

KOKUM AN UNDERUTILIZED FRUIT AND ITS THERAPEUTIC BENEFITS: A REVIEW ON ITS NUTRITIONAL ASPECT

Abstract

Kokum, is an underutilized fruit scientifically named as *Garcinia indica* Choisy consisting of Nutraceutical properties benefitting to ailments due its abundance in phytoconstituents such as Garcinol, HCA and anthocyanin. These are typically located in India's western ghats and harvested in the summer season between April and May, belonging to Guttiferae family it is used widely from pharmaceutical industries using it as a drug for cure whereas confectionary industry producing wine to skincare products. Though kokum holds its place in Ayurveda by using its sources due to presence of several bioactive substances like xanthenes, flavonoids and phenolic acids is being fully utilized to treat various disorders. Studies are demonstrating this substance mode of action against tumor cells including anti-histamine and anti-inflammatory effects. Mainly kokum rind part is utilized majorly which not only possess fat reducing properties curing obesity but also prevents the action of the enzyme citrate which transforms carbs into fats.

Keywords: Kokum; Garcinia; Garcinol; rind; Anthocyanin; Nutrition.

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I. INTRODUCTION

Kokum a primitive fruit which is scientifically named as *Garcinia indicia Choisy* and is one of the most under used herb. It is chiefly ground in Western Ghats which itself is a great source of biodiversity for many plant species. In India such as Goa, Maharashtra, Karnataka, Gujarat, Surat, and Kerala as well as in some tropical regions of Assam, Meghalaya and West Bengal (Rai and Sayeed, 2022). This evergreen shrub belongs to the widely cultivated Clusiaceae family that is well distributed in continents Asia and Africa. This genera varieties are greatly used in dealing with the medical conditions within Ayurveda, some sources can be natural products, timber, edible fruits and resin. In India numerous species of these are used for their indigenous medical qualities and is a reservoir of many bioactive compounds includes xanthones, flavonoids, benzophenones, phenolic acids etc. (Angami *et al.*, 2020). According to Indian traditional medicinal system kokum is consumed in dealing with gastrointestinal disorders, liver disorders, sunstroke and rheumatic disorders because of its richness in antioxidants including anthocyanin, hydroxy citric and garcinol but also attributes in the production of summer drinks and wine production. In wine making its constituents gives a unique feature, anthocyanin adds color and hydroxy citric being an anti-obesity compound makes it a healthier option for patron. Kokum being a tropical fruit produces deep red pigment in liquid form like juices, which is non consumable due to its high acidic nature which in turns give sour taste (Machamangalath *et al.*, 2016).

Kokum is called out with many different names in different languages such as in it is referred as murgal in Tamil, kokamba in Marathi, in Kannada it is called murgina and tintali in Oriya etc. Complete statistics is not accessible with respect to productivity and area production as it is not cropped in an organized mode. Accordance to a survey by state of Maharashtra's chief conservator of forests just 43,000 of state's 46,600 kokum trees were found in the districts of Ratnagiri and Sindhudurg (Ranveer and Sahoo, 2017). Kokum fruit comprises of various bioactive compounds which holds anti-fungal anti-bacterial properties. Scientific researchers have showed its antagonists mechanism towards tumor cells lines which additionally attributes anti-histamine and anti-inflammatory properties, citing breast cancer, leukemia and liver cancer. Kokum is being conventionally served as a drug to cure stomach related issues, skin diseases and healing injuries. Kokum fruit's dried part is mainly used in the cooking it gives food a sweet-sour flavor also it possesses citric acid, acetic acid, malic acid, garcinol and ascorbic acid (Ananthkrishnan and Rameshkumar, 2016). This fruit is considered as an anthelmintic and cardio tonic. The rind of kokum is used to make squash and kokum juice which heals various health issues such as piles, bowel complaints, hemorrhoids, inflammatory problems, ulcers, colic problems, dysentery, and dermatitis. It facilitates easy digestion and prevents hyper perspiration. It is a natural antacid for gastric problems prepared from yogurt, rind and salt gives relief from ulcerations and burning sensations. In skin related issues like reducing inflammatory sores, ulcers and fissures on the hands and lips are cured by application of kokum butter which acquires wound healing property even curries are made from powdering the dried rinds of kokum and sold in Goa's many local communities for the use as an acidulant (Zahid *et al.*, 2016). Butter made from kokum is similar to cocoa butter it shows tolerance towards milk fat, has fatty acid and triacylglycerol compositions. In confectionery industry it is also used in making soaps and candles (Dhaka and Mittal, 2021).

Nutraceutical properties in kokum majorly plays beneficial role in human health as it is rich in protein, tannin, starch, crude fat and citric acid. The bio active compounds present in the rind are anthocyanin, hydroxy citric acid and garcinol. Kokum's two main anthocyanin pigments are cyanidine-3-glucoside and cyaniding-3-sambubioside, respectively (Vasundhara *et al.*, 2016). These have been articulated from chromatographic test with HPLC and NMR spectroscopy. It is known that anthocyanin make up around 2.4% of the biomass of the entire fruit, and that these pigments can harbor more free radicals and are soluble in water. It is an important bio active compound group that are a subclass of flavonoids and is liable for giving flesh red or purplish color in fruits. Another compound is HCA (hydroxy citric acid) found in kokum contained in amounts up to 23 % on a dry basis, it is mostly present in leaves and rinds as HCA and to a lesser extent, as HCA lactone. Garcinol the third component in kokum consists of 1.5 % of the fruit, it is a yellowish-orange color fat soluble pigment present in the rinds of kokum when level up to 2-3 %. Well, this can be separate out from the rinds of the fruit by using ethanol and extraction of hexane (Waghmare *et al.*, 2019). There are compounds present in kokum fruit other than these three which are furfural and its derivatives, cyanidin-3-glucose present as anthocyanin in caffeine and rind, out of all furfural and cynadin-3-glucose are great antimicrobials. The amount to which these bio active compounds get extracted to different solvents determines how effective they are as bactericide. The extract of fruit is been used as edible in several cooking practices, the fruit is said to be mainly cropped during the summer April – May of every year (Sharath *et al.*, 2015). The extract of the fruit containing both antifungal and antibacterial properties is utilized as a bio preservative for food staples for storage. Also, it has been found that the fruit's rind part possesses fat reducing properties due to presence of HCA which in turn treats obesity therefore it inhibits the action enzyme citrate which is responsible for converting carbohydrates into fats (Jagtap *et al.*, 2015). Being a seasonal fruit kokum is commonly preserved by sun drying and salting, extracts of kokum acts as a reliever in curing nerve pain because of the presence of caffeine but to keep in lead to person mind kokum if taken in excess than the high dose of caffeine will inhibit loco motor nerves may dozing (Joshi *et al.*, 2018).

II. BOTANICAL CLASSIFICATION

Since decades, the plant is being used as a drug to cure ailments due to its bioactive availability. And they carry medicinal properties which is beneficial for health and wellbeing. The fruit of the plant is consumed as a whole or made it in a combination within modern pharmaceuticals. *Garcinia indica* belonging to Guttiferae family, reportedly rich in polysaccharides used in many functional foods (Malar *et al.*, 2022). *Garcinia* is a large genus found primarily in tropical regions, most of its species' fruits are consumed by both animals and human. This genus seeds from a few species contains edible fat. Family species are mostly shrubby or woody with branches that are typically horizontal with yellow latex, many of them include active substances (Doan *et al.*, 2018).

Due to its dioicous nature and cross pollination naturally occurring kokum populations exhibit significant variances in fruit, three major varieties of *Garcinia* are *G. gummi-gutta*, *G. indica*, and *G. xanthochymus*. Prevailing amino acids that are found in *Garcinia* fruits are alanine, leucine, proline and phenylalanine. Kokum is gathered from the wild, grown in backyard gardens and very slightly farmed as a rain fed crop (Patil *et al.*, 2016).

Scientific Classification is as Following: - Garcinia Indica
Kingdom – Plantae
Clade – Tracheophytes
Clade – Angiosperms
Clade – Eudicots
Clade – Rosids,
Order – Malpighiales,
Family – Clusiaceae,
Genus – Garcinia, Modera
Species – G. indica.
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(Kumar and Kaushal, 2019)

III. MORPHOLOGY

Garcinia trees are well recognized for their delectable fruits and therapeutic qualities. The three main species grown in tropical regions are *Garcinia mangos tana* L. (mangosteen or purple mangosteen), *Garcinia gummi-gutta* (L.) N. Bobson. (Malabar tamarind), and *Garcinia indica* (kokum). The majority of *Garcinia* species apomictic, which results in limited genetic variation. The tree's structure, fruit's size, color and form as well as other relevant traits are depicted by germplasm exploration and genetic diversity analysis (Murthy *et al.*, 2018). The mature kokum fruit must be processed before consumption, not to be eaten straight away. The kokum fruit deteriorates more quickly as a result of weight loss, rotting, shriveling damage from handling and transit and other factors (Shedge *et al.*, 2023).

Kokum is a medicinally important polygamo dioecious tree appears from moderate to large sizes, and growth up to the height 15-20 meters. The canopy is said to be thick and dense with green leaves, branches are drooped when full grown up to 10-18 meters and flowering time is from month of November to February. It takes about 15 years of cropping with proper care and management to yield 30-50 kg of fruit (Kumar and Kaushal, 2019). In 2019 Dike and Deodhar explained briefly various kinds of floral type of trees can be found in *G. indica*, their reports says it is polygamo dioecious that comes in three kinds, one is male or no fruit yielding, second one is female or high fruit yielding and third one is bisexual or less fruit yielding (Baskaware and Deodhar, 2022). In Karnataka Western Ghats two varieties of kokum were discovered one produces red fruit while other produces yellow fruit, the yellow coloring variety is a special kind typically referred as "bili murugalu" (Kumari *et al.*, 2021).

In a present study of Deoxyribonucleic acid (DNA) based molecular marker discriminating gender of kokum, simple sequence repeat (SSR) from male, female and bisexual flowers was discovered. The most prevalent SSR motif found in transcriptome was "AG/TC", the analysis shows higher amount of inter- gender polymorphism (Patil and Pawar, 2019).

Garcinia indica Choisy fruits are spherical, orange to pink, deep purple when they ripe are fully mature its color changes from green to light green and from red to purplish red, diameter is 4 cm, pulp is red and fleshy. Seeds 5-8 are largely enclosed and appears compressed. To identify them in the field characters to be known are: Branches with pointed crown and bending. Berries are deep purple in color when matured and smooth but not flat (Shameer *et al.*, 2016).

IV. PHYTOCONSTITUENTS

Garcinia indica when subjected to phytochemical examination, active phytochemicals that are potentially used in medicines are present in the leaves and fruits of *G. indica* these phytochemicals have anthelmintic and antibacterial properties it was discovered that the fruit's extracts included a variety of phytochemicals including glycosides, steroids, alkaloids, terpenoids, tannins, flavonoids and phenols (Narayanappa *et al.*, 2022). Kokum fruit retains many antioxidants that are beneficial one such in pericarp of kokum is an antioxidant which is a life booster known as Xanthones, the anthocyanin pigments are acquired from it and utilized as a natural food preservative (Pawaskar *et al.*, 2017). The phenolic compound antioxidant capabilities arise from several factors of methods, including the removing of free

radicals, the chelation of iron and copper ions, and the inhibition of free radicals producing enzymes. The Folin-Ciocateu reagent technique was used to determine the phenol content. The colorimetric technique using aluminium chloride was used to measure the number of flavonoids (Aravind *et al.*, 2016). A variety of *G. indica* leaf and bark extracts were tested for their anti-bacterial properties. Qualitative phytochemical analysis shows that it is a potential source of a wide range of phytochemicals. Twelve extracts in all were all examined, eleven extracts contained carbohydrate and flavonoids, excluding an aqueous extract of the bark (Desai *et al.*, 2019).

Kokum extract provided the largest zone of inhibition against streptococcus mutans and enterococcus faecalis bacteria, according to the current study, which showed that it had a higher zone of inhibition than the other items evaluated, including chlorhexidine. The findings show that these herbal extract's active ingredients are capable of dissolving bacterial cell walls which prevents it from growing (Sushma *et al.*, 2020).

Anthocyanin: Percentage of anthocyanin in kokum fruit is significantly high and has huge potential in manufacturing in colored fermented beverages. Red pigment makes around 2-3 percent of kokum. These are one of the major subgroups and widely spread plant's constituent commonly known as flavonoids. These are the reason for pigmented bright colors in many fruits, flowers and cereal grains. The polarized character of anthocyanin creates solubility in many other solvents such as methanol, ethanol, acetone and water (Soumya *et al.*, 2019). Anthocyanin is reformed by hydroxylation, methylation, glycosylation and acylation which makes it more stable and adaptable. Kokum's anthocyanin is water soluble and have antioxidant properties. These flavonoids having two aromatic rings attached to a central C3 pyran ring (Alappat and Alappat, 2020). However, the antioxidant activity of anthocyanin greatly relies on its chemical composition, number of hydroxyl group attached and the position but also conjugated double bonds and the occurrence of electron donors in the structured ring. Different kinds of flavonoids can be produced by modifying six common aglycons known as anthocyanidins that function as good effective donors of hydrogen (Martin *et al.*, 2017).

HCA: Among other compounds Hydroxy citric acid is another chemical compound found in different Garcinol species which includes *G. cambogia*, *G. indica* and *G. atroviridis* and is a derivative of citric acid and chiral compound also known as hydroxy citrate. It has been reported that HCA expands the release of serotonin in the brain which prompts the suppression of appetite to enhance weight reduction. It is also known as "Garcinia acid" since it found in high concentrations in garcinia species (Singha *et al.*, 2017). Many reports show HCA (Hydroxy citric acid) effect on weight loss by inhibiting the action of ATP (adenosine triphosphate) lyase the enzyme responsible for catalyzing extra mitochondrial cleavage to oxaloacetate and acetyl co-enzyme. It also increases glycogen content in liver and muscles by inhibiting the mechanism of glycolysis which stops the action of phosphofructokinase and also an inhibitor synthesis of fat and cholesterol (Tomar *et al.*, 2019).

Garcinol: Garcinol is commonly found in large amount and in pure form in dried kokum plums through extraction or chromatographic purification or crystallization. It is a potent antioxidant found in *G. indica* shares structural similarities with curcumin in that it possesses hydroxyl groups both in phenols and in alcohols as well as beta diketone moiety. Isogarcinol is made by treating garcinol with diluted hydrochloric acid. Their main role is

playing against various tumor models by inhibiting histone acetyl transferases (Schobert and Biersack, 2019). The primary functional class of garcinol with anti - cancer properties is C8 side chain. C3 ketonic group and phenolic ring group are its main oxidative sites which are more active in its oxidized products during metabolic transformation (Aggarwal *et al.*, 2020).

The presence of anthocyanins such cyanidin-3-glucoside and cyaniding-3-sambubioside which are stated for the treatment of dysentery, tumors, cardiovascular ailments, and liver problems is thought to be the reason of the red color of kokum, according to the reports. Its potential therapeutic benefits including its anti-oxidative, anti-inflammatory, anti-cancer abilities were discovered in vitro investigations (Bellary *et al.*, 2016).

The findings and the outcome of research suggested due to their high phenolic and flavonoid contents Western Ghats kokum species resulted in impressive vitro antioxidant action against free radicals (Gunjal *et al.*, 2021). Garcinol may have an effect by blocking histone acyltransferase and maybe post transcriptionally modulating miRNA profiles involved in carcinogenesis according to reports. Studies conducted in the laboratory have indicated this substance has the potential to treat a variety of diseases, including leukemia, breast, colon and pancreatic cancers. It also contains ascorbic acid in great amount which is been used as a tonic for heart (Mane *et al.*, 2018).

V. NUTRITIONAL VALUE

Fermenting the kokum fruit by using different yeasts and lactic acid bacterial strains to produce its juice, which enhances the nutritive value gives therapeutic effects and consumed in the form of refreshment drinks. Having sweet tangy flavor and eye appealing color adds it on the welcome table menu mostly during the summer season (Bhanjer *et al.*, 2021). Frequently, the seeds oil used to make “Red Mango” an Ayurvedic medicine which is used to treat skin conditions (Pramanik *et al.*, 2018).

Fresh rind of kokum contains 80 % of moisture content, 1% protein, 1.7% tannin, 0.9% pectin, 4.1% total sugar and 1.4% fat. The rind further more has HCA up to 10.3-12.7 % that acts as an anti-obesity agent and a yellow crystalline substance called garcinol content is 1.7% called an anti-cancer agent (Khapare *et al.*, 2020). Nutritional composition of kokum leaves is to contain 75% of moisture content, 2.3g of protein, 0.5g of fats, 1.24g of fiber, 17.2g of carbohydrates, 15.4 mg in iron, 250 mg in calcium, 10 mg in vitamin C and 18.10 mg in oxalic acid according to the reports. The seeds are said to be high in oleic and stearic triglycerides. In terms of proteins, refined kokum seed flour is considered finest over kokum seed flour shows favorable chemical and physical characteristics that employ to complement in a variety of dietary system and may help developing nations with their concerns with protein deficiency (Chate *et al.*, 2019).

According to the current study, kokum, aonla and ginger can be used to make tasty beverages by altering the degree of both sugar and carbonation. It continues to have potential uses and applications that has so far to be completely discovered, deduced and comprehend. Kokum based ebullient beverages are a novel idea that offer the fruit’s nutritious components as well as its natural colors and aromas. In addition, the carbonation benefits could be used commercially (Hegde *et al.*, 2018).

Prime Metabolites Composition of *Garcinia Indica*

Nutrient	Amount(g/100mg)
Total Carbohydrates	6.24
Total Proteins	4.78
Crude Fats	0.12
Reducing Sugar	0.63

(Parthasarathy and Nandakishore, 2016).

VI. MEDICINAL USE

Kokum fruit dry part bark is abundant in hydroxyl citric acid which is exclusive and compelling that regulates metabolism in obesity and is also associated with prevention of cardiovascular risk factors that is caused from abdominal obesity. It has made its place in Ayurveda over years in treatment of disorders of the heart, allergies, sunstroke, diarrhea, dysentery, piles and burns by acting as a therapeutic agent (Bayineni *et al.*, 2019). Black kokum is known to be a great source for hypocholesterolemia agent, fighting cancer due to presence of antioxidants which not only solves cardiovascular diseases, skin allergies but also neurodegenerative chronic diseases such as Alzheimer's and curb appetite which causes reduction in lipogenesis and fatty acids synthesis (Grewal, 2016).

Garcinia indica also contains vitamins such are B1, B2, vitamin E and vitamin C these are necessary for preventing rise in blood sugar level, shows decrease in insulin resistance, controlling glycemic activity and prevention of protein glycation which indicates that it can be used as adjuvant therapy (Shetty *et al.*, 2018). Kokum also contains minerals in good amount such are potassium, magnesium and manganese which aids in controlling blood pressure, provides shield against stroke and coronary diseases, additionally this species possesses antibacterial, cardiac tonic, antiscorbutic characteristics. It helps relieve discomfort from tumors as well as piles and diarrhea (Nayak *et al.*, 2019).

Folklore vaidyas of the western ghat employ that vrukshamla seed oil (*Garcinia indica* Choisy) also known as margarine or oil of kokum for cracked hands and feet and other skin conditions because it is incredibly nourishing, unctuous, Mardavakara (gives softness). It has been used in Ayurveda for number of purposes, it is administered externally to skin diseases, dysentery, diarrhea with mucus, fissured lips and ulcerations (Mohammed *et al.*, 2017).

In summer season drink is made from the kokum concentrate or kokum squash with traditional method that not only influences good gut health but gives relief from the heat produced in the body. In which certain quantity of sugar is used in the fruit barks to provide solar energy which converts it to make syrup, when combined together extends the shelf life and taste (Thakur, 2018). The kokum fruit is collected to manufacture kokum syrup also known as "Amrit kokum" a tasty sharbat or beverage which is beneficial in fever. The aqueous extraction from the fruit of this species is also used in order to reduce anxiety (Shirke and Pinjarkar, 2023). Kokum is well used with cumin and pomegranate to create a sports beverage contains electrolytes and anti-bacterial properties which increases efficiency and boosts up the performance of athletes (Chauhan *et al.*, 2022).

Kokum barks extract has given effects against *Candida albicans*, *Penicillium sp.* and *Aspergillus flavus*. Methanol extracted from leaves of the fruit has shown effects against bacterial infections, it acts as a neuroprotective agent for striatal dopaminergic neurons in Parkinson's disease. Whereas aqueous rind extract of the fruit kokum exhibits anti diabetic action in streptozotocin- induced hyperglycemic rats (Rameshkumar, 2016).

G. indica rind has been shown to have anti-depressant and anti-anxiety benefits that does not affect motor functions or interferes cognitive performances. Whereas, *G. indica* fruit extract possesses certain number of antioxidants such as HCA employed in ecological sustainable AgNPs (silver nanoparticles) to replace hazardous compounds as a result it has numerous usages in bio medical industry as a reliable source of agents minimizing and capping (Lim *et al.*, 2021).

In pharmaceutical research all intestinal cells show physiological potent inhibitory characteristics, as shown by the garcinolat IC₅₀ standards for 72h treatments (Dabhade and Koli, 2022). In a study it has been also concluded that natural extracts of *Garcinia indica* fruit and *Achyranthes aspera* seeds are combined to create effervescent granules and coffee *Arabica L.* beans preventing pancreatic lipase from functioning and alpha amylase which can be helpful in the cure of metabolic diseases and weight reduction (Patel *et al.*, 2022).

In a present study a 4-week treatment with *G. indica* fruit juice without generating any toxicity, decreased body weight and enhanced metabolic markers including glucose resistance, dyslipidemia, and glucose and leptin levels. Oral administration of *G. indica* juice for four weeks has potential for reducing adiposity (Nampoothiri *et al.*, 2021). A study showed that medications for *C. difficile* might be used with kokum extracts or the herb's pure form. In a recent study conducted in India, the methanolic extracts from the leaves and fruit of kokum shown strong bacterial resistance in the examined isolates. *Salmonella Typhi*, *Salmonella Para typhi A*, and *Salmonella Typhimurium* were inhibited by kokum leaf extract, and *Bacillus Subtilis*, *Escherichia coli*, *Enterobacter aerogenes* and *staphylococcus aureus* were all reported to be susceptible aureus were all reported to be susceptible to the aqueous extract of kokum rind (Justin *et al.*, 2018).

VII. USE IN CONFECTIONARY INDUSTRY

According to a study kokum fruit is illustrated as a prospective industrial by product for business manufacture due to its chemical traits. One such example is Kokum fats used in chocolate preparations. Dried part of kokum, rind and seed have many applications being used to prepare seasonings as they give an aromatic flavor to the food additionally it is a great alternative for vinegar, lime juice and tamarind providing sour taste in curries and gravies (James *et al.*, 2016). Normally *Garcinia* seeds are difficult to extract by traditional method, so powdering the *G. indica* rind makes it easy to utilize, for storage, for transporting, and market to branch out such as spice or an element for kokum juice. The kokum fruit is juicy and the rind is removed by drying the fruit with sugar in the sun, collecting the syrup and storing it like a squash for later use (Sthapit *et al.*, 2016). 'kokum', 'Buransh', and 'Nannari' are the only herbal drinks from the western ghats, Uttarakhand, Andhra Pradesh respectively according to a research of indigenous health beverages from India but production is only permitted in the region from where they originally come (Adlakha and Koul, 2019).

The edible fat known as kokum butter is obtained through kernel seeds which is used in confectionary industry making ointments, soaps and in pharmaceuticals like skin care goods due to its capacity to treat ulcers, fissures and softening the skin. They are frequently used to preservation of fish and useful supply of acid for coagulating rubber (Dehankar and Dehankar, 2018). The assortment, handling and trading of kokum seeds as butter indicates considerable income opportunities for a native farmer. Surplus surge in the demand of kokum butter for use in confectionary industry generated increase in supply as well (Pawar *et al.*, 2018). Some reports suggests that kokum seeds are being used to produce oil it is extracted by skimming out the oil and heating followed by cooling dried kernel powder and eradicating the oil that collects on top since it is extensively used in tropical and subtropical regions. Oil may be effectively extracted from the seeds using chloroform as a solvent. In an analysis two solvents used in extraction of oil from the kokum seeds, chloroform yielded the most (Bhande and Giri, 2017).

Kokum fat acts as a gelator since it includes stearic acid in higher amount however, when administered alone it requires concentration around 20% to form oleo gel. Thus, it is thought that combination of kokum fat with artificial gelator is a better option in food industry for commercializing (Nagavekar *et al.*, 2019). Kokum butter is a suitable alternative for cocoa butter because it contains similar properties to lipids in terms of fatty acid components, slippage or fast melting rate, solid fatty elements, iodine presence and saponifying values. These findings demonstrated the positive potential of kokum fat without changing the flavor or other characteristics of the chocolate (Kalse *et al.*, 2021). Some findings of the thermodynamics parameters showed that the adsorption at solid solution interface is spontaneous, endothermic and favorable. Therefore, kokum leaf powder which has been formaldehyde activated and treated with sulphuric acid will be superior choice as dye remover (Jamdade and Ubale, 2019).

The kokum fruit is viable alternative to grapes in the wine business as majority of kokum harvest is only utilized to make syrup and juice the remainder is wasted. So, there is significant economic loss. Therefore, wines are made by diluting kokum juice, adjusting pH levels and fermenting to reduce its dark color and acidity to get good quality wine with light alcohol (Pawaskar *et al.*, 2020).

VIII. CONCLUSION

Though, being abundant in phenolic components such as HCA, Garcinol and Anthocyanin, performing various activities in pharmacology shows Garcinia has the potential to be an effective medicinal agent for managing and preventing a variety of ailments. However, since the majority of trials have been performed in vitro or in vivo, additional clinical research is required to determine the effectiveness, safety and efficacy for human consumption. The touted health advantages of this fruit have greatly expanded the availability of it in different processed forms. In addition to its therapeutic properties, it offers a lot of processing value. Chock- full of, B complex vitamins, minerals and other nutrients that help regulate blood pressure and heart rate. This adaptable golden fruit has been used from a very long time to treat digestive issues. The thorough knowledge of plant and their applications may contribute to the development of innovative- plant- based drugs.

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