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Non-traditional products from kokum: Inland and global opportunities

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Abstract
Garcinias (Mangosteen, Kokum) are tropical fruits, and are rich source of nutrients, minerals, vitamins, and dietary fibers. They are also abundant with bioactive compounds namely xanthones, benzophenones, hydroxycitric acid, and anthocyanins. Many studies have detailed that these compounds possess antioxidant, anti-inflammatory, anticancer, antimicrobial, antiallergy, antiulcer, antiparasitic, and antihelminthic activities to aid in human health and also weight loss and appetite reducing properties, making them good dietary supplements. Therefore, bioactive compounds extracted from Garcinia fruits could be used in the preparation of pharmaceuticals and nutraceuticals. *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. This review presents an overview of the bioactive compounds derived from Garcinia fruits and their biological activities for promoting human health as food and drug.

Keywords: Garcinia, garcinol, hydroxycitric acid, nutraceticals.

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 Nine Garcinia species were distributed wildly in the Western Ghats region, of which 7 species are endemic to the region (Sabu *et al.*, 2013) [5]. Garcinia species include evergreen trees and shrubs, dioecious and in several cases apomictic. Many species of Garcinia have fruit with edible arils, and most are eaten locally; some species' fruits are highly esteemed in one region, but unknown just a few hundred kilometers away. Garcinia kola is highly valued because of its medicinal use as the stem, root and bark serve as raw material for pharmaceutical properties. Garcinia kola is popular in south eastern Nigeria as it is extensively used in herbal medicine. (Ukaoma *et al.*, 2013) [7].

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 extractable 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

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. 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, cardio protection, correcting conditions of lipid abnormalities, and endurance in exercise. (Brito *et al.,* 2017 [1]

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. (Nayak et al., 2010) [2].

3. 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 4ºC. 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 3 has been taken from their US patent.

Table 2: 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.

4. Kokum wine- The Red Kokum juice has about 4 percent sugars and can be feremented to produce wine. Kokum wine is prepared in Goa using the traditional method (Obolskiy *et al.,* 2009) [3] 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.

5. Kokum honey- Honey is concentrated floral nectar. So far no efforts are reported to establish apiculture units in a kokum plantation but if this is done then 'Kokum honey' can be obtained with excellent medicinal qualities. Some novel applications under research in our laboratory3. 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.

6. 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.

7. Kokum Gamboge, also known as camboge, is the exudate from the bark of Garcinia species. Garcinia species are perhaps known all over the world in ancient times by this value added product. The dried exudates are used as a pigment in Indian murals and European water paintings and dyeing clothes and also for colouring wood, metal and leather. (Utpala and Nandakishore 2016.) [8] Though primarily gamboge was used as a colouring agent, several traditional medicinal uses were also attributed to the exudate. Recent phytochemical investigations showed the bark exudates as rich source of bioactive secondary metabolites such as caged xanthones. (Parthasarathy and Nandakishore 2016) [4].

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

Garcinia fruits especially mangosteen, kokum are used in the preparation of nutraceuticals, dietary supplements, and other health foods because of their nutrient richness and chemical compounds with potential health promoting properties. All the three fruits are rich in bioactive phytochemicals such as xanthone (*Shan et al.,* 2011) derivatives and benzophenone derivatives. Brindle berry and kokum are abundant with hydroxycitric acid. While, mangosteen and kokum fruits are rich in anthocyanin derivatives. 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.

References

1. Brito L, Luiza A, Berenger R, Raquel M: An overview of anticancer activity of Garcinia and Hypericum Food Chem Toxicol (In Press), 2017.
2. Nayak CA, Rastogi NK, Raghavarao KSMS Bioactive constituents present in *Garcinia indica* Choisy and its potential food applications: a review. Int, J Food Prop. 2010; 13:441-453.
3. Obolskiy D, Pischel I, Siriwatanametanon N, Heinrich M. *Garcinia mangostana*, a phytochemical and pharmacological review. Phytother Res. 2009; 23:1047-1065
4. Parthasarathy U and Nandakishore OP. Garcinia bark exudates- an important phytochemical source. Curr. Sci., 2016; 110:1617-1619
5. Sabu T, Mohanan N, Krishnaraj MV, Shareef SM, Shameer PS and Roy PE. *Garcinia Pushpangadaniana*, (Clusiaceae) a new species from southern Western Ghats, India. Phytotaxa. 2013; 116(2):51-56.
6. Shan T, Ma Q, Guo K, Liu J, Li W, Wang F, Wu E. Xanthones from mangosteen extracts as natural chemopreventive agents: potential anticancer drugs. Curr Mol Med. 2011; 11:666-677.
7. Ukaoma AA, Ukaoma VO, Okechukwu RI, Iwuagwu M. Phytochemical screening and antibacterial properties of Garcinia kola. The Journal of Phytopharmacology. 2013; 2(3):34-38.
8. Utpala P and Nandakishore OP Garcinia bark exudates– an important phytochemical source. Cur. Sc. 2016; 110 (9):1617-1619.