REVIEW ARTICLE

Nutritional, therapeutic, and pharmaceutical potential of *Hibiscus* species

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Abstract

The present review article explains nutritional, therapeutic, and pharmaceutical potential of various *Hibiscus* species. *Hibiscus* plant possesses great aesthetic and nutritional values. *Hibiscus* species bear different color flowers mainly rose mallow, red, white, yellow, and saffron which secrete nectar and attract insect pollinators. The plant contains diverse bio-molecules, i.e., phenols, alkaloids, anthocyanins, tannins, quinines, flavonoids, alkaloids, quercetin, terpenoids, saponins, cardiac glycosides, protein, free amino acids, carbohydrates, reducing sugar, mucilage, and essential oils. Plant also contains various acids such as citric acid, malic acid, tartaric acid and allo-hydroxycitric acid lactone, and *Hibiscus* acid. Its leaves and flowers contain *p*-coumaric, chlorogenic, and *trans*-ferulic acid derivatives as well as quercetin and kaempferol flavonoids which display multiple biological activities, i.e., anti-inflammatory, anti-hypertension, chemopreventive, antifertility, abortifacient activity, anti-pregnancy, antilipidemic and antihyperglycemic, anti-oxidant, antidepressant, antidiabetic, anti-carcinogenic, and antimicrobial activity. *Hibiscus* green tea lowers down blood pressure and reduces hypertension. Vegetative parts and flowers of Gurhal are used for many dietary purposes. This article resolves out presence of unique phytochemicals found in Gurhal plant which could be used to fight various human aliments and diseases as alternate medicine.

Key words: Alternate medicine, cultural, *Hibiscus* species, nutritional, therapeutic and pharmaceutical potential

INTRODUCTION

Hibiscus rosa-sinensis is commonly known as Gurhal, belongs to the family Malvaceae. This is a perennial flowering plant grown throughout the seasons in tropical and subtropical areas worldwide. The plant is grown with many showy hybrids, but the most popular is the *Hibiscus* [Figure 1]. This is a shrub and native to Africa India, China, Sudan, Malaysia, Taiwan, and many other countries. *Hibiscus* is grown for its colorful flowers, leaves, stems, seeds and roots. *Hibiscus* flowers and seed oils are widely used in food, cosmetic and pharmaceutical formulations. *Hibiscus* has medicinal values that have been mentioned in Ayurveda and the Chinese system of medicine. It is commonly known as Lalambari or Gudhal in Hindi and Jaswandh in Marathi. *Hibiscus* genus has more than 300 species of flowering plants, including *Hibiscus sabdariffa* Lin. It is considered a versatile plant that can provide many health benefits. The generic name is derived from the Greek word "o" (hibskos), which was the name given to *Althaea officinalis* by Pedanius Dioscorides (c. 40–90).[1] The genus includes annual and perennial herbaceous plants, as well as woody shrubs and small trees.

Syriacus hibiscus is the national flower of South Korea while *H. rosa-sinensis* is the national flower of Malaysia and Haiti. *Hibiscus* flowers are traditionally worn by Tahitian and Hawaiian girls. If the flower is behind the left ear, the woman is married or in a relationship. If the flower is worn on the right, she is single or ready for a relationship. *Hibiscus* is the symbolic flower of Hawaii. In temperate regions the common garden *Hibiscus* and an ornamental species *Hibiscus syriacus* is grown. This is a synonym of "Rose of Althea" or "Rose of Sharon" but it is unrelated with *Hypericum calycinum*. There are other species of *Hibiscus* with white, yellow and pale pink flowers also found in other parts of the world [Figure 1]. Plants of the genus *Hibiscus* are annual and perennial

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Figure 1: Floral and vegetative parts of various *Hibiscus species*

herbaceous plants, mainly woody shrubs and small trees. The plant contains fiber. It can also be made into candy and used as decoration.[2]

In Hindi, this plant is called Gurhal, and is mentioned as Japakusum in ancient Indian literature. This is traditionally used in worship to appease the Sun, the God of energy, and is sung in Sanskrit mantra. Red *Hibiscus* flowers are offered to the Hindu goddess Kali and Lord Ganesha, as well as Aditya (sun). Red flowers are also used on other religious occasions. Gurhal is often seen in Northeastern and Bengali art. This plant is known by its well-known name, rose mallow, because of its lovely blossoms, which attract insect pollinators to feed on nectar. The main insects that visit this plant are nutmeg caterpillars and radish caterpillars. Leaves are alternate, ovate to lanceolate, often with toothed or lobed (toothed) edges. The flowers are large, conspicuous, trumpet-shaped, have five or more petals, range in color from white to pink, red, blue, orange, peach, yellow or purple and are 4–18 cm wide. The fruit is a dry, five-lobed capsule containing a number of seeds in each lobe, which are released when the capsule dehisces (opens) at maturity. It is red and white.

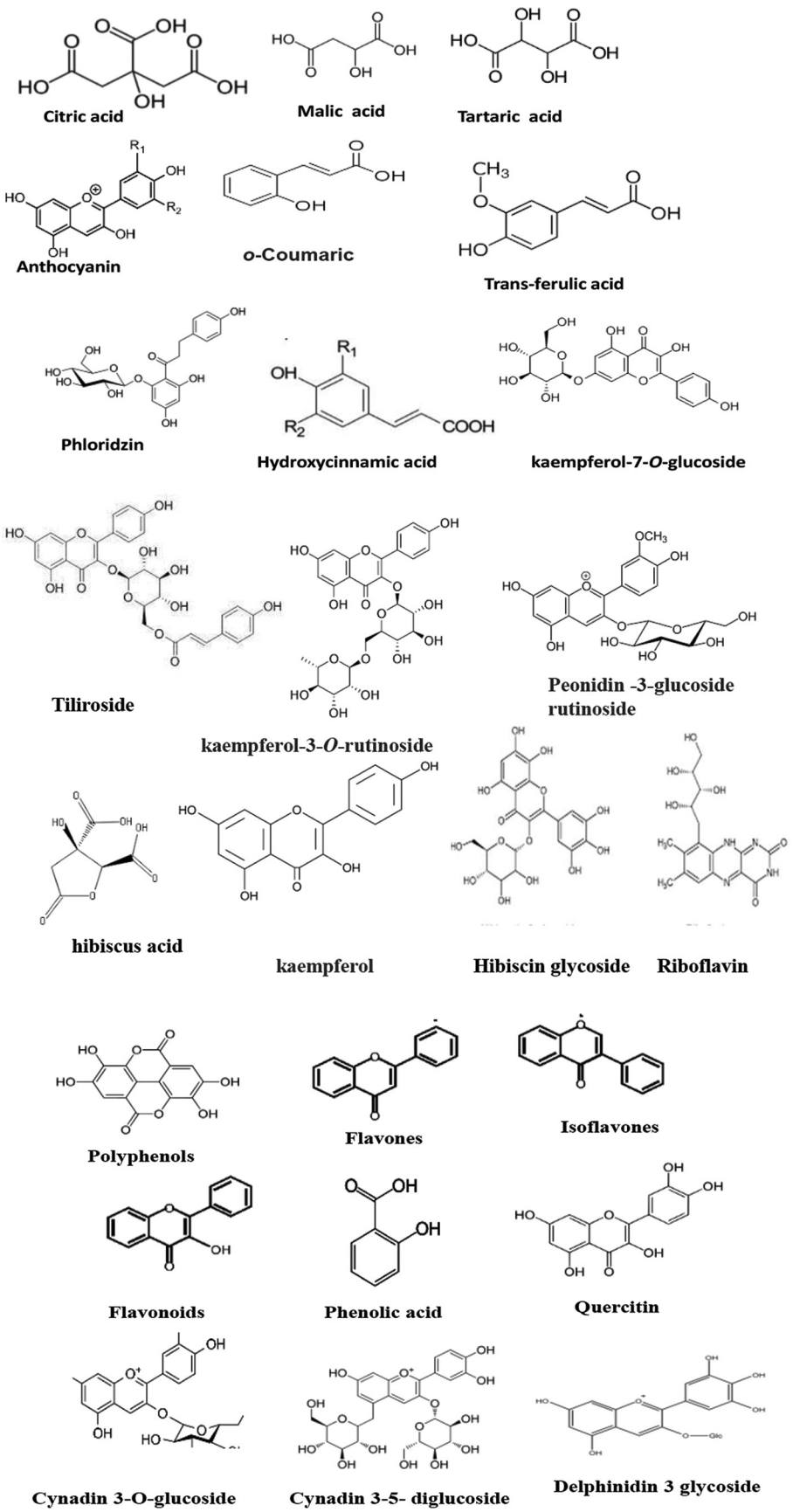

Figure 2: Important biologically active compounds isolated from various species of *Hibiscus* which are responsible for the diverse medicinal and therapeutic activities

H. rosa sinensis, is widely cultivated in the tropics as an ornamental plant. It is often planted as a fence or hedge plant, and has several forms of flowers with varying colors [Figure 1]. In most of the subtropical countries *Hibiscus* is cultivated for obtaining flowers, leaves, stems, seeds and roots. *Hibiscus* flowers and seed oils are widely used in food, cosmetic, and pharmaceutical formulations. Aside from ornamental importance, *Hibiscus* is also used for feed, food, industrial, and medicinal preparations. It is used as colorant, component of salads, developed into jams, among others. Its extracts were used to remedy hair fall and dandruff. *Hibiscus cannabinus* fibres are used to make paper. *Hibiscus* flower tea is used to restore liver and kidney functions. The oil extracted from *Hibiscus* seeds is used in cooking. Calyces are also used as a colorant in food. The root bark of *H. syriacus* is used in traditional medicine treatment of dysentery, eczema, tinea, and scabies.[3] Root bark of *H. syriacus* also shows anticancer effects,[4] antioxidant,[5] and human neutrophil elastase inhibitory[6] [Table 1].

DATA COLLECTION AND SOURCE OF INFORMATION

For writing this comprehensive research review on *Hibiscus*: Various electronic databases were searched, using keywords, *Hibiscus*, gurhal, therapeutic and nutritional antioxidant, antimicrobial, antityrosinase, anticancer, anti-hyperlipidemia, antiulcer, anti-inflammatory, and hepatoprotective activities. For collection of relevant information specific terms such as medical subject headings (MeSH) and keytext words, such as Gurhal "*Hibiscus rosa sinenesis*" and its therapeutic uses" published till 2023 were used in MEDLINE. *Hibiscus* species" is one such plant and has shown to exhibit broad range anti-dyslipidemic, anti-depressant, anti-allergic, antimicrobial, and anti-carcinogenic properties. Most specially for retrieving all articles pertaining to the traditional uses of *Hibiscus* species for therapeutics, electronic bibliographic

Table 1: Major and minor biochemical ingredients found in Gurhal plant species with their biological activity

Hibiscus species	Plant part	Biochemical component/s	Biological activity
H. cannabinus L.	Leaf extracts	Anti-obesity substances	[20]
H. sabdariffa	Leaf extracts	Antimicrobial, antiparasitic, and anticancer agents	[21]
H. sabdariffa.	Leaf tea	Herbal drinks	[28]
H. sabdariffa.	Leaf tea	Herbal tea	[29]
H. rosa sinensis	Flowers	Cardioprotective effect	[33]
H. roseus	Flower extracts	Bioactive phenolic compounds Catechin, epicatechin, and others	[35]
H. sabdariffa L.	Leaf extracts	Chemopreventive properties	[39]
H. sabdariffa	Extracts foods	Phenolic acids, flavonoids, and anthocyanins	[41]
H. rosa sinenesis Linn.	Ethanolic extract	Antidepressant	[43]
H. rosa-sinensis	Root Extract	Antidyslipidemic and antioxidant activities	[46]
H. rosa sinensis	Leaf extract	Hypoglycemic activity	[50]
H. rosa sinensis	Ethanol flower extract	Antilipidemic	[51]
H. rosa-sinensis Linn.	Ethanolic root extract	Antifertility and estrogenic activity of	[55]
H. rosa-sinensis	The extract	Luteolysis	[57]
H. rosa-sinensis Linn	Flower extracts	Relieve headache, fever and inflammation	[59]
H. rosa sinensis	The extract	Anti-estrogenic potentiality	[60]
H. rosa sinensis Linn.		Decrease in the sperm count	[63]
H. rosa-sinensis Linn	Flower extracts	Antioxidant and antibacterial activities	[73]
Hibiscus sp.	Anthocyanin-rich extracts	DNA damage protective properties	[74]
H. rosa sinensis	extract	Anticancer	[75]
H. rosa sinensis	extract	Wound healing	[76]
H. rosa-sinensis L.	Leaf extracts	Pathogenic oral microorganisms	[78]
H. rosa sinensis Linn.	Leaf hydroalcoholic extract	Experimental colitis	[81]
H. rosa-sinensis	Water extract	Inhibiting human pathogenic fungi	[82]
H. rosa-sinensis L	Water extract	Insecticidal	[87]
H. rosa-sinensis Linn	Water extract	Larvicidal effect in Culex quinquefasciatus	[86]

H. rosa-sinensis: Hibiscus rosa-sinensis, H. sabdariffa: Hibiscus sabdariffa, H. cannabinus L.: *Hibiscus cannabinus* L.

databases were searched and abstracts of published studies with relevant information on various species of *Hibiscus* were collected.

Furthermore, additional references were included through searching citations of various studies done on the present topic. For literature, search-related terms were used individually and in combination. For a collection of recent knowledge and incorporation of new information, research articles, books, conference proceedings, and survey reports of relevant public health organizations were selected and read thoroughly. Data were collected based on a broader overview for its interpretation in the context of the present topic. The present review aims to systematically analyze published data on the effects of plant constituents derived from *Hibiscus* species on various human health problems. This was achieved by searching databases including SCOPUS, Web of Science and EMBASE, PubMed, Swissprot, Google, and the Cochrane Library. From this general approach, findings and results were identified and summarized in this final review. This review highlighted the food and pharmaceutical uses of *Hibiscus* genus.

PHYTOCHEMISTRY

Hibiscus genus shows much wider bio-organic molecular diversity that belongs to citric acid, malic acid, tartaric acid, and allo-hydroxycitric acid lactone, i.e. *Hibiscus* acid, which is unique to *Hibiscus*. *H. rosa-sinensis* flower contain tannins, quinines, phenols, flavonoids, alkaloids, terpenoids, saponins, cardiac glycosides, protein, free amino acids crbohydrates, reducing sugar, mucilage essential oils and steroids according to phytochemical examination.[7] Both *H. roseus* leaves and flowers contain *p*-coumaric, chlorogenic, and *trans*-ferulic acids derivatives as well as quercetin and kaempferol flavonoids. More specifically, flavonoids and phloridzin exclusively found only in leaves. Plant also contains catechin, epicatechin, kaempferol-3-*O*-rutinoside, kaempferol-3-*O*-glucoside, kaempferol-7-*O*-glucoside, tiliroside, poenin, and peonidin-3-*O*-glucoside. Other chemical constituents are many; however, some of the most important include alkaloids, quercetin and large amounts of hydroxycinnamic acid derivatives. *Hibiscus* flowers contain anthocyanins that are used to give color and flavor to beverages and many other processed food items. *H. tiliaceus* contains hibiscones A-D and hibiscoquinones that provides red color [Figure 2].[7]

To provide a dark red shade to fibers metal mordants such as Sn, Al, and Cu are mixed in anthocyanin extract (AEs) of *H. rosa-sinensis*.[8] *Hibiscus roseus* belongs to Italy. Plant bears beautiful soft pink flowers. These contain phenolic bio-organics mainly polyphenols that act as anti-aging molecules. Flower extract is used for cosmetic purposes. *H. roseus* leaves (HL) and flowers (HF) possess. p-Coumaric, chlorogenic, and trans-ferulic acids derivatives as well as quercetin and kaempferol, flavonoids which are responsible for anti-collagenase activities. These also show mucolytic activity [Table 1].[9] *Hibiscus* species also contain steroids which showed anticancer activity against several cancer cells such as lung, breast, and liver.[10] *Hibiscus* contains anthocyanins which are natural colorants and good antioxidants.[11] *Hibiscus* plant also possesses polyphenols, alkaloid, flavonoid, and tannins.[12] *H. sabdariffa* flowers are rich in anthocyanin and anthraquinones contents.[13] [Table 1]. *H. micranthus* also contains saponins, steroids, phenols, anthraquinones, and diterpines which show antibacterial and would healing activity [Table 1 and Figure 2].[14]

NUTRITIONAL USES

Hibiscus radiatus (Malvaceae), seeds rich in protein are edible.[15] These contain about 14.9% protein, 21.2% crude fiber, 14.6% fats and oils, 35.6% carbohydrate by weight. *Hibiscus* seed also contain physiologically important amino acids such as lysine, arginine, and leucine, phenylalanine, and glutamic acid. Its seed oil contains phytosterols and tocopherols, calcium, iron, and Vitamin B2, and moderate amounts of antioxidants, such as, Vitamin C, and anthocyanin. Fresh leaves contain traces of calcium, phosphorus, and iron [Table 2]. Most of these nutrients are antioxidant in nature which reduces the risk cancer and development of cardiovascular disease.[16] Gurhal seeds are used as a source of food products, lipid and protein composition and food applications of the seeds.

Hibiscus contains various photochemical compounds with high nutritional and medicinal value.[17] There are many organic acids in the Roselle drink, including citric, malic, and tartaric acid. Plant also contains hydroxycitric and *Hibiscus* acid and both have economic value. *H. sabdariffa* flowers are used for medicinal purposes and intake as dietary supplement. *Hibiscus* tea, a blend of dried *Hibiscus* flowers, leaves, and dark red sepals is a good pain soothing and anti-stress agent. Tea is known as a natural diuretic; it contains vitamin C and minerals and is often used as a mild medicine.

Table 2. Major nutritional components found in *Hibiscus* species

Nutritional value	Calyx	Seeds	Leaves
Carbohydrate (g)	10.2	25.5	8.7
Fat (g)	0.1	21.4	0.3
Protein (g)	2	28.9	3.5
Vitamin C (mg)	17	9	2.3
Calcium (mg)	150	350	240
Iron (mg)	3	9	5
Thiamine (mg)	0.05	0.1	0.2
Riboflavin (mg)	0.07	0.15	0.4
Niacin (mg)	0.06	1.5	1.4

This is used in some Arabian countries and is called karkade and is consumed as a hot and cold beverage. Tea made from *Hibiscus* calyx (flowers) is known by many names in many countries around the world and is served hot or cold. This drink is famous for its color, spiciness and flavor. In Jamaica, Trinidad, and many other Caribbean islands, this drink is called sorrel. In Philippines, vegetative parts and flowers of Gurhal are used for many dietary purposes mainly as vegetables, for coloring soups. *Hibiscus* calyces contain pectin that can be used in making jams and jelly, besides they are good sources of calcium, iron, vitamins such as niacin and riboflavin. *Hibiscus* is a large depository of nutritional components and pharmaceuticals[15,18] [Tables 1 and 2].

THERAPEUTIC USES

The flowers of *H. rosa-sinensis* are edible and are used in salads in the Pacific Islands. The flower extract is used to care hare. *Hibiscus* has been used by different societies as a remedy for several conditions. Egyptians used *Hibiscus* tea to lower body temperature, treat heart and whim-whams conditions, and as a diuretic to increase urine production. In Africa, tea was used to treat constipation, cancer, liver complaint, and cold symptoms. Pulp made from the leaves was applied to the skin to heal injuries. In Iran, drinking sour tea is still a common treatment for high blood pressure. Petals of *Hibiscus* and lime juice are used to provide unique color to beverages.

Hibiscus flowers are used to add color, tanginess, and flavor to beverage. A regular intake of three cups of *Hibiscus* tea daily for 30 days controls blood pressure in hypertensive cases very effectively.[19] *H. cannabinus* L. leaves are considered a favorable source of natural anti-obesity agents.[20]

H. sabdariffa L. phytochemicals show antimicrobial,[16] antiparasitic, and anticancer properties[21] Flower extract contains active components which display antihypertensive, antiatherosclerotics, anti-hypercholesterolaemics, antinociceptives, antipyretics, antimutagenics, antifungals, antibacterials, and chemopreventives. Plant also contains anthocyanins, polysaccharides and organic acids which are used to treat chronic and degenerative diseases.[22] *H. sabdariffa* contains angiotensin- converting enzyme inhibition activity and shows anti-hypertensive goods.[23] *H. sabdariffa*, daily intake before breakfast for 4 weeks, lower down blood pressure very fast.[24] It also balances both systolic and diastolic blood pressure.[25] *Hibiscus* tea also contains bioflavonoids, which are believed to help an increase in low-density lipoprotein (LDL) cholesterol effects of sour tea (*H. sabdariffa*) on lipid profile and lipoproteins in patients with type II diabetes.[26] Its roots are used to make colorful creations believed to cure affections similar as cough, hair loss or hair graying. The leaves and flowers are base into a fine paste with a little water, and the performing lathery paste is used as a soap plus conditioner Leaf and flower excerpt is potentially used in ornamental skin care. Its flower extract successfully absorb ultraviolet radiation.[27]

ETHNO BOTANICAL USES

Most tribal people in North-East, Chhattisgarh, Orissa, and Himachal extensively use *Hibiscus* plant parts as well as its products. In tribal villages, *Hibiscus* leaves are used to treat smaller injuries, stomachaches, and abdominal disorder. However, non-availability of such plants in close vicinity imposes restrictions on using medicinal plants. One species of *Hibiscus*, known as kenaf (*H. cannabinus*), is extensively used in paper-making. In ancient times and even today inner bark of the sea *Hibiscus* (*Hibiscus tiliaceus*), called 'hau', is *used* in making huge ropes for holding ships in dockyards.[16] The roselle (*H. sabdariffa*) is used as a vegetable. Root water extract is used as mouth washer. Fine paste of bud and root paste along with rice water is prescribed for irregular menstruation. The inner bark of the sea Hibiscus (*H. tiliaceus*), known as "hau," is used to make rope, and the wood for making canoe floats in Polynesia.

Hibiscus plant has so many potential health benefits, its fresh leaf extract is used to prevent kidney stones, it is sedative and has respiratory qualities. None of these advantageous medical outcomes are supported by clinical research as of yet. Furthermore, *Hibiscus* anthocyanins have demonstrated antioxidant efficacy in shielding rats from hepatotoxicity. A long history of use exists in Africa and the surrounding tropical nations for *Hibiscus*. Sachets and fragrances have been made from its aromatic blossoms. *H. sabdariffa* fibres are used to make stiff rope and are a good alternative of jute. The crimson, meaty calyx is used to make jellies and jams. The leaf concoction is used by tribal to treat nerve, heart ailments and to find relief in hypertension. Plant leaves are used as laxative and pain-soothing medicines. In Africa, the mucilaginous leaves are used topically as an emollient. Tribal has their own *Hibiscus*-based therapeutic preparations which are used to treat stomach ailments, fever, muscle cramps, and cancer.

BIOLOGICAL ACTIVITY

Cardioprotective

Flower extract of *H. rosa sinensis* is highly useful in cardiovascular problems. Continuous use of *H. sabdariffa* leaf extract cut down triglyceride, cholesterol, and low-viscosity lipoprotein. It supports high cholesterol sequestration from fat depots.[28] *H. sabdariffa* tea also restores lipid profile in patients suffering from cardiovascular problems and type II diabetes.[29] *H. sabdariffa* seeds are rich in phytosterol and tocopherol, and are good antioxidant than sunflower oil.[30] These lowers down LDL cholesterol [Table 1].[31] The aqueous paste of flowers and leaves is highly beneficial in stomach ailments, high blood pressure, bacterial infections,

and fever.[32] Dried pulverized flowers of *H. rosa sinensis* augments endogenous antioxidant compounds in rat heart and also prevents the isoproterenol induced myocardial injury.[33]. It assists in healing of myocardial ischemic reperfusion injury due to high antioxidant effects [Table 1].[34]

ANTI-AGING AGENTS

Hibiscus contains gentle acids that remove black spots and darkness of skin. It also possesses phenolic compounds which can be used for skin cosmetic purposes [Table 1]. Presence of acids and phenolic compounds shows little exfoliating effect on the skin and make skin glowing, fresh, smoother and fair complexion. Flower and leaf aqueous paste inhibit the activity of the enzyme elastase, which is responsible for breaking down our skin's precious elastin, *Hibiscus* helps to slow the visible signs of aging by firming and lifting your skin. *H. roseus* contain bioactive phenolic compounds catechin, epicatechin, kaempferol-3-*O*-rutinoside, kaempferol-3-*O*-glucoside, kaempferol-7-*O*-glucoside, tiliroside, oenin, and peonidin-3-*O*-glucoside. Most of them are tested as anti-aging agents in skin-care cosmetics.[35] Leaves and flowers of *Hibiscus roseus*. In addition, plants are also sources of natural moisturizers, flavorings, and pigments, which make them very interesting for skin cosmetic applications.[36] The noticeable antioxidant activity of phenolics is also partially responsible for their anti-aging effects, which are possibly due to their ability to reduce collagen degradation and in provide UV protection.[37] These natural phenolic-rich extracts show high antioxidant capacity and glowing effect on the skin.[38]

CHEMOPREVENTIVE EFFECTS

Aqueous extracts of dried flowers of *H. sabdariffa* L., (HSE) are rich in phenolic acids, flavonoids, and anthocyanins. It also contains polyphenols possess anti-oxidative and antitumor-promoting effects.[39] These potentially cut down tumor growth and work actively against human gastric carcinoma cells through apoptosis induction and JNK/p38 MAPK signaling activation.[40] This effect of *Hibiscus* extract in AGS cells might be mediated via p53 signaling and p38 MAPK/FasL cascade pathway. It also leads to as an increase in the phosphorylation of p53 and the usage of a specific p38 inhibitor, SB203580.[40] Dried flowers of *Hibiscus* are also used in folk medicines for treatment of hypertension, inflammation caused due to tumor progression [Table 1].[41]

ANTI-INFLAMMATORY AND HYPERTENSION

H. sabdariffa flower aqueous contains rich in phenolic acids, flavonoids, and anthocyanins which effectively work against atherosclerosis, liver disease, cancer, diabetes, and other metabolic syndromes. *H. sabdariffa* Linn is used to make folk medicines for the treatment of hypertension, and inflammatory conditions.[41] *Hibiscus* herbal tea cut down blood pressure and is used in treatment of hypertension [Table 1].

ANTIDEPRESSANT ACTIVITY

H. syriacus root bark extract significantly cut down the depression-like behavior by activating the CREB/BDNF signaling pathway. It helps to remove out depression induced by restraint stress.[42] Similarly, crude ethanolic extract of floral part of *H. rosa sinensis* (HRS) showed antidepressant effect at 100–500 mg/kg in forced induced swimming test, tail suspension test.[43] *H. rosa-sinensis* flower contain flavonoids and anthocyanidins[44] which are responsible for show anti-depressant-like effects [Table 1].

ANTI-DYSLIPIDEMIC ACTIVITY

H. rosa sinensis (*Malvaceae*) root extract showed anti-oxidant activity in alloxan induced diabetic rats. Root extract also causes significant decrease in the levels of blood glucose, plasma lipids and reactivated post heparin lipoprotein lipase activity. It inhibited the generation of super oxide anions and hydroxyl radicals, in both enzymic and non enzymic systems *in vitro*[46]. Similar antioxidant activity was reported by Pooja *et al.*, 2009[47] in leaves of *H. sabdariffa in vitro*. It shows inhibitory activity on lipid peroxidation. Ethanolic extract of *H. sabdariffa* calyces showed high antioxidant activity than aqueous extract of leaves.[48] *H. rosa-sinesis* leaf extract provides relief in hyperlipidemic condition in experimental animals. It reduces production of reactive oxygen species which are key factors of initiation of atherosclerosis and the development of cardiovascular diseases [Table 1].[49]

ANTILIPIDEMIC AND ANTIHYPEGLYCEMIC

Ethanol flower extract of *H. rosa sinensis* cut down blood glucose (41–46%) and insulin level (14%) after 21 days in experimental animals. It significantly lowers down the total cholesterol and serum triglycerides by 22% and 30%, respectively. It supports rise in HDL-cholesterol by (12%) than that of glibenclamide (1%). *Hibiscus* extract shows hypoglycemic activity more than that of glibenclamide but is not mediated through insulin release.[50] But it is fail to show significant effect in streptozotocin diabetic while glibenclamide significantly lowered the glucose level up to 7 h.[51] *H. rosa sinensis* alcoholic leaf extracts cut down glucose level by 39% in glucose induced hypoglycemic rats. It happens because of enhanced secretion of insulin and an increased utilization of glucose, due to direct stimulation of glucose uptake.[52] *H. rosa-sinensis* ethanolic leaf extract cut down in blood glucose levels in experimental animals [Table 1].[53]

ANTI-FERTILITY AND CONTRACEPTIVE EFFECTS

H. sabdariffa possess bio-organics which show blocks muscle tone and stimulate contraction of the rat bladder and uterus.[2] *H. rosa-sinensis*, shows anti-fertility effects in and show strong contraceptive action and affects estrogen activity in rats.[54] More specifically, *H. rosa-sinensis* stimulate menustration in human females but it's overdose also break pregnancy (abortion).[55,56] It may possible as decreased levels of plasma progesterone and act as anti-pregnancy agent.[57,58] *Hibiscus* is also used to reduce menstrual cramps, assist in childbirth and relieve headache, fever, and inflammation.[59] Benzene extract of flower inhibits implantation in mouse.[60,61] Flowers of *H. rosa sinensis*, are potential used for contragestive purposes for family planning and birth control in the North-Eastern states of India [Table 1].[62] In mouse, *Hibiscus rosa-senensis* flowers benzene extract exhibited antiestrogenic activity.[62] It also shows antiovulatory effects and irregular estrous cycle with prolonged estrus and metestrus.[63] *H. rosa sinensis* ethanolic extract of the roots shows anti-fertility and estrogenic activity.[55] It also cut down spermatogenic elements of testis and epididymal sperm count.[63] It also effect oestrous cycle and reproductive organs of male rats.[63,64] *H. rosa sinensis* slow down spermatogenesis and activity of accessory reproductive organs in rats.[66,67] It significantly cut down sperm formation and increase the infertility in male rats [Table 1].[68,69] Aqueous extracts of Hibiscus macranthus affect testis function in male rat.[70] Similarly, leaf extracts of *Hibiscus rosa sinensis* to effect on the gonadotrophin hormone level which regulate the activity of the androgens in relation to spermatogenesis.[71]

ANTIOXIDANT ACTIVITY

H. rosa-sinensis Linn leaf contains polysaccharides which showed strong antioxidant activity.[72] Its flower also showed antioxidant activity.[73] AEs *H. rosa-sinensis* (petal) and *H. sabdariffa* (calyx) contain anthocyanin which also showed antioxidant and DNA protective activity. This high antioxidant is due to presence higher amounts of total phenolic content and total anthocyanin contens in extracts [Table 1].[74]

ANTICARCINOGENIC ACTIVITY

H. rosa sinensis extract cut down hyperproliferation and oxidative damage caused by benzoyl peroxide and ultraviolet radiations in mouse skin.[75] Its crude extract exerts a protective effect against the tumor development. This anti-tumor potential is due to the presence of gentisic acid. *H. rosa sinensis* extract on 7,12-dimethyl benz(a)anthracene (DMBA)/croton oil-mediated carcinogenesis in mouse skin through 12-O-tetradecanoyl phorbol-13-acetate (TPA)-induced tumor promotion response and oxidative stress. It also causes significant reduction in MDA formation and H_2O_2 content ($P<0.05$) at both doses [Table 1].[76]

WOUND HEALING

H. rosa sinensis and *Hibiscus hirtus* ethanolic extracts promote wound healing through reduction in contraction, period of epithelialization, tensile strength (skin-breaking strength), granulation tissue weight, and hydroxyproline content.[76,77] It significantly increased dry and wet weight of granulation tissue and hydroxyproline content in test animals than controls [Table 1].

ANTIMICROBIAL ACTIVITY

H. rosa-sinensis extracts showed strong antimicrobial potential *Streptococcus mutans* and *Lactobacillus acidophilus*. *H. rosa-sinensis* (25 µg/ml) extracts were found to have antimicrobial activity against *S. mutans* and *L. acidophilus* with MIC values of 6.25 µg/ml and 25 µg/ml respectively.[78] Similarly, Crude, phenolic-rich extracts (CPREs) of *H. sabdariffa,* showed strong antimicrobial potential against *Aspergillus ochraceus* EMCC516. In treatments a dose of 100 µg/mL of HCPRE showed irregular cell organelles and cell vacuolation.[79] Similar activity is reported in *H. rosa-sinensis* flower extract against human pathogens [Table 1].[80]

Hydroalcoholic extract of *H. rosa sinensis* Linn assists in prevention of experimental colitis in rats.[81] *H. rosa sinensis* were found active against methicillin-resistant *Staphylococcus aureus* (MRSA), *S. aureus*, *Escherichia coli*, *Pseudomonas aeruginosa,* and *Klebsiella pneumonia*. Its petroleum ether extract from flowers at concentrations of 4 mg/disc and 2 mg/disc displayed the strongest inhibition zones of 18.6 ± 2.85 mm and 18.5 ± 0.29 mm, respectively, as compared to vancomycin (30 µg/ml).[59] *H. rosa-sinensis* was also found capable of inhibiting human pathogenic fungi.[82,83] *H. sabdariffa* L. calyces extract shows activity against hospital isolates of multidrug-resistant *Acinetobacter baumannii*. *H. sabdariffa* (Hs) extract shows anti-microbial activity; against *C. albicans* pre-formed biofilm at 3.125 mg/ml and was able to inhibit the hyphae initiation and adherence of cells. It also reduces the *C. albicans* load and cut down viable colony count and effectively increasing the lifespan of worms [Table 1].[83]

ANTI-VIRUS

Aqueous extract of *H. sabdariffa* (AEHS) and its bioactive constituent protocatechuic acid, showed antiviral effects against HSV-2 clinical isolates and anti-enzymatic activity against urease.[84] It cut down reduction in HSV-2 infection and found successful against urease-producing bacteria [Table 1].[84]

ANTI-PARASITIC

Methanolic extract of leaves of *Hibiscus mutabilis* (Malvaceae) showed anti-worm activity against bovine *Setaria cervi* worms. It contains ferulic acid that showed significant microfilaricidal activities against the microfilaria (L(1)) and adult of *S. cervi.* Ferulic acid causes an increased proapoptotic gene expression and decreased expression of anti-apoptotic genes simultaneously with an elevated level of ROS and gradual dose-dependent decline of parasitic GSH level [Table 1].[85] *H. syriacus* ethanol extracts showed acaricidal efficacy against *Ornithonyssus sylviarum*.[86] Similarly, methanol extract of *H. rosa-sinensis* L. (Malvaceae) shows anticestodal effects of leaf against *Hymenolepis diminuta* (Rudolphi, 1819), a zoonotic tapeworm. *H. rosa-sinesis* leaf extract shows anticestodal effect against *H. diminuta*, indicating and help to control intestinal helminthic infections.[87] *H. sabdariffa* ethanolic kill ciliate parasite *Philasterides dicentrarchi*, and successfully inhibits the parasite population growth rate, proliferation, cellular defense mechanisms, and reduces pathogenicity.[88]

INSECTICIDAL ACTIVITY

Extracts of *Hibiscus* species are larvicidal in nature and found active against *Culex quinenfasciatus* Say.[89] *H. rosa-sinensis* Linn water extract shows larvicidal potential against second and fourth-instar larvae mosquito *Culex quinquefasciatus* Say. *C. quinquefasciatus* is vector of lymphatic filariasis. *H. rosa-sinensis* plant was found active aphid infestations primarily melon aphids, *Aphis gossypii* Clover.[90] *H. rosa-sinensis* L was found effective against mealybug, *Paracoccus marginatus*.[91] It reduces the longevity of female mealybug, *Maconellicoccus hirsutus* (Green), reduced from 28°C at 20°C to 19–21° at 25–30°C [Table 1].[92]

CONCLUSION

Hibiscus genus contains vast floral, chemical, and molecular diversity having therapeutically important bio-organics. Due to the presence of these bio-organic constituents, *Hibiscus* plants display much wider therapeutic effects and multiple biological efficacies such as antifertility, antiestrogenic, anti-implantation abortifacient, anti-ovulatory, anti-inflammatory, anticonvulsant, antioxidant, antispasmodic, anthelmintic, anti–hyperglycemic, contraceptive, CNS depressing, diuretic, depurative, emmenagogue and it effectively lowers blood pressure. Cardio-protective, hypotensive antidiabetic, anticonvulsants and antioxidant activity. Plant contains anthocyanin and anthraquinone pigments which are prominent anti-oxidants. These natural pigments are used to add unique color to beverages, ice-creams, and other processed food items. Its soft flower extracts contain phenolic compounds and pigments which are used in the preparation of skin-care cosmetics and anti-aging molecules. Its phenolic compounds display great antioxidant and anti-aging properties and show inhibition of dermal enzymes (e.g., collagenase) check effects of UV radiation. Plant components showed anti-cancer, antidepressant activity, antimicrobial, antioxidant, anti-lipidemic anxiolytic, and mucolytic activity. Besides benefits plants also show negative effects. It reduces fertility in both males and females, sperm production in males, it reduces ovulation, prevents implantation, and causes miscarriage.

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