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PHARMACOLOGICAL AND THERAPEUTIC PROFILE OF HIBISCUS SABDARIFFA L – A REVIEW

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ABSTRACT

Hibiscus sabdariffa L. (commonly called roselle) is a drug and food plant in Malvaceae. Traditionally, it has been of importance as a food and beverage ingredient as well as a natural cure in various cultures. The plant is wealthy in bioactive compounds together with organic acids (citric, malic, and ascorbic), anthocyanins (delphinidin-3-sambubioside), flavonoids (quercetin and luteolin), phenolic compounds, sterols, triterpenes, fatty acids, polysaccharides, alkaloids, and essential vitamins. Pharmacological investigations have shown that Hibiscus sabdariffa has been found to exhibit a variety of beneficial effects on health. These anthocyanins and phenolic compounds of hibiscus help in treating hypertension by relaxing blood vessels through various mechanisms like increasing nitric oxide release, reducing calcium entry into cells, and blocking angiotensin-converting enzyme. These combined actions induce vasodilation and also lend a slight diuretic effect, which in turn lowers blood pressure. For anemia, hibiscus helps in the formation of RBC, increases the hemoglobin levels, protects the cells from oxidative stress, and supports the process of normal blood function. improves the antioxidant defense mechanism and blocks α-amylase and α-glucosidase and prevents kidney damage by inhibiting the DPP-4. Additionally, Hibiscus shows potential anticancer and anti-

inflammatory effects by influencing NF-κB/MAPK signaling, lowering cytokine levels, and causing cell death in cancer cells. Overall, Hibiscus sabdariffa offers valuable bioactive compounds with significant therapeutic uses in heart, metabolism, infection, blood, and inflammation issues.

KEYWORDS: Hibiscus, Phytochemicals, Antioxidants, Antihypertensive, Anticancer.

INTRODUCTION

The multipurpose plant Hibiscus sabdariffa L., popularly called roselle, is prized for its culinary and industrial applications. Producing food and fiber are just two of its many uses, and it grows well in multi-cropping systems. Roselle seeds are harvested for their oil in China, where the plant is well known for its traditional therapeutic uses. Both the powdered seeds and the leaves are used in regular meals in West Africa. Hibiscus sabdariffa is used in food and pharmaceutical industries in addition to its culinary and agricultural uses.[1]

Hibiscus sabdariffa exhibits a wide range of therapeutic benefits due to its rich composition of anthocyanins, flavonoids, and organic acids. It is well known for its antihypertensive effect, where it helps lower blood pressure by promoting vasodilation and inhibiting angiotensin-converting enzyme. The plant also possesses strong antioxidant properties, protecting cells against oxidative stress and reducing the risk of chronic diseases. Its antimicrobial activity makes it useful against certain bacteria, fungi, and parasites. In addition, Hibiscus shows a hepatoprotective role, safeguarding the liver from chemical-induced damage and improving liver function. It has demonstrated antidiabetic potential by reducing blood glucose levels, improving insulin sensitivity, and regulating lipid metabolism. Furthermore, Hibiscus contributes to weight management and cardiovascular health by lowering cholesterol, triglycerides, and LDL levels. Traditionally, it has been used as a mild diuretic and digestive aid, supporting kidney and gastrointestinal health. Its anti-inflammatory effects also make it beneficial in managing conditions like arthritis and other inflammatory disorders.[2]

TAXONOMY

Kingdom : Plantae

Subkingdom : Tracheobionta (Vascular plants)

Super division : Spermatophyta (Seed plants)

Division : Magnoliophyta (Flowering plants)

Class : Magnoliopsida (Dicotyledons)

Subclass : Dilleniidae

Order : Malvales

Family : Malvaceae

Species : Hibiscus sabdariffa L.

Hibiscus sabdariffa

CHEMICAL CONSTITUENTS

Organic acids :
- Citric acid
- Malic acid
- Tartaric acid
- Ascorbic acid

Anthocyanins :
- Delphinidin-3-sambudioside

Flavonoids :
- Qurcetin
- Kaempferol
- Goss pectin
- Luteolin

Phenolic compounds :
- Protocatechuic acid
- Caffeic acid
- Gallic acid

Fatty acids :
- Oleic acid
- Linolic acid
- Palmitic acid
- Stearic acid

Polysaccharides :
- Pectin
- Mucilage

Sterols & triterpenes
- Beta-sitosterol
- Stigmasterol
- Lupeol
- Campesterol

Volatile & aromatic compounds :
- Hexanal
- Nonanal
- Terpenes

Alkaloids :
- Reserpine

Enzymes & vitamins :
- Vitamin C
- Vitamin E
- Riboflavin
- Niacin

Medicinal uses

S.no	Disease	Chemical constituents	Mechanism	Reference
1.	Hypertension	Anthocyanins (Delphinidin-3-sambubioside)	Hibiscus sabdariffa anthocyanins and phenolics enhance endothelial NO production, increasing cGMP and causing vascular smooth muscle relaxation then block Ca^{2+} entry, reducing contractility and contributing to relaxation. Anthocyanin compounds such as delphinidin-3-sambubioside and cyanidin-3-sambubioside competitively inhibit ACE, lowering angiotensin II and aldosterone levels which leads to vasodilation and reduced blood volume.	[3]
		Quercetin	Hibiscus sabdariffa (HS) extract increases intracellular glutathione, enhancing antioxidant capacity. This protects vascular endothelium and improves vasodilation beneficial for lowering blood pressure.	[4]
		Anthocyanins Phenolic acids	The extract promotes vasodilation through the endothelium derived nitric oxide to CGMP signaling cascade. It inhibits the Ca^{+2} influx into vascular muscle; it usually blocks both receptor operated and voltage gate channels. Aqueous HS extracts has anthocyanins and phenolic acids which inhibits angiotensin converting enzyme, promote diuresis and enhance vasodilation via bradykinin and prostaglandins.	[5]
2.	Anemia	Phenolic acids	H. Sabdariffa extract has high antioxidant activity and polyphenolic contents, support hematopoietic processes or enhance usage of iron, facilitates regeneration of RBCs and elevating hemoglobin and PCV .	[6]
		Vitamin C	The extract H.sabdariffa gives increased levels of hemoglobin in levodopa anemia model, which involves provision of iron, vitamin C from the extract and improve the RBC quality, it also stimulate erythropoiesis by raising RBC numbers and hemoglobin content per cell. Through antioxidant activity it reduce the damage of cells and contribute to normalize cell metrics like MCV, MCH and MCHC (Mean Corpuscular Volume Hemoglobin & Hemoglobin concentration.	[7]
		Quercetin	The extract of H. Sabdariffa gives antioxidant protection of the hematopoietic stem cells from the oxidative damage. It also stimulate the erythropoiesis and hemoglobin synthesis by	[8]

			primarily targeting the erythroid lineage without affecting platelet counts. It also shows huge improvement in the iron content for the hemoglobin synthesis.	
		Gallic acid	The extract of H.sabdariffa gives antioxidant protective effects, it decrease the MCHC by lower hemoglobin concentration by inhibiting the dehydration, then it increase MCV by improve cell hydration, also it increase MPV by potential platelet involvement, there it inhibit the Grados channel (calcium channels) which maintain RBC hydration.	[9]
3.	Urinary tract infections	Phenolic acids Anthocyanins	The extract of H sabdariffa inhibits the initial adhesion of C. Albanians cells and suppresses the yeast-hyphae transition, which is critical for robust biofilm formation. The effect was observed both at early stages and against pre-formed biofilms. A noteworthy reduction unto 50% disruption of established biofilms was recorded.	[10]
		Kaempferol Quercetin	The extract of H.sabdariffa firstly disrupt internal PH and membrane integrity, then it inhibit peptidoglycan synthesis, stopping cell division and block the quorum sensing, disrupt the signals from the biofilm, then they prevent bacterial adhesion and reduce early biofilm establishment, finally it degrade EPS (erythropoiesis) production and weaken any forming biofilm matrix .	
4.	Diabetes	Polyphenols	The effect of Hibiscus sabdariffa L. polyphenol extract (HPE) in streptozotocin (STZ) induced diabetic nephropathy. The results show that HPE reduced kidney mass induced by STZ significantly, as well as improving hydropic change of renal proximal convoluted tubules in the rats. HPE also significantly reduced serum triglyceride, total cholesterol and LDL in STZ induced rats. Treatment with HPE significantly increased the activity of catalase and glutathione and reduced lipid peroxidation.	[11]
		Phenols	The plant has both α-glucosidase & α-glucosidase inhibitory activities. In addition, the red variety possessed higher antioxidant capacity as exemplified by the OH scavenging abilities, Fe2+ chelating ability and inhibition of Fe2+ induced pancreatic lipid peroxidation in vitro. The enzyme Inhibitory activities and antioxidant properties of the roselle extracts agreed with their phenolic content. Hence, inhibition of α-amylase and α-glucosidase,	[12]

			coupled with strong antioxidant properties could be the possible underlying mechanism for the antidiabetic's properties of H. sabdariffa calyces; however, the red variety appeared to be more potent.	
5.	Cancer	Anthocyanins	Treatment with anthocyanins significantly modulated inflammation-related pathways. Specifically, pathways involved in complement activation, leukocyte migration and chemotaxis, granulocyte migration, neutrophil migration, and myeloid leukocyte migration were upregulated, supporting the recruitment of innate immune cells. There was an increase in the regulation of vasculature development, which may facilitate immune infiltration and suggest a regulatory feedback mechanism in response to vascular destruction.	[14]
		Poly-phenolic compounds	HSE treatments inhibited the cell invasion via down-regulation of PI3K/Akt signaling and further inactivation of NF-κB, followed by a reduction of MMP-9 expression. Most significantly, HSE inhibited the growth of prostate tumor xenograft in athymic nude mice . The data also showed that HSE down-regulated the Akt/NF-κB/MMP-9 signaling pathway in vitro and in vivo. HSE represents an accessible possible source of polyphenolic compounds useful for the preparation of food supplements. These findings indicate that HSE could be developed as potent anticancer agent.	[15]
		Anthocyanins Saponins Phenols	The active phytochemicals of HS are involved in the regulation of cell proliferation, and restoration of checkpoint pathways by preventing over-dividing of cells with damaged genomes or inducing these cells to commit suicide through the classical pathway of apoptosis. It has been noted that flower extracts of the plant containing cyanidin-3-glucoside and anthocyanin significantly inhibit the growth of cervical cancer cells and dried leaf extract of the plant containing saponins, phenols showed proliferation inhibitory effects in prostate cancer cells.	[16]
6.	Inflammation	Essential oils	The anti-inflammatory activity of the essential oil extracted from H. Sabdariffa might be inhibiting the activation of NF-κB and MAPK (JNK and ERK1/2). Thus, the essential oil extracted from H. Sabdariffa is a good source of a natural product with a beneficial effect against inflammation, and it may be applied as a food	[17]

			supplement.	
		Poly-phenolic compounds Flavonoids	Hibiscus sabdariffa has been reported to have anti-inflammatory effects due to the presence of polyphenol compounds. Flavonoids are also commonly found in it, which inhibit the transcription factor nuclear factor kappa (NF Kβ).	[18]
		Essential oils	These extracts also significantly decreased the inflammatory markers tumor necrosis factor-alpha (TNF-α), interleukin-6 (IL-6), and interleukin-1 beta (IL-1β).	[19]
		Polyphenols	The methanol extract of H. sabdariffa improved spatial memory consolidation in Wistar rats and prevented impairment in spatial memory long term storage process by maintaining the ratio of IL-1β/IL-1 in the plasma and hippocampus of Wistar rats who experienced overtraining. H. sabdariffa is a potent anti-inflammatory substance that prevents impairments in spatial memory consolidation in overtrained Wistar rats.	[20]
7.	Anti – Fungal activity	Anthocyanins Flavonoids	The HS extract demonstrated efficacy against C. albicans biofilms at a concentration of 3.125 mg/ml and was capable of preventing the initiation of hyphae and cell adherence. Additionally, the HS extract successfully decreased the C. albicans levels effectively eliminating the Candida cells, resulting in a lower viable colony count.	[21]

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