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Hibiscus Rosa Sinensis Linn.: A phytochemical and pharmacological review

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***Abstract*---**Hibiscus Rosa Sinensis Linn. (Malvaceae) is a popular medicinal plant found in tropical and sub-tropical region of world. All plant parts of Hibiscus Rosa Sinensis Linn are most widely used to treat several ailments like anti-Tumor, anti-fertility, anti-ovultory, anti-implantation, anti-Inflammatory, analgesic, anti-estrogenic, anti-pyretic, anti-spasmodic, anti-viral, anti-fungal, anti-bacterial, hypoglycemic, spasmolytic, CNS depressant, hypertensive and juvenoid Activity. Due to its multidimensional pharmacological approach it is certain to emerge as a effficient player in the flourising field of herbal supplements, medicines and health care system. This review aims to present recent details on botany, ethnomedicinal uses, photochemistry, pharmacological effects, toxic effects, with the purpose to find research gaps demanding for upcoming research and investigation of Hibiscus Rosa Sinensis Linn. Principal constituents reported in Hibiscus Rosa Sinensis Linn are flavones, containing quercetin-3-sophorotrioside, kaempferol-3xylosylglucoside,quercetin-3-diglucoside, quercetin-3,7-diglucoside, cyaniding-3,5-diglucoside,

cyaniding-3-sophoroside-5-glucoside and other constituent are cyanidin chloride, cyclopeptide alkaloid, ascorbic acid, riboflavin, thiamine, hentriacontane, taraxeryl acetate, ß-sitosterol, malvalic acids and cyclic acids sterculic. Complete literature was probed via websites,online databases, thesis and texts. The available reports was portray physicochemical parameters, nutritional aspects and phytochemical analysis of bioactive plant parts. Friendly holistic conservation approaches offered by plant biotechnology applications are also discussed. Nonetheless, further studies are needed to propose the mechanistic role of crude extracts and other bioactives, and even to explore the structure–function relationship of active components.

***Keywords*---**hibiscus rosa sinensis linn, phytoconstituent, ethnomedicinal, traditional medicine, pharmacology.

Introduction

A conspicuous evergreen shrub geographically found in the Middle East and Eastern Asia named China rose, the red flower also called *Hibiscus Rosa Sinensis* of Hibisceae tribe and family Malvaceae.[1] Plant species of *H. rosa-sinensis Linn are native to* China and India and are a potent medicinal plant (used as traditional medicine "Zhujin" in china). Specifically, this plant is familiar with a wide range of names, like "Japa" or_Japapushp, Arkapriya" in Sanskrit, "Shoe flower" in English, "Jasund" in Hindi, "Angharee-hind" in Persian, and "Wadamal" in Sinhalese. The taxonomic classification of *Hibiscus Rosa Sinensis is* Plantae-Kingdom, Magnoliopsida-Class, Spermatophyta- Phylum, Angiospermae-Subphylum, Malvales- Order, Malvaceae- Family, Hibiscus-Genus, and Rosa Sinensis- Species. The whole part of this plant has immense nutritional and therapeutic importance. The flowers are rich in anthocyanin. *Hibiscus Rosa Sinensis* flowers can be consumed fresh or rustle up in some regions, used as an alternative for spinach, with edible roots, lacks very much flavor, made into a kind of pickle and are mucilaginous & fibrous or employed as a dye for imparting color to conserved fruits and rustle up vegetables.[2,3] Hibiscus herb is utilized in Ayurvedic medicine for the treatment of inflamed and/or damaged tissue, wound healing, cold and to regenerate the integument. Exposures to temperatures >11°C bring about severe leaf damage, decreased growth rate, and death of plant.[4] with the frost tolerant Lavatera Thuringia, Improvement of *Hibiscus rosa-sinensis* was achieved by somatic hybridization, for increased frost tolerance as conservation approaches to reduce the disappearance of this important species.[5,6]

Table 1
Ayurvedic plant formulations along with their manufacturers and uses

Formulations	Use	Manufacturer
Hair Oil	Prevent premature greying of hair and stimulates hair growth	Dhee Ayurved
Hair Gel	Hair Conditioner	Dr. Jain's Forest Herbals Pvt. Ltd
Moisturizer	Hibiscus flower extract is rich in	Serendipite

Hibiscus Rose	both amino acids and antioxidants, giving a more lifted, youthful look and feel.	Organiques
Handmade Hibiscus Soap	Perfect formulation for dry skin to moisturize.	Vatu Healthcare
Dead sea essentials by hibiscus hand cream	Hand Cream	AHAVA Hydrating
Coconut Hibiscus	Fragrance mist for women	Bodycology
Hibiscus Flower Extract	• Supports healthy blood pressure • supports healthy weight management • supports healthy cholesterol levels	Nusapure
Herbal Tisane Hibiscus Immunity tea	A pure herbal blend based upon a unique formulation to help increase overall immunity and general well-being	*Blessed Tea & Tisane*

Recently, its countless ethnomedicinal uses lead the way, for researchers to explore *Hibiscus Rosa Sinensis* Phytochemistry further.[7] *Hibiscus Rosa Sinensis, Hibiscus cannabinus. Linn* and *Hibiscus sabdariffa. L.,* species are a significant source of trade fiber, while certain species of the plant are used in diet and others have therapeutic properties. There were a few others such as *H. tiliaceous, H. microanthus, H. asper,* and *H. acetosella*. underlining the medicinal potential of the Hibiscus plant because of its unique blend of phytochemicals.[8] Many species of Hibiscus are considered to be ornamental and are cultivated in gardens. In Ayurveda, fruits of *Hibiscus Eesculentus. L.* is regarded as a tonic, astringent, and aphrodisiac. The bioactive compounds found in crude plant extracts make it suitable for a broad range of medicinal properties like anti-diabetic, anti-proliferative, anti-inflammatory, anti-obesity, nephroprotective, anti-ulcer, hepatoprotective, hypersensitive, and hypolipidemic.[9] Indubitably, the existence of apparent biologically active compounds like tannins, flavonoids, saponins, carbohydrates, steroids, phenols, glycosides, quinones,terpenoids, cyclopeptide alkaloids, vitamins and flavonoids, has been increasingly reported with enormous prospective in modern therapeutic uses. Hereof, this review explores the pertinent data on biological elucidation, Phytochemistry, ethnomedicinal uses, pharmacological activity, antioxidant activities and pernicious, in addition to the preservation of *Hibiscus Rosa Sinensis*. Its crucial aspects to prevent various diseases and to promote health, as a natural anti-oxidant source, have been also praised.

Research Methodology

For this review, an appropriate research methodology is opted for the selection of articles is set forth below in Figure 1.

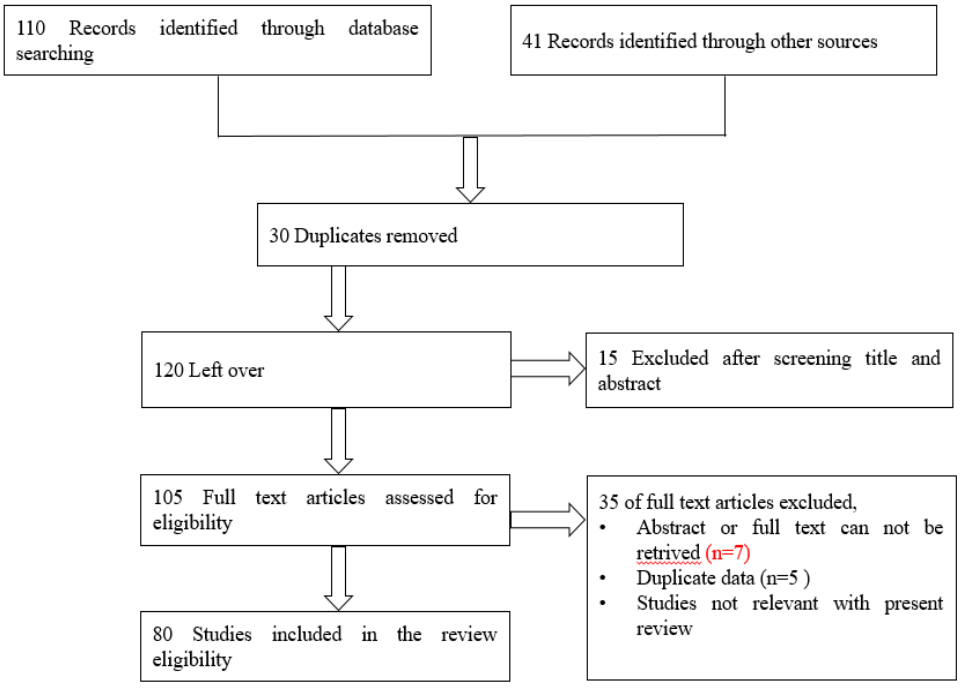

Figure 1. Flow diagram of research methodology

Botanical Description

Habitat

A perennial, evergreen shrub, Hibiscus rosa-sinensis, is widely disseminated in tropical and sub-tropical regions. The plant is native to China, India, Burma, Philippines, Florida, California, and Hawaii. This species is additionally found in Kuwait and was scrutinized to color camel wool for extraction of the red dye permanently. In the Brazilian landscape it is engrossed both as small trees and as shrubs.

Microscopic and Morphological Characteristics

Morphological characteristics of the plant Hibiscus Rosa-sinensis and its parts (Figure 3a–c) depict it as an evergreen, short size perennial shrub of height 1-3m. It has medium textured oval, lobed glossy dark green leaves of width 4–6 inches and length up to 8 inches. It has short red-colored, showy flowers of size 5-5.5cm. The leaf has a biconvex transverse section and revealed that the lower and upper epidermis is covered with a cuticle, having glandular and non-glandular trachoma containing polygonal cells. Dorsi-ventral structure of lamina having upper palisade in one row is being discontinuous in the central rib region and is showing cortical tissues, a large central collateral vascular bundle and sub-

epidermal collenchymas, on both of the surfaces. Mesophyll, as well as cortical tissue, contains scattered cluster crystals of secretory glands, calcium oxalate and in the parenchymatous tissues, mucilage cells are also present, with anisocytic type stomata. A horizontal segment of petal showed that homogenous mesophyll is enclosed in the outer and inner epidermis, traversed by small collateral vascular bundles is the parenchymatous cortex, almost rounded, alternating with large mucilage cavities with thin-walled parenchymatous cells having small intercellular space and the homogenous mesophyll made of thin wall and narrow intercellular space having almost rounded parenchymatous cells.

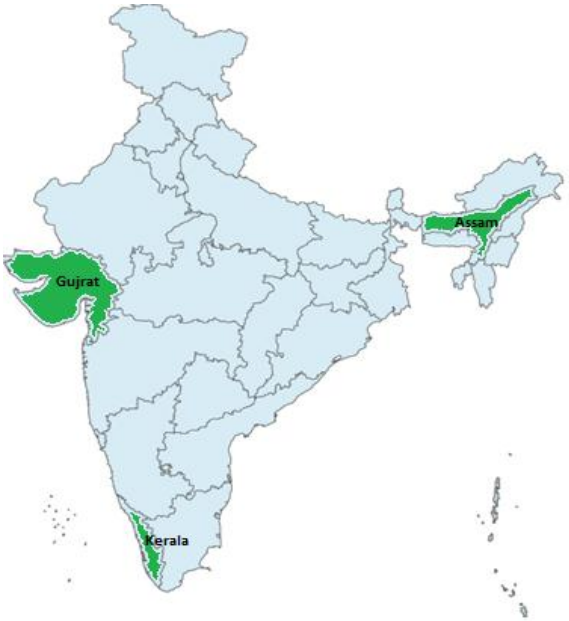

Figure 2. Natural distribution of *Hibiscus Rosa-Sinensis*. The shaded area indicates natural habitat of *Hibiscus Rosa-Sinensis* in India

(a) (b)

(c)

Figure 3. Hibiscus rosa-sinensis (a) Whole plant; (b) Flower; (c) Leaf

Ethnomedicinal Uses

Due to the wide range of medicinal uses of its leaves and flowers, Hibiscus rosa sinensis, a traditional herbal plant, is utilized by various indigenous inhabitants groups in numerous ways. [10]

Table 2
Ethnomedicinal uses of Hibiscus rosa sinensis

Plant Part Used	Extraction process	Uses	Country
Flower	Decoction	regulate the menstrual cycle	Bangladesh
Flowers	Hot water extract	as a tonic and Emmenagogue orally	China
Bark	Hot water extract	orally as an Emmenagogue	China
dried leaves and flowers	Hot water extract	used for sick infants	Cook Islands
Leaves or Flowers, with or without Gardenia taitensis leaves,	Fried or boiled in coconut cream	used as a massage or taken internally	Cook Islands
dried leaves and flowers	Hot water extract	Gonorrhea	Cook Islands
dried leaves and flowers	Infusion	Abortifacient	Cook Islands
Flower	Hot water extract	to produce abortion and regulate menstruation	East indies
Juice of leaves, in combination with Vernonia cinerea	Hot water extract	midwives administer it orally to stimulate expulsion of afterbirth	East indies
Fresh leaf juice	-	enhance childbirth and for diarrhea	Fiji
flowers and	Hot water extract	ease childbirth	Fiji

leaves			
dried flowers	Infusion	aid digestion	Fiji
Flowers	Hot water extract	Grippe	French Guiana
Peeled twig			Ghana
Flowers	Hot water extract	Sodorific and Anti-Tussive (by boiling unopened flowers, Syrup is made and administered orally with sugar)	Guadeloupe
Leaf		to promote abscesses draining	Guam
dried flowers	Decoction	flu and cough	Haiti
dried leaves	Decoction	Orally for stomach pain, flu and cough	Haiti
macerated leaves	macerated leaves in a bath for the head	eye problems	Haiti
Flowers	Eaten	to produce lactation	Hawaii
Flowers		to cause abortion, regulate menstruation and used as an Emmenagogue	Indonesia
Leaves	Juice	taken orally by women in labor	Indonesia
fresh leaf	Decoction	oral Antidiarrhoeal	Japan
Flower	Orally	Used as an Emmenagogue in females and as an aphrodisiac in males	Kuwait
Roots	Hot water extract	venereal diseases and administered orally for fevers	Malaysia
Flowers	Hot water extract Infusion	Expectorant	Malaysia
Bark	Extract of Water	Administered orally as Emmenagogue	Malaysia
Leaves, flowers, or bark	Infusions	orally administered for the treatment of dysentery	Mexico
Roots	Hot-water extract	administered orally for cough	Nepal
Flowers	Dried Powder	to accelerate parturition taken intravaginally, during labor pains, 2-4 teaspoonfuls are given	Nepal
Flowers	Hot water extract	regulate menstruation, administered orally	New Britain (East)
Flowers	Hot-water extract Decoction	Administered orally as abortifacient and as an Emmenagogue	New Caledonia
Fresh leaves and flowers	Water extract	Used to induce labor, given orally	Northern Ireland
young leaves	soaked in coconut	the solution is administered	Northern

and Flowers	water	orally in the Northern Provinces to induce labor	Ireland
Flowers	Hot-water extract of flowers and soaked the Leaves for several hours in coconut juice	Administered orally to get relief from labor pain	Papau-New Guinea
dried flowers	Hot water extract	Used as an oral contraceptive in males and as an Emmenagogue in females	Peru
dried stems	Hot water extract	Used as oral contraceptive and Emmenagogue	Peru
Fresh flowers	water extract Bruised,	administered orally for a sodorific effect in bronchial catarrh and applied to inflammations and tumors	Philippines
Root, bark and flower	Hot water extracts	external emollients	Philippines
flowerbed	Paste	applied on the skin of cancerous swellings	Philippines
Hibiscus Leaves along with leaves of Vernonia cinerea,	juice	stimulate expulsion of the afterbirth	Philippines
Hibiscus Leaf along with Vernonia cinerea leaves,	hot water Extract	applied as an emollient externally	Philippines
fresh leaves	Decoction	Administered orally to regulate irregular menstrual periods in women	Rarotonga
fresh flower	Infusion	Given as an abortifacient orally	Rarotonga
flowers and leaves	Extract of hot-water	Administered orally to ease childbirth	Samoa
fresh flowers and leaves	Water extract	induce labor	Samoa
Leaves	eaten as spinach and cooked	Food	Matabeleland and Nyasaland in South Africa
flowers	Decoction and infusion	Amenorrhea	Trinidad
petals	Decoction	To treat amenorrhea and administered orally to induce abortion	Vanuata
leaves	Decoction	Administered orally for the treatment of hemorrhage of the uterus	Vanuata
Eight leaves	squeezed and boiled	Administered orally during	Vanuata

	with water for a few minutes	menstruation. Repeat the treatment during the following menstrual cycle.	
Bark, stem	Decoction	Menorrhagia.	Vanuata
Grate a handful of bark	Cool the Decoction and take not more than 2 or 3 doses.		Vanuata
leaves	Infusion	For the treatment of menorrhagia, administered orally	Vanuata
Flowers	taken orally	Dysmenorrhea and as an abortive	Vietnam
bark	Extract of Water	Administered orally as an Emmenagogue	Vietnam
dried flowers	Hot-water extract Decoction	Administered orally for abortion, contraceptive in Ayurvedic medicine. and as an anti-fertility agent, Female patients administer the sexual parts of flowers that are pistil and stamens. One dose is made up of 4-5 flowers, and at intervals of 5-6 hours, 2-3 doses are taken daily)	India
Dry bud	Eaten	treat diabetes (A mature bud (unopened flower) is chewed and consumed daily, initially for 10 days before taking meals early in the morning, or till the blood sugar level falls below the tolerance limit.)	India
Leaves and Flowers	Consumed orally	Treat painful bowel motion and constipation. Flowers and leaves along with water are broken down to form a mucilaginous juice and filter. Before going to bed, consume a half cup of filtrate daily)	India
Flower	hot water Extract	Consumed orally an emmenagogue and for the treatment of menorrhagia and bronchitis	India
Flowers	“Jaggary” along with decoction	Treatment of menarcheHRo34 and used as a contraceptive	India
Leaves	Extract of hot water	Used as anodyne, aperients, laxative and to ejaculate the placenta post parturition	India
In addition	Juice	Emollient	India

with Veronia cineria juice, Externally			
Root	Juice	Abortifacient	India
Root juices 5ml each of Plumbago rosea and *Hibiscus Rosa Sinensis*	Juice	Consumed before meal, along with red-colored brain of a locally known as Magur, a fresh water fish species	India
Root	Hot water extract	Consumed orally for coughs and as a demulcent	India
fleshy red calyx		For preparing jam, jellies and cold and warm teas and drinks	India
Roselle juice	Juice	to quench thirst.	Thailand

Nutritional and Physiochemical Analysis

Various nutritional and physicochemical parameters of *Hibiscus Rosa-Sinensis* were studied and are described in Tables 3 and 4.[11,12]

Table 3
Physio-chemical analysis of various parts of *Hibiscus Rosa- Sinensis*

Parameter	Leaves	Flower	Root	References
Extractive value Chloroform-soluble extract (%) Water-soluble extract (%) Ethanol-soluble extract (%) Petroleum ether-soluble extract (%)	 NR 36 9.6	 NR 33.6 18.4	 2.80 5.30 2.60 1.45	[13,14]
Total ash (%) LOD (%) Acid–insoluble ash (%)(leaves & flower) Water-soluble ash (%) Sulphated-ash (%) Moisture (%)	14 86 5.5 1.5 9 2.63	5.5 78 2 1.5 13 83.00	7.75 0.53 0.75 6.32	[13,14]
Total phenolic contents (mg Gallic acid equivalent /100g)	301 ± 21	735±46	NR	[13]
Antioxidant capacity equivalent to Ascorbic acid (mg ascorbic acid /100g)	96 ± 35	640 ± 56	NR	[13]

Table 4. Mineral analyses of *Hibiscus Rosa- Sinensis*

Minerals (mg/g)	Flower	Leaves	Powder	Reference
Fiber (g)	1.50 0.35	3.99%	15.7	
Fat (g)	1.54	69.7	3.9	
Protein (g)	13.71	7.01%	3.9	
Carbohydrate (g/100g)	54.02	31.66	86.3	14, 15,16,17,18
Beta carotene (µg)	7.502 4.32		3.9	
Vitamin C (mg)	236.45	772.57mg/g-1	39	
Calcium (mg)	1.48	181.00 mg/g-1		
Potassium (mg)	0.82		1.7	
Iron (mg)				
Zinc (mg)	0.4113%	0.38mg/g-1		
Sodium		520mg	265	
Phosphorous				

Phytochemistry

Phytochemical screening of flowers, stems, roots and leaves of hibiscus rosa-sinensis confirmed the presence of several active phytoconstituent like saponins, flavonoids, phlorotannins, terpenoids, glycosides, along with compounds like riboflavin, thiamine, niacin, Phytosterols, Terpenoids, tannins, and phenolic compounds. These phytoconstituents possess a wide variety of pharmacological effects. [19]

Phenolic compounds

Ten polyphenolic compounds extracted from methanolic extract of shade-dried flower, *p*-hydroxybenzoic acid, quercetin-7- *O*-galactoside, neochlorogenic acid, vitexin, apigenin, Gallic acid**,** quercetin, kaempferol along with newer active compounds, scutellarein-6-*O*-*a*- L-rhamnopyranoside-8-*C*-*β*-D-glucopyranoside and kaempferol-7-*O*-[6'''-*O*-*p*-hydroxybenzoyl-*β*- D-glucosyl-(1-6)-*β*-D-glucopyranoside].

Flavonoids

Quercetin, myricetin, rutin, and kaempferol are the four flavonoids reported in the flower of *Hibiscus Rosa Sinensis*.

Essential oils

Researchers have reported that fresh flowers of *Hibiscus Rosa Sinensis* contained 1 – iodoundecane (50.568%), essential oils v/w (0.30-0.50 %), 2, 2, 4-trimethyl 3-pentanone (1.556%), 2-cyclopentylethanol (2.404%),1,2-benzene dicarboxylic acid isodecyl octyl ester (11.056%), neopentane (7.641%), 2-propenamide (1.543%), 2-

propeonic acid, 1-tetrazol-2-ylethanone (3.993%), 1-4 butanediyl ester (1.543%), amylnitrite (3.993%) and 4- trifluoroacetoxyoctane (1.480%) [13]

Proanthocyanidins and anthocyanins

Flowers of Hibiscus rosa-sinensis contain substantial quantities of proanthocyanidins and anthocyanins. Vitamins, cyclopeptide alkaloids, niacin, thiamine, ascorbic acid and riboflavin were isolated from the flowers. Magenta and Crushed red flower varieties yield dark purplish dye, cyandin diglucoside and anthocyanin pigment.

Metals

Atomic absorption spectrophotometer depicts the presence of metal in the decoction of *Hibiscus Rosa Sinensis* leaves, including Potassium 612.9 - 787.2, sodium 129.6 - 344.2, Magnesium 574.8 - 877.9, Zinc 1.32 - 1.92, Iron 1.16 - 2.53, Cobalt 1.25 - 1.68, Calcium 748.3 -907.5, Copper 0.107 - 0.129, Manganese 0.147 - 0.188, Chromium 0.142 - 0.164, Nickel 0.244 - 0.496, Cadmium 0.058 - 0.064, Aluminum 0.299 - 0.472, , Barium 1.67 - 2.45 and Lead 0.087 - 0.122mg/100g. Stem bark contain 9-decynoic acid, 8-Nonynoic acid and their methyl esters. Carotene, p-sitosterol and taraxeryl acetate were also isolated from the stem bark and leaves of the plant. The edible flower encompasses nitrogen, moisture, fat, iron, crude fiber, calcium and phosphorus. Additionally, fatty alcohols, fatty acids, leaves and hydrocarbons also hold around 7.34mg per100 g of carotene, catalase, mucilage and gentisic acid. Contrarily, Root barks contain cyclopropenoids. Even though the stems, leaves and flowers hold a little number of cyanidin chlorides and cyanin, quercetin is isolated from the whole plant part. Nonetheless, teraxeryl acetate, malvalic acids and ß-sitosterol are also reported only in leaves and stems.

GC-MS interpretations indicated that methanolic extracts of flowers of *Hibiscus Rosa Sinensis* contain various components including ethyl ester, Ethanimidic acid, Propanal, 2,3dihydroxy, N-ethyl-, Ethylenediamine, Propanamide, Ethene, ethoxy-, O-Methylisourea hydrogen sulfate, Hexadecanoic acid, 7-Formylbicyclo(4.1.0) heptanes, methyl ester, N-Formyl-β-alanine, (Z)6,(Z)9-Pentadecadien-1-ol, Butanedial, 1-Propanol, 2-methyl- Methane carbothiolic acid, 2-Butanamine, (S)-, 1,3,5-Triazine-2,4,6-triamine, have been shown to possess antioxidant, pesticide, anticancer, dermatitigenic, anemiagenic and hypocholesterolemic properties. Additionally, Ethylenediamine, Propanal, 2,3-dihydroxy, 2-Butanamine, (S), (Z) 6,(Z) 9-Pentadecadien-1-ol, 1-Propanol, 2-methyl- and o-Methylisourea hydrogen sulfate have been known to possess antimicrobial and antioxidant activities. the Flowers of *Hibiscus rosa-sinensis* possess cyanidin-3-sophoroside, eco-friendly, Non-carcinogenic and biodegradable pigment, also used as an indicator for various acid-base titrations.[20]

Essential oil

A handful of bioactive constituents can be isolated from essential oil via the hydrodistillation extraction method of *Hibiscus Rosa Sinensis*. Acetylenic fatty

acid and a monounsaturated fatty acid is 2-octanoic acid, used in a number of food flavoring lipstick and perfumes. Studies revealed that 2-octanoic acid inhibited hepatitis C virus, thus acting as a potent medicinal agent to treat chronic hepatitis C. Biologically active sesquiterpene alcohol '[2,2-Dimethyl-4-(3-methylbut-2-enyl)-6-methylidenecyclohexyl]methanol' was detected in several plants. Antimicrobial activity of a plasticizer compound found in the plant extract '2-(2-ethylhexoxycarbonyl) benzoic' was reported and may lead to antiproliferative and antioxidant properties.[21]

Flavonoids and Anthocyanins- cyanidin-3,5-diglucoside, cyanidin-3-sophoroside-5-glucoside, quercetin-3- diglucoside and quercetin-3,7-diglucoside, are the major constituents reported in hibiscus rosa-sinensis. However, other compounds such as quercetin, hentriacontane, cyclopeptide alkaloid cyanidin chloride and vitamins including thiamine, ascorbic acid and riboflavin were also reported. β-sitosterol, stigmasterol, three cyclopropane, and taraxeryl acetate compounds with their derivatives were identified in the stems and leaves, whereas, flavonoids, cyanidin diglucoside, and vitamins- ascorbic acid, thiamine, niacin and riboflavin, were found in flowers. *Hibiscus Rosa Sinensis* extract is known to possess medicinally active anticancer and antioxidant constituents like glycosides, riboflavin, margaric acid, carotene, gentisic acid, quercetin, malvalic acid, niacin and lauric acid. The ethanolic extract of *Hibiscus Rosa Sinensis* flower was also analysed by GC-MS and Propanol,3,3'-dithiobis(2,2-dimethyl- SS)- or (RR)-2,3-hexanediol, 2-Hydroxy-2-methylbutyric acid, n-Hexadecanoic acid, Heptanoic acid, 2-ethyl- Trans-(2-Ethylcyclopentlyl) methanol, 3-N-Hexylthiolane, SS-dioxide Hexanedioic acid, 1,2-Benzenedicarboxylic acid, bis(2-ethylexyl) ester, diisooctyl ester, 5.5'- (tetrahydro-1H,3H-furo(3,4-c)furan-1,4-diyl)bis-, (1S-(1α,3a α,4β,6a α)-Squalene, 1,3-Benzodioxole, 2R-Acetoxymethyl-1,3,3-trimethyl-4t-(3-methyl-2-buten-1-yl)-1cyclohexanol were identified. Sterols, carbohydrates and glycosides, phenolic compounds and tannins, triterpenoids, saponins, mucilage and flavonoids were reported in the roots of hibiscus rosa-sinensis.[22]

Pharmacological activities

Extracts from Hibiscus rosa-sinensis possess multiple bioactive attributes and pharmacological activities, including antiasthmatic, analgesic, antidepressant,[23] anticancer, antidiarrhoeal,[24] antidiabetic, anthelmintic, antihypertensive, anti-inflammatory, antimicrobial, antipyretic, antiulcer, anxiolytic, chemo-preventive, hepatoprotective, non-toxicity and wound healing effects. Also, nanoformulations and nanoparticle studies on *Hibiscus Rosa Sinensis* are underway.

Analgesic and anti-inflammatory activities by ethanolic root extract of *Hibiscus Rosa Sinensis* was used to evaluate Anti-inflammatory activity and analgesic activity by acetic acid induced writhing test, carrageenan induced paw-edema test, flick test, tail immersion test, paw-edema test induced by dextran and formalin-induced paw-licking test in dose range 250 mg/kg and 500 mg/kg. Hibiscus extract upon orally administered has shown dose-dependent analgesic by prolonging reaction time and anti-inflammatory by inhibiting edema ($p<0.05$) effects on both treated and standard groups upon comparison with the control group. [25]

Antibacterial activity by Polyacrylamide gel electrophoresis was used to evaluate Antibacterial activity. The protein was run through it to view their protein profile. Antibacterial activity by disc and agar diffusion methods showed that a maximum zone of inhibition (ZOI) was found with the cold extraction against *B. subtillis*, *E. coli* specifically., 17.00 ± 2.91 and (14.50 ± 1.71) mm respectively, then proceed with hot extraction against *Escherichia coli*, *Salmonella* sp. as 11.66 ± 3.14 and 10.60 ± 3.09 mm respectively. The methanolic extract exhibited maximum ZOI against *B. subtillis*, *Escherichia coli* at 18.86 ± 0.18 and 18.00 ± 1.63 mm followed by ethanolic extract, which showed utmost ZOI recorded against *Salmonella* sp. at (20.40 ± 1.54) mm. Maximum ZOI was found from the crude protein from flower against *Salmonella* sp., *Escherichia coli* specifically16.55 ± 1.16 and 14.30 ± 2.86 mm. Hence, the flower could be used as an antibacterial agent against human pathogens as an alternative source. The potential antibacterial activity of *Hibiscus Rosa Sinensis* extract is confirmed, however, more research is required for drug development studies.[26]

Antioxidant and anti-dyslipidemic of *Hibiscus Rosa sinensis* root extract in alloxan-induced diabetic rats model was used to assess the antidyslipidemic activities of root extract of *Hibiscus Rosa Sinensis*. The root extracts approximately 500 mg/kg body weight. p.o. was administered orally for fifteen days which caused reactivation of post heparin lipoprotein lipase activity, a significant decrease in the levels of plasma lipids and blood glucose in diabetic rats induced by alloxan. Moreover, in *in-vitro* enzymic and non-enzymic systems, a root extract of about 50–500 lg inhibited the hydroxyl radicals and superoxide anions generation. Thus, antioxidant and antidyslipidemic activities of *Hibiscus Rosa Sinensis* in root extract were demonstrated, which might be used to prevent diabetic-dyslipidemia and related complications.[27]

Anti-hyperlipidemic effect in about 400 mg/kg b.w. triton induced and atherogenic diet-induced hyperlipidemic rats of ethanolic extract of *Hibiscus Rosa sinensis* flower was assessed and was compared with 10 mg/kg body wt. Simvastatin is a known antihyperlipidemic drug. Based on an acute oral toxicity study, dose selection was made from 50 mg to 5000 mg/kg body weight and was according to the guideline of OECD. On oral administration of 500 mg/kg body wt. of the ethanolic extract of *Hibiscus Rosa Sinensis* flowers a notable reduction of about $P<0.01$ was found, in triglycerides, total cholesterol, VLDL, LDL and an increase in HDL in both models of hyperlipidemic rats in comparison with hyperlipidemic control. Thus the antihyperlipidemic potential of the drug was reported.[28]

Antihyperlipidemic potential of ethanolic extract of *Hibiscus Rosa Sinensis* fractions in triton and atherogenic diet-induced hyperlipidemia rat. 500 mg/kg body weight dose was administered to different fractions of selected plant and possible anti-hyperlipidemic activity was evaluated in triton and atherogenic diet-induced hyperlipidemic rats for a time interval of 48 hours and 14 days. Saline solution of triton 400 mg/kg was given in rats intraperitoneally in the triton model, while in the diet-induced model, an oral atherogenic diet was given for 20 days in rats to induce hyperlipidemia and then using antihyperlipidemic drug simvastatin, a comparison was also made with the chosen drug. The experimental hyperlipidemic rats, when compared with hyperlipidemic control group, showed a

reduction in serum lipid parameters such as LDL, VLDL total cholesterol, triglycerides and elevation in HDL-C in both the models thereby conforming positive response to Anti-hyperlipidemic activity.[28]

In an animal model, Ethanolic extracts of *Hibiscus Rosa Sinensis* leaves were explored for ameliorating hyperlipidemic potential. A lipogenic diet of 20% sunflower oil, 0.5% sodium cholate and 2.5% cholesterol was given to induce hyperlipidemia in experimental animals. Different animal groups were administered a 400 mg/kg dose of leaf extracts of the plant by intraperitoneal (IP) injection for 14 days at a regular time interval of 12 hours and lipid profiles of the rabbits were measured for LDL-C, TC, HDL-C and triacylglycerol (TAG) concentrations at the end of treatment. The hyperlipidemic rabbit (HyL-Rs) groups treated with the plant extract showed an increased level of HDL-C concentration and different levels of reduced serum lipid components. Particularly, the maximum capacity of the plant extracts was found in reducing serum total cholesterol levels in animals considered for experiment purposes. Also, this research found that the experimental plant extracts have the tendency but varying capacity to alter the serum lipid profile of HyL-Rs and was due to their phytochemical peculiarities, which suggested the in-vivo hypolipidemic activity of certain phytochemicals.[29]

Hypoglycemic and antioxidant activity of oral aqueous methanolic leaves extract about 400 mg/Kg of *Hibiscus Rosa Sinensis* on streptozotocin-induced diabetic rats and changes in renal and hepatic functions were investigated. Hibiscus leaves extract was applied to treated rats and showed decreased levels of aspartate aminotransferase (AST), cholesterol, plasma glucose, creatinine, uric acid, and alanine aminotransferase (ALT) and increased hepatic Malon-di-aldehyde was reported in diabetic rats. Also, the leaves extract of the hibiscus abolished the reduced level of plasma protein levels and superoxide dismutase in the liver caused by STZ injection. STZ treated rats only showed degeneration in mostly hepatocyte and glomeruli and some pathological effects in kidneys and liver. The *Hibiscus Rosa Sinensis* leaves extract decreased the pathological alteration and the treatment group was shown to have protective effects on kidney and liver in STZ-induced diabetic rats. By spectral analysis (1H, UV and 13C-NMR), phenylpropanoids glycoside and Luteolin-8-C-glucoside were isolated and identified from *Hibiscus Rosa Sinensis.* Hence, aqueous extract of leaves of *Hibiscus Rosa Sinensis* possesses hypolipidemic and antidiabetic activity in diabetic rats which can be because of the antioxidant property of the extract of hibiscus.[30]

Modulation of diabetic stress using petals of Polyphenols rich *Hibiscus Rosa Sinensis Linn.* using petals possess a wide range of medicinal uses with edible petals and have high nutritional value. Eight potent phytochemicals were isolated from LC-MS and HPLC-DAD analysis of ethyl acetate fraction of *Hibiscus Rosa Sinensis* (E*Hibiscus Rosa Sinensis).* E*Hibiscus Rosa Sinensis* in about dose of 25 mg/kg body weight was given by intragastric route in STZ-induced experimental diabetic rat to evaluate the antidiabetic potential of *Hibiscus Rosa Sinensis* and metformin was used for comparison. *Hibiscus Rosa Sinensis* administration normalized the STZ-induced changes of glycated hemoglobin, blood glucose, antioxidant defense system and toxicity markers and the marker genes

expressions involved in the diabetic stress-signaling pathway, like PI3K, P38MAPK, AKT, Nrf2 and NF-κB, were modulated. These findings were reinforced by histopathological studies of the liver. The overall results were comparable with metformin. Thus, phytochemicals of Hibiscus act as an important source in reducing complications of diabetes. Thus anti-diabetic effect and phytochemical composition of Hibiscus petals were explored. The results were compared with metformin-treated groups. The presence of 8 effective phenolic compounds having various pharmacological activities was revealed by a phytochemical study. These phenolic has a synergistic effect and is possibly the reason for hibiscus petals' protective effect. Hence, these results provide future insight into the molecular and cellular mechanism of the antidiabetic activity of *Hibiscus Rosa Sinensis* and justify its effectiveness in the treatment of diabetic subjects.[31]

Diabetes Mellitus as the possible effect of *Hibiscus Rosa Sinensis* extract in STZ-induced DM in rats was investigated and its impact on biochemical markers. The effect of hydro-ethanol extract of aerial part of *Hibiscus Rosa Sinensis* on albumin, blood sugar, urea, albumin to globulin ratio, uric acid, C- peptide, creatinine, insulin and activity of diagnosis markers enzyme alanine aminotransferase, aspartate aminotransferase, gamma-glutamyl transpeptidase and alkaline phosphatase were examined in the liver, plasma, kidney in the experimental and control group. To diabetic rats, administered oral aqueous extract of *Hibiscus Rosa sinensis* about 500 mg/kg for 4 weeks and a significant reduction in the urea levels, blood sugar, creatinine, uric acid and elevated activity of albumin to globulin ratio, C- peptide, insulin, and albumin and restored all enzyme markers to about control level. Thus, the anti-hyperglycemic activity of *Hibiscus Rosa Sinensis* was confirmed and ultimately reduces the damage to renal and liver in rats associated with STZ-induced DM.[32]

In Brazilian traditional medicine, the flower of *Hibiscus Rosa Sinensis* is only used for diabetes management and in female Wistar-rats, showed anti-fertility activity. But, no scientific validation has been reported on the effect of *Hibiscus Rosa Sinensis* in diabetes and pregnancy. Aqueous extract of flower of *Hibiscus Rosa Sinensis* on pregnant rats with diabetes and the outcome was reported in maternal and fetal. Adult female virgin, Wistar rats were taken. Streptozotocin about 40 mg kg^{-1} was given to induce diabetes and then the rats were mated. Four groups of pregnant rats were made (n = 11 minimum animals in each group): diabetic, diabetic treated, non-diabetic, and non-diabetic treated. To the treatment groups, during pregnancy aqueous extract of *Hibiscus Rosa Sinensis* was administered orally to rats. Biochemical parameters, fetal parameters and maternal reproductive outcomes were analyzed at term pregnancy. In comparison to the non-diabetic group, the non-diabetic treated group showed increased atherogenic index (AI), decreased HDL-C, increased pre-implantation loss rate and increased coronary artery risk index (CRI). *Hibiscus Rosa Sinensis* treatment did not produce toxicity, but on cardiac and reproductive functions, a deleterious effect was reported. The diabetic-treated group reported a rise in fetal and maternal weight, lesser CRI, AI and pre-implantation loss rate upon comparison with the untreated diabetic group.[33]

Hyperlipidemic mitigating impact of the flower of Hibiscus Rosa Sinensis in Type II diabetes mellitus(T2DM) was investigated. T2DM subjects were divided into age

groups 30-60 years into experimental and control groups. To the experimental group, flower powder (2g) of Hibiscus Rosa Sinensis was given daily for 60 days. The blood sample of subjects was evaluated. Significant effects of flower powder of Hibiscus Rosa Sinensis on lipid parameters and blood glucose were reported. Hibiscus Rosa Sinensis inexpensive than other hypoglycemic drugs and reduces the symptoms of diabetes with a low adverse effect on health in a natural manner. 34.

Antidepressant activities

A *Hibiscus Rosa Sinensis* and M *Hibiscus Rosa Sinensis* exhibit potent anti-depressant activity via a noradrenergic, serotonergic and dopaminergic mechanism. Also, it possesses potent medicinal activity in the management of CNS disorders and pre-clinical trials had evidenced it. A remarkable reduction in immobility time in TST and FST was reported, which is similar to imipramine about 10 mg kg^{-1}, i.p.), which acts as production control. Immobility duration was depleted by *Hibiscus Rosa Sinensis* extract. In both FST and TST, immobility was induced by an α1-adrenoceptor antagonist, Prazosin (62.5µg kg^{-1}, i.p), a serotonin synthesis inhibitor, p-chlorophenyl alanine (100mg kg^{-1}, i.p, for 3 days) and a classical Dopamine 2 receptor inhibitor, Haloperidol (50µg/ kg, i.p.).[35]

Gastroprotective activity of flower extracts of *Hibiscus Rosa Sinensis* was investigated by Pylorus ligation analysis; ethanol and aspirin-induced ulcers in rats. Pharmacological and phytochemical screening of extracts confirmed the presence of tannins, alkaloids, and flavonoids. As compared to the reference standard, significant gastroprotective action was reported in gastric ulcer-induced rat models. More percentage of protection was observed in water extract (250 mg/kg), 76.8%, 77.12%, 84.17%, in aspirin-induced, ethanol-induced and pylorus ligation ulcer rat models, respectively. The reported gastroprotective effect is due to the free radical scavenging effect of tannins, mucus production and flavonoids. It can be concluded that flower extracts of *Hibiscus Rosa Sinensis* possess significant gastroprotective activity in experimentally induced gastric erosion in rats.[36]

Inhibitory effect on alkaline phosphatase enzyme by ethanolic extract of the *Hibiscus Rosa Sinensis* flower in graded concentrations of 0.1-100 mg/ml reaction mixture with its water-soluble fraction along with compounds isolated from this fraction was evaluated for antagonistic activity on ALP enzyme activity in-vitro. Water-soluble fraction and methanolic extract showed potent inhibitory effects on the ALP activity in-vitro. High inhibitory activity was reported by compounds isolated from the water-soluble fraction due to the presence of quercetin-7-O-galactoside, with high potent inhibitory enzyme activity reaching 100% at 100 mg/ml reaction mixture. Ten polyphenolic compounds were isolated from water-soluble fractions, along with newer natural compounds.[37]

Post-Coital antifertility Activity was reported using ethanolic extract of the roots of *Hibiscus Rosa Sinensis* possesses estrogenic and antifertility activity. A dose of 400 mg/kg b.w, a strong uterotropic and anti-implantation i.e. inhibition of 100% activity was observed and was confirmed by histological studies. With dose administration of 4000 mg/kg b.w, no behavior change and mortality were

observed in all control and treated groups of mice. So, $1/10^{th}$ of the doses were tested for antifertility. The ethanolic extract of *Hibiscus Rosa Sinensis* at a dose of 400 mg/kg administered orally to the rats exhibit significant anti-implantation activity since no implants were observed in all the treated animals, which indicates 100% anti-implantation activity. By visual examination of animal weight, no toxicity was observed. All the animals were mated after discontinuation of treatment and caused pregnancy and normal litter delivery, which indicates the reversible action of the extract.[38]

Hypertensive activity has reported the aqueous leaf extract effects of *Hibiscus Rosa Sinensis* of 200 mg/kg on kidney function in hypertensive rats. A significant nearly $p < 0.05$ increase in Na+ level of normotensive rats was found after administration of *Hibiscus Rosa Sinensis* leaves extract, so it can interfere with normal renal function and elevated salt retention. Although leaf extract of *Hibiscus Rosa Sinensis* decreases blood pressure (BP) but compromised the integrity of the kidney may results if the plant is used for the cure of hypertension. The extract when administered to Hypertensive rats, showed a significant rise in AST, Na^+ concentration and urea as compared with normal control. Hence, the administration of *Hibiscus Rosa Sinensis* in albino rats reported decreased BP but may have an unwanted renal effect. Significant $p < 0.05$ rise in the ALT, urea, AST, Ca^{++} and Na^+ level in hypertensive rats when compared to normal control. Among hypertensive rats, high elevation in Ca^{++} level as compared with normal control, K ions were decreased in hypertensive control rats and insignificantly total protein level was affected in the test rats upon comparison with control.[39]

Spermatogenesis was examined *Hibiscus Rosa Sinensis* flower crude extract on male albino rats, as an oral anti-fertility agent. Healthy Eighty-four male albino rats were included in the study, among them twenty-four rats were taken control, assigned as group-I and left sixty rats were divided into groups of five, named group-II to group-VI with 12 rats in each group. Further two subgroups were made from each group, each containing six rats and marked as a and b. To subgroup an in each group, the crude extract was given with a dose of 150 mg/kg and to the “b” sub-group 300mg/kg dose. Considering from group II to group V, the extract treatment duration was increased gradually, initially starting from 15 days for group II, 30 days for group III, 45 days for group IV and 60 days for group V. After the last oral dose, the rats have sacrificed accordingly. Histological studies by Biopsy were considered using H&E stain and their testes were weighed. For 60 days, the extract was given to group VI (last group), after 30 days of the final oral dose, rats were sacrificed and histological examination was done by taking a biopsy. Similarly, at the regular interval,s the testes of the control group were collected and accordingly their histological examination was done. Hence, the crude flower extract of *Hibiscus Rosa Sinensis* caused changes in testes mainly in germinal epithelium, on fed orally to male albino rats in specific doses for 30, 45 & 60 days in the range from minor damage to near-total sloughing based on the treatment time.[40]

Wound healing activity N-butyl alcoholic extract of flowers of *Hibiscus Rosa Sinensis* was assessed for wound healing activity, by examining the macrophage's action, angiogenic activity and collagen fiber deposition. Various concentrations of

recombinant bovine-basic fibroblast growth factor or N-butyl alcoholic flower extract of *Hibiscus Rosa Sinensis* were applied in rats in an excisional wound healing model. On the ninth day, histopathology was assessed by Masson's trichrome (MT) staining, immunohistochemistry for a vascular endothelial growth factor (VEGF), transforming growth factor-β1 (TGF-β1), CD68 and hematoxylin and eosin(HE). In mice, a carbon clearance test (CCT) was used to evaluate immunomodulation by N*Hibiscus Rosa Sinensis*. In the N*Hibiscus Rosa Sinensis*-M, M*Hibiscus Rosa Sinensis* -H and control-rbFGF groups, as compared to the model the post-surgery wound healing was maximum and 5% dimethyl-sulfoxide (DMSO)-control groups post day 3rd. Much greater wound contraction of M*Hibiscus Rosa Sinensis* -H and N*Hibiscus Rosa Sinensis* -M groups as compared to the control rbFGF group by the 6th day. MT and HE staining reported that in control groups of N*Hibiscus Rosa Sinensis* -M and N*Hibiscus Rosa Sinensis* -H, significantly greater collagen deposition, fibroblast distribution and epithelialization as compared to model groups. Also, more intense staining was found with immune-histochemistry, of VEGF, CD68, TGF-β1 in *NHibiscus Rosa Sinensis* and control-rbFGF groups in comparison to the model groups and control group of 5% DMSO. As compared to the carboxyl methylcellulose group, significantly higher phagocytic indices and clearance were found in mice of control groups of N*Hibiscus Rosa Sinensis* -M and N*Hibiscus Rosa Sinensis* -H. By enhancing the collagen fiber deposition response, and increasing macrophages and angiogenesis activities via TGF-β1 and VEGF, *NHibiscus Rosa Sinensis* accelerates wound repair.[41]

Wound healing activity was reported by a study by the ethanolic leaves extract of *Hibiscus Rosa Sinensis* has reported wound healing activity, toxicity profile and antioxidant potential. The *in-vitro* antioxidant property was assessed by using superoxide radical scavenging, NO scavenging activity and DPPH radical scavenging activity. The general behavioral pattern of mice was studied by performing acute toxicity studies and ELEHR toxic effects on various hematological and biochemical parameters, pancreas and kidney, body, histopathology of liver, organ weight were studied by performing sub-acute toxicity studies. To evaluate the wound healing properties, the Burn wound model incision, dead space model, and excision model were used. All models, recorded the strong antioxidant activity, for ELEHR, in a concentration-dependent manner. Because there was no severe alteration, it has a reasonable safety profile as revealed by toxicological evaluation. Groups treated with ELEHR showed increased epithelisation period and wound contraction rate in the burn wound and excision models, but as compared to the controls, significantly more wound breaking strength in the incision wound model was reported, in ELEHR treated group. Histological studies were performed on the skin of healed-excised wounds, which showed in the extract-treated group there is restoration to normal architecture. Enhanced connective tissue markers and antioxidants that were evaluated in the dead-space wound model, further upheld the wound healing activity.[42,43]

Androgenic Alopecia activity by *Hibiscus Rosa Sinensis* was reported for induction and development of androgenic alopecia, a subcutaneous dose of testosterone was administered to albino rats (male) for 21 days. Three groups were made; groups I, II and II. Firstly, Group-I was treated with vehicle, Group II

with finasteride and Group III with ethanolic extract of leaves of *Hibiscus Rosa Sinensis* topically along with testosterone. Signs of alopecia were observed on the dorsal skin. One animal from each group was sacrificed and follicular density and morphology were studied, after the treatment period. From the 2nd week of treatment, vehicle and testosterone-treated animals become alopecic, while ethanolic extract of *Hibiscus Rosa Sinensis* and finasteride-treated animals didn't become alopecic and was supported by the follicular-morphology study. Thus, significant anti-androgenic alopecia activity was found in ethanolic extract of *Hibiscus Rosa Sinensis* and is equivalent to finasteride.[44]

Anti-fertility activity was found that the total benzene flowers extract of *Hibiscus Rosa-sinensis Linn*, when given in albino rats, from day one to ten of pregnancy, possess potent orally-effective anti-fertility activity, extract activity was dose and duration dependent. No effect of the extract was found on blastocyst per se from implanting and zygote tubular transport. However, administration of extract during implantation and pontamine blue reaction reported that in at least 70°/o of the females, interruption in implantation was responsible for the anti-fertility activity of the drug. By using the Delayed implantation technique it was stated that the extract, alters progesterone estrogen balance, in any way or other. The treated extract in females, maintain pregnancy by a high dose of oestrone, which further tends to support the curtailment of estrogen. However, to achieve full contraception, the anti-implantation factor alone, invoking, isn't capable enough and the absorption of the fetus was found with the drug.[45]

Hair Growth Promoting Activity *Hibiscus Rosa-sinensis Linn* reportedly has shown wide range of therapeutic effects on different ailments. Many traditional approaches have been employed to evaluate these therapeutic values. In the present study, the petroleum ether extract of *Hibiscus Rosa Sinensis* leaf was examined for its hair-growth-promoting property in male albino rats. The hair growth-promoting activity of the test sample was compared with a 2% ethanolic solution of Minoxidil which was taken as a standard. Both qualitative and quantitative analyses have been performed to evaluate the pharmacological activities of the sample. The petroleum-ether extract of *Hibiscus Rosa Sinensis* Linn shows the hair promoting activity significantly when compared to standard.[46]

Immunomodulatory Potential of flowers of *Hibiscus Rosa Sinensis* were studied for immunomodulatory properties i.e. phagocytic activity, humoral and cell-mediated immune response on "Wistar-albino rats". Hydroalcoholic extract of flowers of *Hibiscus Rosa Sinensis* (75, 150 & 300 mg/kg, p.o.) was tested in haemagglutination-Ab titer, CCT, delayed type of hypersensitivity. Hence, the study suggests that hydroalcoholic extract exhibited significant enhancement of immune activity in a dose-dependent manner as compared to control.[47]

Anti-Pyretic Activity was reported and traditionally *Hibiscus Rosa Sinensis* was used by local communities for the treatment of fever. But, there is scarce data to support the antipyretic effects. Ethanolic extracts of the flower of *Hibiscus Rosa Sinensis* and *Hibiscus Rosa Sinensis var. Alba* (white-colored flower) was used. For the evaluation of the safety of extracts, acute toxicity tests, phytochemical

analysis and heavy metals screening was performed. Upon injecting Brewer's Yeast s.c. fever was induced in rats and then treatment was given using four extracts in the first model at doses of 5 & 50 mg/ kg. By performing an acute toxicity test, the test dosages for the study were obtained. Ibuprofen was the reference drug (100 mg/kg). A digital thermometer was used to record the temperatures of rats. Thus, it was concluded that a significant ($p < 0.05$) reduction in the total temperature was obtained with white flower extract of 5mg/kg and 50 mg/kg, in comparison with the positive control group. This suggested the possibility of its therapeutic effectiveness, also claimed by traditional medicine practitioners, as a plant-based antipyretic agent.[48]

Estrous cycle and ovarian activity was reported by using benzene extract of flower of *Hibiscus Rosa Sinensis* was administered intraperitoneally to adult mice at a dosage of 120 and 250mg/kg BW and lead to irregular estrous cycle with prolonged metestrus and estrus. Anti-ovulatory effect of the extract was indicated by the absence of corpora lutea and an increase in the atretic follicle. Estrogenic activity of the extract also showed increased uterine weight, premature cornification of the vaginal epithelium and early opening of the vagina in immature mice. Thus, imbalance in the hormonal environment is responsible for the anti-ovulatory effect, as, by atretic follicle, there could be a rise in the estrogen endogenous secretion and also flower extract is found to be estrogenic.[49]

Antimicrobial activity of the air-dried flower of *Hibiscus Rosa Sinensis*, contain naringenin [5,7,4'-trihydroxyflavanone (1)], and a mixture of squalene and hydrocarbons. The structure elucidation of compound (1) was performed by 1-D and 2-D nuclear magnetic resonance analysis. Also, compound (1) showed mild activity against fungi, S. aureus, T. mentagrophytes and C. Albicans by Antimicrobial tests. Compound (1) didn't possess cytotoxic activity against a normal Chinese hamster ovarian cell line, human lung adenocarcinoma (A549).[50]
Anti-microbial evaluation of *Hibiscus Rosa Sinensis* plant extracts against Pathogenic Bacteria using four different extracts of *Hibiscus Rosa Sinensis*- Ethyl acetate, Hexane, Distilled water and Methanol were tested against Gram-negative bacterias (Bordetella bronchiseptica, P. Aeruginosa) and gram-positive bacteria (S. Aureus, B. subtilis, Micrococcus luteus, Streptomyces alboniger, Staphylococcus epidermis). The Agar diffusion method was used to evaluate antibacterial activity. Significant antibacterial activity was shown by ethyl acetate leaves extract against the "ORANGE" cultivar. Among the four test extracts, methanol extract and ethyl acetate extract indicated showed good anti-microbial activity in comparison to the other extracts and the Hexane extract reported very less activity against the tested bacterias, the MIC of ethyl acetate extract was screened, and inhibitory action was found at concentration 0.625 mg ml^{-1}. The methanolic extract possesses antimicrobial activity and acts as the most favorable solvent for extraction as compared to all the other extracts.[51]

Antimicrobial activity by isolation and identification from the flower extract of *Hibiscus Rosa Sinensis* by invitro and insilico approach using agar-diffusion method, the anti-microbial activity of flower extract of *Hibiscus Rosa Sinensis* was performed using multiple solvents, Out of which, methanolic extract of flowers of *Hibiscus Rosa Sinensis* showed better results as compared to the other solvent extracts. GC-MS revealed the presence of 7 biologically active molecules. N.

gonorrhea protein was used to dock these bioactive molecules. Finally, best docking scores of 7.955 were observed with benzene dicarboxylic acid with efficient binding energy values i.e. -38.692 kcal/mol as compared to the other ligand molecules. From the extract Benzene, dicarboxylic acid was isolated and was tested using different concentrations, on human diseases producing microbial strains. Thus, a good anti-gonorrhoeal activity was shown in all levels against N. gonorrhoeae, suggesting that benzene dicarboxylic acid can be an efficient drug candidate to treat venereal diseases.[52]

Hypolipidemic Activity was evaluated by Seven groups of Male Wistar rats(180-230gm) were made with six in each group (n=6). The 1st group acted as a control, *Hibiscus Rosa Sinensis* flower extracts were given to the 2nd, 3rd and 4th groups with a dose of 80mg/kg, 160mg/kg and 240 mg/kg b. w. orally, daily once for 5 days and the same doses of *Hibiscus Rosa Sinensis* flower extracts for 30 days. The cardiac puncture technique was used to collect the blood and allowed it to clot. For the estimation of TG, TC, LDL, HDL, and VLDL levels, serum was separated. A significant decrease in TG and serum cholesterol levels and an increase in HDL levels. Therefore, the extract of *Hibiscus Rosa Sinensis* possesses hypolipidemic/ hypocholesterolemic effects. For lowering TC and LDLC and increasing HDLC in hypercholesterolaemic rats, Phenolic active principles were observed to be responsible.[53]

Hyperproliferation and Oxidative Damage was evaluated and was caused by Ultraviolet Radiations and Benzoyl Peroxide in Mouse Skin. The ameliorative potential of *Hibiscus Rosa Sinensis* extract was investigated in mice skin. To induce hyperproliferation and oxidative stress, the combination of a single topical application of BP in the concentration of 20 mg/0.2 ml/animal followed by UV radiations of nearly 0.420 J/m2 /s was used. reduction in the antioxidant enzymes and detoxification, while significantly raised malondialdehyde formation, ornithine decarboxylase activity, hydrogen peroxide concentration and DNA synthesis were found with a Single application of benzoyl peroxide before UV-B radiation exposure. Partial restoration of the levels of cellular protective enzymes (P0.05) was found with pretreatment of *Hibiscus Rosa Sinensis* extract of 3.5 mg and 7 mg/ kg b.w. Moreover, a statistically significant reduction of hydrogen peroxide content and malondialdehyde formation (P0.05) were found at both doses. Thymidine incorporation in DNA and ornithine decarboxylase activity were also decreased in a dose-dependent manner (P0.05) by plant extract. Therefore, *Hibiscus Rosa Sinensis* extract exerts a protective effect against the tumor promotion stage.[54]

Hepatoprotective effect

The alcoholic *Hibiscus Rosa Sinensis* leaf extract was evaluated for its Protective effects against “piroxicam-induced toxicity”. Out of total adults 60 Swiss albino mice were orally treated with piroxicam for 15 days with 30 mg kg^{-1} bodyweight AEH, 6.6 mg kg^{-1} and with both AEH and piroxicam. Results reported piroxicam alone significantly increased the aspartate transaminase, alkaline phosphatase and alanine transaminase enzymes activity with great renal lipid peroxidation whereas AEH reported protective activity against toxicity caused by piroxicam and was also effective to combat oxidative stress-induced hepatic damage.[55]

Anti-cancerous properties of *Hibiscus rosa sinensis* Oil extract reported that it exhibits anti-cancerous and genotoxicity properties, Inhibit the growth of cancer cells was found when treated with hibiscus extract.

Cytotoxic activity was reported by flower decoction of *Hibiscus Rosa Sinensis* flowers stops cell division anywhere in cell cycle thus contains antimitotic constituents.[56]. Cytotoxic Activity was evaluated of stem and leaf extracts of *Hibiscus Rosa Sinensis* against Leukaemic Cell Line (K-562). By using the cold extraction method, The petroleum ether, methanolic and crude ethyl acetate extracts of the stem and leaf of *Hibiscus Rosa Sinensis* were prepared. On MDBK as control and K-562, the *in vitro* cytotoxic activity of the 20 - 100 µg/ml extracts was evaluated using 3-(4,5-dimethyl-2-thiazolyl)-2,5-diphenyl-2H-tetrazolium bromide and 3-(4,5-dimethylthiazol-2-yl)-5-(3-carboxymethoxyphenyl)-2-(4-sulfophenyl)-2H-tetrazolium assays, followed by morphology detection using Hoeschst staining. Higher activity with IC50 value: 30.9 ± 1.1 µg/ml against K-562 cells was found with methanolic leaf extracts than ethyl acetate and petroleum ether extracts that exhibit IC50 of 57.6 ± 0.61 and 87.6 ± 0.91 µg/ml ($p < 0.05$), respectively. Meanwhile, methanolic stem extracts reported IC50 of 79.80 µg/ml against K-562. For all the extracts, MDBK cells as positive control showed IC50 > 100 µg/ml. On treating K562 cells with methanolic leaf extract at a concentration of 30 µg/ml, the former were found to undergo apoptosis with nuclear segmentation after one day of incubation. Cell death was produced by methanolic leaf extracts on Leukaemic cells by apoptosis.[57]. In-vitro inhibition of melanoma cell growth was reported,as the aqueous flower extract of *Hibiscus Rosa Sinensis* inhibit the growth of melanoma cell in a dose-dependent way at concentration thereby not affecting the growth of nontransformed cells.[58]

S. No.	Type Of Nanoformulation	Biological Activity	Result	Ref. No.
1.	Hybrid of Cellulose–ZnO Nanocomposite and *Hibiscus rosa-sinensis* leaves extract	Anti-bacterial activities	Synthesized nanomaterials showed good antibacterial properties.	[59]
2.	Using *Hibiscus rosa Sinensis* leaf extracts green synthesis of Fe-ZnO Nanoparticles	Anti-bacterial activities	LDPE/Fe-ZnO has shown Anti-bacterial towards E.coli	[60]
3.	*Prepared AuNPs (gold Nanoparticles) utilizing* Hibiscus and Curcumin	Anti-cancer activities	*AuNPs- Hibiscus was active as an anti-cancer agent against cell line HCT -116 and MCF-7*	[61]
4.	Biologically synthesized upon mixing zinc chromate and oxide nanoparticulate with leaf extract of *Hibiscus Rosa Sinensis*	Photocatalytic activity	The particle size of nanoparticles was confirmed by X-ray diffraction with 14 nm for $ZnCr_2O_4$ nanoparticles stiffened at 700 °c, 26 nm at 500 °c, 56 nm at 200 °c and 70 nm at RT. particles size of nanoparticles was confirmed by HR-TEM and SEM, was $f_{particles}$ 14.5 ± 2 nm for HR-TEM and agglomerated cubic shaped particles sized 60–70 nm for HR-SEM. Structural analysis	[62]

			was confirmed by FTIR. For $ZnCr_2O_4$mixed oxide nanoparticles, band gaps were calculated from UV–vis DR at RT was 2.47 eV at 2.40 eV at 200 °c, 3.19 eV at 500 °c and 3.09 eV at 700 °c. Band gaps of DR of $ZnCr_2O_4$mixed oxide nanoparticles were confirmed by Fluorescence excitation with efficient Photocatalytic activity.	
5.	*Hibiscus Rosa sinensis* along with synthesized Co_3O_4-NPs and MgO-NPs Nanoparticles	Nanoparticles reported multiple biomedical applications such as bactericidal action against antidiabetic activity, UTI, antioxidant action leishmania, larvicidal activity, and antioxidant and biocompatibility studies.	NPs were active against UTI reported inhibition zone against Proteus *Vulgaris,* Pseudomonas *Aurigen osa*, and *E.coli.* Specifically, Co_3O_4-NanoParticles reported larvicidal action against *Aedes Aegypti*. Reported Leishmanicidal activity against promastigote and amastigote parasites. NPs showed antidiabetic activity as they have inhibited α-glucosidase and α-amylase enzymes. Nanoparticles reported antioxidant action and were biocompatible nanomaterials.	63
6.	Ag nanoparticle Green formulation using *Hibiscus rosa-sinensis*	Liver cancer behavior	Nanoparticles reported low cell viability and high Anti-cancer activity in the liver against SNU-387, LMH/2A, N1-S1 Fudr cell lines, and McA-RH7777 also no cytotoxicity was reported on HUVEC. Synthesized NPs inhibited 50% DPPH in 78 µg/Ml concentration.	64
7.	The synthesized nanocomposite of ZnO/TiO_2 using *Hibiscus ros a-sinensis* extract	Structural, Morphological and Antibacterial activities	*E.coli* and *S.aureus* microorgan isms showed inhibition zone at 61.4 ± 3.6 and 39.6 ± 4.4 were increased upon doping with TiO_2 to 82.3 ± 6.7 and 54.3 ± 2.8.	65
8.	PCL-PEO double network colorimetric pH sensor Development using electrospun fibers that contain extract *of Hibiscus Rosa sinensis* and silver	Major anthocyanin and minor co-pigments	Cyanidin-3-sophoroside as Major anthocyanin (318.1 mg/mL) and minor co-pigments were reported.	66

	nanoparticles for monitoring food			

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