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## HIBISCUS SABDARIFFA L.-A REVIEW ON ITS PHARMACOLOGICAL ACTIVITY & MEDICINAL USES

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### Abstract

The shrub Hibiscus sabdariffa is a member of the Malvaceae family. There are more than 200 species of hibiscus in the world. It has been noted that Hibiscussabdariffa has numerous therapeutic benefits. The calyx is red and has five large sepals, the leaves are 7.5 to 12.5 cm long, and the fruit is a velvety capsule that is 1.25-2 cm long and green in color with five valves that each contain three to four seeds. The entire plant exhibits a wide range of pharmacological properties. The presence of phytochemicals like flavonoids, pectin, antioxidants, anthocyanins, hibiscus acid, vitamin C, protein, citric acid, and β-carotene is primarily responsible for these activities.

**Keywords:** Hibiscus sabdariffa, Pharmacological activities, phytochemistry, plant description

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Division	Tracheophyta	Bengali	Lal-mista, Chukar
Order	Malvales	Marathi	Lal- Ambadi
Family	Malvaceae	Tamil	PulichchaiKerai
Genus	Hibiscus L	Telugu	Yerragogu
Species	Hibiscus sabdariffa	Hindi	Gonguru, Lal- Ambari, Putuja

### Introduction

The annual herbaceous shrub Hibiscus sabdariffa L. has many contemporary medicinal applications in many countries worldwide. It is commonly referred to as Roselle and is a member of the Malvaceae family [1]. The meaty calyx (sepals) that encloses the organic product (containers) is the plant's most economically important component. The whole plant can be used as a beverage, or the dried calyces can be dissolved in water to create a lovely, refreshing beverage, or they can be dissolved in water and consumed hot. It also has some medicinal qualities [2]. The seeds, which are occasionally used to feed animals, contain 17.8–21% non-consumable oil and 20% protein [3-4].

**Varieties:** H. sabdariffa Var. AltissimaWester. Sabdariffa Var. Sabdariffa.

Classification [4]		Vernacular Name [6]	
Kingdom	Plantae	English	Roselle, Red Sorrel
Class	Magnoliopsida	Assam	Chukiar

**Common names** include sorrel, carcade, lemon bush, karkade, jelly plant, jelly okra, Wonjo, Asamsusur, Bissap, Saril, Mesta [5].

### Ecology & Plant description

The plant is capable of thriving in various soil types, performing well even in less fertile soils. However, for optimal economic yields, soils rich in organic matter and essential nutrients are recommended. It is capable of withstanding relatively high temperatures throughout its growing and fruiting stages. The plant requires an ideal rainfall range of 45-50 cm, distributed over a growing period of 90-120 days. Typically reaching a height of about 3.5 meters, it has a deep, penetrating taproot and cylindrical stems that are smooth or nearly smooth, usually dark green to red in color. The leaves are alternate, measuring 7.5-12.5 cm in length, green with reddish veins, and may have long or short petioles. The leaves of young seedlings and the upper leaves of mature plants are simple, while the lower leaves are deeply lobed, with 3-5 or even 7 lobes and toothed edges. Flowers grow singly in the leaf axils, reaching up to 12.5 cm in width, and are

yellow or buff with a rose or maroon eye, turning pink as they wilt at the end of the day. The calyx is typically red, made up of five large sepals with a collar of 8-12 slender, pointed bracts around the base. These bracts enlarge towards the end of the day, measuring 3.2-5.7 cm, and fully encase the fruit. The fruit is a velvety capsule, 1.25-2 cm long, green when immature, and has five valves, each containing 3-4 seeds. As the capsule matures and dries, it turns brown and splits open. The seeds are kidney-shaped, light brown, 3-5 mm long, and covered in fine, stout, stellate hairs. The plant takes approximately 3-4 months to reach the commercial maturity stage, just before the flowers are harvested. Roselle is best suited to tropical climates with well-distributed rainfall ranging from 1500 to 2000 mm annually, and it grows well from sea level up to around 600 meters in altitude. It thrives in warm, humid conditions and requires a minimum night temperature of 21°C. It is especially vulnerable to frost and fog damage and requires about 13 hours of sunlight during the initial growth phase to prevent premature flowering [7-8].

#### **Cultivation**

*Hibiscus sabdariffa* L is relatively easy to grow in a variety of soils, though it can tolerate less fertile soils. The plant requires 4-8 months of growth, with nighttime temperatures of at least 20°C, along with 13 hours of daylight and monthly rainfall ranging from 5-1000 mm (130-250 mm) during the early growth stages to prevent premature flowering. Rainfall or high humidity during the harvesting and drying phases can negatively impact the quality of the calyces and reduce overall yield. The quality of *Hibiscus sabdariffa* L is influenced by factors such as seed quality, local growing conditions, harvest timing, post-harvest handling, and particularly the drying process. It is commonly grown as a supplementary crop and is vulnerable to fungal, viral, and bacterial infections, as well as insect damage. A single plant can yield approximately 1.5 kg of fruit, equating to around 8 tons per hectare, while leaf yields can reach up to 10 tons per hectare [9-11].

#### **Pharmacological Activities**

##### **Antihypersensitive**

In a clinical trial involving a small number of patients, it was shown that *Hibiscus sabdariffa* reduced the systolic and diastolic circulatory strain through an imbue ment arranged with 10 mg of dry calyx, according to reviews using standardized concentrations of the plant. Other research on Roselle suggests that daily use of hibiscus tea, when quickly incorporated into a diet, lowers blood pressure in adults who are pre- and mildly hypertensive [12-13].

##### **Apoptosis**

By reducing Retinoblastoma (RB) phosphorylation and Bcl-2 expression, a protocatechuic corrosive of Roselle has been found to trigger apoptosis in leukemia cells and impair the survival of human Promyelocytic Leukemia HL-60 cells in a targeted and time-subordinate manner [14].

##### **Antiatherosclerotic**

Roselle is an indication of antiatherosclerosis action. The results showed that the serum levels of triglycerides, cholesterol, and low-thickness lipoprotein cholesterol (LDL-C) were lower in rabbits fed a high-cholesterol diet (HCD) and *Hibiscus sabdariffa* extract (HSE) than in rabbits fed a high-cholesterol diet (HCD). The experiment was conducted by stimulating the concentration of roselle in rabbits along with elevated cholesterol abstinence from food. Serious aortic atherosclerosis was reduced in rabbits when HSE was completely encouraged. These results suggest that HSE exhibits an antiatherosclerotic movement and inhibits serum lipids [15].

##### **Antioxidant properties:**

The antioxidant properties of roselle aqueous extract were shown to effectively reduce nephrotoxicity induced by the organophosphorus pesticide Malathion in albino rats by decreasing oxidative stress on the kidneys. In Wistar rats, chronic administration of NaNO<sub>3</sub> induced toxicity, which was alleviated by the antioxidant effects of ethanolic seed extract of Roselle, primarily due to the presence of Tocopherol (Vitamin E) and Ascorbic acid (Vitamin C) in significant amounts in the seed oil of *Hibiscus sabdariffa* L. Both the chloroform and ethyl acetate fractions of the ethanolic extract of dried roselle flowers exhibited antioxidant and free radical scavenging activities against hydrogen peroxide, with inhibition rates ranging from 79-94% at a dosage of 500 µg. Additionally, the antioxidant potential of roselle seed oil was assessed using the DPPH method, revealing a 65% inhibition of DPPH at a concentration of 5 g/l for *Hibiscus* seed oil [16-17].

##### **Antibacterial, antifungal and antiparasitic activity:**

The cHs water extract and protocatechuic acid (5 mg/ml) inhibited the growth of methicillin-resistant *Staphylococcus aureus*, *Klebsiellapneumoniae*, *Pseudomonas aeruginosa*, and *Acinetobacterbaumannii*. Additionally, protocatechuic acid exhibited stronger antimicrobial activity against these pathogens in juices compared to human plasma in a dose-dependent manner. The study also demonstrated that the antibacterial effect was unaffected by temperature, as evidenced by a heat treatment. *Hibiscus* extract showed antibacterial properties against *Streptococcus mutans*, a cariogenic bacterium found in the oral cavity, with a minimum inhibitory concentration of 2.5 mg/ml, as well as *Campylobacter* species (such as *Campylobacter jejuni*, *Campylobacter coli*, and *Campylobacter fetus*), which are known to contaminate meats like poultry, beef, and pork, at concentrations ranging from 96-152 µg/ml. The aqueous methanol extract of dried cHs also exhibited in vitro inhibitory effects against several bacterial strains, including *S. aureus*, *Bacillus stearothermophilus*, *Micrococcus luteus*, *Serratiamarcescens*, *Clostridium sporogenes*, *Escherichia coli*, *K. pneumoniae*, *Bacillus cereus*, and *Pseudomonas fluorescens*, though it did not affect the growth of the fungus *Candida albicans*. The fresh cHs

water extract, ethanol extract, and protocatechuic acid (20 mg/ml) effectively inhibited the growth of foodborne pathogens such as *Salmonella typhimurium* DT104, *E. coli* O157:H7, *Listeria monocytogenes*, *S. aureus*, and *B. cereus*. Again, the antibacterial effect remained unaffected by heat treatment, with the ethanolic extract showing a stronger antimicrobial effect than the aqueous extract. The study suggests that both the ethanolic extract and protocatechuic acid could be potent agents for use as food additives to prevent contamination by these bacteria. Additionally, a methanol-water extract of Hibiscus was effective against *E. coli* O157:H7 strains isolated from food, veterinary, and clinical samples, with the highest concentration (10%) being the most effective. Raw extracts of Hibiscus seeds (200 mg/l) also displayed antimicrobial activity against three types of Gram-negative bacteria, with the strongest activity observed against *Salmonella*, followed by *Shigella* and *Enterobacter* [18-22].

### **Antipyretic, Antinociceptive and anti-inflammatory activities**

Although it is commonly claimed that Hibiscus sabdariffa (Hs) is effective in reducing fever in popular medicine, there are limited studies available to support this. The antipyretic and anti-inflammatory properties of cHs extract were investigated in vivo. Both ethanol (more potent) and aqueous extracts demonstrated antipyretic effects by significantly reversing yeast-induced fever in rats. The mechanism of action differs from that of aspirin, a prostaglandin inhibitor. Fever is associated with increased production of cytokines such as interleukins (IL), interferons, and tumor necrosis factor-alpha (TNF- $\alpha$ ), and the cHs extract may play a role in inhibiting the production of some of these substances, leading to an anti-inflammatory effect. Similar findings suggest that flavonoids, polysaccharides, and organic acids may be the active compounds responsible for these pharmacological effects. In a more recent study, the ethanolic extract of the calyces also exhibited antinociceptive effects in a rodent model. Another in vivo study showed that both fractions of the raw aqueous-ethanolic extract of dried cHs exhibited significant immunostimulatory activity by increasing the production of IL-10 and reducing TNF- $\alpha$  levels. Furthermore, the polyphenol extract appears to exert its anti-inflammatory effects by inhibiting cyclooxygenase-2 (COX-2) expression through down-regulation of JNK and p38 MAPK signaling pathways [23-26].

### **Clinical studies**

The claim for its mitigating action is further supported by a review conducted with ten reliable volunteers. Consuming dried cHs WE reduced the fixation of plasma monocyte chemoattractant protein 1 (MCP-1), a biomarker used to evaluate provocative diseases [27].

### **Nephroprotective activity**

Two studies have been conducted to assess the nephroprotective effects of Hibiscus sabdariffa (Hs) extracts on diabetic nephropathy in streptozotocin-induced type 1 diabetic rats. Diabetic nephropathy can

progress to end-stage renal disease. One study investigated the impact of polyphenol extracts of Hs at doses of 100 and 200 mg/kg/day on streptozotocin-induced diabetic nephropathy in rats. The extract showed beneficial effects, including a reduction in kidney mass and improvement in the hydropic changes of renal proximal convoluted tubules. It also lowered serum triglyceride, total cholesterol, and LDL levels, while enhancing catalase and glutathione activity and reducing lipid peroxidation in the kidney. The extract was found to reduce kidney mass and improve the hydropic changes of renal proximal convoluted tubules in the rodent model. These positive effects were likely due to improved oxidative status and modulation of the Akt/Bad/14-3-3c signaling pathway, which is involved in anti-apoptotic mechanisms. Another in vivo study further revealed that the nephroprotective effects were a result of the protection of the kidneys from oxidative stress [28-30].

### **Cancer-preventive activity**

Hibiscus sabdariffa (Hs) is rich in phenolic compounds such as protocatechuic acid, which has demonstrated in vitro protective effects against hepatocyte cytotoxicity and genotoxicity induced by tert-butylhydroperoxide (t-BHP). These protective effects were attributed to its ability to inhibit DNA repair synthesis caused by t-BHP and its radical-scavenging properties. Protocatechuic acid also inhibited skin tumor formation in CD1 mice induced by 12-O-tetradecanoylphorbol-13-acetate (TPA) and reduced the survival of human promyelocytic leukemia HL-60 cells. The mechanism behind its anticancer effects may involve antitumor activity by reducing reactive oxygen species (ROS), DNA damage, G1 phase cell cycle arrest, and inducing apoptosis. Apoptosis induction was linked to the phosphorylation and degradation of retinoblastoma (RB) protein and the suppression of Bcl-2 protein. Similar effects were observed in human gastric carcinoma (AGS) cells, where apoptosis was likely mediated through the p53 signaling pathway and the p38 MAPK/FasL pathway. Another group of compounds found in cHs extracts are anthocyanins, such as delphinidin-3-sambubioside, which induced apoptosis in human leukemia cells via the p38-FasL and Bid pathways, as well as through ROS-mediated mitochondrial dysfunction. It also induced apoptosis in smooth muscle cells (SMC) through the p38 and p53 pathways. Recently, the anticancer activity of Hs leaf extracts was evaluated against human prostate cancer cells both in vitro and in vivo. The study found that the anti-apoptotic effects were mediated through both intrinsic (Bax/cytochrome c-mediated caspase 9) and extrinsic (Fas-mediated caspase 8/t-Bid) pathways, as well as by inhibiting the growth of prostate tumor xenografts in athymic nude mice. Extracts from the leaves, as opposed to the calyces, may provide a more potent source of polyphenolic compounds [31-33].

### **Anti-obesity activity**

Pre-clinical data from Brazil suggests a potential role in managing certain obesity-related conditions, such as

hyperlipidemia. However, further research is recommended. A study found that a standardized water extract of *Hibiscus sabdariffa* (33.64 mg of total anthocyanins per 120 mg) was able to reduce weight gain in obese mice while simultaneously increasing fluid intake in both healthy and obese mice. This effect is likely mediated through the regulation of the PI3-K/Akt and ERK pathways, which are critical in adipogenesis. Both in vitro and in vivo studies have shown that *Hibiscus* extract (or tea) can inhibit amylase activity, thus blocking the digestion of sugars and starches, potentially aiding in weight loss. A study conducted in Mexico using an ethanol extract of *Hibiscus sabdariffa* concluded that the extract could be considered a potential anti-obesity agent due to its effects on fat absorption and body weight in rats. The therapeutic use of the extract, likely due to its polyphenol content, was also explored in patients with metabolic syndrome, a cluster of obesity-related disorders. Meanwhile, another study showed that the water extract was more effective in inhibiting triglyceride accumulation when free of fiber and polysaccharides. However, when polyphenols were isolated and fractionated, the benefits of the whole extract proved greater than the sum of its individual components [34-36].

#### Anti-diabetic activity

Chronic hyperglycemia, dyslipidemia, and protein digestion—all of which result from abnormalities in the regulation of insulin activity and discharge—are hallmarks of diabetes mellitus, an endocrine and metabolic disorder. A type II diabetic rodent display (high fat eating routine model) was used to examine the defensive effects of a polyphenol concentrate of Hs. The concentrate demonstrated anti-insulin resistance properties at 200 mg/kg by reducing hyperglycemia and hyperinsulinemia. Additionally, it reduced plasma-driven glycation end products (AGE) development and lipid peroxidation, as well as serum triacylglycerol, cholesterol, and the ratio of low-density lipoprotein/high-thickness protein (LDL/HDL) [37].

#### Lactating activity

In lactating Albino Wistar rats, the ethanolic seed extract of Hs (200–1600 mg/kg) raised the serum prolactin level ( $p < 0.01$ ) in a dose-dependent manner in comparison to the control [38].

#### Phytochemistry

The phytochemistry of *Hibiscus sabdariffa* L. (commonly known as roselle) reveals a diverse array of bioactive compounds, primarily in its flowers, leaves, and calyces. These compounds contribute to its medicinal and nutritional properties.

1. **Anthocyanins:** *Hibiscus sabdariffa* is particularly rich in anthocyanins, which are water-soluble pigments responsible for its deep red color. The predominant anthocyanins in *H. sabdariffa* include delphinidin, cyanidin, and peonidin glycosides. These compounds are known for their antioxidant properties,

contributing to the plant's ability to combat oxidative stress [39].

2. **Flavonoids:** The plant contains various flavonoids, including quercetin, kaempferol, and hibiscetin. These flavonoids have been associated with anti-inflammatory, anti-cancer, and cardiovascular protective effects [40].
3. **Organic Acids:** Several organic acids, including citric, malic, and tartaric acids, have been identified in *H. sabdariffa*. These acids contribute to the plant's sour taste and are thought to play a role in its antioxidant activity [41].
4. **Polysaccharides:** The plant's calyces also contain polysaccharides, which have demonstrated immunomodulatory effects. These polysaccharides may contribute to *H. sabdariffa*'s potential as an anti-inflammatory agent [42].
5. **Phenolic Compounds:** *Hibiscus sabdariffa* is a significant source of phenolic acids, such as chlorogenic and caffeic acids. These compounds are recognized for their antioxidant and antimicrobial properties [43].
6. **Alkaloids and Other Secondary Metabolites:** Some studies have identified alkaloids and various secondary metabolites in *H. sabdariffa*, although these compounds are less studied compared to anthocyanins and flavonoids. They may contribute to the plant's therapeutic properties [44].

#### Conclusión

*Hibiscus sabdariffa* may have a variety of new medical uses and therapeutic targets, according to data from in vitro and in vivo research. *Hibiscus sabdariffa* is almost non-toxic and comparatively harmless. Numerous phytochemicals found in *H. sabdariffa* may be responsible for several of its pharmacological characteristics. The plant has been used to flavor sauces, jellies, soft drinks, and food coloring. Roselle seems to be a good and promising source of natural red colorants that dissolve in water. Plant extract from *Hibiscus Sabdariffa* may help lower the chance of contracting a number of diseases. Anthocyanins, flavonoids, organic acids, and phenolic acids are among the bioactive compounds found in the plant that contribute to its medicinal qualities.

#### Disclosure Statement

There are no conflicts of interest.

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