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Kokum (*Garcinia indica*) a beneficial underutilised crop: A review

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Abstract:

The consumption of underutilized plants for medicinal as well as nutritional use is being reported long back. Majorly the consumers of these plants are tribal sects of the society because they are the keepers of traditional knowledge on different uses of plant genetic sources. Even in today's time underutilized plants are still utilized during the famine and similar situations as they provide sufficient nutrition; Kokum is one of them. Kokum (Garcinia indica), is an indigenous tree found in India. It belongs to cluisiaceace family (Padhaye et al. 2009). The present article throws a light on the health impact of kokum (Garcinia indica).

Key words: *health. Kokum, traditional uses.*

Introduction

Kokum (Garcinia indica),isan indigenous tree found in India. It belongs to cluisiaceace family (Padhaye et al.2009). The tree is found in coastal regions of Maharashtra, Goa, Karnataka, Kerala. It is also found in eastern and north eastern part of India such as Andhra Pradesh, Assam(Baliga MS et al.2010). There are many vernacular names (Table 1) for kokum in every states as follows (Dhamija et al.2013). The genus Garcinia has 200 species of which 20 are found in India (Ramchandran, 2014).

Morphology of Kokum tree

Kokum being a tropical evergreen tree is 15m in height with slanting branches (Braganza et al.2012). The flowering period of kokum tree is from November to February. The fruit is of spherical shape and is red or dark purple colour, having 4-8 seeds intact in them (Jagtap et al.2015). The fruits are been harvested in April-May (Priya et al. 2013). The temperature required for its growth is 20° C to 35° C and rainfall of about 2500 to 4000 mm is

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favourable for the growth of this tree (Kureel et al.2009).Laterite and alluvial soil is required for the kokum plantations. Kokum is favourably grown around coconut plantations and also intercropped between coconut and areca nut plantations (Braganza et al.2012).

Garcinol is found in the rinds of kokum. This are yellow fat-soluble pigments consisting of 2-3% in the rinds. Garcinol is being studied for its anti-cancer, anti- ulcer properties(Ramchandran, 2014). Hydroxycitric acid also present in rinds of kokum helps as a inhibitor in synthesizing fat and cholesterol, thus helps in reducing weight, and is thus used for treating against obesity (Swami et al.2014). Kokum is also rich in anthocyanin content and are responsible for red and purple colours in fruits. Cyanidin 3-glucoside and cyanidin 3-sambubioside are two compounds which are responsible for the red colour of the fruit (Nayak et al.2009).

The kokum fruit has sweetish acidic taste and a peculiar flavour, thus the dried peel is used as an acidulant in fish curries. The rinds are blended with jaggery and refreshing drink is made in summers as the kokum has a cooling effect on body and thus helps from sun-stroke and dehydration. Amrut kokam, kokum agal, kokum sherbets are also made. Kokum is been proven beneficial fruit for curing against many health challenges such as anti-obesity, anti-fatigue, anti-depression, anti-inflammatory, anti-bacterial, anti-viral. The oil obtained from fruit is edible and is used in confectionery foods, also the kokum butter is of great importance in cosmetic industries as its been proved to be a good moisturizer and in healing skin wounds(Ramchandran, 2014 and Braganza et al.2012). Diseases and parts of kokum used are depicted in Table 2.

.PhytoChemistry

Garcinia Indica contains various chemical constituents such as Garcinol and Isogarcinol which are polyisoprenylated benzophenone derivatives, hydroxycitric acid, xanthochymol, isoxanthochymol, cycloxanthochymol, garsubillin, guttiferon isoforms, combogenol, mangostin, Gambogic acid, kolaviron, procyanidines, anthocyanins and caged derivatives of xanthone. (Padhaye et al. 2009 and Hemshekhar et al. 2011). It also contains citric acid, acetic acid, malic acid and ascorbic acid. (Jagtab et al 2015). Kokum rind has highest concentration of anthocyanin (2.4g/100g of fruit) in the form of cyanadin-3-glycoside and cyaniding-3-sambubioside as major pigment, from any natural source. (Baliga et al.

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2011). Seeds are rich in fat and contain essential fatty acids.Kokum butteris basically the fat (24%)present in the kokum seed and remains solid at room temperature. Unrefined kokum butter is yellow in colour, while refined is white. Total free fatty acid present is 7.2% of kokum butter. (Dhamija et al.2013 and Ramachandran, 2014). Phytochemical composition of kokum is discussed under table 3 to 6 respectively.

Hydroxycitric Acid

Major organic acid present in *Garcinia Indica* is hydroxycitric acid (HCA) , the derivative of citric acid. It is present in free acid as well as in lactone forms in the rind of kokum. It is found in large quantities in Garcinia species, Garcinia Indica, Garcinia combogia and Garcinia atroviridis, hence it is also called Garcinia acid. It is present in the rinds and leaves of kokum. 20-30% of hydroxycitric is present in the rinds on dry basis. HCA is known its anti-obesity properties. Studies have shown significant effect of HCA in weight reduction. Studies have shown that weight loss is due its ability to inhibit the enzyme adenosine triphosphatase-citrate-lyase. Also suppressing appetite by increasing the release of serotonin. Inhibition of pancreatic alpha amylase and intestinal alpha glucosidase is responsible for thedecresed carbohydrate metabolism, considered as the cause of weight reduction. It prevents the synthesis of fat and cholesterol thus lowering the accumulation of lipid. Studies have shown HCA's potential in reducing total cholesterol level and LDL-C levels. It reduces fat synthesis in the body from 40-70%. It is used in rats to stimulate the activity of carnitine palmitryl transferase (CTP-1), which burns fat thus helping in weight reduction. It can be separated both thermal and non-thermal process. Isolated HCA is not stable,rapidly forms HCA lactone (HCAL). It is generally isolated in the form of sodium, potassium or calcium salt. Cation exchange column can be used for the separation of free HCA and lactone. Dertermination of HCA and lactone is also done by liquid chromatography. One of the separation method is using aqueous sodium and methanol extraction then treating with neutralized HCl. Pure HCA is obtained by using acetone, which will be in crystal form(Hemshekhar et al. 2011, Onakpoya et al. 2010, Milind and Isha 2013, Mishra et al. 2006, Swami et al. 2014, Jagtab et al. 2015, Han et al. 2016).

Garcinol

Garcinol, which is also known as camboginol (a triisoprenylated chalcone), is one of the major bioactive constituent present in the rinds of kokum in the level of 2-3%. It is a fat-

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soluble yellow coloured pigment. It is a derivative of polyisoprenylated benzophenone containing phenolic hydroxyl group. It is a potential antioxidant present in kokum. (Jagtab et al 2015, Ramachandran 2014). It is separated in forms of crystals from the hexane extract of the rind. It has a molecular weight of 602 Dalton. The antioxidant present in Garcinol is similar to that of curumin because it contains both phenolic hydroxyl group and β-diketone moiety. The free radical scavenging ability of Garcinol in DPPH is found to be 3 times higher than that of DL-α tocopherol and 85% similar to that of ascorbic acid. Presence of phenolic hydroxyl group makes Garcinol an active antioxidant. It also has anticancer and antiulcerous properties. It has been reported that the potential effect of Garcinol in treating gastric ulcer caused by *Helicobactor Pylori* or by hydroxyl radicals. H. Pylori infection can be treated using Garcinol as an alternative antibiotic for Clarithromycin, having lot of side effects. (Swami et al. 2014, Hemshekhar et al.2011, Padhaye et al. 2009, Yamaguchi et al. 2000).

Anthocyanin

Anthocyanins are water soluble pigments present in the cell sap of fruits and vegetables. These are polyophenls containing hydroxyl group. It is responsible for the red, purple and blue colour in fruits and vegetables. These on hydrolysis yields coloured agylocones.(Shakuntala and Shadakshwaraswamy 2010). Anthocyanin is present in kokum in the form of ascyanidin-3-glucoside and cyanidin-3sambubioside pigments. In kokum it is present in 2-3%. It is extracted by hydraulic press of the rind in 1% acidified water as solvent. It have potential antioxidant property, can scavenge free radicals. It reduces the heart diseases and risk of cancer. It is identified by different methods like thin layer chromatography, HPLC, mass and NMR spectroscopy. Kokum anthocyanin can be concentrated by forward osmosis method using semi-permeable nonporous activelayer of cellulose triacetate fixed in a nylon mesh with NaCl solution as an osmotic agent. (Nayak and Rastogi, 2010, Jagtab et al. 2015, Swami et al.2014, Padhaye et al. 2009).

Health Benefits of Kokum

Antiageing effects:

Ageing is a natural and continuous process and one of the real features of the development of wrinkles on the skin with age by the action of the enzyme elastase(Baliga & Katiyar, 2006)Kokum pigments are beneficial in skin problem for skin protection due to its UV light absorbing properties. Kokum having anti hyaluronidase and anti elastase activities which favours skin care(Sahasrabudhe et al.2010)

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Antidiabetic effects:

Diabetes is a chronic disorder identify by high blood glucose or either insufficient insulin depending on the type of diabetes.(Ranjita Misra et al.2011) Kokum rinds are utilized in the treating of diabetes. Kokum restores the level of erythrocyte an intracellular antioxidant and studies have proven it isbeneficial in preventing the risk of developing secondary complications; which depicts potential characteristics of kokum in treating both hyperglycemia and other complications(Yamaguchi et al.2000).

Cardioprotective effects:

Cardiovascular disease development derives from atherosclerosis. Atherosclerosis is a inclusive term used to describe the thickening of the arteries caused by the formation and deposition of an atherosclerotic plaque.(Ranjita Misra et al.,2011)Kokum enhances the eNOS expression and catalyses the NO production, which results in improved endothelial dysfunction, harmonizes blood pressure and therefore may have an positive effect in preventing atherosclerosis.(Xu, Ikeda, & Yamori,2004)

Antibacterial effects:

Hexane and benezen are the extracts from the rinds of kokum. Even kokum leaf extract possessed by inhibitory activity against pathogenic Salmonella typhi. Garcinol possesspositive impact in enhancing the antibacterial effects of clarithromycin on H. pylori (Sang et al.2001; Sang et al.2002). Theaqueous extract of Kokam rind are reported to have highest antibacterial activity against Bacillus subtitles, followed by Escherichia coli, Enterobacter aerogenes and Staphylococcus aureus. (Varalakshmi et al.2010)

Anticancer effects:

Chemotherapy is an important integral part of cancer treatment. Many studies suggests that Kokum has played a potential role in inhibiting the growth of cancer cells than that of normal immortalized cells. Kokum and its derivatives can inhibit with intestinal cancer cell

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growth without affecting normal cells. The garcinol from kokum acted as an anti-cancer agent by inhibiting HAT activity and instigating apoptosis(Balasubramanyam et al.2004)

Antiobesity effects:

Methanolic extract of the dried fruit of kokum display remarkable anti-hyperlipidemic activity in rats using cholesterol induced hyperlipidemic model Many studies have shown that the utilization Kokum helps in reduction of appetite, and inhibits lipogenesis and conrols body weight due to the presence of hydroxycitric acid (Preuss et al.2004). Darji reported that significantly, decrease in total cholesterol, triglycerides, LDL-C, VLDL-C levels and increase in HDL-C.(Darji et al.2010). In-vitro studies signifies, that the increase in adipocytokine secretion and up-regulation of adipocyte specific gene expression without activation of PPARγ on curing rats adipocytes with cyaniding 3-glucoside. Furthermore, in vivo studies also showed increase in the gene expression of adiponectin in the white adipose tissue(Tsuda et al.2004)

Antioxidant activity:

Antioxidant are micronutrients and there importance due to their ability to neutralize free radicals and their reactions. In a dietary component desirable properties is considered to be anti-oxidant effect (Mishra et al.2006). Apart from HCA and garcinol, kokum contains other compounds with potential antioxidant properties. These includes citric acid, malic acid, polyphenols, carbohydrates (Cadenas et al.1996), anthocyanin pigments and ascorbic acid (Peter et al.2001). Methanolic extract of kokum fruit showed potent anti-oxidant activity compared to standard ascorbic acid. Gracinol was showed to have super oxide anion scavenging activity in phenazene methosulphate NADH- nitroblue tetrazolium system.

Traditional Products of Kokum and their application.

Kokum Butter (bhirndel tel):

Seeds were sun dried and the outer black shells and the inner white colored of the seeds were peeled and chopped, ground into the fine paste. Then they are cooked and dried to get the butter. Kokum butter is used as a specific remedy for diarrhoea and dysentery (Kureel et al.2009). Also kokum butter is also more popular over cocoa as an intensive skin moisturizer.

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Kokum Syrup (Amrit Kokum):

This product is prepared from fresh ripe kokum rind by adding the cane sugar 1:2. The mixture is preferably kept in sunlight after packaging in glass container for 8 days with continuously stirring. Then the mixture is strained through muslin cloth and stored in container. The preservative also added if required i.e. sodium benzoate. This product needs to be diluted 5 to 6 times with water before consumption.

Sol Kadi (Sol curry):

It is prepared with the fresh kokum fruit and with fresh coconut milk, salt, sugar and spices are added in various concentrations and the mixture is dried in tray dryer.

Kokum Agal (Salted juice):

It is a salted juice prepared from Kokum fruit. The salt is added and the 4 levels of different concentrations of pulp was added. i.e. (14,16,18,&20%). Then mixture was stirred daily for seven days. After seven days whole mixture was strained through stainless steel sieve of 1mm, and the juice was filled in pasteurized bottles.

Kokum Wine:

The kokum wine is prepared by using the traditional method in Goa with the addition of commercial baker yeast. The red kokum juice contain about 4% sugar and thus, fermented to produce kokum wine.

Kokum Fruit Bar:

With the addition of adequate level of sugar and other ingredients the fruit bar is prepared by drying the boiled kokum pulp. (Bafna, 2014)

Kokum Rind Powder:

Firstly, the kokum rind was dried at definite temperature in a tray dryer and the dried rind was ground. And the ground product is sieved in a sieve to get uniform particle size. This powder can be used as raw material for different curry preparations, ingredients in different mixes like sarbat, solkadhi etc.

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Cosmetic application of kokum:

Kokum is used as natural moisturizer to keep skin supple and silky smooth because it has emollient property. It also useful for the treatment of severely dry skin, ulceration and fissures of lips, hands, feet etc. (Swamiet.al. 2014)

5.9. Kokum RTS beverage:

This was prepared by using the clear juice obtained from kokum pulp with the dition of sufficient amount of sugar develop by pasteurization and cooling. (Bafna, 2014)

Conclusion and Future Scope

Underutilized crops, which often refers as minor, neglected, under exploited, under developed, local, traditional, niche crops, should be dealt with care and thus proper decision in their cultivation and post-harvest process can help the farmers to cultivate such crops in more numbers (Priya et al.2013). New ways for conservation and various techniques of farming should be implemented for such underutilized crops (Padulosi et al.2000). Farmers should be guided in proper way from farming techniques, such as its sowing, use of fertilizers, harvesting, and storage. Well-structured researched and developmental progammes should be laid out for crops like kokum for its conservation and also to broaden the genetic base by breeding progammes (Chaudhuri, 2005).

Kokum plantation is not of organized manner hence statistics regarding area production and productivity is not available. According to survey in 2010, Kokum is grown in 1000 ha area in Konkan region with production of 4500 MT of fruits. A survey conducted by Chief Conservator of Forest showed that out of 46,600 Kokum trees in state of Maharashtra 43,000 trees existed in Ratnagiri and Sindhudurg Districts. It was reported that 1674 MT of Kokum fruits were used for production of dried Kokum, 757 MT for preparation of Kokum syrup and 40 MT for manufacture of Kokum butter. A farmer's livelihood is depended on cultivation of such underutilized crops. The trees are found in single or in clusters throughout Goa, but has shown gradual increase because of the the efforts taken by Forest Department, Government of Goa. The harvesting time of kokum is also limited which is from April to May. The fruits are very much perishable, thus have shelf life of 4-5 days.

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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 rainy season
- Absence of any postharvest technology for drying of rind, cutting of fruits or preparation of Kokum drink leading to poor quality product.
- Lack of awareness about its medicinal virtues.
- Very narrow band of market.

Studies have shown Kokum as wonderberry for the health of humankind. Every part of Kokum tree is useful in curing various diseases. Thus, it's a need of hour to conserve such crop and take majors to cultivate it. This can be happen by creating awareness among farmers, processors and consumers about its economic and medicinal value and also developing pre and post harvesting techniques suitable for it. (Priya et al.(2013) and Braganza et al.2012)

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Appendix 1

Table 1: Vernacular names of Kokum

States	Vernacular Names
Andhra Pradesh	Puranapuli
Assam	Tintali
Goa	Amsol, Kokum, Birondd, Ratambi
Gujarat	Kokum
Karnataka	Murgala, Punarpuli
Kerala	Kokkam, Punampuli
Maharashtra	Bhirand, Kokam, Kokambi, Amsol, Katambi, Ratamba
Tamil Nadu	Murgal

Table 2: Table 2: Diseases and parts of kokum used (Jagtap et al. 2015)

Traditional uses of kokum	Plant Part involved
Digestive	Fruit
Anti – dysentery	Fruit, Rind and leaves
Antacid	Kokum Rind and leaves
Anti- diarrheal	Fruit, Rind and leaves
Anti-piles	Fruit, Rind and leaves
Anti-ulcer	Rind

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Anti-colic	Rind and leaves
Anti-obesity (Fruit)	Fruit
Antihelminthic	Fruit
Anti- asthamatic	Fruit
Cardiotonic	Fruit
Hepatoprotective	Fruit
Anti-tumor	Fruit
Anti- hyperplasia	Leaves
Wound healing	Kokum butter
Analgesic	Rind, Fruit
Anti-inflammatory	Rind
Anti-dermatis	Rind
Anti-perspirant	Rind
Astringent	Leaves, fruits and roots
Demulcent	Kokum butter

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Table 3: Chemical Composition of Fresh Kokum fruit (Swami et al. 2014)

Sl. No.	Chemical Constituents	%
1.	Moisture	80.00
2.	Protein (N x 6.25)	1.92
3.	Crude fat	10.00
4.	Crude Fibre	14.28
5.	Total Ash	2.57
6.	Carbohydrates	35
7.	Starch	1.00
8.	Pigments	2.40
9.	Tannin	2.85
10.	Pectin	5.71
11.	Ascorbic acid	0.06
12.	Hydroxy Citric Acid	22.80

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Table 4: Fatty acid composition of kokum butter (Ramachandran 2014)

Sl. No	Fatty acid composition	%
1	Palmitic acid	2.5
2	Stearic acid	56.4
3	Olien	39.4
4	Linolein	1.7

Table 5: Free fatty acid composition of kokum (Ramachandran 2014)

Sl. No	Free fatty acid composition	%
1	Oleic acid	40-50
2	Palmitic acid	5-8
3	Linoleic acid	2-4
4	Stearic acid	40-50

Table 6: Chemical composition of kokum leaves (Milind and Isha 2013)

Sl. No	Chemical constituents	Per 100g
1	Carbohydrate	17.2g
2	Protein	2.3g
3	Fat	0.5g
4	Fibre	1.24g
5	Iron	15.14mg
6	Calcium	250mg
7	Ascorbic acid	10mg
8	Oxalic acid	18.10mg

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Appendix 2

(a) Kokum tree

(b) Kokum fruits

(c) Cut open Kokum fruit

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(d) Dried kokum rinds

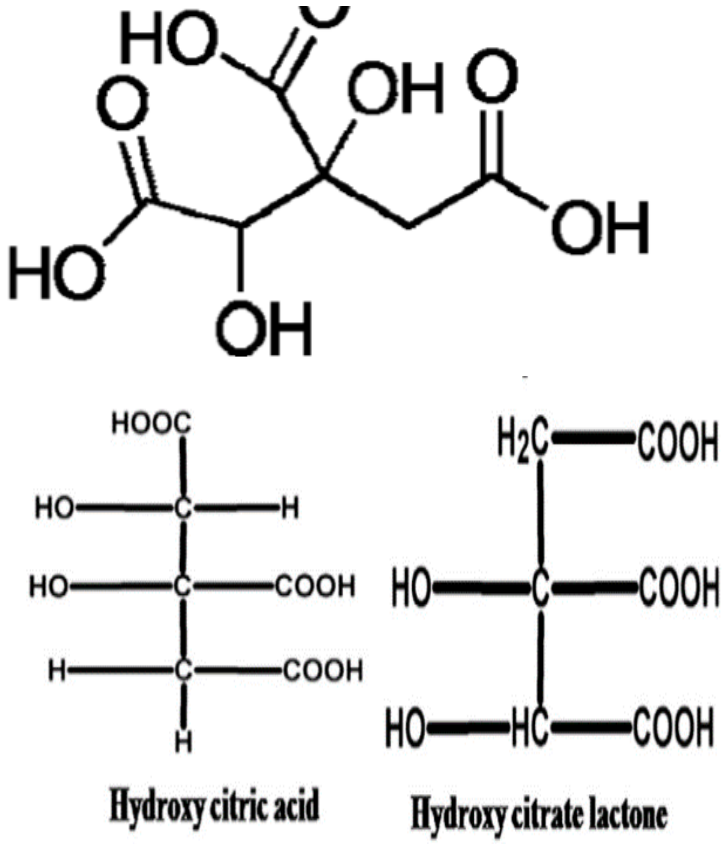

Fig 1:Structure of Hydroxycitric acid (Jagtap et al. 2015, Baglia et al. 2011)

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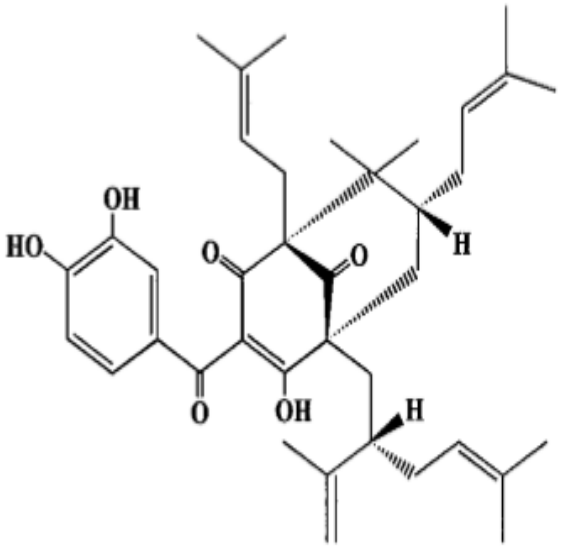

Fig 2: Chemical structure of Garcinol (Yamaguchi et al. 2000)

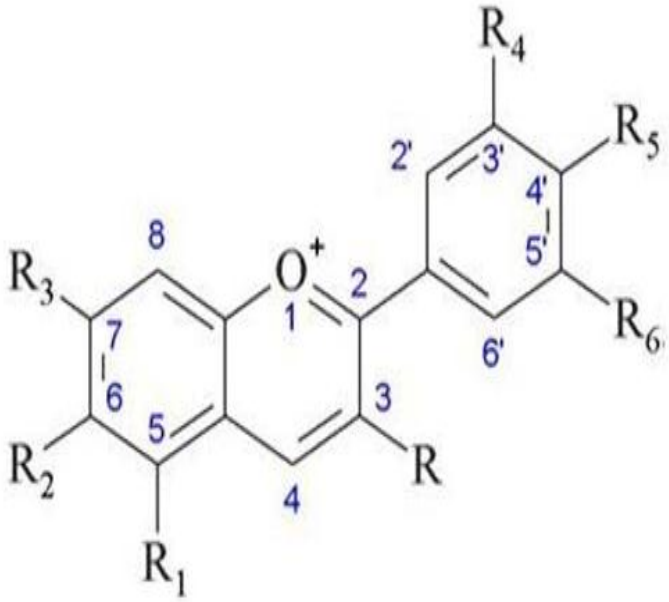

Fig 3: Structure of anthocyanin (Ramachandran 2014)