokum is an important minor fruit belonging to family Guttiferae. *Garcinia indica* which has $2n = 54$ is a slender evergreen tree. There are approximately 400 species of *Garcinia* identified so far of which 40 are known to be edible. Burkill (1966) described 24 species that are used for various purposes. While Allen (1967) mentioned six commonly grown species for their fruit in Malaya. *Garcinia indica* (Kokum) is found to grow widely in tropical rain forests of Western Ghats in Konkan, Goa, South Karnataka and Kerala. It is also reported to flourish in evergreen forests of Assam, Khasi, Jayantia hills, West Bengal and Surat district of Gujarat. 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. A full tree of Kokum attains a height of 16 to 20 meters. According to survey conducted of the erstwhile Bombay State out of the total 46000 trees, about 43000 trees are in Ratnagiri and Sindhudurg districts only.

Kokum is said to be dioecious, but seems, to be highly variable in sex forms like papaya (*Carica papaya*). Variability also exists of the fruit. So far no any variety has been reported in Kokum (*Garcinia indica*).

Khanvilkar (1984) and Khanvilkat *et al.* (1986, 1987) made an effort to evaluate certain types in Kokum for their Oogysuci-chemical composition and yield and reported that genotypes 'KK-87', 'KK-155', 'KK-76', 'KKK-153' and 'KK149' as promising in respect of fruit yield and fruit numbers. Considering the economic importance of this fruit serious efforts have to be made to develop and evolve an ideal type in Kokum.

Hydroxycitric acid

The main active component in the herbal extract of *Garcinia* compound is Hydroxycitric acid (HCA). The earliest research, conducted in the 1970s, into the antiobesity effects of HCA was conducted by Hoffmann-La Roche Pharmaceuticals. Studies have shown the ability of HCA to inhibit the actions of citrate cleavage enzyme, suppress fatty acid synthesis, increase hepatic glycogen synthesis, suppress food intake, increase energy expenditure, curb appetite, reduce plasmatic cholesterol levels, and inhibit fat synthesis from excess carbohydrate calories.

The herb *Garcinia cambogia* and its active ingredient, hydroxycitric acid, have been promoted as an aid to weight loss. Hydroxycitric acid has a chemical composition similar to citric acid (the primary acid in citrus fruits). Preliminary research, based on laboratory experiments and animal research, suggests that HCA may be a useful weight loss aid. A study analyzing the claims was recently published in the Journal of the American Medical Association. The carefully designed research found that *Garcinia cambogia* failed to produce either significant weight loss or loss of body fat beyond that produced by a placebo.

Within cells, hydroxycitric acid is a powerful inhibitor of the citrate cleavage enzyme. This enzyme is critical for producing the substrate for synthesis of fatty acids. The theory behind sales of the herb or its purified active ingredient is that hydroxycitric acid taken orally will get into the body's individual cells where it will block the enzyme, block fat synthesis and therefore significantly reduce body fat mass.

The study failed utterly to detect any benefit for weight loss or fat loss by the herb. Several reasons could be suggested. 1) Neither *Garcinia cambogia* nor its active ingredient hydroxycitrate blocks fat synthesis or aids in weight loss; 2) neither the herb nor its active ingredient, when taken orally, is absorbed and reaches the cell intact where it is supposed to exert its influence; 3) the herb or its active ingredient might work only in people who have lost weight already and would prevent weight regain; 4) the herb might work if the dose or timing were different, for example given between meals instead of just before.

What this study showed was that under the usual conditions in which people trying to lose weight might use the herbal product, it was of no benefit. The low-calorie diet plan was what led to weight loss.

Hydroxycitric acid is included in many fat loss supplements claiming to increase fat burning. It has been promoted heavily as a fat loss agent with no legitimate science past the superficial rodent studies. Many of the products even boast of having this ingredient as a major selling point. Some go as far as to name the product after it - Hydroxy-this and Hydroxy-that. Well a new study reveals what we have known all along. Hydroxycitric acid in no way aids in fat metabolism. This was a very sophisticated study that revealed HCA had no effect on energy expenditure either during rest or during intense exercise.

There seems to be no such drug/herb that can cause weight loss without following an appropriate diet, this seems obvious with the frequency of obesity in the American population. Although there may be some evidence in using HCA in combination with other medications and exercise regimens designed to promote weight loss.

Owing to a substantial increase in glucose uptake by working muscle, glucose homeostasis during sustained aerobic exercise requires a severalfold increase in hepatic glucose output. As exercise continues and liver glycogen declines, an increasing proportion of this elevated glucose output must be provided by gluconeogenesis. Increased gluconeogenic efficiency in trained individuals is a key adaptation promoting increased endurance, since failure of hepatic glucose output to keep pace with muscle uptake rapidly leads to hypoglycaemia and exhaustion. Pre-administration of (-)-hydroxycitrate, a potent inhibitor of citrate lyase found in fruits of the genus *Garcinia*, may aid endurance during post-absorptive aerobic exercise by promoting gluconeogenesis. Carnitine and bioactive chromium may potentiate this benefit. The utility of this technique may be greatest in exercise regimens designed to promote weight loss.

Excessive exposure of tissues to fatty acids is likely to be the chief cause of the various dysfunctions that lead to sustained hyperglycemia in type II diabetes. These dysfunctions are likely to be substantially reversible if body fat and dietary fat can be greatly reduced. Disinhibition of hepatic fatty acid oxidation with hydroxycitrate (HCA) and carnitine has considerable potential as a new weight-loss strategy, but in diabetics runs the risk of further enhancing excessive hepatic gluconeogenesis. Since the clinical utility of metformin in diabetes is probably traceable to inhibition of gluconeogenesis, its use as an adjunct to HCA/carnitine treatment of obesity in diabetics deserves evaluation, particularly as metformin therapy itself tends to reduce body weight. A consideration of relevant evidence suggests that metformin therapy will not impede the activation of fatty acid oxidation by HCA/carnitine, and is likely to potentiate the appetite-suppressant and thermogenic benefits of this strategy. Indeed, since metformin has been reported to lower body weight and improve cardiovascular risk factors in obese non-diabetics, a broader application of a metformin/HCA/carnitine therapy for obesity can be contemplated.

The increasing prevalence of obesity combined with the low efficacy of conventional treatments led us to examine the weight-loss effects of *G cambogia*, a natural source of the citrate-lyase enzyme inhibitor HCA. Our double-blind, randomized controlled trial was designed from the consumer's perspective: we administered either a placebo or widely available *G cambogia* preparation in suggested amounts along with dietary recommendations typical of that provided in package inserts.

As potential consumers, we may ask why it remains uncertain that HCA derived from an over-the-counter product reaches its cellular destination in amounts adequate to

actively inhibit citrate cleavage enzyme. Why are diet plans suggested to consumers that may render *Garcinia*'s active agent nonabsorbable or inadvertently switch off the target citrate cleavage enzyme? Critical tests pinpointing each step in HCA uptake, distribution, and biological effects in humans are long overdue.

The need now exists to build, piece by piece, a strong series of human studies that establish if any *G cambogia* preparations can be added to the list of safe and effective weight-loss or weight-gain-prevention agents. Until this scientific foundation is established, consumers must rely on appropriately designed studies, such as ours, to judge if herbal weight-loss products such as the evaluated *G cambogia* preparation offer effective therapy beyond that of well-established diet and exercise measures.

OTHER *Garcinia* SPECIES

Garcinia is a rich genus having more than 200 listed species known for their medicinal as well as other industrial properties.

Four species are economically very important in India but only three are cultivated. *Garcinia indica* Choisy is the source of Kokum, extensively grown in the Konkan coast. It also provides Kokum butter used in cuisine and local medicine. The dried rind is used for garnishing curries and in the preparation of cooling syrups. In Kerala, *G. gummigutta* (L.) Rob (*G. cambogia* (Gaertn.) Desr.), locally known as kodampuli or kodapulin is traditionally grown in homesteads for the fruit rind that is used in garnishing fish curries, in ayurvedic preparations and polishing gold and silver. *G. mangostana* L. is cultivated for its delicious fruit in lower Nilgiris, Courtallam and other parts of South India. *G. morella* Desr. Is still seen mostly in the wild and is the principal source of gamboge used in medicine. It is also known as *Garcinia kola*, bitter kola, Malabar tamarind, *Garcinia cambogia*. It is distributed in the moist forests of SE Asia, West and Central Africa.

Garcinia cambogia

Other Common Names: Various forms of the family - Guttiferae. *Garcinia kola*, bitter kola, Malabar tamarind, *Garcinia cambogia*

Range: SE Asia, West and Central Africa

Habitat: **Moist forest**

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

Garcinia has been used historically in India for treatment of edema, delayed menstruation, constipation and intestinal parasites. This herb is currently used in the United States as a component of weight loss formulas. Various species of South Asian plants of the genus *Garcinia* (particularly *Garcinia cambogia*) have high contents of hydroxycitrate (HCA), which is the active ingredient in this and many other currently marketed weight loss products. However, it has not yet been shown, in controlled studies published in the scientific literature, to be effective in weight loss in humans.

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

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

Garcinia cowa

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

Garcinia gummi-gutta (L.) Robson

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

Trade name: Kokam

Family: Clusiaceae

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

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

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

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

Habitat: Semi-evergreen to evergreen

Propagation: By seeds, stem cuttings and grafts

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

Garcinia hombroniana

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

Garcinia kola

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

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

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

Garcinia malabarica

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

Garcinia -Mangosteen

Common name : English: mangosteen; Spanish: mangostán, mangostín; French: mangoustan; **Indonesia, Malaysia:** manggis; **Philippines:** manggustan, manggis; **Cambodia:** mongkhut; **Laos:** manghud; **Thailand:** mangkut; **Vietnam:** cay mang cut

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

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

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

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

or more in height. Mangosteen can be successfully grafted onto rootstocks of *Garcinia venulosa*, *G. xanthochymus* and *G. hombroniana*.

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

Trees should be fertilized every 3-4 months during the first 3 years of growth, and thereafter 1-2 times per year. Mulching is recommended to add nutrients and organic matter to the soil, conserve moisture and control weeds. With good care, trees can begin to produce fruits at 6-8 years from planting. Young trees produce about 100-200 fruits per year, while a mature tree can produce from 500-1,000 or more. In Puerto Rico, mangosteen fruits from July to December.

Cultivars and Related Species: Although Mangosteen is apomictic, with female plants producing clonal seeds without fertilization. Thus, there is little variation in mangosteen and almost no cultivars exist. However, the Malaysian Department of Agriculture has identified two clones, 'GA1' and 'GA2', whose fruits differ in shape, weight, external color, and number of seeds. It is hypothesized that mangosteen is a polyploid that arose from natural hybridization between *Garcinia hombroniana* y *G. malaccensis*.

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

Chemical Composition-The bitter and astringent rind of the fruit of *Garcinia mangostana*, according to W. Schmid, contains tannin, resin, and crystallizable *mangostine* ($C_{20}H_{22}O_5$), forming golden-yellow, tasteless scales, melting at 190° C. (374° F.), readily soluble in alcohol or ether, insoluble in water. Basic lead acetate precipitates it from its alcoholic solution. Its solution in alkalies reduces gold and silver solutions. The acidity of the fruit is due to malic acid. The resinous exudation of the trunk of the tree was investigated, in 1858,

by N. Reitler in Wittstein's laboratory (*Vierteljahresschr. f. prakt. Pharm.*, Vol. VII, p. 170), and found to consist of 88 per cent of resin, soluble in alcohol and in ether. Ammonia differentiates it into a soluble and an insoluble resin.

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

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

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

Nutritional composition per 100 g mangosteen fruit

Carbohydrate	6-20 g
Fat	0.1-1 g
Protein	0.6 g
Calcium	7-11 mg
Phosphorous	4-17 mg
Potassium	19 mg
Iron	0.2-1 mg
Vitamin A	14 IU
Vitamin B1	0.03 mg
Vitamin B2	0.03 mg
Niacin	0.3 mg
Vitamin C	4.2-66 mg

Related Products:

1) **KOLA BITTER or MALE KOLA.** These seeds have a coffee-like, astringent and bitter taste. They are produced by the *Garcinia Kola*, Heckel, of western Africa.

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

Garcinia morella

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

***Garcinia xanthochymus* Hook**

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

Garcinia parvifolia

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

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

Global R & D on Genus *Garcinia*

Kokum in Globalized World

Countrywise list of Institutions engaged in Research on *Garcinia* Species

* denotes focus on Kokum chemical/biomedical research

Australia

School of Chemistry, University of Sydney, New South Wales 2006, Australia

Cameroon

Faculty of Sciences, University of Yaounde I, P.O. Box 812, Yaounde, Cameroon.
alainmeli@yahoo.com

Peoples' Republic of China

Chinese Medicine Laboratory, Hong Kong Jockey Club Institute of Chinese Medicine, Hong Kong, PR China.

Republic of China (Taiwan)

Faculty of Medicine, Yarsi University, Jakarta 10510, Indonesia.

School of Pharmacy, Kaohsiung Medical University, Kaohsiung, Taiwan 807, Republic of China

* Institute of Biochemistry and Molecular Biology, College of Medicine, National Taiwan University, Taipei, Taiwan

France

Institut de Chimie des Substances Naturelles, Centre National de la Recherche Scientifique, 91198 Gif-sur-Yvette Cedex, France

India

*Tissue Culture and Cryopreservation Unit, National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi 110012, India

*Human Resource Development, Central Food Technological Research Institute, Mysore-570 020, India.

*Department of Biochemistry and Nutrition, Central Food Technological Research Institute, Mysore 570-020, India

*Transcription and Disease Laboratory, Molecular Biology and Genetics Unit, Jawaharlal Nehru Centre for Advanced Scientific Research, Jakkur, Bangalore-560064, India

Japan

Division of Food Science, Incorporated Administrative Agency, National Institute of Health and Nutrition, 1-23-1 Toyama, Shinjuku-ku, Tokyo 162-8636, Japan.

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I. A list of biomolecules from various species of *Garcinia* under research

Although the current interest has focused only on HCA and Garcinol as biopharmaceutically useful chemicals , several biomolecules such as organic acids, phenolics, anthocyanins and flavonoids, a large number of Xanthones, lactones, glycosides, terpenoids, lipids and enzymes are being investigated. This compilation is prepared for the first time in world to help the researchers and industrialists interested in *Garcinia* biochemistry and biotechnology.The list is indicative of the research work done in various countries since 1969.

- | | |
|--|---|
| 1) (-)-Hydroxycitric Acid | 11) 4 ",4 ",5 "-Trimethylfurano(2 ",3
":3,4)- Xanthone |
| 2) 1 3 6 Tri Hydroxy-7-Methoxy-8-3
7-Dimethyl-2 6 Octadienyl
Xanthone | 12) 4 Hydroxywogonin 7-
Neohesperidoside |
| 3) 1,3,5-Trihydroxyxanthone | 13) 7-O-Methylgarcinone E |
| 4) 1,5-Dihydroxyxanthone10-
Trihydroxy-2-Methyl-2-(4-
Methylpent-3-Enyl) | 14) Acyl-Acp Thioesterases |
| 5) 1-O-Methylsympoxanthone | 15) Alpha-Mangostin |
| 6) 2 5 Di Hydroxy-1 6-Dimethoxy
Xanthone | 16) Assiguxanthone-A |
| 7) 2,5-Dihydroxy-1-
Methoxylxanthone, | 17) Assiguxanthone -B |
| 8) 2-Ethyl-3-Methylmaleimiden-
Beta-D-Glucopyranoside | 18) Atroviridisone B |
| 9) 3",4',4",5,5",7,7"-Heptahydroxy-
3,8"-Biflavanone | 19) Bangangxanthone A |
| 10) 3,8"-Binaringenin | 20) Bangangxanthone B |
| | 21) Benzophenones |
| | 22) Benzophenone-Xanthone
Dimmers |
| | 23) Benzoylphloroglucinol |
| | 24) Beta-Mangostin |

- 25) Biflavanones Gb-1,
 26) Biphenyl
 27) Cambogin
 28) Chromone
 29) Cowagarcinone A
 30) Cowagarcinone B
 31) Cowagarcinone C
 32) Cowagarcinone D
 33) Cowagarcinone E
 34) Cycloartane Derivatives
 35) Depsidone
 36) Digeranylbenzophenone
 37) Dulcinoside
 38) Dulcisflavan
 39) Dulcisisoflavone
 40) Dulcixanthone -A
 41) Dulcixanthone- B
 42) Dulxanthone E
 43) Dulxanthone -C
 44) Dulxanthone -D
 45) Friedelin
 46) Friedolanostanes
 47) Gambogenone
 48) Gambogic Acids
 49) Gamma-Mangostin
 50) Garcibracteatonate
 51) Garcihombronanes
 52) Garcinia Acid Esters
 53) Garcinaxanthone E,
 54) Garcinielliptone Fb
 55) Garcinisidone-A
 56) Garcinoic Acid
 57) Garcinol
 58) Garcinone D
 59) Garcinone E
 60) Garcinone E
 61) Garcinones A
 62) Garcinones B
 63) Garcinones C
 64) Garsubellin A
 65) Garsubellins
 66) Geranylated Biphenyl
 67) Griffipavixanthone
 68) Guttiferone
 69) Guttiferone H
 70) Guttiferone I
 71) Hanburinone
 72) Hydroxybiflavanonols
 73) Hydroxycitric Acid Lactones
 74) Isocowanin (8-Geranyl-4- (3,3-Dimethylallyl)-7-Methoxy-1,3,6-Trihydroxyxanthone))
 75) Isoflavones
 76) Isogarcinol
 77) Isomoreollin B
 78) Isonormangostin
 79) Jasmonates
 80) Kolaflavanone
 81) Kolaviron
 82) Lactones Flavonoids
 83) Lanostanes
 84) Lateriflorone
 85) Latisxanthone A
 86) Latisxanthone B
 87) Latisxanthone C
 88) Latisxanthone D
 89) Lavendar Lactone
 90) Lupeol
 91) Mangostanol
 92) Mangostin 3 6 Di-O Glucoside
 93) Mangostin A Xanthone
 94) Methoxy-Beta-Mangostin
 95) Morellic acid
 96) Morellin
 97) Morellinol Di Hydro Morello Flavone
 98) Morello Flavone 7-Beta Glucoside
 99) Morelloflavone.
 100) Morellic Acid
 101) Naringenin
 102) Nemorosonol
 103) Neoisobactrin A
 104) Neoisobactrin B
 105) Neomorellin
 106) Nervosaxanthone2,5-Dihydroxy-1-Methoxylxanthone,
 107) Nigrolineaxanthones T-W N-Propyl Dihydrojasmonate (Pdj)
 108) Oleanolic Acid
 109) Polyamines
 110) Polyisoprenylated Benzophenones
 111) Prenylated Depsidone
 112) Prenylated Xanthones
 113) Prenylxanthones
 114) Protostane Triterpenes
 115) Pyranoxanthones

116)	Pyrones
117)	Pyrrolidines
118)	Rubraxanthone
119)	Scortechinones
120)	Seco-Lateriflorone
121)	Sitosterol
122)	Smeathxanthones
123)	Sorbifolin-6-Galactoside
124)	Sphaerobioside Acetate
125)	Subellinone
126)	Subelliptenone A
127)	Sympoxanthone
128)	Taxifolin 6-C-Glucoside
129)	Tetraprenylated Xanthones
130)	Tetraprenylxanthonoid
131)	Tocotrienols
132)	Xanthochymol
133)	Xanthones
134)	Xerophenone

Information available on the internet

As on 30th November 2005, the following web engines were used to gather scientific information with regard to *Garcinia*.

- A search with Google website returned 6,30,000 entries for *Garcinia*
- The search on Scholar.google website which searches only for scientific papers returned 1,710 entries for *Garcinia* and 71 entries under *Garcinia indica*.
- The Pubmed database of Natinal library of Medicine, National institute of health, USA revealed 237 entries under *Garcinia* and 15 entries under *Garcinia indica*.
- The Scirus website which searches only technical papers found 700 journal articles for *Garcinia*.

The progress of Scientific research since 1969

- Using the web link <http://web5.silverplatter.com> that searches Biological abstracts database since 1969 in all 476 research abstracts were found under *Garcinia*. The journal papers were broadly classified into 9 major areas of research and development namely ecology and ethnobotany; taxonomy and diversity; biochemistry; pharmacology, medicine and nutrition; agronomy or cultivation; pathology; genetics and breeding; processing and production and others. The papers were then sorted out and assigned the respective areas of R & D as indicated in Table 1. Figure 1 graphically presents the progress of the work in the past 36 years.

Table 1:-Priority areas in *Garcinia* research

Area of Research and Development	Number of Papers (1969-2005)
Ecology & Ethnobotany	79
Taxonomy & Diversity	25
Biochemistry	150
Pharmacology, Medicine & Nutrition	158
Agronomy	16
Pathology	7
Genetics	4
Processing & Production	20

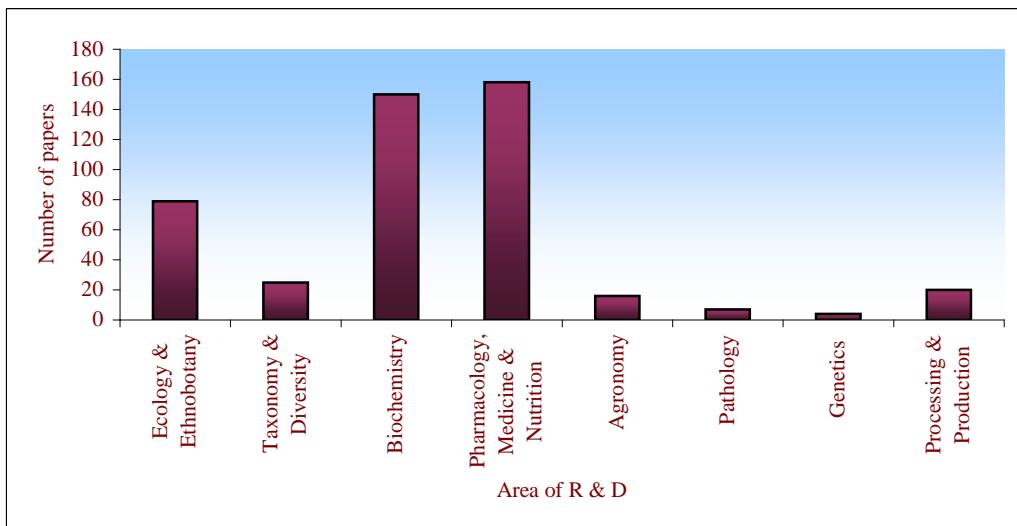


Figure 1:-The progress of research work on Garcinia since 1969-2005

Research on different species of *Garcinia*-a sample bibliography

Some sample abstracts of research papers which show the key areas identified by the research community across the world are presented below.

1. Title: Phylogenetic relationship of mangosteen (*Garcinia mangostana*) and several wild relatives (*Garcinia* spp.) revealed by ITS sequence data

Yapwattanaphun, Chinawat and Subhadrabandhu, Suranant (Japan) analysed the phylogenetic relationships among 17 *Garcinia* species including *G. mangostana* (mangosteen) by comparing sequences of the internal transcribed spacer (ITS) region of nuclear ribosomal DNA (nrDNA). Both parsimonious and neighbor joining (NJ) analyses revealed that *G. mangostana* is closely related to *G. malaccensis* believed to be a progenitor of mangosteen. Another suspected progenitor of mangosteen, *G. hombroniana*, was more distant from *G. mangostana* than *G. malaccensis* phylogenetically. *Garcinia hombroniana* formed a cluster with *G. rostrata*, *G. speciosa* and *G. sicygiifolia*, and this cluster was

connected with a cluster of *G. mangostana* and *G. malaccensis*. The ITS sequence analysis showed that *G. atroviridis*, *G. cowa*, *G. dulcis*, *G. malaccensis*, *G. mangostana*, *G. rostrata* and *G. viltersiana* have nucleotide additivity (two different nucleotides at the same nucleotide position) at several sites in the ITS region. The occurrence of these species might be related to hybridization with ancestors, but the genomic compositions, even chromosome numbers, of these species are still unknown.

Source: Journal-of-the-American-Society-for-Horticultural-Science. 2004; 129(3): 368-373.

2. Title: Cytotoxic benzophenone derivatives from *Garcinia* species display a strong apoptosis-inducing effect against human leukemia cell lines.

Matsumoto, Kenji; Akao, Yukihiro; Kobayashi, Emi; Ito, Tetsuro; Ohguchi, Kenji; Tanaka, Toshiyuki; Iinuma, Munekazu and Nozawa, Yoshinori (Japan) examined the in vitro effects of the benzophenone derivative garcinol, isogarcinol, and xanthochymol on cell growth in four human leukemia cell lines. All of the compounds exhibited significant growth suppression due to apoptosis mediated by the activation of caspase-3. A loss of mitochondrial membrane potential was found in garcinol- and isogarcinol-induced apoptosis, but not in xanthochymol-induced apoptosis. The growth inhibitory effects of isogarcinol and xanthochymol were more potent than that of garcinol, which is a well-known cytotoxic benzophenone derivative.

Source: Biological-and-Pharmaceutical-Bulletin. 2003; 26(4): 569-57.

3. Title: An account of the economic potential and commercial exploitation of four lesser known *Garcinia* species from India.

Kumar, K. J. Lathan and Kalesh, K. S. (India) stated that native trees with less economic value are fast disappearing from the developing tropical areas of the world. Most of the lesser-known edible trees are cut alarmingly from their habitat and no effort is being observed to reintroduce them into their own areas. This has led many on the road of extinction. Four species of *Garcinia* with much economic potential which needs attention and popularization is explained here

Source: Journal-of-Economic-and-Taxonomic-Botany. 2003; 27(3): 692-694

4. Title: A novel depsidone and some new xanthones from *Garcinia* species

Ito, Chihiro; Miyamoto, Yoshiaki; Nakayama, Minako; Kawai, Yuko; Rao, K Sundar and Furukawa, Hiroshi (Japan) studied the constituents of three EtOH extracts of the stem bark of *Garcinia assigu* Lantb., *Garcinia dulcis* (Roxb.) Kurz., and *Garcinia latissima* Miq., belonging to the Guttiferae, collected in Central Province of Papua New Guinea, were studied. A novel depsidone named garcinisidone-A (1), six new xanthones named assiguxanthone-A (3) and -B (9) and dulxanthone-A (4), -B (6), -C (7), and -D (11), and four new pyranoxanthones named latisxanthone-A (13), -B (14), -C (15), and -D (16) were isolated, as well as some known xanthone, benzophenone, chromone, and biflavanone derivatives, and their structures were elucidated by spectroscopic methods. Among these components, garcinisidone-A (1), six new xanthones named assiguxanthone-A (3) and -B (9) and dulxanthone-A (4), -B (6), -C (7), and -D (11), and four new pyranoxanthones named latisxanthone-A (13), -B (14), -C (15), and -D (16) were isolated, as well as some known xanthone, benzophenone, chromone, and biflavanone derivatives-methods)

5. Title: Three xanthones from *Garcinia subelliptica*

Minami, Hiroyuki; Takahashi, Emi; Kodama, Mitsuaki and Fukuyama, Yoshiyasu (Japan) have isolated three new xanthones, 2,5-dihydroxy-1-methoxylxanthone, 1-O-methylsympoxanthone and \Garciniaxanthone E, along with the previously known sympoxanthone and subelliptenone A from the wood of *Garcinia subelliptica*. Their structures have been elucidated mainly on the basis of spectroscopic data and confirmed by converting them into the corresponding known compounds. Garciniaxanthone E is the second geranylated xanthone isolated from *Garcinia* species.

Source: *Phytochemistry-(Oxford)*. 1996; 41(2): 629-633

6. Title: *Garcinia dhanikhariensis* (Clusiaceae), a new species from Andaman Islands, India

Srivastava, S K (India) described and illustrated a new species *Garcinia dhanikhariensis* (Clusiaceae) from South Andaman.

Source: *Nordic-Journal-of-Botany*. 1994; 14(1): 51-53

7. title: xanthones from three garcinia species

Ampofo S A And Waterman P G (UK) have isolated a number of xanthones including three that appear to be novel from the stem bark of three previously uninvestigated *Garcinia* species [*Garcinia nervosa*; *G. polyantha*; *G. pyrifera*]. The novel compounds are characterized as isocowanin (8-geranyl-4- (3,3-dimethylallyl)-7-methoxy-1,3,6-trihydroxyxanthone), isocowanol (8-geranyl-4-(3-hydroxymethyl-3-methylallyl)-7-methoxy-1,3,6-trihydroxyxanthone) and nervosaxanthone (4,8-di(3,3-dimethylallyl)-2(1,1-dimethylallyl)-1,3,5,6-tetrahydroxyxanthone). The chemotaxonomic significance of oxygenation patterns in these xanthones is briefly discussed.

SO: *Phytochemistry-* (Oxford). 1986; 25(10): 2351-2356.

8. Title: Terpenoid And Biflavonoid Constituents Of *Calophyllum-Calaba* And *Garcinia-Spicata* From Sri-Lanka

Gunatilaka A A L; De'silvaa M Y J; Sotheeswaran S; Balasubramaniam S And Wazeer M I M (SRI LANKA) isolated and characterized from leaf extractives of *C. calaba* a new bark acid, isochapeleric acid (cis-chapeleric acid), chapeleric acid, friedelin, friedelan-3.beta.-ol, canophyllal, canophyllol, friedelan-3-.beta.,28-diol, canophylllic acid and amentoflavone 13C NMR spectra of methyl chapelierate and methyl isochapelierate which were recorded and interpreted. Leaf extractives of *G. spicata* afforded an unidentified long chain carboxylic acid, Chemotaxonomic significance of the occurrence of some of the above foliar constituents in *Calophyllum* and *Garcinia* species [some of which have medicinal uses] is discussed.

Source: *Phytochemistry-(Oxford)*. 1984; 23(2): 323-328

TITLE: The essential oil of the fruit of *Garcinia huillensis* Welw. ex. Oliv. Chagonda, Lameck-S and Chalchat, -Jean-Claude (Zimbabwe) collected the edible fruits of *Garcinia huillensis* Welw. ex. Oliv. growing wild in the Gutu and Rusape areas of Zimbabwe, hydrodistilled and examined by GC-MS for essential oil composition. The main components from the fruit collected from the Rasa area, Gutu, were a-humulene (23.0%), valencene (18.2%), beta-caryophyllene (12.6%), caryophyllene oxide (6.3%) and delta-selinene (5.0%). The Rusape oil contained beta-caryophyllene (53.9%), alpha-humulene (10.1%) and valencene (4.0%) as the major components.

On this background it would be interesting to see the latest research trends as evidenced by the publications which appeared in 2005.

- Present status of research on various aspects of species in Genus *Garcinia*

We have included this data to show the state of the art in scientific research on genus *Garcinia* that includes *G. indica* species. In 2005, about 87 research publications appeared in various scientific journals. These are indicative of the thrust areas and research priorities of various countries, companies and institutions and may provide useful leads to the readers of this compendium. 32 references which specifically mention *Garcinia* are listed here.

1. **Bioefficacy of a novel calcium-potassium salt of (-)-hydroxycitric acid.**
Bernard W Downs / Manashi Bagchi / Gottumukkala V Subbaraju / Michael A Shara / Harry G Preuss / Debasis Bagchi, *Mutat Res*, Nov 2005
2. **Bioefficacy of a novel calcium-potassium salt of (-)-hydroxycitric acid**
Downs, B.W. / Bagchi, M. / Subbaraju, G.V. / Shara, M.A. / Preuss, H.G. / Bagchi, D., *Mutation Research - Fundamental and Molecular Mechanisms of Mutagenesis*, Nov 2005
3. **Rapid in vitro multiplication and conservation of *Garcinia indica*: A tropical medicinal tree species**
Malik, S.K. / Chaudhury, R. / Kalia, R.K., *Scientia Horticulturae*, Nov 2005
4. ***Garcinia cambogia* toxicity is misleading**
Burdock, G. / Bagchi, M. / Bagchi, D., *Food and Chemical Toxicology*, Nov 2005 Martinez-Garza, C. / Pena, V. / Ricker, M. / Campos, A. / Howe, H.F., *Forest Ecology and Management*, Oct 2005
5. **Phenolic compounds from the fruit of *Garcinia dulcis*.**
S Deachathai / W Mahabusarakam / S Phongpaichit / W C Taylor, *Phytochemistry*, Oct 2005
6. **Bangangxanthone A and B, two xanthones from the stem bark of *Garcinia polyantha* Oliv.**
Lannang, A.M. / Komguem, J. / Ngninzeke, F.N. / Tangmouo, J.G. / Lontsi, D. / Ajaz, A. / Choudhary, M.I. / (...) / Sondengam, B.L., *Phytochemistry*, Oct 2005
7. **199 POSTER Protective effect of flavonoids from *Garcinia kola* seeds on D-galactosamine induced toxicity in mice**
EJC Supplements, Oct 2005
8. **Comparison of the effects of three different (-)-hydroxycitric acid preparations on food intake in rats**
Louter-van de Haar, Johanna / Wielinga, Peter Y. / Scheurink, Anton JW. / Nieuwenhuizen, Arie G., *Nutrition & Metabolism*, Sep 2005
9. **Friedolanostanes and lanostanes from the leaves of *Garcinia hombroniana*.**
Vatcharin Rukachaisirikul / Somsak Saelim / Pueksa Karnsomchoke / Souwalak Phongpaichit, *J Nat Prod*, Aug 2005

10. **Complete NMR assignments of the antibacterial biflavanoid GB1 from *Garcinia kola*.**
Quan-Bin Han / Song-Fong Lee / Chun-Feng Qiao / Zhen-Dan He / Jing-Zheng Song / Han-Dong Sun / Hong-Xi Xu, *Chem Pharm Bull (Tokyo)*, Aug 2005
11. **Benzopyran, biphenyl, and tetraoxxygenated xanthone derivatives from the twigs of *Garcinia nigrolineata*.**
Vatcharin Rukachaisirikul / Kwanruthai Tadpatch / Anyarat Watthanaphanit / Neangnoi Saengsanae / Souwalak Phongpaichit, *J Nat Prod*, Aug 2005
12. **Atrovirisidone B, a new prenylated depsidone with cytotoxic property from the roots of *Garcinia atroviridis*.**
Dharma Permaniaa / Faridah Abas / Maulidiani / Khozirah Shaari / Johnson Stanslas / Abdul Manaf Ali / Nordin Hj Lajis, *Z Naturforsch [C]*, Jul 2005
13. **Constituents of the pericarp of *Garcinia subelliptica*.**
Chien-Chang Wu / Jing-Ru Weng / Shen-Jeu Won / Chun-Nan Lin, *J Nat Prod*, Jul 2005
14. **Antibacterial caged-tetraprenylated xanthones from the fruits of *Garcinia hanburyi*.**
Yaowapa Sukpondma / Vatcharin Rukachaisirikul / Souwalak Phongpaichit, *Chem Pharm Bull (Tokyo)*, Jul 2005
15. **Xanthones from *Garcinia smeathmannii* (Oliver) and their antimicrobial activity**
Komguem, J. / Meli, A.L. / Manfouo, R.N. / Lontsi, D. / Ngounou, F.N. / Kuete, V. / Kamdem, H.W. / (...) / Sondengam, B.L., *Phytochemistry*, Jul 2005
16. **Xanthone and sesquiterpene derivatives from the fruits of *Garcinia scorchedinii*.**
Yaowapa Sukpondma / Vatcharin Rukachaisirikul / Souwalak Phongpaichit, *J Nat Prod*, Jul 2005
17. **Xanthones and benzophenones from *Garcinia griffithii* and *Garcinia mangostana***
Nilar / Nguyen, L.H.D. / Venkatraman, G. / Sim, K.Y. / Harrison, L.J., *Phytochemistry*, Jul 2005
18. **Activity of medicinal plant extracts against hospital isolates of methicillin-resistant *Staphylococcus aureus*.**
S P Voravuthikunchai / L Kitipipit, *Clin Microbiol Infect*, Jun 2005
19. **Antiaflatoxigenic and antioxidant activities of *Garcinia* extracts.**
G S Joseph / G K Jayaprakasha / A T Selvi / B S Jena / K K Sakariah, *Int J Food Microbiol*, May 2005
20. **Xanthones from *Garcinia cowa Roxb. latex*.**
W Mahabusarakam / P Chairerk / W C Taylor, *Phytochemistry*, May 2005
Five xanthones named cowagarcinone A-E and six previously reported xanthones were isolated from the latex of **Garcinia** cowa Roxb. Their structures were determined on the basis of spectroscopic analysis. The crude latex and the isolated compounds

21. **A Novel Cytotoxic Guttiferone Analogue from *Garcinia macrophylla* from the Suriname Rainforest** - *Planta Med* 2003; 69: 864-866 -.
Russel B Williams Et Al, *Planta Med*, Apr 2005
No Abstract Available
22. **Dietary *Garcinia cambogia* does not modify skin properties of mice with or without excessive sucrose intake.**
Daichi Oikawa / Hachidai Hirakawa / Kohsuke Hayamizu / Yoshinori Nakamura / Nobuya Shiba / Tomonori Nakanishi / Hisao Iwamoto / (...) / Mitsuhiro Furuse, *Phytother Res*, Apr 2005
23. **Guttiferone I, a new prenylated benzophenone from *Garcinia humilis* as a liver X receptor ligand.**
Kithsiri Herath / Hiranthi Jayasuriya / John G Ondeyka / Ziqiang Guan / Robert P Borris / Eirik Stijfhoorn / Dennis Stevenson / (...) / Sheo B Singh, *J Nat Prod*, Apr 2005
24. **A geranylated biphenyl derivative from *Garcinia malvogostana*.**
H R W Dharmaratne / K G N P Piyasena / S B Tennakoon, *Nat Prod Res*, Apr 2005
25. **An antibacterial biphenyl derivative from *Garcinia bancana* MIQ.**
Vatcharin Rukachaisirikul / Wanpen Naklue / Yaowapa Sukpondma / Souwalak Phongpaichit, *Chem Pharm Bull (Tokyo)*, Mar 2005
26. **High dose of *Garcinia cambogia* is effective in suppressing fat accumulation in developing male Zucker obese rats, but...**
Saito, M. / Ueno, M. / Ogino, S. / Kubo, K. / Nagata, J. / Takeuchi, M., *Food and Chemical Toxicology*, Mar 2005
27. **Bioactive benzophenones from *Garcinia xanthochymus* fruits.**
Scott Baggett / Petr Protiva / Eugene P Mazzola / Hui Yang / Elizabeth T Ressler / Margaret J Basile / I Bernard Weinstein / Edward J Kennelly, *J Nat Prod*, Mar 2005
28. **High dose of *Garcinia cambogia* is effective in suppressing fat accumulation in developing male Zucker obese rats, but highly...**
M Saito / M Ueno / S Ogino / K Kubo / J Nagata / M Takeuchi, *Food Chem Toxicol*, Mar 2005Oboh, G. / Ekperigin, M.M. / Kazeem, M.I., *Journal of Food Composition and Analysis*, Mar 2005
29. **Unified synthesis of caged *Garcinia* natural products based on a site-selective Claisen/Diels- α -Alder/Claisen rearrangement**
Tisdale, Eric J. / Slobodov, Irina / Theodorakis, Emmanuel A., *Proceedings of the National Academy of Sciences of the United States of America*, Feb 2005
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Vatcharin Rukachaisirikul / Patima Phainuphong / Yaowapa Sukpondma / Souwaluk Phongpaichit / Walter C Taylor, *Planta Med*, Feb 2005
31. **(-)-Hydroxycitrate ingestion and endurance exercise performance.**
Kiwon Lim / Sungpil Ryu / Heajung Suh / Kengo Ishihara / Tohru Fushiki, *J Nutr Sci Vitaminol (Tokyo)*, Feb 2005
32. **Screening for tyrosinase inhibitors among extracts of seashore plants and identification of potent inhibitors from *Garcinia*...**
Toshiya Masuda / Daiki Yamashita / Yoshio Takeda / Shigetomo Yonemori, *Biosci Biotechnol Biochem*, Jan 2005

Names and addresses of some Kokum researchers from western ghat states

MAHARASHTRA

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LIST OF KOKUM PROCESSORS AT DAPOLI

		At Nargoli, Tal. Dapoli, Dist. Ratnagiri.
1) Ashika Nursery	C/o Amrute, At Post Gavhe, Tal. Dapoli, Dist. Ratnagiri.	4) Anil Pendse At Post Murdi, Tal. Dapoli, Dist. Ratnagiri.
2) Shri Koparkar Nursery	At Post Gavhe Tal. Dapoli, Dist. Ratnagiri	5) Sunil Bal At Post Ladghar, Tal. Dapoli, Dist. Ratnagiri.
3) Kokan Food Products		

Part D: Photofeature on Kokum and the national seminar



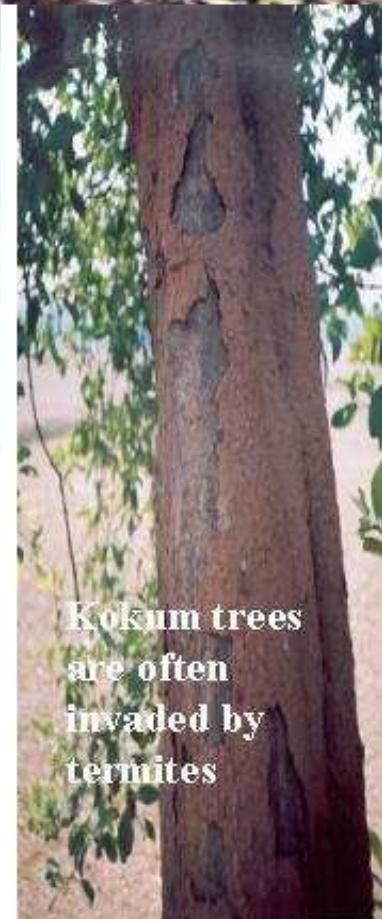
Kokum graft laden with fruits



Various stages of ripening

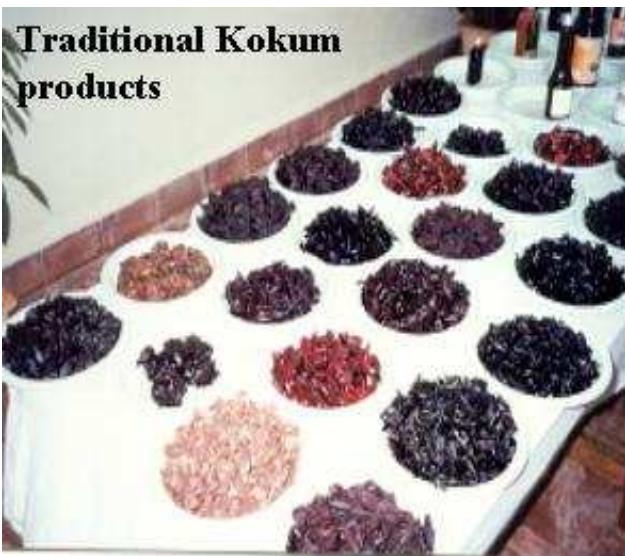


Prize winning Kokum variety



Kokum trees
are often
invaded by
termites

Traditional Kokum products



KOKUM BUTTER

Commercial Kokum products

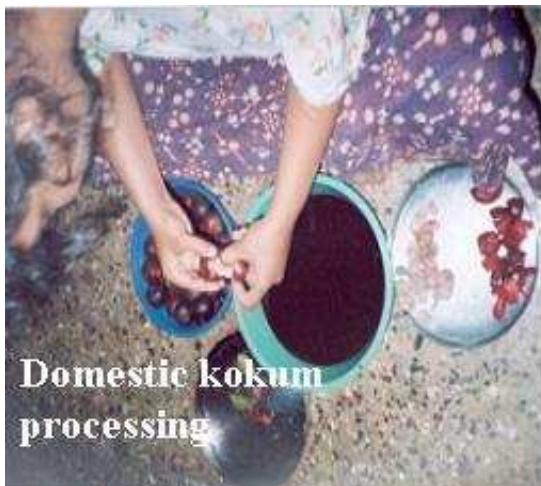


Kokum juice



**Carbonated Kokum beverage,
Dapoli**





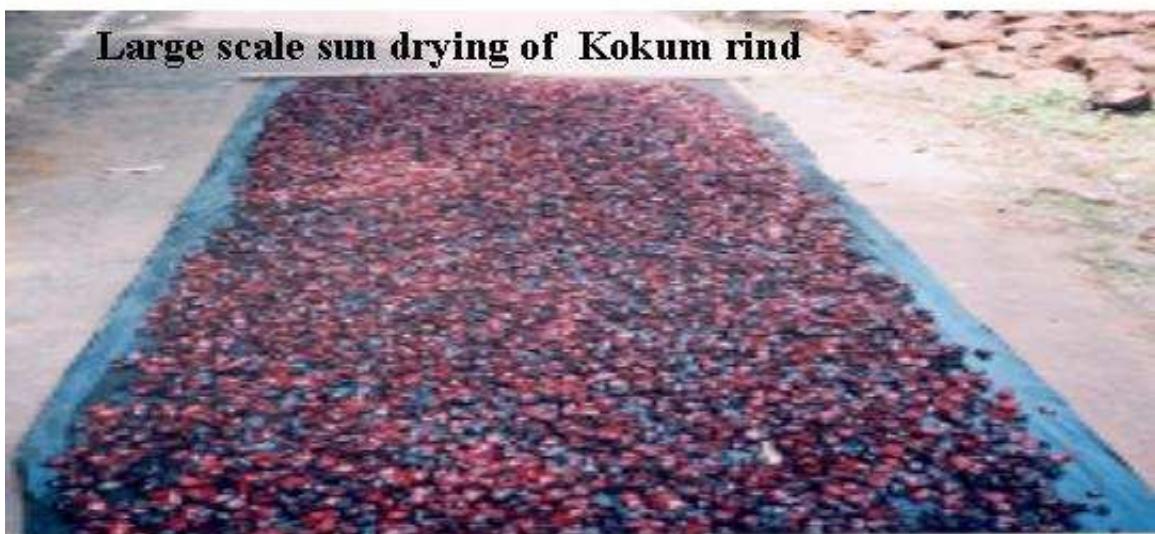
Domestic kokum processing



Large scale processing



Large scale sun drying of Kokum rind-a common scene in Konkan



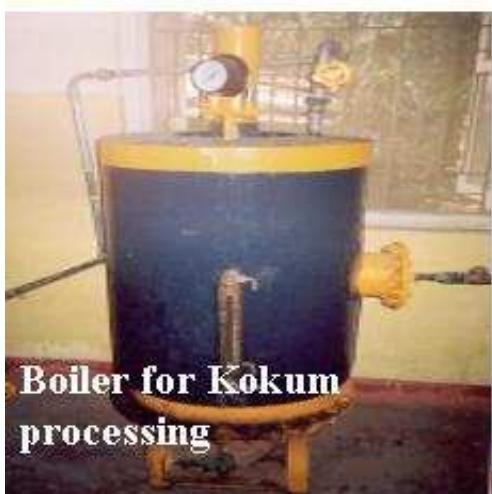
Large scale sun drying of Kokum rind



**Kokum
crusher**

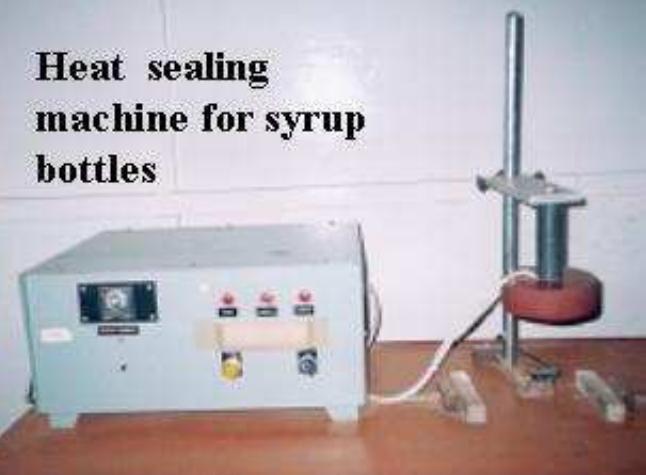


**Kokum
pulper**

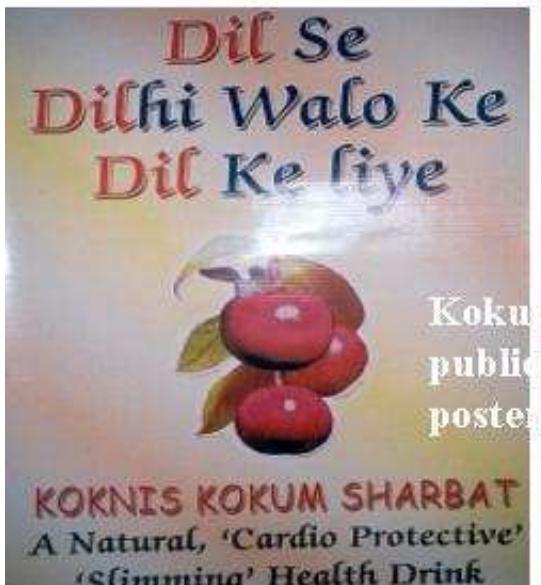


**Boiler for Kokum
processing**

**Heat sealing
machine for syrup
bottles**



**Carbonated Kokum beverage-bottling
operations, Mahajan's factory**



Kokum Product development workshop

कॉकम विषयक
प्रोडक्ट डेवलपमेंट कार्यशाला
१२ & १३ मेरुदंग कुलाळ



Snapshots of
First kokum
seminar

NATIONAL SEMINAR ON KOKUM
(Garcinia indica)
Organized by: Dr.Balasaheb Sawant Kenkan Krishi
Vidyapeeth, DAPOLI, Western Ghats Kokum Found. Govt.
& National Horticulture Board (Govt. Of India)
Venue: Regional Fruit Research Station, Vengurla. 12 & 13 MAY 2001

