Review Article

The traditional uses, phytochemistry and pharmacology of genus *Hibiscus*: A review

Abstract

The genus Hibiscus belongs to the mallow family, Malvaceae comprising of about 275 species growing in tropical and sub tropical areas. The various species of genus Hibiscus have been used as traditional medicine all over the world. There are numerous reports of their traditional medicinal uses in various countries like India, Nigeria, China, and Srilanka etc. to cure various ailments such as hypertension, cardiac diseases, stomach-ache, urine problems, skin diseases and many more. Based on the historical knowledge, various pharmacological and phytochemical studies on some species of the genus Hibiscus have been done. Nevertheless, there are no up-to-date articles published which can provide an overview of pharmacological effects of the genus Hibiscus. Therefore, the main objective of the review article is to provide a systematic comprehensive summary of traditional uses, phytochemistry and pharmacology of the genus Hibiscus and to build up a correlation between its traditional ethano-botanical uses and pharmacological activities so as to find some advanced research opportunities in this field. The given information on the ethano-botanical uses, phytoconstituents and various medicinal properties of the genus Hibiscus was gathered from the online scientific databases through search in Google, Google Scholar, Science Direct, NCBI, Pubmed, Springer Link, Research Gate by using some keywords as. Besides these websites other published literature and unpublished Ph.D. thesis and M.Sc. dissertation were also consulted. Previously conducted research revealed that the genus contains good amount of phytoconstituents such as antioxidants, phytosterols, saponins, lignin, essential oils, glycosides, and anthocyanins etc. Presence of these bioactive compounds in the crude extracts of the plants make it suitable for various medicinal properties like anti inflammatory, anti-diabetic, anti-obesity, anti-proliferative, anti-ulcer, hypersensitive, hypolipidemic, hepatoprotective, nephroprotective and many more. Additionally, this review article showed that mainly two species of the genus i.e. H. rosa-sinensis and H. sabdariffa have been explored for their pharmacological activities. There are few reports on some other species like H. tiliaceous, H. microanthus, H. asper, H. acetosella. This review highlights the medicinal potential of the plant Hibiscus due to its unique blend of phytochemicals. These phytoconstituents can be further assessed and subjected to clinical trials for their proper validations. Although large amount of the data regarding pharmacological effects has already been added to the existing reservoir but still potential of certain species like H. radiatus, H. hirtus, H. moschetous, H. trionum and many more is not yet unveiled and can be considered as future prospects that need to be worked out.

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INTRODUCTION

Hibiscus is a genus of flowering plants with numerous medicinal properties belongs to mallow family, Malvaceae. The genus is quite large, comprising several hundred species that is native to warm-temperate, sub-tropical and tropical regions throughout the world. There are about 275 species of *Hibiscus* in the tropical and sub-tropical regions (Lowry 1976). Out of them *H. rosa-sinensis*, *H. syriacus*, *H. cannabinus*, *H. radiatus*, *H. vitifolius*, *H. sabdariffa*, *H. schizopetalus* etc. are commonly found in India. Along with a flowering plant it also has various medicinal properties. Plants with medicinal properties have a bright future because over 50% of all modern clinical drugs used today are of natural origin (Sumathi *et al*. 2012). More than 7500 species out of 17000 species of higher plants are used in the various traditional systems of medicine like Ayurveda, Siddha and Unani (Kala *et al.* 2007). Because plant-based medicines are organic in origin and have less or no side effects as compared to all opathicmedicine, their use has increased, which monetarily stands about US$120billion, and

is expected to reach US$7 trillion by 2050 (Singh *et al.* 2014). The primary benefits of using the plant-derived medicines are more beneficial because they are readily affordable and accessible (Garbi *et al.* 2016). For the discovery of new more effective bio-therapeutic agents, the interest is increasing to find the chemical composition of plants (Roja *et al.* 2000). The various parts of this plant have been known to contain numerous medicinal properties like antihypolipidemic, antiproliferative, antioxidant, antimicrobial, anti-inflammatory and other pharmological properties (Salem *et al.* 2014)**.** This review will focus on the phytochemistry and pharmacological properties of *Hibiscus* in detail.

BOTANY

Chart 1: Taxonomic Classification

Botanical name	*Hibiscus*
Domain	Eukaryota
Kingdom	Plantae
Subkingdom	Tracheobionta
Phylum	Tracheophyta
Subphylum	Spermatophytina
Class	Magnoliopsida
Sub class	Dilleniidae
Super order	Rosanae
Order	Malvales
Family	Malvaceae
Sub family	Malvoideae
Tribe	Hibisceae
Genus	*Hibiscus* L.

Chart 2: **SYNONYMS**

Species	**Synonyms**
Hibiscus acetosella Welw. ex Hiern	*Hibiscus eetveldeanus De Wild. & T. Durand*
Hibiscus adoensis Hochst. ex A. Rich.	*Kosteletzkya adoensis (Hochst. ex A. Rich.) Mast.*
Hibiscus calycinus Willd.	*Hibiscus calyphyllus Cav.*
Hibiscus calyphyllus Cav.	*Hibiscus calycinus Willd.*
Hibiscus cuneiformis DC.	*Alyogyne cuneiformis (DC.) Lewton* *Cienfuegosia cuneiformis (DC.) Hochr.* *Fugosia cuneiformis (DC.) Benth.*
Hibiscus eetveldeanus De Wild. & T. Durand	*Hibiscus acetosella Welw. ex Hiern*
Hibiscus elatus Sw.	*Taliparitis elatum (Sw.) Fryxell*
Hibiscus esculentus L.	*Abelmoschus esculentus (L.) Moench*
Hibiscus ficulneus L.	*Abelmoschus ficulneus (L.) Wight & Arn.*
Hibiscus flavus Forssk.	*Pavonia arabica Hochst. & Steud. ex Boiss.*
Hibiscus glaber Matsum. ex Nakai	*Taliparitis glabrum (Matsum. ex Nakai) Fryxell*
Hibiscus hakeifolius Giord.	*Alyogyne hakeifolia (Giord.) Alef.* *Cienfuegosia hakeifolia (Giord.) Hochr.* *Fugosia hakeifolia (Giord.) Hook.*
Hibiscus hamabo Siebold & Zucc.	*Taliparitis hamabo (Siebold & Zucc.) Fryxell*
Hibiscus hastatus L. f.	*Taliparitis hastatum (L. f.) Fryxell*
Hibiscus laevis All.	*Hibiscus militaris Cav.*
Hibiscus lampas Cav.	*Thespesia lampas (Cav.) Dalzell*
Hibiscus macrophyllus Roxb. ex Hornem.	*Taliparitis macrophyllum (Roxb. ex Hornem.) Fryxell*

MORPHOLOGICAL CHARACTERISTICS

The genus includes both annual and perennial herbaceous plants, as well as woody shrubs and small trees. The leaves are alternate, ovate to lanceolate, often with a toothed or lobed margin. The flowers are complete, large, conspicuous, and trumpet-shaped, with five or more petals, colour from white to pink, red, orange, peach, yellow or purple and from 4 to 18 cm broad. Flower colour in certain species, such as *H. mutabilis* and *H. tiliaceus* changes with age. The fruit is a dry five-lobed capsule, containing several seeds in each lobe, which are released when the capsule dehisces (splits open) at maturity. [**Figure1**]

Figure 1: A. *Hibiscus schizopetlous,* **B.** *H. rosa– sinensis,* **C.** *H. radiates,* **D.** *H. sabdariffa,* **E.** *H. syriacus,* **F.** *H. mutabilis*

Chart 3: TRADITIONAL USES: Traditional uses of *Hibiscus* species

Species	Country/Region	Plant part used	Traditional uses	Proportional administration	References
H. asper	Nyong valley in Cameroon	Whole plant	To cure female infertility	-	Jiofack *et al*. 2009
H. cannabinus L.	Africa	Stem peels	To cure fatigue and anaemia	-	Agbor *et al*. 2005b and Lee *et al*. 2007
H. cannabinus	Kwa Nibela, Peninsula, St Lucia, South Africa	Whole plant	To cure chicken pox	Boiled juice	Kokwaro, 1976 and Williams, 2007
H. linarifolius wild	Nigeria	Leaves	Treatment of Typhoid fever	Decoction	Borokini *et al*. 2012
H. macrophyllus Roxb.	Tripura, India	Leaves and Flower	To cure cough and sexual problems	-	Sen *et al*. 2011
H. rosa-sinensis	Guimaras island, Phillipines	Flower	To cure boils	Crush and apply as poultice	Ong *et al*. 2014
H. rosa-sinensis	Bangladesh	Flower	Regulation of menstrual cycle	Decoction	Alam, 1992
H. rosa-sinensis	China	Flower and Bark	Emmenagogue	Hot water extract	Burkhill, 1966 and Pardo *et al.* 1901
H. rosa-sinensis	Cook Islands	Flower and leaves	Ailing infants, Gonorrhea	Hot water extract	Whistler, 1985
H. rosa-sinensis	East Indies	Flower and leaves	Regulate menstruation produce abortion. To stimulate expulsion of afterbirth	Hot water extract of flower.	Burkhill, 1966
H. rosa-sinensis	Fiji	Leaves	Digestion, Diarrhea	Juice	Singh, 1986
H. rosa-sinensis	French Guiana	Flowers	Grippe	Hot extract	Luu, 1975
H. rosa-sinensis	Ghana	Peeled Twig	Chewstick	-	Adu-Tutu *et al*. 1979
H. rosa-sinensis	Guadeloupe	Flowers	Sodorific, Anti-tussive	Hot extract	Vitalyos, 1979
H. rosa-sinensis	Guam	Leaves	To Promote draining of abscesses	-	Haddock, 1974
H. rosa-sinensis	Haiti	Leaves and Flowers	Flu & cough, stomach pain, Eye problems	Decoction	Kobayashi, 1976
H. rosa-sinensis	Hawaii	Flowers	Lactation	-	Nath *et al*. 1992
H. rosa-sinensis	India	Stem and Flowers	Abortion, Antifertility, Contraceptive, Diuretic,	Hot water extract	Nath *et al*. 1992, Tiwari *et al*. 1982, Maheswari *et al*. 1980, Jain *et*

			Menorrhagia, bronchitis, Emmenagogue, Demulcent, Cough, Abortifacient		*al.*1970, Malhi *et al.* 1972, Reddy *et al*. 1989, Dixit, 1977 and Hemadri *et al.*1983
H. rosa-sinensis	Indonesia	Leaves and Flowers	Menstruation, Abortion, Emmenagogue, Women in labor	Juice	Quisumbing, 1951 and Van *et al.*1953
H. rosa-sinensis	Japan	Leaves	Anti-diarrhoeal	Decoction	Shimizu *et al*. 1993
H. rosa-sinensis	Kuwait	Flowers	Aphrodisiac	-	Alami *et al.* 1976
H. rosa-sinensis	Malaysia	Roots and Flowers	Fever, Expectorant, Emmenagogue	Hot water extract	Burkhill, 1966 and Hooper, 1929
H. rosa-sinensis	Mexico	Barks and leaves	Dysentery	Infusion	Zamora-Martinez, 1992
H. rosa-sinensis	Nepal	Roots	Cough	Hot water extract	Suwal, 1970
H. rosa-sinensis	New Britain	Flowers	Menstruation	Hot extract	Holdsworth, 1977
H. rosa-sinensis	New Caledonia	Flowers	Abortifacient	Decoction	Holdsworth *et al*. 1980
H. rosa-sinensis	Northern Ireland	Flowers	To induce labor	Water extract	Ramirez *et al*. 1988
H. rosa-sinensis	Peru	Flowers	Contraceptive, Emmenagogue	Hot water extract	Pardo *et al.*1901
H. rosa-sinensis	Philippines	Flowers	Bronchial Catarrh, Emmolients, Cancerous, Swellings	Hot water extract	Watt *et al.* 1962
H. rosa-sinensis	Trinidad	Flowers	Amenorrhea	Decoction	Wong, 1976 and Ayensu, 1981
H. rosa-sinensis	Vanuata	Stem and bark	Menorrhagia	Decoction	Bourdy *et al.* 1992
H. rosa-sinensis	Vietnam	Flowers	Dysmenorrhea, Abortive	Infusion	Quisumbing, 1951
H. sabdariffa L.	India, Africa, Mexico	Infusion of leaves or calyces	Diuretic, Chlorectic. Febrifungal, hypotensive effect	-	Morton, 1987
H. sabdariffa L.	Egypt	Calyces	Treatment of cardiac and nerve diseases, increase production of urine	-	Leung, 1996
H. sabdariffa L.	Egypt and Sudan	"Karkade" Calyces	To lower body temperature	-	Leung, 1996
H. sabdariffa L.	India	Seeds	Relieve pain in urination and indigestion	Decoction	Morton, 1987
H. sabdariffa L.	Brazil	Roots	Stomachache emollient properties	-	Morton, 1987
H. sabdariffa	Chinese Folk Medicine	Roots	To treat liver disorder and high blood pressure	-	Morton, 1987

H. sabdariffa	Iran	Sour hibiscus tea	To treat hypertension	-	Burnham *et al.* 2002
H. sabdariffa	Nigeria	Seeds	Rise or induce lactation in cases of poor milk production, poor letdown and maternal mortality	-	Gaya *et al.* 2009
H. schizopetalous (Mast.) Hook. F.	India	Leaf and Flower	Fresh wound	-	Sens *et al.* 2011
H. surratenius	Nyong valley in Cameroon	Aerial parts	Polyhydromnius	-	Jiofack T. *et al*. 2009
H. surratenius	South Africa	Leaves	Malaria	Decoction/ Oral	Yetein *et al*. 2013
H. talbotii	India	Roots	Indigestion	-	Jagtap *et al.* 2008
H. tiliaceous	Srilanka	Flower	Earache	Boiled in milk	Dixit, 1977
H. tiliaceous	Srilanka	Flower	Emollient properties and anti-depressant like activities	-	Dixit, 1977
H. tiliaceous	Srilanka	Bark, branches, and Flower buds	Mild laxative and lubricant in childbirth or labor pain and rubbed on stomach to treat bronchitis	Slimy sap	Hemadri *et al.* 1983
H. tiliaceous	Srilanka	Wood and flower	Treatment of skin diseases	-	Hemadri *et al.* 1983

PHYTOCHEMICAL ANALYSIS

Secondary metabolites are the important compounds present in the plants possessing major role in defence. Phytochemical studies on genus *Hibiscus* has been started million years ago and is being explored till date. These studies reveal that the plant is perfect blend of various phytoconstituents like flavonoids, tannins, saponins, carbohydrates, steroids, phenols, glycosides, quinones, terpenoids etc. The extraction of such economical phytochemicals has been done from various plant parts such as leaves, stem, flower and roots using different solvents viz. water, methanol, ethanol, ethylacetate, chloroform and petroleum ether for extract preparation. **Table 1** illustrates presence of diverse phytoconstituents in different species of *Hibiscus* where it is clearly observed that H. *sabdariffa* and *H. rosa-sinensis* has been well explored in this regard but still little is known about *H. acetosella, H. cannabinus, H. syriacus* and many more.

Table 1: Phytochemical studies of different *Hibiscus* species

Species	Solvent used for Extraction	Class	Bioactive compound	Reference
H. cannabinus	Acetone	-	Grossamide K1, Erythrocanabisine H2, Phellandrene, Phytol, Nonanal, 5-Methyl-furfural, 2-Hexenal, Benzene acetaldehyde	Pappas *et al.* 2003, Moujir *et al.* 2007, Seca *et al.* 2001
H. esculentus	Aqueous	Flavonoid	(-)-Epigallocatechin	Shui *et al.* 2004
H. mutabilis	Aqueous	Anthocyanin	Cyanidin 3-xylosylglucoside and cyanidin 3-glucoside, the red flowers of *H. mutabilis* contained quercetin 3-sambubioside, isoquercitrin, hyperin, guaijaverin and kaempferol glycosides	Ishikura, 1982
H. mutabilis	Aqueous	Anthocyanin	Cyanidin-3-sambubioside	Amrhein *et al.* 1989
H. mutabilis	Methanol	Flavonoids	Quercetin and hyproside	Iwaoka *et al.* 2009
H. mutabilis	Aqueous	Flavonoids	Quercetin 3- sambubioside and cyanidin 3-sambubioside	Lowry *et al.* 1976
H. mutabilis	Methanol, choloroform and petroleum ether	Phenols, flavonoids, and anthocyanins	Quercetin, Quercemericrine, Quercetin-3-D-syloside, Quercetin-3-Sambubioside, Isoquercetin, Kaempherol, Cyanidine, Cyanidine-3-slosylglucose, Cyanidine-3-monoglucoside, Hibiscones, Hibiscoquinones, Beta-sitosterol	Barve *et al*. 2010
H. mutabilis	Aqueous	Phenols and flavonoids	Steppogenin, genistein, salicylic acid, rutin, potengriffioside A, kaempferol 3-O-rutinoside and emodin	Hou *et al*. 2015
H. rosa sinensis	Aqueous	Anthocyanin	Cyanin, cyanidin chorides, methyl-10-oxa-11-octadecynoate, methyl-8-oxa-9- octadecynoate, methyl-9-methylene-8-oxaheptadecanoate and methyl10-methylene-9-oxactadecanoate	Sharma *et al.* 2001
H. rosa sinensis	Choloroform	Anthocyanin	Cyanidin3-sophoroside	Vastrad *et al.* 2018 and Bhakta *et al.* 2018
H. rosa sinensis	Methanol	Glucoside	Luteolin-8-C-glucoside.	Begum *et al.* 2015
H. rosa sinensis	Aqueous	Sterols	Beta Sitosterol	Khare *et al.* 2004

H. rosa sinensis	Aqueous and methanol	Flavonoids	Quercetin-3- di-0-beta-D-glucoside, quercetin-3-7-di-0-beta-D-glucoside, quercetin-3-0-beta-D-sophorotrioside, kaempferol-3-0-beta-D-xylosyl-glucoside, cholesterol, campesterol, ß-sitosterol, catalase	Ross *et al.*1949 and Subramanian *et al*. 1972
H. rosa sinensis	Methanol	Flavonoids	Cyclopeptide alkaloid, quercetin, hentriacontane	Srivastava *et al.* 1976 and Khokhar, 1992
H. rosa sinensis	Aqueous	Flavonoids	Quercetin-3,5-diglucoside, quercetin-3,7-diglucoside, cyanidin-3,5-diglucoside and cyaniding-3-sophoroside3-5-glucoside and kaempferol-3-xylosylglucoside	Joshi *et al.* 2004
H. rosa sinensis	Methanol	Flavonoids	Quercetin, quercetin-3-diglucoside, ß-sitosterol, cyanidin-3,5-diglucoside	Kumar, 2018
H. rosa sinensis	Aqueous	Phenols, flavonoids, and anthocyanins	Hibiscetin, Cyanidin, Cyanidine glucosides, Taraxeryl acetate, b-Sitosterol Campesterol, Ergosterol, Cyclopropenoids	Gilani *et al.* 2005, Adhirajan *et al.* 2003, Kholkute 1977b, Singh *et al.* 1882, Gauthaman *et al.* 2006, Sachdewa *et al.* 1999, Sachdewa *et al.* 2001, Sharma *et al.* 2004a, Sharma *et al.* 2004b and Ajay *et al.*2007
H. sabdariffa	Aqueous	Anthocyanin	Delphinidin-3-sambubioside, Cyanidine-3-sambubioside, Delphinidin-3-sambubioside	Jabeur *et al.*2017
H. sabdariffa	Aqueous and methanol	Anthocyanin	Delphinidin-3-sambubioside (hibiscin), cyanidin-3-sambubioside (gossypicyanin), cyanidin-3,5-diglucoside, delphinidin (anthocyanidin)	Hida *et al.* 2007
H. sabdariffa	Aqueous	Anthocyanin	Delphinidin-3-sambubioside (hibiscin), delphinidin-3-glucoside and cyanidin-3-glucoside (chrysanthenin)	Williamson *et al.* 2013
H. sabdariffa	Aqueous	Anthocyanin	Cyanidin-3-sambubioside (gossypicyanin), cyanidin-3,5-diglucoside and cyanidin-3-(2G-glucosylrutinoside)	Du *et al.* 1973 and Shibata *et al.*1969
H. sabdariffa	Aqueous	Flavonoids	Hibiscitrin (hibiscetin-3-glucoside), sabdaritrin, gossypitrin, gossytrin and other gossypetin glucosides, quercetin and luteolin	Subramanian *et al.*1972
H. sabdariffa	Aqueous	Flavonoids	Chlorogenic acid, protocatechuic acid,	McKay, 2009 and Williamson *et al*. 2013

			pelargonidic acid, eugenol, quercetin, luteolin and the sterols β-sitosterol and ergosterol	
H. sabdariffa	Aqueous	Flavonoids	3-monoglucoside of hibiscetin (hibiscitrin)	McKay, 2009 and Williamson *et al.* 2013
H. sabdariffa	Methanol	Flavonoids	7-glucoside of gossypetin (gossypitrin) and sabdaritrin and hydroxyflavone named sabdaretin.	Rao *et al.* 1942 and Rao *et al*. 1948
H. sabdariffa	Methanol	Flavonoids	Gossypetin-8-glucoside (0.4%) and gossypetin-7-glucoside	Rao *et al.* 1942 and Rao *et al*. 1948
H. sabdariffa	Aqueous	Flavonoids	β-sitosteryl-β-D-galactoside	Subramanian *et al.* 1972
H. sabdariffa	Aqueous	Flavonoids	Quercetin, luteolin and its glycoside	Salama *et al*. 1979, McKay, 2009 and Williamson *et al*. 2013
H. sabdariffa	Aqueous	Flavonoids	Quercetin-3-glucoside, rutin, quercetin-3-rutinoside kaempferol	Salah *et al*. 2002
H. sabdariffa	Aqueous, Ethenol and chloroform	Flavonoids	Atechin and ellagic acid, protocatechuic acid, catechin, gallocatechin, caffeic acid, gallocatechin gallate	Beltran-Debon *et al*. 2010, Herranz-Lopez *et al.* 2012, Peng *et al.* 2011, Ramirez-Rodrigues *et al.* 2011a and Ramirez-Rodrigues *et al.* 2011b
H. sabdariffa	Aqueous	Organic Acids	Citric Acid, Mallic Acid, Tartaric Acid, Ascorbic Acid.	Eggensperger *et al.* 1996 and Schilcher, 1976.
H. sabdariffa	Aqueous	Organic Acids	Citric Acid, Mallic Acid	Buogo *et al.* 1937, Indovina *et al.*1938 and Reaubourg *et al.*1940
H. sabdariffa	Aqueous	Organic Acids	Ascorbic Acid and Hydroxycitric acid(2S,3R)	Ismail *et al.* 2008 and Morton, 1987
H. sabdariffa	Methanol	Phenolic Acid	Protocatechuic acid (PCA)	Lin *et al.* 2012 and Yang *et al.* 2010
H. sabdariffa	Aqueous and methanol	Phenolic Acid	Chlorogenic acid	Lee *et al.* 2002, Lin *et al.* 2003, McKay, 2009, *Williamson et al.* 2013, Clifford *et al.* 2003 and Alarcon *et al.* 2012
H. sabdariffa	Methanol	Phenolic compounds	Protocatechuic acid and Catechin	Kuo et al. 2012
H. sabdariffa	Aqueous	Phenolic compounds	Ergosterol	Osman *et al*. 1975
H. sabdariffa	Aqueous	Flavonoids and Phenolic acid	Chlorogenic acid isomer I, Chlorogenic acid Chlorogenic acid isomer II 5-O-Caffeoyl-shikimic acid, 3-Caffeoylquinic acid, 5-Caffeoylquinic acid, 4-Caffeoylquinic acid	
H. sabdariffa	Hydroethanol	Flavonoids and	Kaempferol-3-O- rutinoside, Kaempferol-	Jabeur *et al.* 2017

		phenolic compounds	3-p-coumarylglucoside, Myricetin-pentosylhexoside, Quercetin-3-sambubioside, Quercetin-3-rutinoside, Quercetin- pentosylhexoside	
H. sabdariffa	Aqueous	Phenols, organic acids and anthocyanins	b-Carotene, Anisaldehyde, Arachidic acid, Citric acid, Malic acid Tartaric acid, Glycinebetaine, Trigonelline Anthocyanins, Cyanidin-3-rutinoside, Delphinidin, Delphinidin-3-glucoxyloside.	Dafallah *et al.*1996, Farombi *et al.* 2005, Chen *et al.* 1993, Ali *et al.* 1991, 2005, Kamei *et al.* 2003, Chang *et al.* 2006, Suboh *et al.* 2004, Pool-Zobel *et al.* 1999 and Meiers *et al.* 2001
H. syriacus	Chloroform	-	Hibiscuside, Syringaresinol, Feruloyltyramines, Isoflavonoids, Syriacusins A–C, Pentacyclic triterpene caffeic acid esters, Clemicosin A, C and D, Scopoletin, 8-Hydroxy-5,6,7-trimethoxycoumarin	Yokota *et al.* 1978, Yoo *et al.*1998 and Yun *et al.* 1999
H. taiwanensis	Methanol	-	8-Hydroxy-5,6,7-trimethoxycoumarin, (7*S*,8*S*)-Demethylcariolignan E, Hibiscuwanin A, Hibiscuwanin B, Clemicosin A and C, 9,90 -*O*-Feruloyl-(-)secoisolariciresinol Dehydroconifenyl alcohol, Erythro-cariolignan E, b-Syringaresinol, Hibisculide A, Hibisculide B, Hibisculide C, Hibiscutaiwanin, Hibiscusin, Mansonone H, Uncarinic acid, Myceric acid	Wu *et al.* 2004, 2005
H. tilliaceus	Aqueous	Anthocyanin	Cyanidin-3- glucoside	Lowry *et al.* 1976
H. tilliaceus	Methanolic	Anthocyanin	Cyanidin 3-O-sambubioside	Shikawa *et al.* 2015
H. tilliaceus	Aqueous	Amide	Hibiscusamide	Chen *et al.* 2006
H. tilliaceus	Aqueous	Couamirn	Hibiscusin	Chen *et al.* 2006
H. tilliaceus	Aqueous	Phenols	p-coumaric acid, fumaric acid, kaempferol, kaempferol-3-O-D-galactoside, quercetin and quercetin3-O-D-galactosid	Subramanian *et al.*1973
H. tilliaceus	Methanolic	Phenolic compounds	Ergosta-4,6,8, friedelin, germanicol, glutinol, lupeol, pachysandiol, β-sitosterol, stigmast-4,22-dien-3-one, stigmast-4-en-3-one, stigmasterol and 22-tetraen-3-one	Yang *et al.* 2011
H. tilliaceus	Methanol	Phenolic compound	Catechin, rutin, quercetin, and ellagic acid	Hossain *et al.* 2015

H. tilliaceus	Methanol	Phenolic compounds and organic acids	Stigmasterol, Stigmastadienol, Stigmastadienone, 27-Oic-3-oxo-28-friedelanoic acid, Vanillic acid, Syringic acid, Scopoletin, *N-trans*-Feruloyltiramine, *N-cis*-Feruloyltyramine, b-Sitostenone, Stigmasta-4,22-dien-3-one	Kobayashi, 1976, Singh *et al.* 1984 and Whistler, 1985
H. tilliaceus	Aqueous	Organic acids, phenolic compounds, and flavonoids	Azelaic acid, cleomiscosin C, daucosterol, friedelin, fumaric acid, hibiscolactone, kaempferol, quercetin, rutin, scopoletin, β-sitosterol, succinic acid, syriacusin A and vanillin	Zhong *et al.* 2011
H. tilliaceus	Aqueous	Organic acids and phenolic compounds	Vanillic acid, syringic acid, p-hydroxybenzoic acid, phydroxybenzaldehyde, scopoletin, N-transferuloyltyramine, N-cis-feruloyltyramine, β-sitosterol, stigmasterol, β-sitostenone and stigmasta-4-dien-3- one.	Chen *et al.* 2006
H. tilliaceus	Chloroform	Triterpene	27-oic-3-oxo-28-friedelanoic acid	Li *et al*. 2006
H. vitifolius	Ethenol	Flavonoids	Flavonol bioside	Kunnumakkara *et al*. 2007

PHARMACOLOGICAL ACTIVITIES

Besides being eye-catching morphologically, pharmacological activities of *Hibiscus* are also great source of attraction. The plant shows anti-bacterial, anti-fungal, anti-inflammatory, anti-cancerous, anti-hyperepidemic, anti-glycaemic activities along with various other health related benefits like effect on lipid metabolism, anti-hypertensive effects, effects on hairgrowth and anti-analgesic activities.

Anti-bacterial activity

Hibiscus exhibits anti-bacterial activity against different gram-positive and gram-negative bacteria like *Bacillus cereus, Streptococcus faecalis, Streptococcus aureus, Clostridium sporogenes, Micrococcus luteus, E.coli, Pseudomonas aeruginosa, Klebsiella pneumonia, Serratia marcescens, Proteus vulgaris, Proteus rettgeri, Aeromonas hydrophila, Bacillus subtilis* and many more. Studies have been conducted on different plant parts like leaves, flowers, fruits in different extracts like methanol, ethanol, ethyl acetate and aqueous and almost all the plant parts were found to show anti-bacterial activity, however these extracts did not display same results for all the bacterial strains used for different studies. The results obtained by different researchers have been included in **Table 2** along with plant part and bacterial strain used.

Table 2: Anti-bacterial activity of various species of genus *Hibiscus*

Species	Part used	Solvent used for extraction	Test organism	Observation	Author and year
H. rosa-sinensis	Flower	Methanol and Ethanol	*S. aureus, Streptococcus sp., B. subtillis, E. coli, Salmonella sp, P. aeruginosa*	Highest zone of inhibition is recorded against *B. subtillis* and *E.*	Ruban *et al.* 2012

				coli as (18.86±0.18) and (18.00±1.63) mm respectively shown by methanol extract.	
H. rosa-sinensis	Leaves	Hexane, Ethylacetate, Methanol and Aqueous	*Staphylococcus auresus, B. subtilis, Stretpomyces alboniger, Micrococcus luteus, S. epidermis, Pseudomonas aeruginosa, Bordetella bronchiseptica*	Methanol extract is best solvent showing maximum anti-bacterial activity.	Patel *et al.*2012
H. rosa-sinensis	Leaves and Flower	Methanol	*E. coli, S. aureus*	Zone of inhibition for *E. Coli* and *S. aureus* is 23±1.01 mm and 13.75±0.99 mm respectively.	Tiwari *et al.* 2015
H. rosa-sinensis	Leaves	Aqueous and Methanol	*Bacillus subtilis, S. aureus*	Methanol extract had highest zone of inhibition18.82±0.18 mm against *B. subtilis.*	Udo *et al.* 2016
H. rosa-sinensis	Leaves	Aqueous and ethanol	*P. aeruginosa* and *A. hydrophilla*	Ethanol extracts have maximum antibacterial activity with inhibition zone of 6 to 9 mm against *P. aeruginosa* and *A. Hydrophilla* respectively.	Singh *et al.* 2017
H. rosa-sinensis	Flower	Ethanol, Methanol, Aqueous and Ethylacetate	*E.* coli, *P. aeruginosa, S. aureus*	Maximum antibacterial activity is shown by Methanol extracts against all three bacterial strains.	Sobhy *et al.* 2017
H. rosa-sinensis	Leaves and Silver and gold nanoparticles	Deionized water	*Pseudomonas aeruginosa, Bacillus subtilis, Micrococccus luteus, S. aureus, S. epidermidis, Enterobacter aerogenes, E. coli, S. pneumoniae, Aeromonas hydrophila*	Plant extract shows antibacterial activity gainst test organisms in conc. dependant manner.	Tyagi *et al.* 2017
H. rosa-sinensis	Leaves	Ethanol	*Aeromonas hydrophila*	Highest inhibition zone is11mm.	Vijayaraj *et al.* 2017
H. rosa-sinensis	Leaves	Aqueous	*Aeromonas hydrophila*	Maximum inhibition zone is 24mm at 50% concentration.	Amita *et al.* 2018
H. rosa-sinensis	Leaves	Ethanol, methanol and distilled water	*S. aureus and E. coli*	Methanol extract with 10% and 5% cocn. Had antibacterial activity against all the test organisms.	Vastrad *et al.* 2018
H. rosa-	Flowers	Methanol, water	*E. coli, B. subtilis* and *S. aureus*	Methanolic extract show more	Vijayakumar *et al.*

sinensis		and ethyl acetate		activity than other two solvents against all three bacteria.	2018
H. rosa-sinensis	Flower	Methanol and Ethanol extract	*Klebsiella pneumoniae, Escherichia coli, Bacillus subtilis, Staphylococcus aureus, Pseudomonas aeruginosa and Salmonella sp*.	Methanolic extracts show less anti bacterial activity than Ethanolic extracts.	Singh *et al.* 2019
H. sabdariffa	Green and red calyx	Methanol and water (4:1)	*Bacillus cereus, Streptococcus faecalis, Clostridium sporogenes, Micrococcus luteus, E. coli Pseudomonas aeruginosa, Klebsiella pneumonia, Serrita marcessens, Proteus vulgaris and Proteus rettgeri*	Extract shows largest inhibition zonea gainst *Micrococcus luteus.*	Adebisi *et al.* 2011
H. sabdariffa	Calyces	80% aqueous methanol	*E. coli*	The maximum Zone of inhibition was 12.66mm for 10%, 10.75mm for5% and 8.9mm for 2.5% conc.	Fullerton *et al.* 2011
H. sabdariffa	Fruits	85% methanol	*Sarcina lutea, Shigella dysenteriae, E. coli, Shigella boydii, Bacillus subtilis, B. megaterium, B. anthracis, B. cereus and P. aeruginosa*	Fruit extracts had highest activity against *Sarcina lutea* i.e.13±0.21mm.	Mamun *et al.* 2011
H. sabdariffa	Leaves	Ethanol extract	*Listeria monocytogenes, S. typhimurium, E. coli*	Ethanolic extracts of leaves had effective antibacterial activity against the test organisms.	Zhang *et al.* 2011
*H. sabdariffa*L. (roselle)	Calyces	Aqueous and Ethanol extract	*E. coli, Staphylococcu saureus, Salmonella typhi, Shigella dysenteriae, Streptococcus mutans*	Ethanol extracts have better activity as compared to aqueous extract against all the tested organisms.	Edema *et al.* 2012
H. sabdariffa	Calyces	Water and ethanol	*Bacillus subtilis, S. aureus* and *E. coli*	Ethanol extract exhibit slightly higher activity against *B. subtilis* and *S. aureus* than that of water extract However, Roselle water extract has more activity against *E. coli.*	Jung *et al.* 2013
H. sabdariffa	Calyces	Petroleum ether and ethanol	*Kleibsella pneumoniae, Strephyllococcus aureus, B. cerus, Lactobacillus brevis*	Extracts made in Petroleum ether was most effective against bacteria like *Bacillus cereus, Klebsiella pneumoniae, Staphylococcus aureus and Lactobacillus brevis.*	Das *et al.* 2014

H. sabdariffa	Calyx	Petroleum ether, ethyl acetate, methanol and water.	*Staphylococcus aureus* (ATCC25923), *Bacillus subtilis* (NCTC10073) *Klebsiella pneumonia* (ATCC70063) *and Escherichia coli (*ATCC25922).	The aqueous extracts have the greatest anti-bacterial activity with MICs of 125–250 μg/mL.	Osei *et al.* 2014
H. sabdariffa	Leaves	Aqueous	*Escherichia coli, Klebsiella pneumonia, Staphylococcus aureaus* and *Pseudomonas aeruginosa.*	Extract conc.200μg/mL has maximum activity against *P. aeruginosa.*	Sulaiman *et al.* 2014
H. sabdariffa	Leaves	Methanol	*S. typhi, E. coli* and *S. aureus*	Extract exhibit maximum antibacterial activity against *S. aureus.*	Adamu *et al.* 2015
H. sabdariffa	Calyx	Hexane, Ethyl acetate and Methanol	*E. coli* (ATCC25922), *S. aureus* (ATCC29213), *Pseudomonas aeroginosa* (ATCC27853), *Salmonella typhi, Bacillus subtilis*	500μg/mL is the minimum inhibitory concentration (MIC) against *Escherichia coli* for both ethyl acetate and methanol extracts while hexane extracts show no activity at all.	Ajoku *et al.* 2015
H. sabdariffa	Calyx	Aqueous and hydro ethanol 30%	*E. coli, S. aureus, P. aeruginosa and B. subtilis*	Hydro ethanol extract had more potent anti bacterial activity.	Mensah *et al.* 2015.
H. sabdariffa	Seed coats	Aqueous ethanol, hexane and methanol	*E. coli, S. aureus, S. pneumoniae, K. aerogenes, S. species, P. aeruginosa*	None of the extracts show any antibacterial activity against any test organism.	Nathaniel *et al.* 2015
H. sabdariffa	Leaves and fruits	Methanol	*Streptococcus mutans, Staphylococcus aureus, Escherichia coli and Pseudomonas aeruginosa*	Extract exhibit more anti-bacterial activity against gram positive bacteria than gram negative bacteria.	Sekar *et al.* 2015
H. sabdariffa	Leaves and seeds	Phosphate buffer	*Staphylococcus sp.*	Extract showed maximum zone of inhibition of 9mm.	Thiripurasudari *et al.* 2015
H. sabdariffa	Calyces	80%methanol	*Escherichia coli* ATCC25922, *Salmonella enteric* ATCC5174, *Klebsiella pneumonia ATCC*27736, *Proteus vulgaris* ATCC49132, and *Pseudomonas aeruginosa* ATCC27853, *Staphylococcus aureus* ATCC25923, *Staphylococcus epidermidis* ATCC49461 and *Bacillus cereus*	The maximum antibacterial activity of *H. sabdariffa* calyces extract was recorded against *S. aureus* (18.5±0.5mm).	Abdallah *et al.* 2016

			ATCC10876.		
H. sabdariffa	Calyx	Methanol	*Cornybacterium diptheria*, *S. aureus*, *Enterococcus faeclis*, *Listeria monocytogenes*, *B. cereus*, *Proteus mirabilis*, *Proteus vulgaris*, *Pseudomonas aeruginosa (ATCC27853)*, *Serratia marcescens*, *E. coli (*ATCC25922), *Klebsiella pneumonia* (ATCC70063)	Methanol extracts exhibit more activity against all bacteria with inhibition zone ranging from 14 to 36mm.	Garbi *et al.* 2016
H. sabdariffa	Calyces	Hot and cold aqueous	*S. aureus*	The cold aqueous extract at concentration 40mg/mL was exhibiting the maximum antibacterial activity against tested bacteria.	Salman *et al.* 2018
H. sabdariffa	Calyces	Methanol	*E. coli* (ATCC25922), *P. aeruginosa* (ATCC27853), *K. pneumonia* (ATCC15380), *S. typhi* (ATCC4561), *B. subtilis* (NCTC8236), *S. aureus* (ATCC25923)	Maximum activity was reported against *B. subtilis.*	Youns *et al.* 2018
H. sabdariffa	Flower	Methanol	*Aeromonas hydrophila*	Roselle flower extract had antibacterial activity against *A. hydrophila* in a conc. depenedent manner.	Bariyyah *et al.* 2019
H. sabdariffa	Leaves and stem	80% aqueous methanol	*Staphylococcus aureus*, *Pseudomonas aeruginosa*	Leaf extracts show better activity against *S. aureus* and *P. aeruginosa* than stem extract.	Kumar *et al.* 2019
H. syriacus	Leaves	Petroleum ether, Benzene, Chloroform, Methanol and Aqueous extracts	*Bacillus cereus*, *Staphylococcus epidermis*, *Kleibsiella pneumonia*, *Bacillus subtilis*	Methanol extracts show maximum zone of inhibition against all the test organisms.	Punasiya *et al.* 2014
H. tiliaceus	Leaves and bark	Ethanol	*Staphylococcus aureus*, *S. epidermidis*, *S. saprophyticus*, *S. pyogenes*, *Plesiomonas shigelloides*, *Shigella dysenteriae*, *S. flexneri*, *S. boydii*, *S. sonnei*, *Pseudomonas aeruginosa*,	Bark extract has maximum antibacterial effect against *S. aureus* and *S. epidermidis* among all the test organisms.	Abdul *et al.* 2016

			Vibrio cholera, Salmonella typhi		
H. tiliaceus	Fruits, leaves and twigs	Methanol and chloroform, methanol and ethyl acetate fractions	*Pseudomonasa erouginosa*	The strongest anti-bacterial activities were exhibited by the chloroform fraction of fruits at a conc. of 80%.	Andriani *et al.* 2017

Antioxidant activity

Exploration of antioxidant potential of biological forms like plants has always been of greater interest to the pharmacologist. Higher the antioxidant potential, greater benefits can be drawn out of various medicinal plants like hibiscus. Various parts of plant like leaves, bark, flowers, seeds etc have been well worked out for exploring the antioxidant potential following different assays like DPPH, FRAP, ABTS, H_2O_2, NO etc and the same have been highlighted in this review. The solvents used for the preparations of the plant extracts were mainly water, methanol, ethanol and ethylacetate. Numerous *Hibiscus* species have been well acknowledged for higher Antioxidant potential out of which *H.sabdariffa* and *H.rosa-sinensis* have been well studied however only few reports on *H.asper, H.cannabinus, H. platanifolius* and *H.syriacu*s were found suggesting further explorative studies. The details of the same have been mentioned in Table3 along with the plant part used, assay followed and observations.

Table3: Antioxidant activity of various species of genus *Hibiscus*

Species	**Part used**	**Solvent used for extraction**	**Assay performed**	**Observations**	**Author and year**
H. acetosella	Stem	Water and ethanol (70/30)	DPPH	IC50 value for stem extracts is 44μg/mL.	Abdoulaye *et al.* 2018
H. asper	Leaves and calyx	80% methanol	DPPH	Calyx extract had higher % inhibition (53.33-0.25%) against DPPH radical than leaf extract (36.33-0.45%).	Gbadamosi *et al.* 2018
H. cannabinus	Leaves, bark, flowers and seeds	Water	DPPH	Methanol extract of flower (71.84%) exhibit maximum DPPH activity.	Ryu *et al.* 2017
H. cannabinus	Leaves	Ethanol	DPPH	IC50 value for ethanol extract is 44.48μg/mL.	Rusmini *et al.* 2019
H. platanifolius	Leaves	Ethanol and Aqueous	Reducing power and hydrogen peroxide scavenging assay	Ethanol extract shows radical scavenging activity in conc. dependent manner.	Saravanan *et al.* 2011
H. rosa-sinensis	Flower	Methanol	DPPH	IC50 value for methanol extract is 43.9µg/mL.	Falade *et al.* 2009
H. rosa-	Leaves	80%ethanol	Ferric thio cyanate, Hydrogen	Crude extract of leaves exhibits potent antioxidant	Mandade *et al.*

sinensis			peroxide scavenging, DPPH, ABTS radicals' cations and Super oxide an ion radical scavenging by riboflavin methionine illuminate system	activity against all the studied assay.	2011
H. rosa-sinensis	Flower	Ethanol	SOD, GPx, CAT	Ethanol extract at 250mg/kg conc. was more effective than other two doses.	Sankaran *et al.* 2011
H. rosa-sinensis	Stem and leaves	Aqueous and methanol	DPPH reduction assay, scavenging of SO, H2O2 and NO, reducing power, FRAP assay.	Methanol extract possesses significant antioxidant activity as compared to aqueous extract.	Garg *et al.* 2012
H. rosa-sinensis	Leaves	70% ethanol/water extract	Butylated hydroxyl toluene (BHT), Ascorbic acid (ASA)	Extract has two times more antioxidant activity than BHT and ASA.	Ghaffar *et al.* 2012
H. rosa-sinensis	Flowers	Methanol	DPPH	100µg/mL varies between 30.95 to 55.11% scavenging effect.	Sheth *et al.* 2012
H. rosa-sinensis	Root	Aqueous	Super oxide anions and Hydroxyl radicals	The effect was dose dependent and highest i.e.58% for SO and 48% for hydroxylion at peak concentration (500mg/mL).	Kumar *et al.* 2013
H. rosa-sinensis	Petals	Ethanol and ethyl acetate fraction	DPPH	IC50 value for ethanol extract is 36±1.7 µg/mL.	Pillai *et al.* 2014
H. rosa-sinensis	Corolla and calyx	Methanol extract	Ferric ion Reducing PowerAssay [FRAP] Nitric Oxide Scavenging assay	Maximum % inhibition of calyx extracts 66.66% and Corolla is 71.25% against NO.	Guleria *et al.* 2015
H. rosa-sinensis	Flower	Water, ethanol, and absolute ethanol extract	DPPH, Nitric oxide, hydroxyl radical scavenging activity	Flower extract against DPPH show highest activity of 90.20±0.29% at 500mg/ml conc.	Afifty *et al.* 2016
H. rosa-sinensis	Leaves	Ethanol	DPPH, Nitricoxide, Superoxide radical	Extract conc.i.e.1000µg/mL has maximum% inhibition i.e. 91.15±1.32% for DPPH, 86.45±2.09 for NO and 79.12±1.56 for super oxide radicals.	Mondal *et al.* 2016
H. rosa-sinensis	Flowers	Methanol	DPPH, hydrogen peroxide and superoxide radical scavenging activity	The extract showed IC50 values of 28.41±1.7, 36.69±2.3 and 33.32±2.5 µg/mL against DPPH, H2 O2 and superoxide radical respectively.	Purushotaman *et al.* 2016
H. rosa-sinensis	Flower	Ethanol	Hydrogen peroxide scavenging assay	The flower extract exhibits a concentration dependent hydrogen peroxide radical scavenging	Ghosh *et al.* 2017

				activity.	
H. rosa-sinensis	Leaves	Aqueous and Ethanol	DPPH, NO, FRAP and H_2O_2	DPPH 11.8mg/g, NO 66.8, FRAP 15.4, H_2O_2 23.04mg/g.	Prasanna *et al.* 2017
H. rosa-sinensis	Leaves	Mucilage from leaves	FRAP, DPPH, hydroxyl, superoxide, nitricoxide and hydrogen peroxide scavenging assay.	The mucilage showed antioxidant potential against all the assays, but it was detected to belower as compared to the standards used.	Vignesh *et al.* 2018
H. rosa-sinensis	Flower	Methanol and Ethanol extract	DPPH	IC50 value for methanol extract is maximum i.e.19.54µg/mL.	Singh *et al.* 2019
H. rosa-sinensis	Flower	Ethanol extract	DPPH	IC50 value for the ethanol extract is 231.110±1.59µg/mL.	Wahid *et al.* 2019
H. sabdariffa	Calyces	Methanol	DPPH	IC50 for the extract is 230.01±2.40µg/mL.	Luvongal *et al.* 2010
H. sabdariffa	Leaves	Ethanol	DPPH	Anti radical power 0.41mg DPPH/mg.	Zhang *et al.* 2011
H. sabdariffa	Leaves	Aqueous, 95 percent ethanol, ethyl acetate fraction	DPPH	IC50 values for the extracts is ranging from 46.13±0.37 to 94.16± 0.56µg/mL.	Kumar *et al.* 2012
H. sabdariffa	Calyces	Water and ethanol extract	DPPH	Dose dependent activity is shown by both the extracts.	Jung *et al.* 2013
H. sabdariffa	Calyces	Ethanol, methanol, petroleum ether and aqueous	DPPH	Petroleum ether extract show better activity as compared to all other solvents used.	Das *et al.* 2014
H. sabdariffa	Petal	Methanol	DPPH	IC50 is 0.24mg/mL.	Obouayeba *et al.* 2014
*H. sabdariffa*L.	Calyx	Ethanol extract	DPPH	At a conc.250µg/mL calyx extract has maximum 86% scavenging activity.	Sirag *et al.* 2014
*H. sabdariffa*l.	Flower	Methanol	DPPH and ABTS assay	IC50 for DPPH and ABTS were 17.14-2.24 and 85.91-6.72µg/mL respectively.	Zhang *et al.* 2014
H. sabdariffa	Leaves and calyx	Methanol extract	DPPH	IC50 for leaves is 43.48 and for calyces is 37.15µg/mL.	Formagio *et al.* 2015
*H. sabdariffa*L.	Calyx	Ethanol	FRAP and DPPH	The DPPH radical scavenging activity of ethanol extracts is dose dependent and ranged between 14.09 to 35.92% The FRAP value of calyx extract	Ghosh *et al.* 2015

				was 0.784±0.01mg ascorbic acid equivalent/g.	
H. sabdariffa	Calyx and callus	Methanol	DPPH	Calyx extract shows more antioxidant activity as compared to callus extract.	Kouakou *et al.* 2015
H. sabdariffa	Calyx	Aqueous and 30% hydro ethanol	DPPH and hydroxyl radical	A dose-dependent radical scavenging of hydroxyl radicals was observed for each extract.	Mensah *et al.* 2015
H. sabdariffa	Leaves	Ethanol	DPPH	IC50 value is 184.881g/Ml at a conc.50.01g/mL.	Subhaswaraj *et al.* 2017
H. sabdariffa	Flower	Methanol	DPPH, ABTS, FRAP assay	IC50 for DPPH is 195.73µg/mL, ABTS is 74.58 and 46.24µM fe (II)/µg for FRAP.	Widowati *et al.* 2017
*H. sabdariffa*L.	Silver nano particles from bark extract	Methanol	DPPH and ABTS	DPPH and ABTS assays have IC50 31.74±2.06 and 15.45±2.72µg/mL respectively.	Islam *et al.* 2018
H. sabdariffa	Calyces	Methanol	DPPH	Percentage inhibition activity shown by the extract is 53±0.09%.	Youns *et al.* 2018
H. sabdariffa	Calyx	Methanol	DPPH	DPPH radical scavenging activity was reported maximum in genotype 4920 i.e.95.09%.	Jamini *et al.* 2019
H. schizopetalus	Flower	Methanol	DPPH	IC value 50 is 38.2± 0.08µg/mL.	Zahid *et al.* 2014
	Leaves	Methanol	DPPH	IC 50 is 58.9± 0.13µg/M.	
	Flower	Methanol	Nitric oxide	Flower extract showed 80.70% antioxidant activity.	
	Leaves	Methanol	Nitric oxide	Leaf extract showed 75.2% antioxidant activity.	
H. syriacus L.	Leaves	Methanol	DPPH, Superoxide radical scavenging activity in NBTsystem, reducing power and Inhibition of lipid peroxidation induced by TBARS in liver homogenate.	EC50 value is 248.00 and 105.00µg/mL for DPPH and superoxide radicals respectively and EC50 for lipid peroxidation of liver homogenate is 281.61µg/mL.	Umachig *et al.* 2008

Anti-fungal activity

Besides anti-bacterial activity, *Hibiscus* also illustrates anti-fungal behaviour against various detrimental genera of fungi like *Candida albicans*, *Aspergillus niger*, *Tricoderma viride*, *Rhizopus microsporous* and *Trichophyton mentagrophytes*. Plant parts used as well as the extracts used for the studies were like those used in anti-bacterial studies. Comparative analysis of potential of plant extracts in different solvents

was also done by different researchers but positive results were obtained only in few solvents against different genera of fungi. All the results are depicted in **Table 4** reflecting anti-fungal properties of *Hibiscus***.**

Table 4: Anti-fungal activity of various species of genus *Hibiscus*

Species	Part used	Solvent used for extraction	Organism used	Observations	Author and year
H. rosa-sinensis	Leaves	Aqueous, Ethanol, Methanol	*Trichophyton rubrum, Candida albicans*	Ethanol extract showed maximum antifungal activity among all three solvents used.	Das *et al.* 2015
H. rosa-sinensis	Flower	Acetone	*Candida albicans, Aspergillus niger, Tricoderma viride, Rhizopus microsporous*	Maximum zone of inhibition for *Candida albicans* is 20mm, *Aspergillus niger* is16mm *Trichoderma viride* is 12mm and *Rhizopu smicrosporus* is 21mm.	Durga *et al.* 2018
H. sabdariffa	Calyces	80% ethanol	*Candida albicans*	Zone of inhibition for *Candida albicans* is 45.0±0.4 mm.	Edema *et al.* 2012
H. sabdariffa	Calyx	Hexane, Ethylacetate, Methanol	*Candida albicans*	The ethyl acetate fraction exhibited most significant antifungal activity against *Candida albicans* at MIC of 16*µg*/mL.	Ajoku *et al.* 2015
H. sabdariffa	Calyx	Aqueous and hydroethanol 30%	*Candida albicans*	Hydro ethanol extract is more potent antifungal extract.	Mensah *et al.* 2015
H. sabdariffa	Calyces	Methanol	*Candida albicans* (ATCC7596786)	Extract has maximum inhibition zone of 21mm against *Candida albicans.*	Youns *et al.* 2018
H. syriacus gagoma	Root	Methanol	*Trichophyton mentagrophytes*	Methanolic extract of *H. syriacus* gagoma exhibited four times higher activity than its parent against *Trichophyton mentagrophytes.*	Jang *et al.* 2012

Anti-canceractivity

Different cell line studies revealed anti-cancer activities of *Hibiscus*. *H. sabdariffa* is maximum explored member in this regard displaying positive results. Different cell lines like human cancer, Hela cell lines, Leukemia line k-562, hepG2 etc.were used for these

demonstrating the anti-cancer activity of different parts of *Hibiscus* like flower, leaves, calyx, roots, fruit, bark etc. All these details are presented in **Table No.5**.

Table 5: Anti cancerous activity of various species of genus *Hibiscus*

Species	**Activity**	**Part used**	**Organism used**	**Observations**	**Author and year**
H. cannabinus L.	Cytotoxic activity	Seeds extract and seed oil	Human cancer cell lines	Seed extract exhibited a greater cytotoxic activity as compared to seed oil.	Wong *et al.* 2014
H. calyphyllus, *H. deflersii*, *H. micranthus*	Anti-cancer	Aerial parts	HepG2, MCF-7 cell lines	*H. deflersii* petroleum ether fraction showed the most significant cytotoxic effect on HepG2 and MCF-7 with IC50 14.4 and 11.1µg/mL, respectively.	Alam *et al.* 2018
H. rosa-sinensis	Anti cancer activity	Flower	Hela cell lines	Flower extract exhibited potent anti cancer activity against helacell lines.	Durga *et al.* 2018
H. sabdariffa	Cytotoxicity	Fruits	Brine shrimp lethality bioassay	LC value for fruit extract is 5.082±12 µg/mL.	Mamun *et al.* 2011
H. sabdariffa L.	Anti-tumour activity	Seeds	Human cervical hela cells	Percentage inhibition against hela cell lines reached upto 83.67±3.07% at 20µg/mL concentrations.	Zhang *et al.* 2014
H. sabdariffa	Anti-tumor activity	Leaves and calyx	Leukaemia line k-562	Methanol extract from calyx show significant antitumor activity.	Formagio *et al.* 2015
H. sabdariffa	Cytotoxicity	Seeds	H9c2 cardiomyoblast cells	Pre-treatment with seed extract significantly reduced cell apoptosis at concentration of 31.25-250*µg*/mL.	Hosseinia *et al.* 2017
H. sabdariffa	Anti-proliferative	Calyx	Caco-2, hepG-2, HCT8 and A549 cell lines	Calyx extract has significant cytotoxic activity.	Maciela *et al.* 2018
H. sabdariffa	Cytotoxic activity	Leaves	HepG2 cell lines	Administration of leaf extract showed increased cell growth inhibition and decreased cell viability in a dose dependent manner.	Sangeetha *et al.* 2018
H. syriacus	Anti proliferative effect	Root bark	Human lung cancer cells	Acetone extract of *H. syriacus* has potent and dose dependent anti proliferative activity.	Cheng *et al.* 2008
H. tiliaceus	Cytotoxic effect	Leaves and bark	Brine shrimp	Leaf extract of plant has moderate cytotoxic activities with LC50 is 20µg/mL while bark has low cytotoxic effect LC50 is 50µg/mL.	Abdul *et al.* 2016
H. vitifolius	Cytotoxic	Flowers	Hela cell lines	IC50 value agains thella cell lines is 81.27µg/mL.	Nishitha

	activity				*et al.* 2018

SOME OTHER MEDICINAL PROPERTIES

Besides aforementioned activities, *Hibiscus* also displays excellent health benefits like effects on lipid metabolism where rat, rabbit, mice were used for experimental studies and positive behaviour of the *Hibiscus* extracts was elucidated (**Table 6.1).** Similar studies were conducted by various researchers to demonstrate hepatoprotective activity of *Hibiscus* where extracts were known to regulate essential liver enzymes like Aspartate aminotransferase (AST), Alanine transaminase (ALT), Serum glutamic oxaloacetic transaminase (SGOT), Serum glutamic pyruvic transaminase (SGPT) (**Table 6.2**). The plant extracts also showed anti-inflammatory properties as depicted in **Table 6.3.** A significant dose dependent analgesic behaviour of the extracts was observed and the same has been presented in **Table 6.4**. Morphine like activity of the *Hibiscus* extracts was reported by few reports. Effect of the extracts on blood cells like RBCs and WBCs was also observed where the extracts were seen to enhance the blood cell count (**Table 6.5**). Maintenance of blood sugar levels by the extracts was also observed and the extracts exhibit antidiabetic properties which are of greater use and can be considered subject of exploitation for commercial uses (**Table 6.6)**. Reduction in Hypertension levels by the extracts were observed by various researchers and the same has been presented in **Table 6.7**.

Table 6: Other medicinal activities of various species of genus *Hibiscus*

6.1: Effect on lipid metabolism

Species	Activity	Part used	Organism used	Observations	Author and year
H. platanifolius	Hypoglycaemic and hypolipidemic activity	Leaves	Rats	Administration of extract dose of 100 mg and 150mg/kg helps to decrease the increased biochemical parameters in all diabetic rats.	Saravanan *et al.* 2011
H. rosa-sinensis	Lipid lowering effect	Flower petals	Albino Rats	After administration of flower extract, the levels of free fattyacids, phospholipids TG, VLDL, LDL and HDL cholesterol were back to nearly normal.	Gomathi *et al.* 2008
H. rosa-sinensis	Hypoglycaemic and hypolipidemic activity	Flower	Rats	500mg/kg/day dose showed potent hypoglycaemic and hypolipidemic activities.	Bhasker *et al.* 2011
H. rosa-sinensis	Anti-hyperlipidaemic activity	Leaves	Mice	500mg/kg dose of methanol extract showed decrease in levels of cholesterol, triglyceride, and low-density lipids.	Mishra *et al.* 2011
H. rosa-sinensis	Hypoglycaemic and hypolipidemic activity	Flowers	Rats	The decreased levels of blood glucose, carbohydrate metabolizing enzymes, TBARS, and lipid profiles were found after the administration of flower extract.	Sankaran *et al.* 2011
H. rosa-sinensis	Antihyperlipidemic activity	Flowers	Rats	Oral dose of 500mg/kg body wt. of the ethanolic extract exhibited a significant reduction ($p<0.01$) lipid parameters, LDL, VLDL total cholesterol, triglycerides and increase in HDL in rat serum.	Sikarwar *et al.* 2011
H. rosa-sinensis	Hyperlipidaemic activity	Leaves	Rabbits	After treatment with 400mg/kg dose of extract, decrease in total cholesterol, triacylglycerol, low-density lipoprotein cholesterol and high-density lipoprotein cholesterol in diabetic rabbits is observed.	Ojiako *et al.* 2013
H. rosa-sinensis	Hypolipidemic properties	Flower	Albino Wistar Rats	240mg/kg dose has significant hypolipidemic activity.	Biswas *et al.* 2014
H. rosa-sinensis	Hypoglycaemic effect	Leaves	Rats	The treatment of diabetic rats with leaf extract helps to reduce the amount of plasma alanine amino transferase (ALT) enzyme, glucose, cholesterol, aspartate amino transferase (AST) enzyme, uric acid, creatinine and hepatic malon dialdehyde.	Zaki *et al.* 2017
H. sabdariffa	Hypolipidemic activity	Leaves	Hyperlipidic rats	300 mg per kg dose possessed the best hypolipidemic activities.	Gosian *et al.* 2010
H. sabdariffa	Hyperglycaemia,	Calyces	Rat	A dose of 200mg/kg showed significant results against	Peng *et al.* 2011

	hyperinsulinemia, and hyperlipidaemia activity			Hyperglycaemia, hyperinsulinemia, and hyperlipidaemia activities.	
H. sabdariffa	Hypoglycaemic and hypolipidemic effects	Leaves	Rats	A significant ($p<0.05$) reduction in levels of serum cholesterol, triglycerides. LDL-cholesterol and increase in HDL-cholesterol was observed.	Ndarubu *et al.* 2019
H. sabdariffa	Hypolipidemic effect	Calyces	Albino rats	Administration of plant extract lowers the serum lipid levels.	Gaffer *et al.* 2019
H. schizopetalus (Mast) Hook	Hypolipidemic activity	Flowers and leaves	Rats	Cholesterol and triglycerides levels were significantly decreased after the administration of plant extracts.	Zahid *et al.* 2014
6.2: Hepato-protective activity					
H. esculentus	Hepato-protective activity	Pods	Wistar albino rats	Administration of pod extract showed reduction in liver enzymes like SGOT, SGPT, ALP, cholesterol, TG and malondialdehyde, non-protein sulfhydryl sowing to its hepatoprotective activity.	Alqasoumi *et al.* 2008
H. rosa-sinensis	Hepato-protective activity	Leaves	Albino rats	Leaf extracts have significant hepatoprotective activity, where enzymes like ALT, AST, ALP and total bilirubin were decreased.	El-Sayed *et al.* 2018
H. sabdariffa	Hepato-renaltoxicity	Calyx	Albino rats	After the treatment with extract significant increase was observed in the renal indices, urea, uric acid and creatine but sodium and potassium were decreased.	Abubakar *et al.* 2010
H. sabdariffa	Hepato-protective activity	Leaves	Rats	Oral administration of extract exhibits a potent reduction in AST, ALP, ALT and bilirubin levels.	Bhavana *et al.* 2017
H. sabdariffa	Hepato-curative effect	Leaves	Albino rats	Increase the levels of blood in dose dependent manner.	Joshua *et al.* 2017
H. sabdariffa	Ethanol induced hepatotoxicity	Leaves	Rats	Levels of SGOT, SGPT and bilirubin were decreased after the treatment with leaf extract.	Olanrewaju *et al.* 2017
H. vitifolius (Linn.)	Hepato-toxicity activity	Root	Albino rats	The extracts were found to be safe upto a dose of 2000mg/kg but higher than this were toxic.	Samuela *et al.* 2012
6.3: Anti-inflammatory activity					
H. asper hook. F.	Anti-inflammatory	Leaves	Wistar albino rats	Methanolic extract has significant dose dependent activity.	Simplice *et al.* 2011
H. cannabinus	Anti-inflammatory	Seeds	Mice	Maximum effect at 400mg/kg dose was observed.	Chaudhari *et al.* 2015
H. rosa-sinensis and *H. rosa-*	Anti-inflammatory	Flower and leaf	Rats	Dose up to 500mg/kg is not toxic. The white hibiscus had more potent anti-inflammatory effect.	Raduan *et al.* 2013

sinensis alba					
H. sabdariffa	Anti-inflammatory	Calyx	Wistar rats	All the administered doses revealed anti-inflammatory effect.	Saptarini *et al.* 2013
H. sabdariffa	Anti-inflammatory	Seeds	Rats	Extract showed a significant dose dependent anti-inflammatory activity.	Ali *et al.* 2014

6.4: Analgesic activity

H. cannabinus	Analgesic activity	Seeds	Mice and rats	Seed extracts had central and peripheral analgesic activities.	Chaudhari *et al.* 2015
H. rosa-sinensis	Analgesic potentials	Roots	Albino rats	Root extracts showed significant dose dependent activity.	Soni *et al.* 2011
H. sabdariffa	Analgesic activity	Leaves	Wistar albino rats	A dose of 750mg/kg of extract showed analgesic potency as similar as morphine.	Omodamiro *et al.* 2018
H. sabdariffa	CNS stimulant activity	Flowers	Albino rats	Increase in the locomotory activity proved that the extract has the CNS Stimulant activity.	Gresamma *et al.* 2019

6.5: Haemato-toxicity

H. cannabinus	Haematinic activity	Leaves	Rats	A Significant increase in the red blood count, haemoglobin concentration and pack cell volume was observed after extract administration.	Agbor *et al.* 2005a
H. rosa-sinensis	Haemato-protective	Flowers	Rats	Exhibit significant Haemato-protective activity.	Meena *et al.* 2014
H. rosa-sinensis	Anti-haemolytic activity	Flowers	Venous blood samples	The extract had the ability to reduce hydrogen peroxide induced haemolysis.	Purushotaman *et al.* 2016
H. sabdariffa	Haemato-toxicity	Calyces	Rats	After administration of extract increased levels of RBC, haemoglobin and decreased levels of WBC were observed.	Famurewa *et al.* 2015

6.6: Anti-diabetic activity

H. platanifolius	Anti-diabetic activity	Stem	Rats	Ethanolic extract of stems at 250mg/kg dose revealed a decrease in blood glucose level.	Raghavendra *et al.* 2016
H. rosa-sinensis	Anti-diabetic	Leaves	Rats	Upon treatment with leaves extract Diabetic rats blood glucose was elevated to normal values.	Anandhi *et al.* 2013
H. rosa-sinensis	Effect on diabetes	Flower	Rats	Administration of flower extracts decreased blood glucose levels.	Afiune *et al.* 2017
H. sabdariffa	Anti-diabetic	Leaves,	Rats	Leaf extract Reduce sugar level in rats more significantly than	Ojewumi *et al.*

		stem, roots		stem and root extracts.	2013
H. syriacus	Anti-diabetic	Leaves	Rats	Treatment with leaves extract showed a decrease in blood glucose level.	Nirosha *et al.* 2014

6.7: Anti-hypertensive activity

H. sabdariffa	Anti-hypertensive activity	Calyces	Rats	Extract administration helps to reduce hypertension.	Nkumah *et al.* 2015
H. sabdariffa	Hypertension	Leaves	Wistar rats	Extract revealed anameliorative effect against hypertension.	Balogun *et al.* 2019

CONCLUSION

In conclusion this survey features the therapeutic capability of various species of genus *Hibiscus*. Due to the presence of its extraordinary mix of various phytochemicals like phenols, flavonoids, tannins, sterols, glucosides, lignin, anthocyanin and many more, which could be additionally surveyed and exposed to clinical preliminaries for their legitimate approvals. The enormous information in regards to the traditional uses and pharmacological impacts of genus *Hibiscus* has already been added to the existing data base by means of this article but at the same time capabilities of certain more species of the genus is not get disclosed so this can be considered as future possibilities that should be worked out.

ABBREVIATIONS

DPPH:α, α- diphenyl-β-picrylhydrazyl; **FRAP:** Ferric reducing antioxidant power; **ABTS:** 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid); **H_2O_2:** Hydrogen peroxide; **NO:** Nitric oxide; **SOD:** Superoxide dismutase; **GPx:**Glutathione Peroxidase; **CAT:** Chloramphenicol acetylransferase; **MIC:** Minimum inhibitory concentration; **TBARS:** Thiobarbituric acid reactive substance assay;**TG:** Triglycerides; **VLDL:** Very low density lipids; **LDL:**Low density lipids; **HDL:** High density lipids; **AST:** Aspartate amino transferase; **ALT:** Alanine transaminase; **SGOT:**Serum glutamic oxaloacetic transaminase; **SGPT:**Serum glutamic pyruvic transaminase; **WBC:** White blood cells; **RBC:** Red blood cells; **IC50:**Inhibitory concentration 50.

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