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South Indian leafy vegetable Gongura (*Hibiscus sabdariffa* L.) as an important medicinal herb: a review

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Abstract
Hibiscus sabdariffa L. is an herbaceous plant well known to be a South Indian leafy vegetable commonly used for various food products, beverages and have many more medicinal properties like anti-scorbutic, emollient, diuretic, refrigerant, sedative, anti-hypersensitive, anti-atherosclerotic, anti-oxidant etc. Because of the innovation, crop improvement and extension work carried by many researchers there is evaluation in the information regarding the properties of this plant. The research during 2000-2017 presented a lot of medicinal, industrial uses of this plant. This review is a small overview covering the therapeutic uses of *Hibiscus sabdariffa* L.

Keywords: *Hibiscus sabdariffa* L., Phytochemicals, Medicinal properties, Gongura, Leafy vegetable, Rosella and its medicinal uses.

Introduction
Hibiscus sabdariffa L. is an annual herbaceous plant that has many industrial, pharmaceutical uses in many countries all over the world. It is commonly called as Rosella or Roselle and belongs to family Malvaceae (Husseina *et al*. 2010). More than 300 tropical and subtropical Rosella species are there.It is cultivated in warm countries particularly like India, Indonesia, Philippines, Malaysia, Tropical Africa, Brazil, Australia, Hawaii, Florida etc. (Mahadevan *et al*. 2009). Nowadays, it is cultivated in both tropical and subtropical regions including India, Saudi Arabia, China, Malaysia, Indonesia, The Philippines, Vietnam, Sudan, Egypt, Nigeria and Mexico. There are many coloured types of Rosella depending on sepals' colours (Husseina *et al*. 2010). *Hibiscus sabdariffa* L. is cultivated for its stem, leaves, calyces and seeds as all parts have industrial, medicinal and other applications. Fresh juicy and dried calyces are used in the preparation of beverages, jams, jellies, sauces, cakes, puddings, syrup and wine. Tender leaves and stalks are used in food items like sauces, curries and chutneys. This herb is also used in traditional medicine.

There are more than 300 species of hibiscus around the world among them *Hibiscus sabdariffa* L. (Roselle) is best known for its sour test (Ansari *et al*. 2013). Its native distribution is uncertain; some believe that, it is from India or Saudi Arabia. *Hibiscus sabdariffa* L. is commonly known as Roselle, hibiscus, Jamaica sorrel, Indian sorrel or red sorrel (English), karkadeh (Arabic) and in Indian language Gongura, Lal-ambari or Patwa (Hindi), Lal-mista or Chukar (Bengali), Lal-ambadi (Marathi), Yerra gogu (Telugu), Pulichchaikerai (Tamil), Pulachakiri or Pundibija (Kannada), Polechi or Pulichchai (Malayalam), Mesta (Odia) and Chukiar (Assam). Roselle (*H. sabdariffa* L.) is an edible plant used for various activities including foods, Fibre, medicinal purpose etc. The fleshy red calyces are used for making wine, juice, jam, syrup, pudding cakes, pickle, ice cream or herbal tea. Roselle flowers and calyces are also known for their antiseptic, diuretic, antioxidant and anti-mutagenic properties. The traditional medicine use the aqueous extract of this plants as diuretic, for treating gastrointestinal disorders, liver diseases, fever, hypercholesterolemia, and hypertension. Leaves of Gongura are being used for skin ailments by Yanadi tribe in Chittoor district of Andhra Pradesh, India (Sudha *et al*. 2016). So there is a need to assess the potential effects of this plant. Keeping this in view, the present study has been undertaken to compile the research results regarding the medicinal properties of this herb.

Two varieties among *Hibiscus sabdariffa* L. one is variety sabdariffa, cultivated for its red or pale yellow inflated edible calyces, and the other is altissima cultivated for its fibre. It is an erect and mostly branched shrub of about 3.5 metres tall. The stems are cylindrical and typically dark green to red in colour with a deep penetrating tap root system. Leaves are alternate, green to red in colour and are petiolate, palmately lobed (3-7) with serrated margins. Flowers are white pale to yellow in colour with fleshy red calyces.

The sepals of the calyx enlarge and become succulent. Fruits are velvet capsules and turn brown when mature, then they split open and dry. Seeds are brown in colour and are kidney shaped (Ali *et al*. 2005; Mahadevan *et al*. 2009; Orwa *et al*. 2009; Husseina *et al.* 2010; Kumar *et al*. 2012; Zarrabal *et al*. 2012 ; Ansari *et al*. 2013).

Phytochemicals in different part of *Hibiscus sabdariffa* L.

Phytochemicals refer to the natural non-nutritive bioactive compounds found in almost all parts of plant like flowers, leaves, stem, root, bark and seeds which acts in a protective manner in humans by preventing many degenerative diseases and harmful processes by showing anti-oxidant activities. Pioneer works conducted by many scientists and researchers expanded the information regarding the phytochemical composition of *Hibiscus sabdariffa* L.

Research findings shows that alkaloids, anthocyanins, flavonoids, saponins, and tannins were present in the dried petals of *Hibiscus sabdariffa* L. while quinones, steroids and terpenoids were absent. Anthocyanins are the abundant compound, followed by the phenols and flavonoids. They identified 18 compounds namely phenolic acids (chlorogenic acid and protocatechuic acid), flavonoids (gossypetrin, sabdaretin, gossypetin, and luteolin), gossytrin, hibiscetin, rutin, hibiscetrin, myricetin, eugenol, nicotiflorine, quercitrin, quercetin, kaempferol, astragalin and cyranoside (Pacome *et al*. 2014).

The calyces obtained after extraction being rich in carbohydrate and can be used in as a raw material for glucose production (Ajayi *et al*. 2012).They are rich in pectin, crude proteins, calcium citrate, minerals such as iron, phosphorus, calcium, manganese, aluminium, magnesium, sodium, potassium and vitamins like ascorbic acid, riboflavin, niacin, carotene etc. (Padmaja *et al*. 2014).

The infusion of the red petals of Gongura is used as a refrigerant drink during fevers (Mhaskar and Bletter 1989). Roots are used as a stomachic and externally as an emollient while leaves are eaten as vegetable after cooking. They are mainly used as diuretic, digestive, antiseptic, sedative, purgative, demulcent, astringent and tonic (Olaleye 2007).Chemicals present in the leaves include carbohydrates, fatty acids, ash, niacin, thiamine, riboflavin, β-carotene, cholesterol, starch, cellulose, fibre and minerals like calcium, phosphorus, iron, Kaempferol-3-O-rutinoside, Kaempferol-3-O-glucopyranoside, quercetin, citrusin etc. Tartaric acid and saponins are present in roots. Soluble dietary fibre, vitamin C and lutein contents are highest in the leaf of *Hibiscus sabdariffa* L. including high contents of flavanoids and phenolic acids (Zhang *et al*. 2011). Its decoction is useful for high blood pressure and cough. In leaves flavanoids, saponins, phenolics, tannins and steroids, glycosides, alkaloids are found among them flavanoids and phenolics have major contributor (Padmaja *et al*. 2014).

Phyochemistry of *Hibiscus sabdariffa* L. flower include protocatechuic acid, carbohydrates, arabinins, mannose, sucrose, xylose, thiamine, riboflavin, ascorbic acid, niacin, β-carotene, proteins, fat, arabinogalactans, rhamnogalacturans, phytosterols, citric acid, maleic acid, malic acid, oxalic acid, tartaric acid, glyconic acid, utalonic acid, allo oxycitronic acid-lactone, allohydroxy citric acid, hibiscic acid, cynadin-3-glucoside,cynadin-3- sambubioside,cynadin-3-xyloglucoside, delphindin, delphindin-3-glucoside, delphindin-3-sambubioside, delphindin-3 xyloglucoside, flavanoids, delphinine, gossypetin, gossypetin-3-glucoside, hibiscetin, hibiscin, hibiscitrin, sabdaretin, fibre, resins which are having many more importance in the life cycle of human (Ali *et al*. 2005; Orwa *et al*. 2009; Mungole and Chaturvedi 2011; Ijeomah *et al*. 2012; Kumar *et al*. 2012; Ansari *et al*. 2013; Pacome *et al*. 2014).

The presence of steroids and tocopherols were observed in seed oil. Rosella seed oil have low-cholesterol and are rich in other phytosterols and tocopherols, particularly *β*-sistosterol and *γ* –tocopherol. Linoleic, oleic, palmitic acids are in higher percentages among the fatty acids of seed oil (Mohamed *et al*. 2007). The seed of Roselle comprises of 9.9 % moisture, 33.5 g of protein, 18.3 g of total dietary fibre, 13 g of carbohydrate and 22.1 g of Fat. Seeds are enriched with minerals like calcium, phosphorus and magnesium. Seventeen types of essential and non-essential amino acids were identified in the seeds of Rosella. The seeds are rich in lysine, arginine, leucine, glutamic acid and phenyl alanine (Hainida *et al*. 2008). Flavanoids, steroids, saponins, tannins, alkaloids, and phenolic compounds were also observed in seeds (Mungole and Chaturvedi 2011).

In fruits the major phytochemicals are α- Terpinyl acetate, anisaldehyde, caprylic acid, ciric acid, acetic acid, formic acid, pelargonic acid, propionic acid, ethanol, isopropanol, methanol, benzyl alcohol, 3-methyl-1-butanol, benzaldehyde, ascorbic acid and different minerals (Mahadevan *et al*. 2009).

Medicinal properties of *Hibiscus sabdariffa* L.

Rosella or Mesta is used in traditional medicine as well as a leafy vegetable. It was proved by many researchers that it shows anti-hypersensitive, anti-hyper-lipidimic, hepato-protective, diuretic, anticancer, anti-oxidant and having many other properties. It also contains vitamins E and Vitamins C which fulfil the daily requirement of human body. Leaves of Gongura can be used as potential sources of vitamins, minerals, phenolics with antioxidant activity and as antimicrobial agents with potential medicinal value (Zhang *et al*. 2011).

Anti-hypersensitive

By the studies with standardized extract of *Hibiscus sabdariffa* L. it was proved to reduce the systolic and diastolic blood pressure by an infusion prepared with 10 mg of dry calyx (Arellanoa *et al*. 2004). Another experiment with Rosella suggests that the daily consumption of hibiscus tea, in an amount readily incorporated into the diet, lowers blood pressure in pre hypertensive and mild hypertensive adults (McKay *et al*. 2009).

Hepatoprotection

Hibiscus sabdariffa L. leaf extract offers hepatoprotection by influencing the levels of lipid peroxidation products and liver markers in experimental hyperammonemia and this could be due to its free radical scavenging property and the presence of natural antioxidants (Essa *et al.* 2006).

Anti-anaemic activity

Dry fermented calyces of *Hibiscus sabdariffa* L. exhibited a very low pH value which enhanced mineral (iron, zinc, calcium and magnesium) availability and can be used as an alternative source of iron for the treatment of anaemia and some other mineral deficiency diseases. It has high concentration of ascorbic acid (Falade *et al.* 2005). Comparatively higher dose (in the range of 200 to 400 mg/kg) of the extract had a beneficial effect on the red cells, while further increase in dose is not beneficial (Adigun *et al.* 2006).

Apoptosis
Protocatechuic acid of Rosella found to induce apoptosis or cell death in leukaemia cells through reduction of Retinoblastoma phosphorylation and Bcl-2 Expression and inhibiting the survival of human Promyelocytic Leukemia HL-60 cells in a concentration and time dependent manner (Tseng *et al*. 2000).

Anti-atherosclerotic
Rosella shows anti-atherosclerosis activity which was tested by inducing the extract of Rosella in rabbits along with high cholesterol diet and the results showed the levels of triglyceride, cholesterol, and low-density lipoprotein cholesterol were lower in the serum of rabbits fed high cholesterol diet plus *Hibiscus sabdariffa* L. extract than in the serum of rabbits fed high cholesterol diet (Chen *et al*. 2003). Aqueous extracts of petals of Rosella decreases total plasma concentration in rats indicating the cardiovascular protective properties (Mahadevan *et al*. 2009).

Anti-oxidant properties
Roselle contains three times more vitamin C than Black currants and that of nine times more than Citrus (Emmy 2006). By chronic administration of $NaNO_3$, toxicity was induced in Wistar rats and it seems to be alleviated by the antioxidant effect of ethanolic seed extract of Roselle, mainly by tocopherol (Vitamin E) and ascorbic acid (Vitamin C) which are present in substantial amount in seed oil of *Hibiscus sabdariffa* L. (Bako *et al*. 2009). The two Fractions (chloroform soluble fraction and ethyl acetate soluble fraction) from ethanolic extract of Roselle dried flowers showed antioxidant and free radical scavenging properties against hydrogen peroxide (79-94%) at the dose of 500 µg (Mahadevan *et al*. 2009). Due to the anti-oxidation properties of aqueous extract of Rosella, nephrotoxicity induced by organo-phosphorus pesticide like Malathion in albino rats was inhibited as it effectively reduce the oxidative stress on the kidneys (Mossalam *et al*. 2011). The antioxidant property of Roselle seed oil showed the inhibition of DPPH at 5g per litre was 65% (Zoue *et al*. 2012).
Roselle can be used as a natural antioxidative supplement in the prevention of oxidative damage in diabetic patients (Mohamed *et al*. 2013).The results observed by Pacome *et al.* (2014) reveiled that the antioxidant activity of the investigated extract has a scavenging ability of DPPH radical scavenging activity (around 97 %). The IC50 values of *Hibiscus sabdariffa* L. extract was 0.24 mg per ml while that of ascorbic acid used as the reference control was 0.35 mg per ml. This indicated that the compounds constituting mainly petals of *Hibiscus sabdariffa* L., such as anthocyanins, flavonoids and phenolic acid contribute to the antioxidative activity. The extracts from *Hibiscus sabdariffa* L. shows antibacterial, anti-oxidant, nephro- and hepato-protective, renal or diuretic effect, effects on lipid metabolism (anti-cholesterol), anti-diabetic and anti-hypertensive effects and is popularly used in traditional medicines. This might be linked to strong antioxidant activities, inhibition of α-glucosidase and α-amylase, inhibition of angiotensin converting enzymes (ACE), and direct vaso-relaxant effect or calcium channel modulation. Phenolic acids (especially protocatechuic acid), organic acid (hydroxycitric acid and hibiscus acid) and anthocyanins (delphinidin-3-sambubioside and cyanidin-3-sambubioside) are also contributing to the above mentioned problems (Rocha *et al.* 2014). Instant Gongura spice mix is a convenient and economical product which is rich in protein and bioactive components and possessed good antioxidant activity, due to the presence of bioactive components such as polyphenols and ascorbic acid (Rao *et al*. 2017).

Anticancer
Topical application of protocatechuic acid extracted from *Hibiscus sabdariffa* L. prior to treatment with 12 Otetradecanoylphorbol-13-acetate to female mice inhibited the incidence of tumours (Ali *et al*. 2005). The glycoside derivative in Rosella may play a role in the treatment of cancer (Chen *et al*. 2006). It was recorded by many experts that it inhibits mutagenicity, exhibits cytotoxicity and also has inhibitory effect of protocatechuic acid of Roselle on tumour promotion in mouse skin, hence proves as a potential source against tumour promotion (Mahadevan *et al*. 2009). *Hibiscus sabdariffa* L. is a potential source for anticancer activity (Padmaja *et al*. 2014; Solowey *et al*. 2014). Roselle flowers and calyces are reported to be good sources of anti-mutagenic compounds (Prabhakaran *et al*. 2017).

Antibacterial, antifungal, anti-inflammatory and anti-cholesterol activities
It was reported to change the composition of urine as well have beneficial renal effects on consumption of *Hibiscus sabdariffa* L. extract (Ali *et al*. 2005). It shows antibacterial, antifungal, anti-inflammatory and anti-cholesterol properties. Aqueous methanolic extract of Roselle exhibited antibacterial activities against *Staphylococcus aureus*, *Bacillus stearothermophilus*, *Bacillus cereus*, *Micrococcus luteus*, *Serratia mascences*, *Clostridium sporogenes*, *Escherichia coli*, *Klebsiella pneumonia* and *Pseudomonas fluorescence* (Olaleye 2007). Its seeds are good source of antioxidants and their effect increases when combined with other antioxidants (Ismail 2008). It also acts as antiseptic, aphrodisiac, astringent, cholagogue, demulcent, digestive, diuretic, emollient, purgative, refrigerant, resolvent, sedative, stomachic, laxative, and tonic. Rosella is commonly used as a folk remedy for abscesses, bilious conditions, cancer, cough, debility, dyspepsia, dysuria, fever, hangover, heart ailments, hypertension, neurosis, scurvy, and strangury (Orwa *et al*. 2009). Animals kept on a diet supplemented with *Hibiscus sabdariffa* L. calyx ethanol extract showed significant C16:0 excretions in faeces and can be considered as the possible anti-obesity agents, through their tendency to inhibit α-amylase (Zarrabal *et al*. 2009). Roselle protein fractions and its isolates have good nutritional quality and could be a good source of protein fortification for a variety of food products for protein deficient consumers as well as a potential food ingredient (Tounkara *et al*. 2013). Roselle flowers and calyces are also known for their antiseptic, diuretic and antioxidant properties. The traditional medicine use the aqueous extract of this plant for diuretic, treating gastrointestinal disorders, liver diseases, fever, hyper-cholesterolemia and hypertension (Padmaja *et al*. 2014; Prabhakaran *et al*. 2017).

Conclusion
Hibiscus sabdariffa L. is an excellent source of dietary phytochemicals such as anthocyanins, flavonoids, phenolic acids, vitamins and various minerals. The use of Roselle petals as natural antioxidants, natural colorants, anticancerous drugs, antibacterial, antifungal, anti-inflammatory, anti-cholesterol and an ingredient of functional foods seem to be promising and health security enhancing.

References

1. Adigun MO, Ogundipe OD, Anetor JI, Odetunde AO. Dose dependent changes in some haematological parameters during short-term administration of *Hibiscus sabdariffa* calyx aqueous extract (Zobo) in Wistar albino rats. African Journal of Medicine and Medical Sciences. 2006; 35(1):73-77.
2. Ajayi OA, Olawale, AS, Adefila SS. Conversion of sorrel (*Hibiscus Sabdariffa*) calyces to glucose. International Journal of Scientific and Technology Research. 2012; 1(8):130-138.
3. Ali BH, Wabel NA, Blunden G. Phytochemical, Pharmacological and Toxicological Aspects of *Hibiscus sabdariffa* L.: A Review. Phytotherapy Research. 2005; 19:369-375.
4. Ansari M, Eslaminejad T, Sarhadynejad Z, Eslaminejad T. An overview of the Roselle plant with particular reference to its cultivation, diseases and usages. European Journal of Medicinal Plants. 2013; 3(1):135-145.
5. Arellanoa AH, Romerob SF, Sotoc MAC, Tortorielloa J. Effectiveness and tolerability of a standardized extract from *Hibiscus sabdariffa* in patients with mild to moderate hypertension: a controlled and randomized clinical trial. *Phytomedicine.* 2004; 11:375-382.
6. Bako IG, Mabrouk MA, Abubakar A. Antioxidant effect of ethanolic seed extract of *Hibiscus sabdariffa linn* (Malvaceae) alleviate the toxicity induced by chronic administration of sodium nitrate on some haematological parameters in wistars rats. Advance Journal of Food Science and Technology. 2009; 1(1):39-42.
7. Chen CC, Hsu JD, Wang SF, Chianj HC, Yang MU, Kao ES, *et al*, *Hibiscus sabdariffa* extract inhibits the development of atherosclerosis in cholesterol-fed rabbits, Journal of Agricultural and Food Chemiestry. 2003; 51 (18):5472-5477.
8. Chen PN, Chu SC, Chiou HL, Kuo WH, Chiang CL, Hsieh YS. *Cancer Letter*. 2006; 235(2):248-259.
9. Emmy HKI. Chemical composition and anti-oxidant properties of hypocholesterolemic effects of differently treated Roselle (*Hibiscus sabdariffa* L.) seeds. MSc Thesis. Faculty of Medicine and Health Science. University Putra Malaysia. 2006l, 169.
10. Essa MM, Subramanian P, Suthakar G, Manivasagam T, Dakshayani KB, Sivaperumal R. *et al*, Influence of *Hibiscus sabdariffa* (Gongura) on the levels of circulatory lipid peroxidation products and liver marker enzymes in experimental hyperammonemia. Journal of Applied Biomedicine. 2006; 4:53-58.
11. Falade OS, Otemuyiwa IO, Oladipo A, Oyedapo OO, Akinpelu BA, Adewusi SR. The chemical composition and membrane stability activity of some herbs used in local therapy for anemia. Journal of Ethnopharmacology. 2005; 102(1):15-22.
12. Hainida KIE, Amin I, Normah H, Esa NM. Nutritional and amino acid contents of differently treated Roselle (*Hibiscus sabdariffa* L.) seeds. *Food Chemistry*. 2008; 111:906-911.
13. Husseina RM, Shaheinb YE, Hakimb AEE, Awadc HM. Biochemical and molecular characterization of three colored types of Roselle (*Hibiscus sabdariffa* L.). *Journal of American Science*. 2010; 6(11).
14. Ijeomah AU, Ugwuona FU, Abdullahi H. Phytochemical composition and antioxidantproperties of *Hibiscus Sabdariffa* and Moringa Oleifera. Nigerian Journal of Agriculture, Food and Environment. 2012; 8(1):10-16
15. Ismael A, Ikram EHK, Nazri HSM. 2008. Roselle (*Hibiscus sabdariffa*) Seeds - Nutritional composition, Protein quality and health benefits. *Food*. 2008*;* 2(1):1-16
16. Kumar M, Garg R, Garg R. Phytochemical properties and antioxidant activity of *Hibiscus sabdariffa* Linn. International Journal of Pharmaceutical and Chemical sciences. 2012; 1(3):887-890.
17. Mahadevan N, Shivali, P Kamboj P. *Hibiscuss sabdariffa.* Linn- an overview. *Natural Product Radiance.* 2009; 8 (1):77-83.
18. Mc Kay DL, Chen CYO, Saltzman E, Blumberg JB. *Hibiscus Sabdariffa* L. Tea (Tisane) lowers blood pressure in prehypertensive and mildly hypertensive adults. The Journal of Nutrition. 2009, 298-303.
19. Mhaskar KS, Bletter E. Kirtikar, Basu S. illustrated Indian medicinal plants. Mhaskar and bletter Eds Sri, Satguru Publications, New Delhi. 1989; 5:706.
20. Mohamed J, Shing SW, Idris MH, Budin SB, Zainalabidin S. The protective effect of aqueous extracts of Roselle (*Hibiscus sabdariffa* L. UKMR-2) against red blood cell membrane oxidative stress in rats with streptozotocin induced diabetes. *Clinics*. 2013; 68(10):1358-1363.
21. Mohamed R, Andez JF, Pineda M, Aguilar M. Roselle *(Hibiscus sabdariffa)* seed oil is a rich source of γ - Tocopherol, Journal of Food Science, 2007; 72(3):206-211.
22. Mossalam HH, Aty OAE, Morgan EN, Youssaf SMS, Mackawy AMH. Biochemical and ultra structure studies of the antioxidant effect of aqueous extract of *Hibiscus Sabdariffa* on the nephrotoxicity induced by organophosphorous pesticide (Malathion) on the adult albino rats. Journal of American Science. 2011; 7(12).
23. Mungole A, Chaturvedi A. *Hibiscus Sabdariffa* L. a rich source of secondary metabolites. International Journal of Pharmaceutical Sciences Review and Research. 2011; 6 (1):83-87.
24. Olaleye, Tolulope M. Cytotoxicity and antibacterial activity of Methanolic extract of *Hibiscus sabdariffa*, Journal of Medicinal Plants Research. 2007; 1(1):009-013.
25. Orwa C, Mutua A, Kindt R, Jamnadass R, Simons A. *Hibiscus sabdariffa.* L, malvaceae, *Agroforestree Database*:. a tree reference and selection guide version 4.0 (http://www.worldagroforestry.org/af/treedb/). 2009.
26. Pacome OA, Bernard DN, Sekou D, Joseph DA, David NJ, Mongomaké K. Phytochemical and antioxidant activity of Roselle (*Hibiscus Sabdariffa* L.) petal extracts. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2014; 5(2):1453-1465
27. Padmaja H, Sruthi S, Vangalapti M. Review on *Hibiscus sabdariffa* - A valuable herb. International Journal of Pharmacy and Life Sciences, 2014; 5(8):3747-3752.
28. Prabhakaran D, Senthamilselvi MM, Rajeshkanna A. Anticancer Activity of *Hibiscus sabdariffa*.L (Flowers) against Human Liver Cancer (Hepg2) Cell Line. International Journal of ChemTech Research. 2017; 10 (12):351-356.
29. Rao GN, Balaswamy K, Srinivasulu K, Sulochanamma G, Venkateswaran G, Rao PGP. Development of an instant spice mix from *Gongura* (*Hibiscus cannabinus* L.) for deep fat fried snacks and evaluation of its antioxidant activity. Indian Journal of Traditional Knowledge. 2017; 16(3):490-497.
30. Rocha IDC, Bonnlaender B, Sievers H, Pischel I,

Heinrich M. Hibiscus sabdariffa L. A phytochemical and pharmacological review. *Food Chemistry*. 2014; 165:424-443.
31. Solowey E, Lichtenstein M, Sallon S, Paavilainen H, Solowey E, Galski HL. Evaluating medicinal plants for anticancer activity, Hindawi Publishing Corporation, The Scientific World Journal. 2014.
32. Sudha G, Hareesha E, Reddy KSN. Ethno medicinal plants used for skin ailments by Yanadi tribe in Chittoor district, Andhra Pradesh. Unique Journal of Ayurvedic and Herbal Medicines. 2016; 04(01):31-33
33. Tounkara F, Amza T, Lagnika C, Le GW, Shi YH. Extraction, characterization, nutritional and functional properties of Roselle (*Hibiscus sabdariffa* Linn) seed proteins. *Songklanakarin* Journal Science Technology. 2013; 35(2):159-166.
34. Tseng TW, Kao TW, Chu CY, Chou FP, Lin WL, Wang CJ. Induction of apoptosis by *hibiscus* protocatechuic acid in human leukemia cells via reduction of retinoblastoma (RB) phosphorylation and Bcl- 2 expression. *Biochemical Pharmacology*. 2000; 60:307-315.
35. Zarrabal OC, Jones PMH, Flores ZO, Hipolito CN, Dermitz DMB, Uscanga MGA. Hernandez MFP. Effect of *Hibiscus sabdariffa* L. dried calyx ethanol extract on fat absorption-excretion, and bodyweight implication in Rats. Journal of Biomedicine and Biotechnology. 2009, 1-5.doi:10.1155/2009/394592.
36. Zarrabal OC, María D, Dermitz B, Flores ZO, Margaret P, Jones H, *et al*. *Hibiscus sabdariffa* L., Rosella calyx, from ethnobotany to pharmacology. Journal of Experimental Pharmacology. 2012; 4:25-39.
37. Zhang M, Hettiarachchy NS, Horax R, Kannan A, Apputhury PMD, Muhundan A. *et al*. Phytochemicals, antioxidant and antimicrobial activity of *Hibiscus sabdariffa*, *Centella asiatica*, *Moringa oleifera* and *Murraya koenigii* leaves, Journal of Medicinal Plants, 2011; 5(30):6672-6680.
38. Zoue LT, Bedikou ME, Gonnety JT, Faulet BM, Niamke SL. Two novel non-conventional seed oil extracts with antioxidant and antimicrobial activities. Tropical Journal of Pharmaceutical Research.2012; 11 (3):469-475.