



## INTERNATIONAL JOURNAL OF PHARMACY & LIFE SCIENCES (Int. J. of Pharm. Life Sci.)

### Review on *Hibiscus sabdariffa* – A valuable herb

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#### Abstract

*Hibiscus sabdariffa* L. is a well known shrub for various food products, beverages and also for its medicinal properties. Because of the innovative and extensive work carried by many researchers there is evaluation in the information regarding the properties of plant. The research during 1990-2014 presented a lot of medicinal, industrial uses of this plant. This review is a small overview covering all highlights of *Hibiscus sabdariffa* which is a potential source for many industrial and therapeutic uses.

Key-Words: *Hibiscus sabdariffa*, Phytochemicals, Medicinal properties, Different products from roselle

#### Introduction

*Hibiscus sabdariffa* L is an annual herbaceous shrub that has many industrial, pharmaceutical uses in many countries all over the world. It is commonly called as Roselle and belongs to Malvaceae family [1]. More than 300 tropical and subtropical roselle species are there.[2]. It is cultivated in warm countries particularly like India, Indonesia, Phillipines, Malaysia, Tropical Africa and also in Brazil, Australia, Hawaii, Florida [3]. There are many colored types of Roselle depending on sepals' colors [1].

*Hibiscus sabdariffa* L is cultivated for its stem, leaves, calyces and seeds as all parts have industrial, medicinal and other applications. Fresh juicy and even dried calyces are used in the preparation of beverages, jams, jellies, sauces, cakes, puddings, syrup and wine. [2] Tender leaves and stalks are also used in food items like sauces, curries and chutneys. This herb is also used in traditional medicine.

**Common names** include sorrel, carcade, lemon bush, karkade, jelly plant, jelly okra, Wonjo, Asam susur, Bissap, Saril, Mesta. [2]

**Indian vernacular names** include Gongura, Lambari, Patwa, Lal-mista, Chukar, Pundibija, Pulachakiri, Pulichchai and Chukiar. [3]

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#### Morphology

Erect and mostly branched shrub. About 3.5metres tall. Stems are cylindrical and typically dark green to red colored. Deep penetrating tap root system. Alternate leaves, colored green to red, and are petiolate, palmately lobed (3-7) with serrate margins. White pale to yellow colored flowers 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 color and are kidney shaped. [1 2 3 4 5 6 7 8]



a) Roselle, grown in a greenhouse condition at Southern University

Agricultural Research and Extension Center, Baton Rouge, LA. [6]



b) Pink or yellow flower [2]

### Propagation

Two varieties among *Hibiscus sabdariffa* one is var. *sabdariffa*, cultivated for its red or pale yellow inflated edible calyces, and the other is var. *altissima* cultivated for its fiber. Roselle is propagated by seeds and also grows from cuttings. It is insect pollinated and cultivation conditions include:

Warm and humid tropical climate, temperature range between 18°C -35°C with an optimum of 25°C. An altitude 3000 ft. (900 m) above sea level is suitable. Well drained humus rich soils with a  $p^H$  of 4.5 – 8 are preferred. It exhibits photoperiodism. It tolerates floods and winds. [2, 7]

### Phytochemistry of *Hibiscus sabdariffa*

Phytochemicals refer to the non nutritive bioactive compounds found naturally in almost all plant parts like flowers, leaves, stem, root, bark, seeds. These phytochemicals act in a protective manner in humans by preventing many degenerative diseases and pathological processes and show anti oxidant activity. Pioneering work of many scientists and researchers expanded the information regarding the phytochemical composition of *Hibiscus sabdariffa*.

Phytochemical analysis of alkaloids, anthocyanins, flavonoids, polyphenols, quinones, saponins, tannins, terpenes and sterols were done by different researchers using various methods like HPLC and other.

In dried petals researchers work revealed that alkaloids, anthocyanins, flavonoids, saponins, and tannins were present, quinones, steroids and terpenoids were absent in petals of Roselle. They noted that anthocyanins are the majority compound, followed by the phenols and finally flavonoids. They identified 18 compounds and are phenolic acids i.e. chlorogenic acid and protocatechuic acid; flavonoids i.e. gossypetin ,

sabdaretin, gossypetin, luteolin; gossytrin; hibiscetin; rutin; hibiscetrin; myricetin; eugenol; nicotiflorine; quercitrin; quercetin; kaempferol; astragaline; cyanoside. They suggested that flavonoids are predominating than phenolic acids in total phenolic content. From all the work of different researchers it was concluded that the major phenolic compounds in petals of Roselle are sabdaretin, gossypetin, hibiscetin and quercetin. Four different types of anthocyanins were identified and separated i.e 1. delphinidin 3-O-sambubioside; 2. cyanidin 3-O-sambubioside; 3. cyanidin 3-O-glucoside; 4. delphinidin 3-O-glucoside.[9] The calyces also contain pectin, crude proteins and minerals such as iron, phosphorus, calcium, manganese, aluminium, magnesium, sodium and potassium, ascorbic acid, calcium citrate.

The fresh calyces also contain riboflavin, ascorbic acid, niacin, carotene, calcium, and iron that are nutritional apart from phytochemicals. In case of different type of calyces (green colored, light red and dark red) their total phenolic content varies depending on the color of the sepals.

In leaves we can also observe flavanoids, saponins, phenolics, tannins and steroids, glycosides. Among them flavanoids and phenolics have major contribution. Phytochemistry of leaves include carbohydrates, fatty acids, ash, niacin, thiamine, riboflavin,  $\beta$ -carotene, cholesterol, starch, cellulose, fibre and minerals like calcium, phosphorus, iron. Kaempferol-3-O-rutinoside, Kaempferol-3-O-gluco-pyranoside, quercetin, citrusin were isolated from 70% aqueous ethanol leaves extract. Flavanoids, saponins, phenolics, tannins and steroids, glycosides, alkaloids are also present in the stem and root of the plant Roselle. Tartaric acid and saponins are present in roots.

Flower phytochemistry include protocatechuic acid, carbohydrates, arabinins, mannose, sucrose, xylose, thiamine, riboflavin, ascorbic acid, niacin,  $\beta$ -carotene, proteins, fat, arabinogalactans, rhamnogalacturans, phytosterols, citric acid, maleic acid, malic acid, oxalic acid, tartaric acid, glyconic acid, utalonic acid, allo oxycitronic acid-lactone, alhydroxy 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.[2,5,7,8,9,10,11]

The seeds of Roselle comprises moisture content of 9.9%, 33.5 gms of protein, total dietary fibre of 18.3 gms, carbohydrate content of 13g, and 22.1 gms of Fat [12]. Minerals like calcium, phosphorus and

magnesium are present. 17 types of essential and non essential amino acids were identified. The seeds are rich in lysine, arginine, leucine, phenyl alanine, glutamic acid [12]. The presence of steroids and tocopherols were observed in seed oil. Sterol composition of roselle seed oil comprises Cholesterol, Campesterol, Stigmasterol, Clerosterol,  $\beta$ -Sitosterol, 5-Avenasterol. Roselle seed oil have low-cholesterol and rich in other phytosterols and tocopherols, particularly  $\beta$ -sistosterol and  $\gamma$ -tocopherol. Linoleic, oleic, palmitic acids are in higher percentages among the fatty acids of seed oil.[13] Flavanoids, steroids, saponins, tannins, alkaloids, phenolic compounds were also observed in seeds.[10]

In Fruits  $\alpha$ - 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 minerals.[3]

#### Different products and beverages from *Hibiscus sabdariffa*

Different food products, fermented foods and beverages of *Hibiscus sabdariffa* are widely used in different countries. From the fresh flowers of *Hibiscus sabariffa* cold and hot beverages are produced. The juice from the calyces of Sorrel(Roselle) is called "zoborodo"(soborodo), a non-alcoholic drink in Nigeria which involves the production process of solid-liquid extraction leaving the calyx pulp as raffinate which is a heavy organic material that could be converted as glucose.[14]. In Mexico this beverage is called "flor de jamaica"

In Senegal (a state of West Africa) this *Hibiscus sabariffa* known as bissap and drink is prepared through aqueous extraction from a solid-to-solvent ratio. This drink consumption is widespread in Asia and Africa. In Senegal it is more popular and more consumption is observed during the month of Ramadan.

In Egypt, this beverage is called as "drink of the Pharaohs". In Sudan it is called as "tea Karkade". In Mali (Africa) it is called as "da Bilenni". Tea from the *Hibiscus sabdariffa* also called Sudan tea, sour tea which is prepared from ground dried calyces also have medicinal properties and is considered as herbal tea and Roselle is also used as main ingredient in many other tisanes(herbal tea).[15]'Bikalaga' is a fermented food produced from the seeds of *Hibiscus sabdariffa* in African countries, including Burkina Faso, Mali Niger, Nigeria, Cameroon and Sudan among others.[16] And it is also called Furundu, dawadawa botso, datou, Mbuja. In low-income population it is used as meat replacement which is in rich in nutrients and proteins.

Because of the pigments present in flowers, Roselle is also used for food colorant. Thus it is used as a food and food ingredient like jellies, jams, puddings, syrups, beverages.



c) Roselle seeds[2]

#### Seed oil and its importance

To meet the needs of world ever growing population the quest for traditional vegetable oils has increased. It is needed produce inexpensive oils from new low-cost oilseed crops suitable for food, pharmaceutical and industrial applications. *Hibiscus sabdariffa* is one of the possible alternative crops. The sorrel seed oil is rich in unsaturated fatty acids and is also rich of source of lipidsoluble antioxidants, particularly  $\gamma$ -tocopherol. The physico chemical parameters of Roselle seed oil is summarized as acidity, 2.24%; peroxide index, 8.63 meq/kg; extinction coefficients at 232(k232) and 270 nm (k270), 3.19 and 1.46, respectively; oxidative stability, 15.53 h; refractive index, 1.477; density, 0.92kg/L; and viscosity, 15.9 cP. Roselle seed oil belongs to the linoleic/oleic category, its most abundant fatty acids being C18:2(40.1%),C18:1(28%),C16:0(20%),C18:0(5.3%), and C19:1(1.7%).Sterols include  $\beta$ -sitosterol(71.9%), campesterol(13.6%),  $\Delta$ -5-avenasterol(5.9%), cholesterol (1.35%), and clerosterol (0.6%). Total tocopherols were detected at an average concentration of 2000 mg/kg, including  $\alpha$ -tocopherol (25%),  $\gamma$ -tocopherol (74.5%), and  $\delta$ -tocopherol(0.5%).[13]

In countries like Sudan, roselle seeds are used in edible oil production and the byproducts of this process are used for poultry feeding. Mechanical pressing, pressurized solvent extraction, Soxhlet extraction, ultra-sonic extraction and Aqueous Enzymatic Oil Extraction (AEOE) are the different methods for oil extraction. By the physicochemical characteristics of

the oil it was showed that the sorrel seed oil can be used as edible oil and as an industrial feedstock.[17]

Biodiesel (mono alkyl esters of long chain fatty acids) refers to the fuel that is chemically modified and derived from the oils extracted from animal fats and vegetable oils. By transesterification process these high viscosity vegetable oils can be modified to compatible diesel by preventing the adverse affects in combustion process. Roselle seed oil was experimented in Thailand showing its potential to be biodiesel. Their study demonstrated that the crude Roselle seed oil can produce biodiesel by alkali transesterification process with methanol in the presence of KOH (catalyst). [18]

#### **Medicinal properties and other applications**

Roselle is used in traditional medicine. It was proved by many experiments Roselle shows\ antiypersensitive, antihyperlipidemic, hepatoprotective, diuretic, anticancer, anti oxidant and many other properties.

**Antihypersensitive:** By the studies with standardized extract of *Hibiscus sabdariffa* it was proved that *Hibiscus sabdariffa* reduce the systolic and diastolic blood pressure in a clinical trail with some patients by an infusion prepared with 10mg of dry calyx.[19] Other experiment with Roselle suggest that daily consumption of hibiscus tea, in an amount readily incorporated into the diet, lowers BP in pre- and mildly hypertensive adults.[15].

**Apoptosis:** Protocatechuic acid of Roselle found to induce apoptosis in leukaemia cells through reduction of Retinoblastoma (RB) phosphorylation and Bcl-2 Expression and inhibiting the survival of human Promyelocytic Leukemia HL-60 cells in a concentration- and time-dependent manner. [20]

**Antiatherosclerotic:** Roselle shows antiatherosclerosis activity. It was tested by inducing the extract of roselle in rabbits along with high cholesterol diet and the results showed the levels of triglyceride, cholesterol, and low-density lipoprotein cholesterol (LDL-C) were lower in the serum of rabbits fed High cholesterol diet(HCD) plus *Hibiscus sabdariffa* extract (HSE) than in the serum of rabbits fed HCD. Feeding HSE to rabbits significantly reduced severe atherosclerosis in the aorta. These results suggest that HSE inhibits serum lipids and shows an antiatherosclerotic activity. [21] Aqueous extracts of petals of roselle decreases total plasma concentration in rats indicating the **Cardiovascular protective** properties. [3]

**Antioxidant properties:** By anti oxidation properties of roselle aqueous extract, nephrotoxicity induced by organophosphorus pesticide (Malathion) in albino rats was inhibited by effectively reducing the oxidative stress on the kidneys. [22] By chronic administration of NaNO<sub>3</sub>, 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.[23]. 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 500µg.[3]. The antioxidant property of roselle seed oil was also determined by DPPH method and the results showed the inhibition of DPPH at 5g/l was 65% for *Hibiscus* seed oil.[24]

**Anticancer:** Topical application of *Hibiscus* protocatechuic acid prior to treatment with 12-Otetradecanoylphorbol-13-acetate to female mice, initiated with benzo[ $\alpha$ ]pyrene, inhibited the incidence of tumours [5]. It was showed by many experiments that it inhibits mutagenicity and exhibits cytotoxicity. And also the Inhibitory effect of proocatechuic acid of roselle on tumour promotion in mouse skin proves the potential as a cancer chemopreventive agent against tumour promotion.[3]

*Hibiscus sabdariffa* also shows antibacterial, antifungal, anti inflammatory, and anicholesterol properties. Aqueous methanolic extract of roselle exhibited antibacterialactivities (MIC 0.30  $\pm$  0.2- 1.30  $\pm$  0.2 mg/ml) against *Staphylococcus aureus*, *Bacillus stearotherophilus*, *Micrococcus luteus*, *Serratia marseilles*, *Clostridium sporogenes*, *Escherichia coli*, *Klebsiella pneumoniae*, *Bacillus cereus*, *Pseudomonas fluorescens*. [25]. And it shows even renal effects which on consumption of *Hibiscus* extract changes the composition of urine.[5]. It is also reported to be antiseptic, aphrodisiac, astringent, cholagogue, demulcent, digestive, diuretic, emollient, purgative, refrigerant, resolvent, sedative, stomachic, laxative, and tonic, roselle is a folk remedy for abscesses, bilious conditions, cancer, cough, debility, dyspepsia, dysuria, fever, hangover, heart ailments, hypertension, neurosis, scurvy, and strangury.[7]

***Hibiscus sabdariffa* fibres:** During the past few decades the world has developed an increasing interest in natural fibres and its application because of increased environmental awareness and consciousness. Roselle fibres are strong natural fibres have many applications. And currently these biofibres as a reinforcing fibres are very useful in the production of cost effective biocomposites. The advantages include specific strength properties, easy availability, light weight, ease of separation, enhanced energy recovery, high

toughness, non-corrosive nature, low density, low cost, good thermal properties, reduced tool wear, reduced dermal and respiratory irritation, less abrasion to processing equipment, renewability and biodegradability.[26,27,28,29,30]

### Conclusion

Thus by knowing the divergent uses of Roselle plant, evaluation of more information through research, cultivation of different varieties of the plant and more commercial production of natural products of Roselle is recommended.

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#### How to cite this article

Padmaja H., Sruthi S. and Vangalapati M. (2014). Review on *Hibiscus sabdariffa* – A valuable herb. *Int. J. Pharm. Life Sci.*, 5(8):3747-3752.

Source of Support: Nil; Conflict of Interest: None declared

Received: 02.08.14; Revised: 08.08.14; Accepted:11.08.14