

(REVIEW ARTICLE)



Pharmacognostic and therapeutic insights into *Hibiscus sabdariffa* L. and its cultivation in Qarshi Botanical Garden

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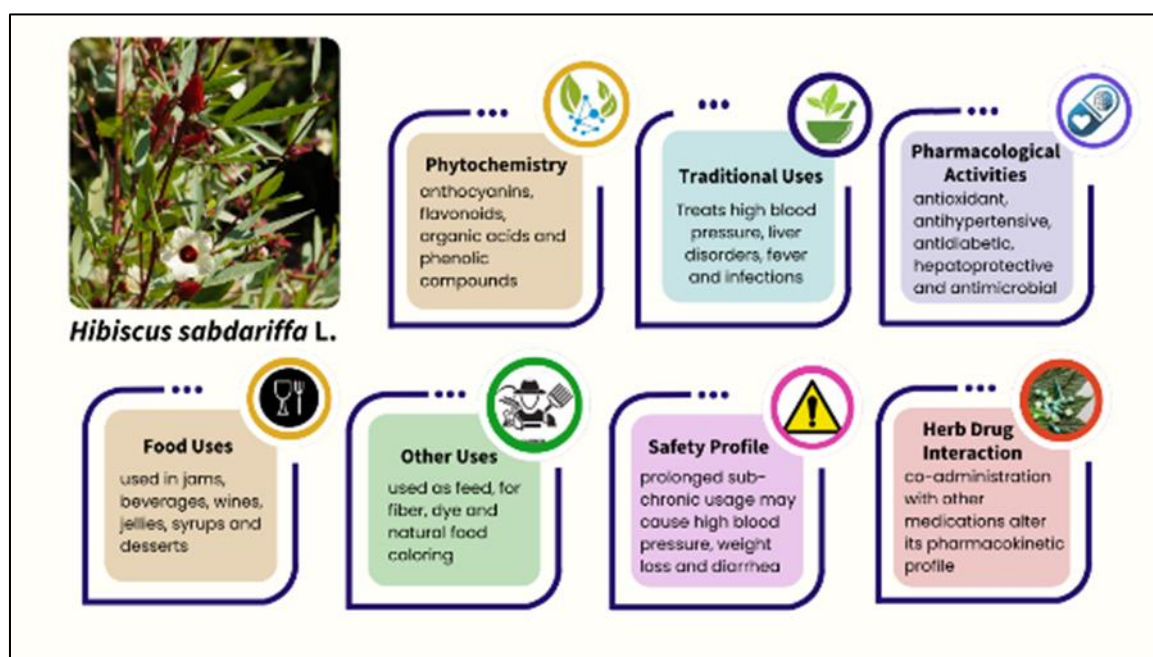
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Abstract

Hibiscus sabdariffa L. commonly known as roselle, is a multipurpose plant widely cultivated in tropical and subtropical regions. It has attracted significant scientific interest due to its nutritional richness and pharmacological potential. The plant possesses diverse bioactive compounds including anthocyanins, flavonoids, organic acids and polysaccharides, which contribute to its medicinal value. This review summarizes current knowledge on the botany, ecology, nutritional composition, phytochemistry and medicinal properties of *H. sabdariffa*, emphasizing its antioxidant, antimicrobial, antihypertensive, hepatoprotective and anticancer activities. Beyond its medicinal uses, this review also highlights its application in agriculture and industrial sector.

Graphical abstract



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Keywords: Herbal tea; *Hibiscus sabdariffa*; Medicinal plants; Roselle; Traditional herbal medicine

1. Introduction

Medicinal plants have been an integral part of traditional healing systems across the world for centuries. Among these, *Hibiscus sabdariffa* L., commonly known as Roselle is a plant of considerable medicinal and nutritional significance. Belonging to the family Malvaceae, it is native to tropical Africa but is now cultivated widely in Asia, the Caribbean and Central America due to its diverse applications in food, beverages and medicine. The taxonomical status, synonyms and vernacular names of *H. sabdariffa* is describe in Table 1. The plant is characterized by its bright red calyces, which are not only visually striking but also pharmacologically active. These calyces are widely used to prepare herbal teas, jams, jellies and traditional medicines [1].

Table 1 The taxonomical status, synonyms and vernacular names of *H. sabdariffa*

Taxonomic Classification	Synonyms	Vernacular Names
Kingdom: Plantae	<i>Abelmoschus cruentus</i> Walp.	English: Roselle, Hibiscus, Jamaica sorrel, Red sorrel, Indian sorrel
Subkingdom: Tracheobionta	<i>Furcaria sabdariffa</i> Ulbr.	Urdu: Gudhal, Gurhal
Division: Anthophyta	<i>Hibiscus acetosus</i> Noronha	Hindi: Lal-Ambari
Phylum: Magnoliophyta	<i>Hibiscus cruentus</i> Bertol.	Tamil: Pulichchai kerai
Class: Magnoliopsida	<i>Hibiscus digitatus</i> Cav.	Bengali: Lal-mista, Chukar
Order: Malvales	<i>Hibiscus fraternus</i> L.	Malayalam: Polechi
Family: Malvaceae	<i>Hibiscus gossypifolius</i> Mill.	Telugu: Yerra gogu
Subfamily: Malvoideae	<i>Hibiscus masuianus</i> De Wild. & T.Durand	Assam: Chukiar
Genus: Hibiscus	<i>Hibiscus palmatilobus</i> Baill.	African: Karkade or Carcadé
Species: <i>H. sabdariffa</i> L.	<i>Hibiscus sanguineus</i> Griff.	Arabic: Karkade
	<i>Hibiscus subdariffa</i> Rottler	
	<i>Sabdariffa digitata</i> (Cav.) Kostel.	
	<i>Sabdariffa rubra</i> Kostel.	

H. sabdariffa grows well in tropical and subtropical climates and can be cultivated on marginal lands with varying levels of rainfall. It is increasingly being adopted as a cash crop in many tropical regions, offering income opportunities for smallholder farmers. The plant is easy to grow under suitable climatic conditions, which makes it accessible to farmers with limited resources [2].

In recent years, roselle has attracted attention as a promising industrial crop. Almost every part of the plant has some economic use to produce a variety of products such as jellies, jams, herbal teas, ice cream, traditional medicines and even paper pulp. Roselle calyces have high nutritional value and could be used either fresh or dry in the production of jam [3]. Its wide range of uses and adaptability to different growing conditions have made it an important crop in many developing countries where agriculture plays a central role in the economy [4].

H. sabdariffa possesses a wide range of pharmacological properties because of its rich phytochemical composition. The plant is known to contain several bioactive compounds such as anthocyanins, flavonoids, organic acids and phenolic compounds, which contribute to its antioxidant, antihypertensive, antidiabetic, hepatoprotective and antimicrobial effects [5]. In many regions, particularly in Africa and Southeast Asia, decoctions and extracts of Roselle are traditionally used for treating ailments such as high blood pressure, liver disorders, fever, and infections. Modern pharmacological studies have validated many of these traditional claims, highlighting the therapeutic potential of *H. sabdariffa* as a source of natural health-promoting compounds [6].

In recent years, there has been growing global interest in plant-based remedies as safer alternatives to synthetic drugs, which often produce undesirable side effects. Within this context, *H. sabdariffa* has emerged as a promising plant species due to its strong antioxidant properties and potential role in preventing chronic diseases associated with oxidative

stress, such as cardiovascular disorders and diabetes mellitus [7]. Moreover, the plant's versatility in both food and pharmaceutical applications has further enhanced its commercial and scientific importance [8].

2. Cultivation and Collection of *H. sabdariffa*

H. sabdariffa is cultivated in Qarshi Botanical Garden, a component of Qarshi Herb Research Centre (QHRC) which is located on the premises of Qarshi Industries (Pvt.) Ltd, Industrial Estate Hattar, District Haripur, KPK, Pakistan (Figure 1). The calyces of *H. sabdariffa* harvested, dried and preserved for use as herbal tea (Figure 2). The seeds are preserved in QHRC seed bank.



Figure 1 (A) Cultivation of *Hibiscus sabdariffa* in Qarshi Botanical Garden (B) Calyx (C) Flower (D) Seed pod (E) Seeds for QHRC Seed Bank

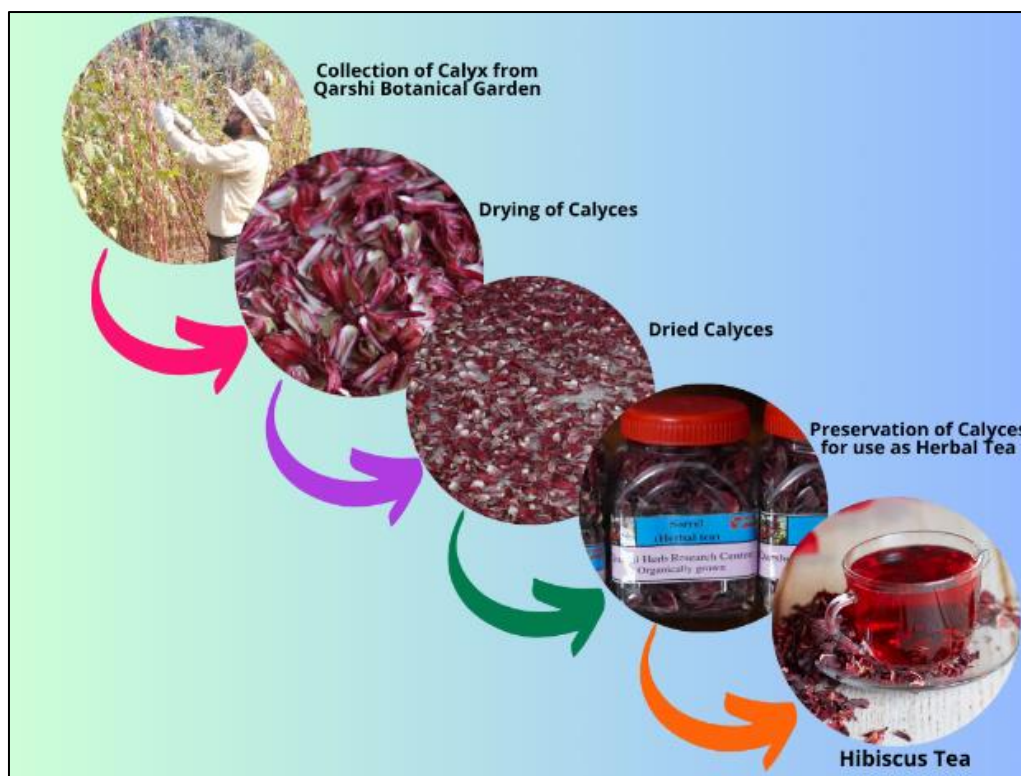


Figure 2 Collection, drying and preservation of calyces for use as herbal tea

3. Botanical Description and Ecology

H. sabdariffa is an erect, branched annual shrub, reaching up to 3.5 m in height with reddish stems and dark green to red leaves that are palmately divided into three to seven lobes. Its flowers are red to yellow with a dark center, containing both male and female organs enclosed by fleshy red calyces [9]. These calyces, rich in anthocyanins, are the most utilized part of the plant for food and medicine. Roselle thrives in warm and humid tropical climates and is sensitive to frost. It prefers full sunlight and well-drained soils, though it can tolerate light shade and greenhouse conditions [10].

4. Nutritional Composition and Food Uses

Roselle is widely used in the food industry for its vibrant color, tangy flavor and nutritional benefits. The red calyces are consumed fresh or dried and used in the preparation of beverages, wines, jellies, syrups and desserts [11]. They are rich in vitamins (ascorbic acid, niacin, riboflavin), minerals (calcium, iron, magnesium and potassium) and natural antioxidants such as flavonoids and anthocyanins [12]. Seeds contain up to 20% oil, high in unsaturated fatty acids, and serve as a protein source that can be roasted and ground into flour or used as a coffee substitute [13]. Fresh leaves and calyces can be eaten raw in salads, as a potherb and as seasoning in curries. Powder of dried seeds have been used in soups and sauces [14].

Proximate analyses revealed that *H. sabdariffa* contains approximately 68.7% carbohydrates, 14.6% crude fiber, and 12.2% ash, along with significant levels of organic acids and pectin [15]. These nutritional components contribute to its classification as a functional food with potential health benefits beyond basic nutrition.

4.1. Herbal Tea

H. sabdariffa is well known for its utilization as herbal tea across the world. The calyces harvested from the plant are employed as herbal infusions and known as hibiscus tea, bissap, roselle, red sorrel, Lo-Shen, Sudan tea, sour tea or karkade in different regions of the world [16]. The tea is sour in taste and rich in riboflavin, ascorbic acid, niacin, carotene, calcium, iron and anthocyanins [17]. Clinical studies indicate that the hibiscus tea helps in lowering high blood pressure and provide a safe alternative for controlling hypertension [18]. The tea supports the cardiovascular health and aids in weight management.

5. Phytochemical Constituents

The bioactive profile of *H. sabdariffa* includes a variety of secondary metabolites such as anthocyanins (delphinidin-3-sambubioside and cyanidin-3-sambubioside), flavonoids, triterpenoids, steroids, saponins and alkaloids [19] (Figure 3). The calyces are particularly rich in anthocyanins responsible for the plant's red pigmentation and antioxidant activity. Two major anthocyanins are delphinidin-3-sambubioside or delphinidin-3-xylosylglucoside and cyanidin-3-sambubioside or cyanidin-3-xylosylglucoside. While minor anthocyanins include delphinidin-3-glucoside and cyanidin-3-glucoside [20]. Additionally, the presence of ascorbic acid, citric acid, succinic acid, oxalic acid and glycolic acid contributes to its diuretic and cooling effects [21]. The role of bioactive constituents for therapeutic potential of *H. sabdariffa* is described in Figure 4.

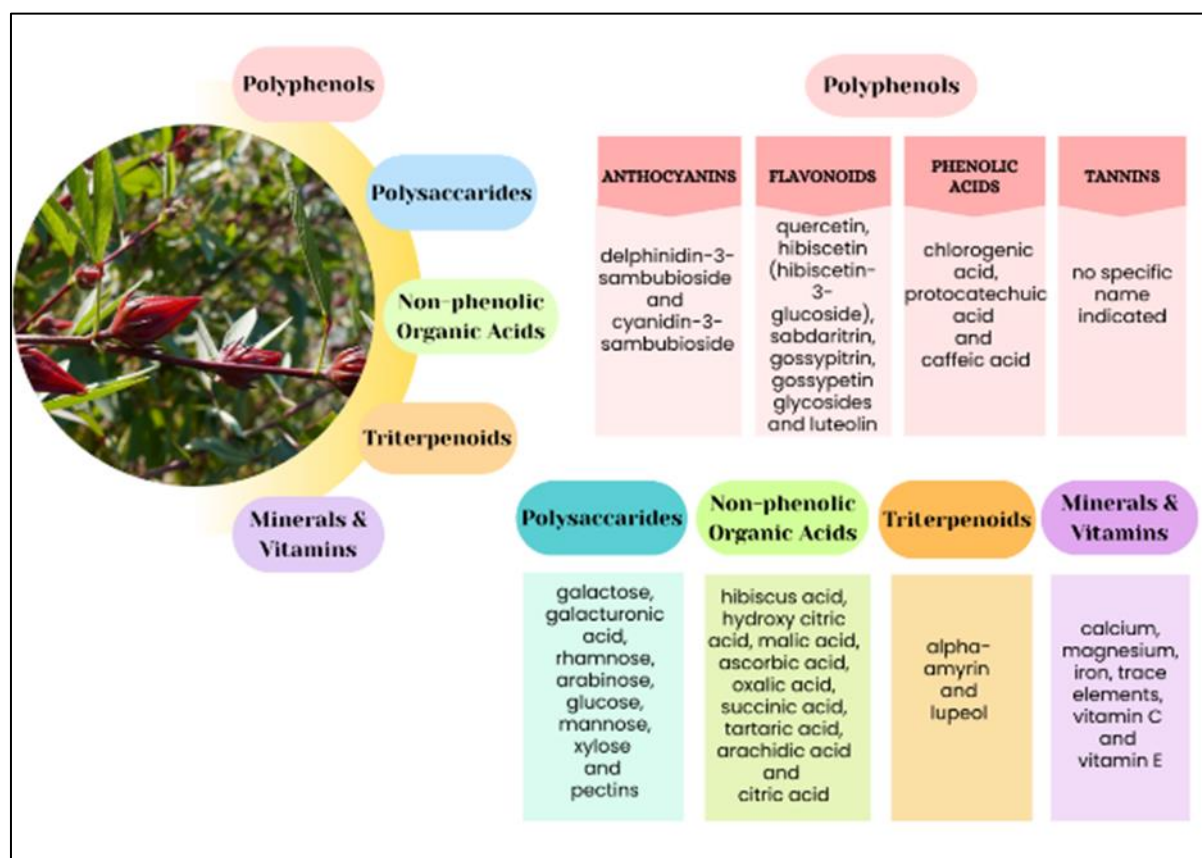


Figure 3 Chemical and nutritional composition of *Hibiscus sabdariffa*

Roselle seeds are rich in sterols including beta-sitosterol (71.9%), campesterol (13.6%), Delta-5-avenasterol (5.9%), cholesterol (1.35%) and clerosterol (0.6%) [22]. The seed oil of *H. sabdariffa* contains linoleic acid (40.1%), oleic acid (28%), palmitic acid (20%) and stearic acid (5.3%) along with high levels of γ -tocopherol (74.5%), making it an excellent source of natural antioxidants [23].

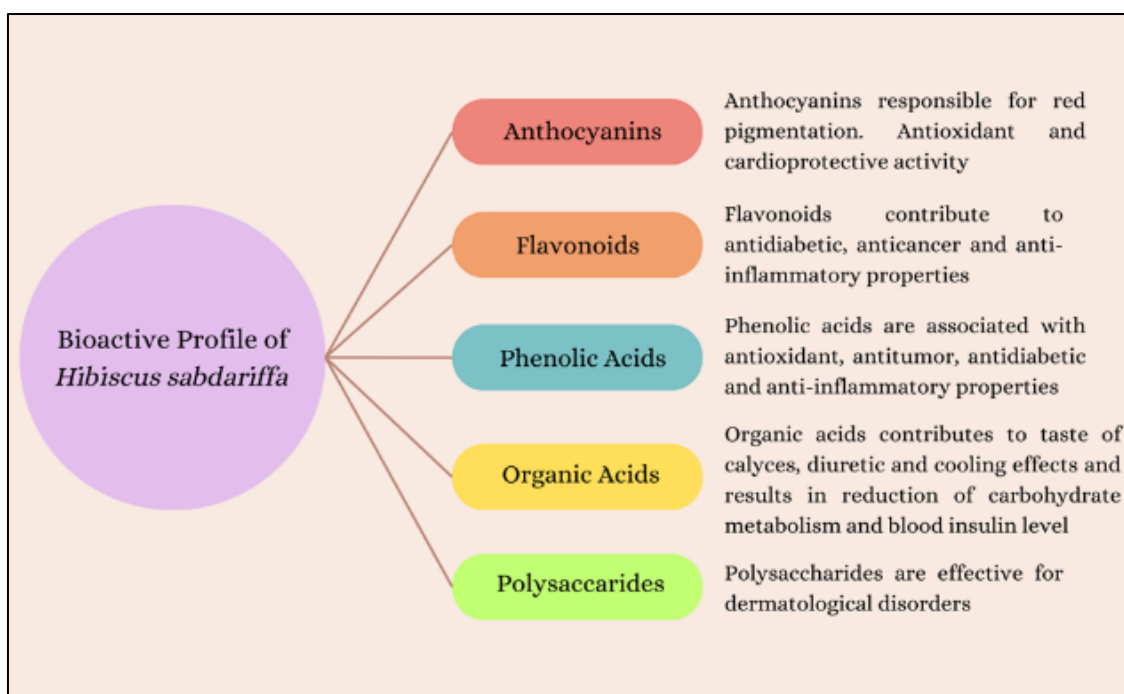


Figure 4 Bioactive profile of *Hibiscus sabdariffa*

Among methods used for the determination of bioactive components, near-infrared spectroscopy (NIRS) is found to be the most effective method to determine bioactive components including total phenol content, total flavonoid content, total antioxidant content, anthocyanins and 1,1-diphenyl-2-picrylhydrazyl in roselle [24].

6. Medicinal and Pharmacological Properties

6.1. Diuretic, Laxative and Cooling Effects

Traditionally, *H. sabdariffa* has been used as a mild laxative and diuretic, attributed to the presence of ascorbic and glycolic acids [25]. Infusions of its calyces are also consumed as cooling beverages to alleviate heat stress by increasing peripheral blood circulation [26].

6.2. Antioxidant Activity

The anthocyanin-rich extracts of roselle exhibit strong antioxidant potential, protecting against oxidative stress and liver damage. Studies have shown that hibiscus anthocyanins significantly reduce malondialdehyde and hepatic enzyme markers in hepatocytes, suggesting hepatoprotective properties [27]. This antioxidant potential of roselle extracts plays a vital role in hepatotoxic activity of *H. sabdariffa* and resulted in significant increase in lipid peroxidation in trials conducted in animal model [28]. Ethanol extracts also demonstrated free radical scavenging and xanthine oxidase inhibitory activities, further supporting their antioxidant efficacy [29].

6.3. Antimicrobial Activity

Extracts of *H. sabdariffa* exhibit antibacterial properties against a wide range of pathogens including *Staphylococcus aureus*, *Escherichia coli*, *Listeria monocytogenes*, and *Salmonella typhimurium* [30]. Previous studies conducted to evaluate the aqueous and ethanolic extracts of roselle for its antimicrobial properties indicate its higher inhibition ability against some major pathogenic bacteria [31]. These findings validate its traditional use in treating infections and suggest potential for use as a natural food preservative.

6.4. Anticancer Properties

Several studies have demonstrated the antiproliferative and pro-apoptotic effects of hibiscus extracts on various human cancer cell lines. Anthocyanins and protocatechuic acid induce apoptosis in leukemia, breast, and gastric carcinoma cells through ROS-mediated mitochondrial pathways [32, 33]. In vitro and in vivo studies revealed that the leaf extract of

hibiscus shows cancer-preventive effect against the human prostate cancerous cells [34]. These results highlight *H. sabdariffa*'s potential as a source of natural anticancer agents.

6.5. Anti-obesity Effect

H. sabdariffa has been reported to have an anti-obesity effect by decreasing the levels of total lipids, cholesterol and triglycerides [35]. The aqueous extract of roselle inhibits body weight gain and tends to reduce the glycemia when investigated on an obese animal model. This in vivo study confirms the anti-obesity potential of *H. sabdariffa* [36]. Clinical trials indicate that the administration of *H. sabdariffa* extract for several days resulted in reduced body weight, fat accumulation and appetite for sweet, fatty and salty foods [37].

6.6. Antidiabetic

Large number of clinical trials have been conducted to evaluate the antidiabetic activity of *H. sabdariffa*. The hibiscus tea shows a significant hypoglycemic and hypolipidemic effects on patients suffering from type II diabetes. Use of calyx extract resulted in decrease in blood cholesterol and lipid profile [38]. Hydroalcoholic extracts of calyces tend to reduce the blood glucose level in alloxan-induced diabetic rats. The presence of polyphenolic compounds improved the blood glucose tolerance level and high-density lipoproteins while the low-density lipoproteins, cholesterol and triglycerides are significantly decreased [39].

Recent studies conducted to assess the physicochemical and pharmacokinetic properties of antidiabetic compounds found in *H. sabdariffa* L. have revealed its potential to be used in new drug formulations for the treatment of diabetes mellitus [40].

6.7. Antihypertensive and Cardioprotective Effects

Roselle tea has been clinically studied for its blood pressure-lowering effects and exhibits antihypertensive activities [41]. In both animal and human trials, aqueous extracts of *H. sabdariffa* significantly reduced systolic and diastolic pressures, comparable to captopril and lisinopril [42, 43]. Studies indicate that the hibiscus tea shows higher reduction in blood pressure when compared with black tea thus confirming its safety and effectiveness in the treatment of hypertension [44]. The anthocyanins are believed to act through diuretic and ACE inhibitory mechanisms, supporting cardiovascular health [45].

7. Industrial and Agricultural Importance

In addition to its medicinal and nutritional uses, *H. sabdariffa* holds considerable industrial and agricultural value. It is a versatile crop with applications across several sectors including food, pharmaceuticals, cosmetics and materials. The calyces are commonly used to make beverages and natural food colorings, while the seeds provide an edible oil that has both nutritional and industrial relevance [46].

The plant is also cultivated for its strong stem fibers, known as roselle hemp, which are used in making ropes and textiles. Its petals can be processed to produce a natural yellow dye, which can be used in the dyeing of cotton fabric [47]. The ethanolic extract of *H. sabdariffa* can be used as anti-aging agent for skin by stimulating the synthesis of collagen and hyaluronic acid in skin cells [48]. Seeds and plant residues can serve as animal feed due to high protein, dietary fiber and oil content [49]. The incorporation of *H. sabdariffa* by-product powder in the preparation of pasta enhanced its nutritional value by increasing its total dietary fiber and mineral contents [50].

8. Safety Profile of *H. sabdariffa*

The therapeutic application of *H. sabdariffa* and its isolated compounds is found to be safe when used in moderate amounts. However higher doses of *H. sabdariffa* or excessive consumption for longer duration in animal models may cause an increase in uric acid level [51], sperm cells disintegration, decrease in epididymis sperm [52], weight loss, diarrhea and even death of animal models [53]. An in vitro study on healthy rats revealed that the total antioxidant capacity was increased due to chronic consumption of *H. sabdariffa* and resulted in increased inflammation and blood pressure [54].

Research studies indicate that the sub-acute and sub-chronic oral administration of aqueous extracts of *H. sabdariffa* calyces are relatively safe and less toxic, however prolonged sub-chronic usage is not recommended [55].

9. Herb-Drug Interaction

The coadministration of *H. sabdariffa* L. with other medications were tested on animal models. A research study indicates that the administration of aqueous extract of *H. sabdariffa* with a frequently prescribed antihypertensive drug “captopril” could alter its pharmacokinetic profile. The results show decreased efficacy of captopril by reducing its area under curve (AUC) and peak plasma concentration in animal models who consume of *H. sabdariffa* L. aqueous extract regularly for two weeks [56]. It is therefore recommended to avoid the consumption of *H. sabdariffa* extracts while administering captopril.

10. *H. sabdariffa* Products available in Market

Table 2 Products of *Hibiscus sabdariffa* available in Market in Pakistan

S. No.	Product Name	Brand Name	Net weight	Price
1	Hibiscus Tea	The Nature’s Store	40 g	950 PKR
2	Hibiscus Tea	Pansari Inn	50 g	500 PKR
3	Hibiscus Flower Tea	Vital Group	30 Tea bags	220 PKR
4	Hibiscus Flower	Caveman Organics	200 g	1170 PKR
5	Organic Hibiscus Tea	Khalis Things	50 g	950 PKR
6	Hibiscus dry Flowers	Bioshop	100 g	1250 PKR
7	Pure Hibiscus Powder	Orior	100 g	799 PKR
8	Hibiscus Powder	Chiltanpure	105 g	999 PKR
9	Hibiscus Powder	Karachi Pansar	100 g	1450 PKR

11. Conclusion

H. sabdariffa is a versatile plant with promising medicinal, nutritional and industrial applications. Its high content of anthocyanins, flavonoids and organic acids underlies its antioxidant, antimicrobial, antihypertensive and hepatoprotective effects. Despite extensive traditional use, more controlled pharmacological and clinical studies are needed to validate its therapeutic potential and identify its active compounds under different environmental and cultivation conditions. Promoting roselle cultivation can contribute not only to improved public health but also to rural economic development.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors have no conflicts of interest to declare.

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