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Formulation and sensory evaluation of value added products developed with underutilized *Garcinia indica* fruit

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Abstract
Garcinia indica commonly known as kokum, has lot of medicinal properties and commercial importance, but the crop remains neglected and hence there is a need to concentrate on diversification and popularization of such underutilized fruits through development of value added products. To take advantage of health promoting properties of Kokum, five different value added products namely, Kokum pickle (KP), Kokum sauce (KS), Kokum sambar mix (KSM), Kokum spice candy (KSC), Kokum popsicles (Kpops) were developed and standardized. Sensory evaluation was conducted on all the products and the results indicate that, Kpops were highly acceptable among all other kokum products, followed by KS, KSC, KP and KSM with good acceptability scores. Value addition of Kokum fruits will improve the consumption by different communities and also reduce the post harvest losses of the underutilised fruit, apart from promoting several health benefits.

Keywords: *Garcinia indic*a, kokum, value addition, sensory evaluation, colour

Introduction
Garcinia indica commonly known as Kokum belongs to the botanical family Clusiaceae. The genus Garcinia contains 200 species out of which over 20 are found in India (Patil, 2008) [21]. It is an indigenous ever green plant grown in Western Ghats of India, lower slopes of Nilgiris and in North Eastern states of Manipur and Assam (Parthasarathy and Nandakishore, 2014). The trees yield fruits annually in the summer season during the months of March to May. The fruits are generally globular or spherical in appearance, which are green when raw and become red to dark purple when fully ripe with unique flavour weighing about 15-20 grams, enclosing 5 to 8 large seeds (Dembitsky *et al*., 2011) [5]. In the whole fruit, seed portion consists of 20 to 23% fruit weight and is very rich in stearic, oleic and stearic triglycerides (Dushyantha *et al*., 2010) [6]. The rind contains moisture (80.0 g/100 g), protein (1%), fat (1.4%), tannin (1.7%), pectin (0.9%), total sugars (4.1%), organic acids like hydroxyl citric acid, lactone and citric acid; anthocyanin's, cyanidin-3-glucoside and cyanidin-3-sambubioside and poly iso prenylated phenolics, garcinol and isogarcinol (Jagtap, *et al*., 2015; Krishnamurthy *et al*., 1982; Nayak *et al*., 2010; Sheela *et al*., 2004) [10, 14, 3, 18, 19, 25]. These nutrients exhibit various phytochemical properties like anti-ulcerogenic, cardio protective, anticancer, chemo preventive, free radical scavenging and anti-obesity effects. Garcinia known for medicinal properties is also used for curing piles, dysentery, tumour pains and cardiac problems. Even fat reducing tablets and capsules based on Garcinia are available in the market (Rasha *et al*., 2015) [24].

Garcinia Kernal accounts to 61% of the seed weight. The kernels of Garcinia seed contain about 33 to 44 per cent oil, which is commercially known as "Kokum butter", also considered as nutritive, demulcent, astringent and emollient. Due to high content of di-saturated and mono-saturated glycerides, it is in great demand as a substitute for cocoa, an extender in chocolate and confectionery products preparations. Hydroxy citric acid (HCA) is one of the most important constituent of Garcinia which is used as an anti obesity agent for keeping fatty acid symbiosis at lower level. Garcinol has antioxidant properties, which includes citric acid, malic acid, polyphenols, carbohydrates, anthocyanin pigment and ascorbic acid. Malic acid is acidic, reddish coloured and gives the pungent sour taste to fruits. Hence it has good demand in confectionery industry (Swami *et al*., 2014) [27].

At present, India produces 10,200 metric tons of Kokum with productivity of 8.5 tons/ha. The estimated demand for Kokum in 2004-2005 was approximately 774.2 metric tons (Nayak *et al*., 2010) [3, 18, 19]. The normal shelf life of fresh fruit is about 5 days at room temperature. Kokum fruit has longer shelf life only at low temperatures.

Traditionally, the fruit rinds are sun dried to reduce water activity and increase shelf-life. The fresh fruits are cut into halves and the seed is removed before sun drying for about 6-8 days. The product obtained after sun drying is commercially called Amsul. Different products like dried ripe Kokum rind (Amsul), Kokum syrup are made from the fruit and rind. Because of the sweetish acidic taste and its typical flavor, Kokum is used as an acidulant in different curries like traditional fish curries etc. The dried rind is also used to make a peculiar soup and cold drinks in summer. The dried rind is extracted with water to make syrup which is sweetened to make a cold drink (Mishra *et al*., 2006) [17]. In some parts of India, rinds are spiced and sweetened with jaggery for feasts (Patil, 2005, Patil, and Kattimani, 2008) [22, 21]. Aqueous Kokum extract also has 4% sugar, which can be fermented to make excellent quality wine. It can also be used in the manufacture of wine, champagne and liquor. Dried kokum rind pieces are powdered, sieved and stored in airtight containers. Powder is used in coconut and fish curries as an acidulant (Nayak *et al*., 2010) [3, 18, 19] and also used to impart an acid flavour to curries instead of tamarind (Rasha *et al*., 2015) [24].

Despite commercial / nutritional and medicinal importance, Kokum crop remained neglected and not much attention is paid for research and development. To take advantages of nutritional and medicinal properties of Kokum, value addition is an important activity which, can be achieved through development of suitable processing methodologies. Studies done by Jadhav *et al* (2001) [8] on shelf life of kokum fruit indicated that maximum shelf life was observed in fruits stored at cold storage (16 days) followed by cool chamber (12 days) and ambient temperature (10 days). During fruiting season, lot of fruits are wasted due to inadequate storage facilities. The only solution to such kind of wastage is value addition to the fruits to enhance the keeping quality of the fruits in form of products. Value addition to Kokum through innovative product development can improve economical importance of the crop, which otherwise remains underutilised. The resultant of this activity creates employment opportunities at rural areas and on the other hand develops suitable products for income generation and adds health benefits to the consumer. With this objective, a study was planned to formulate, develop and standardise innovative value added products with Garcinia (Kokum).

Methodology

Kokum fresh fruits were procured from NEH- ICAR complex Manipur, Imphal. Freshly harvested kokum fruits packaged in carton boxes were collected safely from air cargo at Hyderabad within 10 hours after harvest. Other ingredients were purchased from local market to formulate and standardize different products.

Primary processing

Washing, blanching and tray drying: The fresh Kokum fruits were collected and washed thoroughly in fresh tap water, followed by double glass-distilled water to remove the adhering dust and drained completely. The cleaned kokum fruits were blanched in hot water (90 ± 2 ^{0}C) for 5 minutes with the ratio of kokum fruits to water at 1:2. The blanched kokum fruits were then immediately cooled in cold water at 4 °C equilibrium value (AOAC, 1995) [1]. The kokum fruits were drained after cooling and the residual moisture was evaporated at room temperature, on a clean paper with constant turning over (Excess moisture was removed using dry muslin cloth. One set of fruits were ground after carefully removing the seed. The ground kokum pulp was stored at refrigerated temperature (-4 °C) in sterilized glass containers after adding preservative (sodium benzoate 250ppm) for further product development. Another set of kokum fruits were Gupta and Prakash, 2011) cut into halves, spread on stainless steel trays for drying at 70 °C for first 3 hours and 60 °C for the next 8 – 10 hours in a pre-heated tray drier. The dried kokum was deseeded and ground into fine powder using a grinder (Waring Commercial Blender, WCG75, Torrington, CT) at a medium speed for 2 to 4 min. The powder was then sieved using a sieve analyzer (Retsch, AS200 basic, Hann, Germany) to get a particle size of 150-430µm and was vacuum packed in a Metalized

Polyethylene Terephthalate (MPET) package with OTR of 0.95cc/m2/day and WVTR of 1.2 g/m2/day and stored at room temperature i.e., 35 °C±4 until further use. The processed Kokum pulp and Kokum powder were used in preparation of various products.

Product development: The Kokum pulp and powder were used for formulating and standardizing five different products (Figure. 1) like Kokum Pickle (KP), Kokum Sauce (KS), Kokum Sambar Mix (KSM), Kokum Spice Candy (KSC) and Kokum Popsicles powder (Kpops). Kokum sauce was developed by using 46% of kokum pulp; Kokum pickle (KP) was standardized by using 43% deseeded fresh kokum fruit and 21.5% kokum pulp. Kokum Spice Candy (KSC) was formulated using 52% pulp and Kokum Sambar Mix (KSM) was developed by using 36% of kokum pulp. Kokum popsicles (Kpops) were formulated using 20% Kokum powder.

The sensory assessments were conducted in a purpose-built, ten-booth sensory evaluation laboratory. The panel of 30 members consisted of staff and graduate students of the Post Graduate & Research Centre, Professor Jayashankar Telangana State Agricultural University. All the products prepared were coded using random three-digit numbers and served in transparent glass bowls. Panelists were provided with a glass of water and instructed to sip in between samples. They were given written instructions and asked to evaluate the products for acceptability based on its colour, flavor, texture, taste and overall acceptability using nine-point hedonic scale (0=Dislike extremely to 9=Like extremely) (Meilgaard *et al*., 1999) [16].

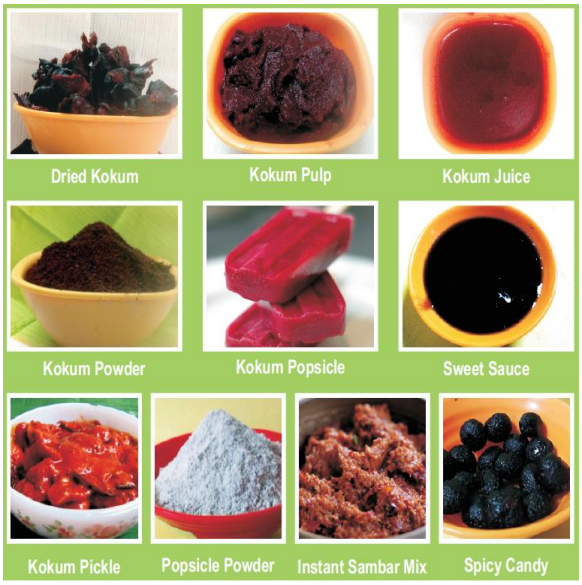
The data obtained from sensory evaluation was subjected to analysis of variance (ANOVA) to test the difference between means (within in the samples) and were analyzed by the Tukey test at 95% ($p < 0.05$) level of significance using statistical software (SPSS). The data was analyzed and presented as mean values with standard deviations.

Results and Discussion:

Color is an important constituent of any food as every food is associated and identified with certain color. Color is the first characteristic the consumer perceives of a food, which confers expectations of quality and flavour (Chetan *et al*., 2010; Chokshi *et al*., 2007) [3, 4]. All the products formulated with Kokum pulp and powder had extremely attractive colour (Figure.1). The results of sensory evaluation (Table. 1) indicate that, colour of all the products formulated with Kokum pulp and powder were highly acceptable with scores ranging from 7.86 ± 0.27 to 8.46± 0.21 on a 9 point scale, with Kpops receiving highest score and KSM receiving lowest score. The attractive reddish colour was due to the

purplish red anthocyanin pigments present in ripe Kokum fruits. Anthocyanins of Kokum are water soluble and possess antioxidant activity. Two major pigments cyanidin-3-glucoside and cyanidin-3-sambubioside are present in the ratio of 4:1 (Nayak *et al*., 2010) [3, 18, 19].

Flavour of all the products evaluated by sensory testing indicate that Kpops flavor (8.40 ± 0.19) was very much liked by the panelists, followed by KSC (8.06 ± 0.18) and KP (8.06 ± 0.22). The flavor of KSM and KS received 7.93 ± 0.18 and 7.86 ± 0.13 respectively on a 9 point hedonic scale. Kokum is used as an acidulant in different curries like traditional fish curries etc, because of its sweetish acidic test and its typical flavour (Patil, 2005) [22]. The acidic and sweet taste went very well in Kpops, KSC and KP. Similar sensory scores were obtained for texture of the products with KP (8.33 ± 0.15) receiving the highest score followed by Kpops (8.26 ± 0.18) and KSC (8.13 ± 0.21). Texture parameter of KS (7.93 ± 0.06) and KSM (7.86 ± 0.29) also received good scores, but were rated low compared to the other Kokum products.



KOKUM SWEET SAUCE

- Kokum
- Cleaning
- Blanching (5 min,1:2 ratio of water)
- Drying (Removing excess moisture with dry muslin cloth)
- Cutting, Deseeding and extraction of pulp
- Addition of water, sugar & jaggery and boil for 10 min.
- Addition of spices (Black Salt, Cumin, Coriander, Chilli, Garlic, Cinnamon and Fennel seed powders)
- Boiling (Till TSS reaches to 65% brix)
- Addition of Preservative (750 ppm Sodium Benzoate)
- Storing Store in a sterilized glass bottle

KOKUM PICKLE

- Kokum
- Cleaning & Cutting in two halves
- Deseeding & Pulp extraction
- Marination for 30 min. (Sliced kokum, Pulp and Salt)
- Sauteing
- Addition of Spices (Chilli powder, Salt, Turmeric, Roasted cumin, Fenugreek seed powder)
- Addition of kachai lemon juice
- Seasoning (Mustard seeds, Garlic pods, Dry chilli and Curry leaves)
- Cooling
- Storing Store in a sterilized glass bottle

KOKUM INSTANT SAMBAR MIX

- Kokum
- Cleaning
- Blanching (5 min,1:2 ratio of water)
- Drying (Removing excess moisture with dry muslin cloth)
- Cutting, Deseeding and extraction of Pulp
- Addition of tamarind pulp and boil for 10 min.
- Addition of Spices (Roasted Coriander, Cumin, Roasted bengal gram, Pepper, Chilli, Curry leaf & Rice powders. Boil for 5 minutes)
- Addition of dry mango powder, Asafoetida, Turmeric, Kachai lemon juice, salt and oil. Mix well
- Grinding
- Storing Store in a sterilized glass bottle & Refrigerate

KOKUM SPICY CANDY

- Kokum
- Cleaning
- Blanching (5 min,1:2 ratio of water)
- Drying (Removing excess moisture with dry muslin cloth)
- Cutting, Deseeding and extraction of Pulp
- Addition of Spices (Black Salt, Cumin, Coriander, Chilli, Pepper, Sugar, Cinnamon and Fennel seeds powder)
- Boiling and mixing like a dough and refrigerate for 1 hour
- Making into small balls using Kachai lemon Juice
- Rolling into powdered sugar
- Storing Store in a sterilized glass bottle

KOKUM POPSICLE

- Kokum
- Cleaning
- Blanching (5 min,1:2 ratio of water)
- Drying (Removing excess moisture with dry muslin cloth)
- Cutting into two halves
- Tray Drying (55°C for 24 hours)
- Separation of seed
- Grinding & Sieving
- Addition of powdered sugar and flavour to popsicle powder
- Preparation of sugar syrup
- Addition of Popsicle powder & mix well
- Pour into moulds and Refrigerate for 8 hours

Fig 1: Products developed with *Garcinia indica*.

Table 1: Sensory evaluation of products developed with Kokum

S. No	Products	Colour	Flavour	Texture	Taste	Overall Acceptability
1	KP	8.33 ± 0.21 [a]	8.06 ± 0.22 [ab]	8.33 ± 0.15 [a]	8.20 ± 0.17 [a]	8.33 ± 0.15 [ab]
2	KS	8.33 ± 0.23 [a]	7.86 ± 0.13 [a]	7.93 ± 0.06 [a]	8.40± 0.16 [a]	8.46 ± 0.13 [ab]
3	KSM	7.86 ± 0.27 [a]	7.93 ± 0.18 [ab]	7.86 ± 0.29 [a]	8.20 ± 0.24 [a]	8.20 ± 0.22 [a]
4	KSC	8.33 ± 0.21 [a]	8.06 ± 0.18 [ab]	8.13 ± 0.21 [a]	8.20 ± 0.20 [a]	8.46 ± 0.13 [ab]
5	Kpops	8.46± 0.21 [a]	8.40 ± 0.19 [b]	8.26 ± 0.18 [a]	8.60 ± 0.16 [a]	8.73 ± 0.11 [b]
	C.D Value	0.64827	0.52323	0.55509	0.53940	0.44498

All the values are expressed as Mean ± SD. Values with similar superscripts in columns are statistically similar at P<0.05% level. Kokum pickle (KP), Kokum sauce (KS), Kokum sambar mix (KSM), Kokum spice candy (KSC), Kokum popsicles (Kpops)

Results of sensory evaluation indicate that taste of all the Kokum products were very much liked by the sensory panelists with scores ranging between 8.20 ± 0.17 and 8.60 ± 0.16 on a 9 point hedonic scale. The scores of taste of products indicate that all the products had very good taste which could be due to the typical flavor of Kokum coupled with the sweetish acidic taste imparted by organic acids like hydroxycitric acid (HCA) (1,2 dihydroxypropane-1,2,3-tricarboxylic acid), citric acid, malic acid and ascorbic acid (Jayaprakasha and Sakariah, 2002) [11].

The overall acceptability of any product is the most important characteristic to ensure consumer acceptability of any product (Figure. 2). All the products formulated with Kokum were very well acceptable as indicated by the scores received on a 9 point hedonic scale. As per the sensory score results, kokum popsicles (Kpops) were highly acceptable (8.73 ± 0.11) among all other kokum products. Kokum sauce (KS) and kokum spice candy (KSC) received the same overall acceptance scores (8.46 ± 0.13) followed by kokum pickle (KP) (8.33 ± 0.15) and kokum sambar masala (KSM) (8.20 ± 0.22).

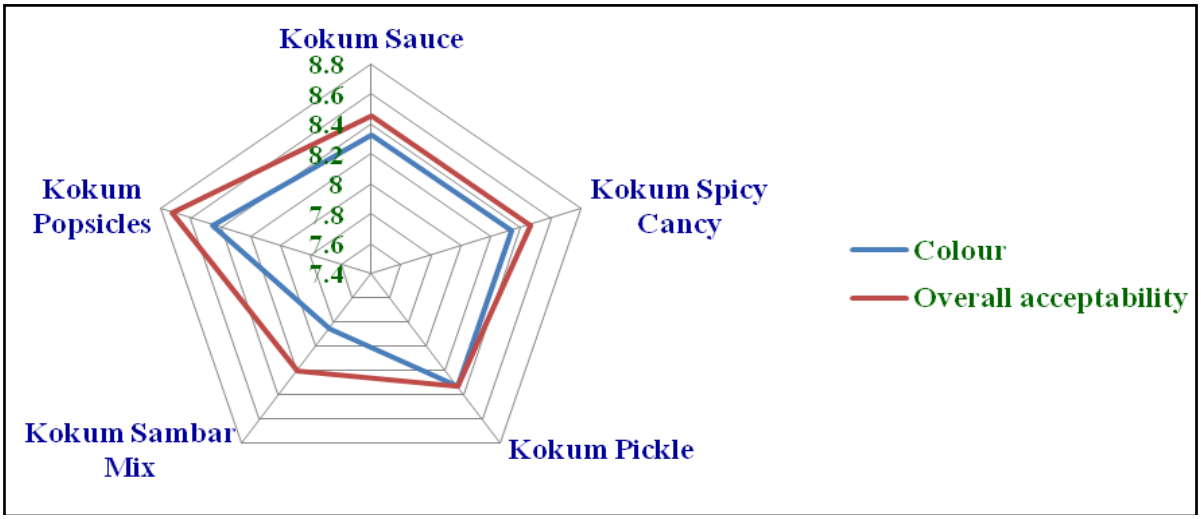


Fig 2: Colour & Overall acceptability of products formulated from Kokum pulp and powder.

Consumer awareness about health hazards associated with synthetic colors is increasing and thereby the use of natural colorants is increasing (Chethana *et al*., 2007; Chetan *et al*., 2010) [2, 3]. The use of natural pigments as food colorants permitted by the regulatory authorities is very limited. Various studies evaluated different sources of anthocyanins along with the pigment concentration (Chetan *et al*., 2010) [3]. Results indicate that the kokum contains highest concentration (2400 mg/100g of fresh fruit) of anthocyanins as compared to other sources (Nayak *et al*, 2010) [3, 18, 19]. Kokum is a rich source of anthocyanin and natural pigments, which are water soluble and help in scavenging free radicals. Hence, the fruit can be further explored for its use as a natural colourant.

Kokum fruit also contains various bioactive compounds and potential compounds such as antioxidant, anti-bacterial (Mishra *et al*., 2006; Ranveer and Sahoo, 2017) [17, 23] and antifungal properties (Yoshida *et al*., 2005) [28]. Scientific research documented its activity against several cancer cell lines, including breast cancer, liver cancer and leukaemia. In addition, kokum also exhibits antihistamine and anti-inflammatory properties (Sahu *et al*., 1989) [26]. Juice and squash made out of the kokum rind is used to cure various diseases such as piles, haemorrhoids, colic problems, ulcers, inflammations, treat sores, dermatitis, diarrhoea, dysentery, ear infection, etc. It facilitates digestion and prevent over perspiration or hyper perspiration when consumed. Kokum works as a natural antacid and a special preparation with rind, yogurt and salt relieves from gastric ulcerations and burning sensation (Jagetia, *et al*., 2002) [9]. The fruits are also used to prepare red beverage which has bilious action. Several studies (Jena *et al*., 2002; Masullo *et al*., 2008; Kirana, and Srinivasan, 2010) [11, 15, 13] reported many health benefits, but there are very few products made with Garcinia available in the market. Hence value addition of *Garcinia indica* (Kokum) enhances the utilization of fruit to the best possible extent, along with availment of health benefits of the fruit through various product forms.

Conclusion

Value addition of kokum into processed products will enhance the health benefits of consumers due to several bioactive components present. Kokum also has a great export potential as natural colorant. Further product formulations and process optimization of Kokum value added products can help explore the untapped potential of kokum. Rigorous efforts are

needed to establish the commercial plantations, value addition, marketing, as well as development of suitable processing technologies. The value-addition initiative allows Garcinia farmer producers to gain better income by promoting utilization of underutilized Garcinia. Hence Garcinia should be extensively promoted for development of various value added products etc for income generation as well as to reduce post harvest losses.

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