The Traditional Uses, Phytochemistry and Pharmacology of Genus Hibiscus: A Review

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Authors’ contributions

This work was carried out in collaboration among all authors. Authors MK and DS designed the study and analysed. Authors GK, NK, CS and KB interpreted and prepared the manuscript. All authors read and approved the final manuscript.

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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 Sri Lanka 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 ethno-botanical uses and pharmacological activities so as to find some advanced research opportunities in this field. The given information on the ethno-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

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websites other published literature and unpublished Ph.D. thesis and M.Sc.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. tiliaceus*, *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.

**Graphical Abstract:**

- **Most Common species**
  - *H. rosa-sinensis*, *H. sabdariffa*

- **Less common species**
  - *H. syriacus*, *H. mutabilis*,
  - *H. tiliaceus*, *H. schizopetalous*

**Ethnobotanical uses**
- Cure for:
  - Hypertension
  - Cardiac diseases
  - Stomach ache
  - Urine problem
  - Hair problems
  - Skin diseases

**Pharmacological activities**
- Anti-inflammatory
- Anti-bacterial
- Anti-diabetic
- Anti-obesity
- Anti-proliferative
- Anti-ulcer
- Hypo lipidemic
- Hepatoprotective
- Nephroprotective

**Phytoconstituents**
- Antioxidants
- Phytosterols
- Saponins
- Lignin
- Anthocyanins
- Glycosides

**Keywords:** Hibiscus; phytoconstituents; pharmacognosy; pharmacology; traditional uses; ethnobotany; anti-bacterial; antioxidant; anti-fungal; anti-cancer activity; Hibiscus schizopetalous; Hibiscus rosa-sinensis; Hibiscus radiates; Hibiscus sabdariffa; Hibiscus syriacus; Hibiscus mutabilis.

**ABBREVIATIONS**

- **DPPH**: α, α'-diphenyl-β-picrylhydrazyl.
- **FRAP**: Ferric reducing antioxidant power
- **ABTS**: 2, 2'-azino-bis-(3-ethylbenzothiazoline-6-sulfonic acid)
- **H₂O₂**: Hydrogen peroxide
- **NO**: Nitric oxide
- **SOD**: Superoxide dismutase
- **GPx**: Glutathione Peroxidase
- **CAT**: Chloramphenicol acetyltransferase
- **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.
1. 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 [1]. 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 [2]. 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 [3]. Because plant-based medicines are organic in origin and have less or no side effects as compared to all opathic medicine, their use has increased, which monetarily stands about US$120 billion, and is expected to reach US$7 trillion by 2050 [4]. The primary benefits of using the plant-derived medicines are more beneficial because they are readily affordable and accessible [5]. For the discovery of new more effective bio-therapeutic agents, the interest is increasing to find the chemical composition of plants [6]. The various parts of this plant have been known to contain numerous medicinal properties like antihyperlipidemic, antiproliferative, antioxidant, antimicrobial, anti-inflammatory and other pharmological properties [7]. This review will focus on the phytochemistry and pharmacological properties of Hibiscus in detail.

2. 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 [Fig.1].

2.1 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 phytoc compounds 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 phytoc compounds 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.

| Chart 1. Taxonomic classification |
|-----------------|-----------------|
| **Botanical name** | **Hibiscus** |
| Domain           | Eukaryota       |
| Kingdom          | Plantae         |
| Subkingdom       | Tracheobionta   |
| Phylum           | Tracheophyta    |
| Subphylum        | Spermatophylla  |
| Class            | Magnoliopsida   |
| Sub class        | Dilleniaceae    |
| Super order      | Rosanae         |
| Order            | Malvalces       |
| Family           | Malvaceae       |
| Sub family       | Malvoideae      |
| Tribe            | Hibisceae       |
| Genus            | Hibiscus L.     |
Fig. 1. A) *Hibiscus schizopetrous*; B) *H. rosasinensis*; C) *H. radiates*; D) *H. sabdariffa*; E) *H. syriacus*; F) *H. mutabilis*

2.2 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.

2.2.1 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.

2.2.2 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,
### 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 |
| | Cientfuegosia cuneiformis (DC.) Hochr. |
| | Fugosia cuneiformis (DC.) Benth. |
| Hibiscus eetveldeanus De Wild. & T. Durand | Hibiscus acetosella Welw. ex Hiern |
| Hibiscus elatus Sw. | Talipariti 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 | Talipariti glabrum (Matsum. ex Nakai) Fryxell |
| Hibiscus hakeifolius Giord. | Alyogyne hakeifolia (Giord.) Alef. |
| | Cientfuegosia hakeifolia (Giord.) Hochr. |
| | Fugosia hakeifolia (Giord.) Hook. |
| Hibiscus hamabo Siebold & Zucc. | Talipariti hamabo (Siebold & Zucc.) Fryxell |
| Hibiscus hastatus L. f. | Talipariti hastatum (L. f.) Fryxell |
| Hibiscus laevis All. | Hibiscus militaris Cav. |
| Hibiscus lampas Cav. | Thespesia lampas (Cav.) Dalzell |
| Hibiscus macrophyllus Roxb. ex Hornem. | Talipariti macrophyllum (Roxb. ex Hornem.) Fryxell |

### 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. [8] |
| H. cannabinus L. | Africa | Stem peels | To cure fatigue and anaemia | - | Agbor et al. [9] and Lee et al. [10] |
| H. cannabinus | Kwa Nibela, peninsula, St Lucia, South Africa | Whole plant | To cure chicken pox | Boiled juice | Kokwaro, [11] and Williams, [12] |
| H. linarifolius wild | Nigeria | Leaves | Treatment of Typhoid fever | Decoction | Borokini et al. [13] |
| H. macrophyllus Roxb. | Tripura, India | Leaves and Flower | To cure cough and sexual problems | - | Sen et al. [14] |
| Species               | Country/Region         | Plant part used       | Traditional uses                                              | Proportional administration | References              |
|----------------------|------------------------|-----------------------|---------------------------------------------------------------|-----------------------------|-------------------------|
| *H. rosa-sinensis*   | Guimaras island, Phillipines | Flower                | To cure boils                                                 | Crush and apply as poultice | Ong et al. [15]         |
| *H. rosa-sinensis*   | Bangladesh             | Flower                | Regulation of menstrual cycle                                 | Decoction                   | Alam, [16]              |
| *H. rosa-sinensis*   | China                  | Flower and Bark       | Emmenagogue                                                   | Hot water extract           | Burkhill, [17] and Pardo et al. [18] |
| *H. rosa-sinensis*   | Cook Islands           | Flower and leaves     | Ailing infants, Gonorrhea                                     | Hot water extract           | Whistler, [19]          |
| *H. rosa-sinensis*   | East Indies            | Flower and leaves     | Regulate menstruation produce abortion. To stimulate expulsion of afterbirth | Hot water extract of flower. | Burkhill, [17]          |
| *H. rosa-sinensis*   | Fiji                   | Leaves                | Digestion, Diarrhea                                           | Juice                       | Singh, [20]              |
| *H. rosa-sinensis*   | French Guiana          | Flowers               | Grippe                                                        | Hot extract                 | Luu, [21]               |
| *H. rosa-sinensis*   | Ghana                  | Peeled Twig           | Chewstick                                                     | -                           | Adu-Tutu et al. [22]    |
| *H. rosa-sinensis*   | Guadeloupe             | Flowers               | Sodonic, Anti-tussive                                         | Hot extract                 | Vitalyos, [23]          |
| *H. rosa-sinensis*   | Guan                   | Leaves                | To Promote draining of abscesses                              | -                           | Haddock, [24]           |
| *H. rosa-sinensis*   | Haiti                  | Leaves and Flowers    | Flu & cough, stomach pain, Eye problems                      | Decoction                   | Kobayashi, [25]         |
| *H. rosa-sinensis*   | Hawaii                 | Flowers               | Lactation                                                     | -                           | Nath et al. [26]        |
| *H. rosa-sinensis*   | India                  | Stem and Flowers      | Abortion, Antifertility, Contraceptive, Diuretic, Menorrhagia, bronchitis, Emmenagogue, Demulcent, Cough, Abortifacient | Hot water extract           | Nath et al. [26], Tiwari et al. [27], Maheswari et al. [28], Jain et al.[29], Malihi et al.[30], Reddy et al. [31], Dixit, [32] and Hemadi et al.[33], Dixit, [34] and Van et al.[35] |
| *H. rosa-sinensis*   | Indonesia              | Leaves and Flowers    | Menstruation, Abortion, Emmenagogue, Women in labor          | Juice                       | Quisumbing, [34] and Van et al.[35] |
| *H. rosa-sinensis*   | Japan                  | Leaves                | Anti-diarrhoeal                                               | Decoction                   | Shimizu et al. [36]     |
| *H. rosa-sinensis*   | Kuwait                 | Flowers               | Aphrodisiac                                                  | -                           | Alami et al. [37]       |
| *H. rosa-sinensis*   | Malaysia               | Roots and Flowers     | Fever, Expectorant, Emmenagogue                              | Hot water extract           | Burkhill, [17] and Hooper, [38] |
| *H. rosa-sinensis*   | Mexico                 | Barks and leaves      | Dysentery                                                    | Infusion                    | Zamora-Martinez, [39]   |
| *H. rosa-sinensis*   | Nepal                  | Roots                 | Cough                                                        | Hot water extract           | Suwal, [40]             |
| *H. rosa-sinensis*   | New Britain            | Flowers               | Menstruation                                                 | Hot extract                 | Holdsworth, [41]        |
| *H. rosa-sinensis*   | New Caledonia          | Flowers               | Abortifacient                                                | Decoction                   | Holdsworth et al. [42]  |
| *H. rosa-sinensis*   | Northern Ireland       | Flowers               | To induce labor                                              | Water extract               | Ramirez et al. [43]     |
| *H. rosa-sinensis*   | Peru                   | Flowers               | Contraceptive, Emmenagogue                                  | Hot water extract           | Pardo et al.[18]        |
| *H. rosa-sinensis*   | Philippines            | Flowers               | Bronchial Catarrh, Emmollients,                              | Hot water extract           | Watt et al. [44]        |
| Species                  | Country/Region           | Plant part used               | Traditional uses                                                                 | Proportional administration | References                  |
|-------------------------|--------------------------|-------------------------------|----------------------------------------------------------------------------------|-----------------------------|-----------------------------|
| *H. rosa-sinensis*      | Trinidad                 | Flowers                       | Cancerous, Swellings, Amenorrhea                                                | Decoction                   | Wong, [45] and Ayensu, [46]  |
| *H. rosa-sinensis*      | Vanuatu                  | Stem and bark                 | Amenorrhea, Abortive                                                             | Decoction                   | Bourdy et al. [47]          |
| *H. rosa-sinensis*      | Vietnam                  | Flowers                       | Dysmenorrhea, Abortive, Infusion                                                 | Infusion                    | Quisumbing, [34]            |
| *H. sabdariffa* L.      | India, Africa, Mexico    | Infusion of leaves or calyces  | Diuretic, Chlorectic, Febirufgal, hypertensive effect                            | -                           | Morton, [48]                |
| *H. sabdariffa* L.      | Egypt                    | Calyces                       | Treatment of cardiac and nerve diseases, increase production of urine            | -                           | Leung, [49]                 |
| *H. sabdariffa* L.      | Egypt and Sudan          | “Karkade” Calyces             | To lower body temperature                                                        | -                           | Leung, [49]                 |
| *H. sabdariffa* L.      | India                    | Seeds                         | Relieve pain in urination and indigestion                                        | Decoction                   | Morton, [48]                |
| *H. sabdariffa* L.      | Brazil                   | Roots                         | Stomachache emollient properties, high blood pressure                           | -                           | Morton, [48]                |
| *H. sabdariffa*         | China (Chinese Folk Medicine) | Roots                       | To treat liver disorder and high blood pressure                                  | -                           | Morton, [48]                |
| *H. sabdariffa*         | Iran                     | Sour hibiscus tea             | To treat hypertension                                                           | -                           | Burnham et al. [50]         |
| *H. sabdariffa*         | Nigeria                  | Seeds                         | Rise or induce lactation in cases of poor milk production, poor letdown and maternal mortality | -                           | Gaya et al. [51]            |
| *H. schizopetalous* (Mast.) | India                  | Leaf and Flower               | Fresh wound                                                                     | -                           | Sens et al. [14]            |
| *H. surratenius*        | Nyong valley in Cameroon | Aerial parts                  | Polyydromnius                                                                   | -                           | Jofack T. et al. [8]        |
| *H. surratenius*        | South Africa             | Leaves                        | Malaria                                                                        | Decoction/ Oral             | Yetein et al. [52]          |
| *H. talbotii*           | India                    | Roots                         | Indigestion                                                                     | -                           | Jagtap et al. [53]          |
| *H. tiliaceous*         | Sri Lanka                | Flower                        | Earache                                                                        | Boiled in milk              | Dixit, [32]                 |
| *H. tiliaceous*         | Sri Lanka                | Flower                        | Emollient properties and anti-depressant like activities                       | -                           | Dixit, [32]                 |
| *H. tiliaceous*         | Sri Lanka                | 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. [33]         |
| *H. tiliaceous*         | Sri Lanka                | Wood and flower               | Treatment of skin diseases                                                     | -                           | Hemadri et al. [33]         |
Table 1. Phytochemical studies of different *Hibiscus* species

| Species         | Solvent used for Extraction | Class               | Bioactive compound                                                                 | Reference                                      |
|-----------------|----------------------------|---------------------|-------------------------------------------------------------------------------------|------------------------------------------------|
| *H. cannabinus* | Acetone                    | -                   | Grossamide K1, Erythrocannabinine H2, Phellandrene, Phytol, Nonanal, 5-Methyl-turfural, 2-Hexenal, Benzene acetaldehyde | Pappas et al. [54], Moujir et al. [55], Seca et al. [56] |
| *H. esculentus* | Aqueous                    | Flavonoid           | Cyaniidin 3-xylosylglucose and cyanin 3-glucoside, the red flowers of *H. mutabilis* contained quercetin 3-sambubioside, isoquercitrin, hyperin, quajaverin and kaempferol glycosides | Shui et al. [57], Ishikura, [58]               |
| *H. mutabilis*  | Aqueous                    | Anthocyanin         | Cyanidin-3-sambubioside                                                             | Amrhein et al. [59]                           |
|                 | Methanol                   | Flavonoids          | Quercetin and hyporside                                                             | Iwaoaka et al. [60]                           |
|                 | Aqueous                    | Flavonoids          | Quercetin 3- sambubioside and cyanidin 3-sambubioside                               | Lowry et al. [1]                              |
|                 | Aqueous                    | Phenols, flavonoids, and anthocyanins                                              | Quercetin, Quercemericrine, Quercetin-3-D-sylsoside, Quercetin-3-Sambubioside, Isoquercetin, Kaempherol, Cyanidine, Cyanidine-3-slosylglucose, Cyanidine-3-monoglucose, Hibiscones, Hibiscoquinones, Beta-sitosterol | Barve et al. [61] |
| *H. mutabilis*  | Aqueous                    | Phenols and flavonoids                                                         | Steppogenin, genistein, salicyclic acid, rutin, potengriffsioside A, kaempferol 3-O-rutinoside and emodin | Hou et al. [62]                                |
| *H. rosa sinensis* | Aqueous                    | Anthocyanin                     | Cyanin, cyanin chorides, methyl-10-oxa-11-octadecynoate, methyl-8-oxa-9- octadecynoate, methyl-9-methylene-8-oxaheptadecanoate and methyl10-methylene-9-oxactadecanoate | Sharma et al. [63]                            |
| *H. rosa sinensis* | Choloroform                | Anthocyanin                     | Cyanidin3-sorphoside                                                             | Vastrad et al. [64] and Bhakta et al. [65]     |
| *H. rosa sinensis* | Methanol                   | Glucoside                      | Luteolin-8-C-glucoside.                                                           | Begum et al. [66]                             |
| *H. rosa sinensis* | Aqueous                    | Sterols                        | Beta Sitosterol                                                                 | Khare et al. [67]                             |
| *H. rosa sinensis* | Aqueous and methanol       | Flavonoids                     | Quercetin-3- di-0-beta-D-glucoside, quercetin-3-7-di-0-beta-D-glucose, quercetin-3-0-beta-D-sorphorotioside, kaempferol-3-0-beta-D-slosylglucose, cholesterol, campesterol, Beta-sitosterol, catalase | Ross et al.[68] and Subramanian et al. [69]    |
| *H. rosa sinensis* | Methanol                   | Flavonoids                     | Cyclopeptide alkaloid, quercetin, hentriacontane                                   | Srivastava et al. [70] and Khokhar, [71]       |
| *H. rosa sinensis* | Aqueous                    | Flavonoids                     | Quercetin-3,5-diglucoside, quercetin-3,7-diglucoside, cyanidine-3,5-diglucoside and kaempferol-3-xylosylglucose | Joshi et al. [72]                             |
| Species          | Solvent used for Extraction | Class                | Bioactive compound                                                                 | Reference                   |
|------------------|-----------------------------|----------------------|-------------------------------------------------------------------------------------|----------------------------|
| H. rosa sinensis | Methanol                    | Flavonoids           | Quercetin, quercetin-3-diglucoside, β-sitosterol, cyanidin-3,5-diglucoside           | Kumar, [73]                |
| H. rosa sinensis | Aqueous                     | Phenols, flavonoids, and anthocyanins | Hibiscetin, Cynadin, Cyanidine glucosides, Taraxeryl acetate, b-Sitosterol Campesterol, Ergosterol, Cyclopropenoids | Gilani et al. [74], Adhirajan et al. [75], Khokute [76], Singh et al. [77], Gauthaman et al. [78], Sachdewa et al. [79], Sachdewa et al. [80], Sharma et al. [81], Sharma et al. [82] and Ajay et al. [83] |
| H. sabdariffa    | Aqueous                     | Anthocyanin          | Delphinidin-3-sambubioside, Cyanidine-3-sambubioside, Delphinidin-3-sambubioside     | Jabeur et al. [84]         |
| H. sabdariffa    | Aqueous and methanol        | Anthocyanin          | Delphinidin-3-sambubioside (hibiscin), cyanidin-3-sambubioside (gossypycyanin), cyanidin-3,5-diglucoside, delphinidin (anthocyani1d) | Hida et al. [85]         |
| H. sabdariffa    | Aqueous                     | Anthocyanin          | Cyanidin-3-sambubioside (gossypycyanin), cyanidin-3,5-diglucoside and cyanidin-3-glucoside (chrysanthemin) | Williamson et al. [86]    |
| H. sabdariffa    | Aqueous                     | Flavonoids           | Hibiscitrin (hibiscetin-3-glucoside), sabdaritrin, gossypitrin, gossyrin and other gossypetin glucosides, quercetin and luteolin | Du et al. [87] and Shibata et al.[88] |
| H. sabdariffa    | Aqueous                     | Flavonoids           | Chlorogenic acid, protocatechuc acid, pelargonicid acid, eugenol, quercetin, luteolin and the sterols β-sitosterol and ergosterol | Subramanian et al.[69]    |
| H. sabdariffa    | Aqueous, Ethenol and chloroform | Flavonoids           | 3-monoglucoside of hibiscetin (hibiscitrin)                                        | McKay, [89] and Williamson et al. [86] |
| H. sabdariffa    | Methanol                    | Flavonoids           | 7-glucoside of gossypetin (gossypitrin) and sabdaritrin and hydroxyflavone named sabdaritin. | Rao et al. [90] and Rao et al. [91] |
| H. sabdariffa    | Methanol                    | Flavonoids           | Gossypetin-8-glucoside (0.4%) and gossypetin-7-glucoside                           | Rao et al. [90] and Rao et al. [91] |
| H. sabdariffa    | Aqueous                     | Flavonoids           | Quercetin, luteolin and its glycoside                                              | Subramanian et al. [69]    |
| H. sabdariffa    | Aqueous, Ethenol and chloroform | Flavonoids           | Quercetin-3-glucoside, rutin, quercetin-3-rutinoside kaempferol                     | Salama et al. [92], McKay, [89] and Williamson et al. [86] |
| H. sabdariffa    | Aqueous, Ethenol and chloroform | Flavonoids           | Atechin and ellagic acid, protocatechuc acid, catechin, gallo catechin, cafeic acid, gallo catechin gallate | Beltran-Debon et al. [94], Herranz-Lopez et al. [95], Peng et al. [96], Ramirez-Rodrigues et al. [97], and |
| Species          | Solvent used for Extraction | Class                | Bioactive compound                                                                 | Reference                                                                 |
|------------------|-----------------------------|----------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| *H. sabdariffa*  | Aqueous                     | Organic Acids        | Citric Acid, Mallic Acid, Tartaric Acid, Ascorbic Acid.                               | Ramirez-Rodrigues et al. [98]                                            |
|                  | Aqueous                     | Organic Acids        | Citric Acid, Mallic Acid                                                               | Eggensperger et al. [99] and Schilcher, [100].                           |
|                  | Aqueous                     | Organic Acids        | Ascorbic Acid and Hydroxy citric acid (2S,3R)                                         | Eggensperger et al. [99] and Schilcher, [100].                           |
| *H. sabdariffa*  | Methanol                    | Phenolic Acid        | Protocatechuic acid (PCA)                                                             | Ismail et al. [104] and Morton, 1987                                     |
| *H. sabdariffa*  | Aqueous and methanol        | Phenolic Acid        | Chlorogenic acid                                                                      | Lee et al. [107], Lin et al. [108], McKay, [89], Williamson et al. [86], Clifford et al. [109] and Alarcon et al. [110] |
| *H. sabdariffa*  | Methanol                    | Phenolic compounds   | Protocatechuic acid and Catechin                                                      | Kuo et al. [111]                                                        |
| *H. sabdariffa*  | Aqueous                     | Flavonoids and Phenolic acid | Chlorogenic acid isomer I, Chlorogenic acid Chlorogenic acid isomer II 5-O-Caffeoylshikimic acid, 3-Caffeoylquinic acid, 5-Caffeoylquinic acid, 4-Caffeoylquinic acid | Osman et al. [112]                                                      |
| *H. sabdariffa*  | Hydroethanol                | Flavonoids and phenolic compounds | Kaempferol-3-O-rutinoside, Kaempferol-3-p-coumarylglucoside, Myricetin-pentosylhexoside, Quercetin-3-sambubioside, Quercetin-3-rutinoside, Quercetin-pentosylhexoside | Jabeur et al. [84]                                                       |
| *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-glucosylxoside | Dafallah et al. [113], Farombi et al. [114], Chen et al. [115], Ali et al. [116], [117], Kamei et al. [118], Chang et al. [119], Suboh et al. [120], Pool-Zobel et al. [121] and Meiers et al. [122] |
| *H. syriacus*    | Chloroform                  | -                    | Hibiscuside, Syringaresinol, Feruloyltyramines, Isoflavonoids, Syriacins A–C, Pentacyclic triterpene caffeic acid esters, Clemsicosin A, C and D, Scopeolin, 8-Hydroxy-5,6,7-trimethoxycoumarin | Yokota et al. [123], Yoo et al.[124] and Yun et al. [125] |
| *H. taiwanensis* | Methanol                    | -                    | 8-Hydroxy-5,6,7-trimethoxycoumarin, (7S,8S)-Demethylcariolignan E, Hibusuwanin A, Hibusuwanin B, Clemsicosin A and C, 8,9,9-O-Feruloyl(-)-secoisolariciresinol Dehydroconiferyl alcohol, Erythro-cariolignan E, b-Syringaresinol, Hibisculide A, Hibisculide B, Hibisculide C. | Wu et al. [126,127] |
| Species          | Solvent used for Extraction | Class          | Bioactive compound                                                                 | Reference                        |
|------------------|-----------------------------|----------------|-----------------------------------------------------------------------------------|----------------------------------|
| H. tilliaceus    | Aqueous                     | Anthocyanin    | Cyanidin-3-glucoside                                                               | Lowry et al. [1]                 |
| H. tilliaceus    | Methanolic                  | Anthocyanin    | Cyanidin 3-O-sambubioside                                                          | Shikawa et al. [128]             |
| H. tilliaceus    | Aqueous                     | Amide          | Hibiscusamide                                                                     | Chen et al. [129]                |
| H. tilliaceus    | Aqueous                     | Coumarin       | Hibiscusin                                                                       | Chen et al. [129]                |
| H. tilliaceus    | Methanolic                  | Phenolic       | p-coumaric acid, fumaric acid, kaempferol, kaempferol-3-O-D-galactoside, quercetin and quercetin3-O-D-galactosid | Subramanian et al. [130]         |
| H. tilliaceus    | Methanol                    | Phenolic       | Ergosta-4,6,8,9, friedelin, germanicol, glutinol, lupeol, pachysandiol, β-sitosterol, stigmaster-4,22-dien-3-one, stigmast-4-en-3-one, stigmasterol and 22-tetraen-3-one | Yang et al. [106]                |
| H. tilliaceus    | Methanol                    | Phenolic compound | Catechin, rutin, quercetin, and ellagic acid                                       | Hossain et al. [131]             |
| H. tilliaceus    | Methanol                    | Phenolic compounds and organic acids | Stigmasterol, Stigmastadienol, Stigmastadienone, 27-Oic-3-oxo-28-friedelanoic acid, Vanillic acid, Syringic acid, Scorpoletin, N-trans-feruloyltiramine, N-cis-Feruloyltiramine, b-Sitostenone, Stigmasta-4,22-dien-3-one | Kobayashi, [25], Singh et al. [132] and Whistler, [19] |
| H. tilliaceus    | Aqueous                     | Organic acids, phenolic compounds, and flavonoids | Azelaic acid, cleomiscosin C, daucosterol, friedelin, fumaric acid, hibiscolacontone, kaempferol, quercetin, rutin, scopoletin, β-sitosterol, succinic acid, syriacusin A and vanillin | Zhong et al. [133]               |
| H. tilliaceus    | Aqueous                     | Organic acids and phenolic compounds | Vanillic acid, syringic acid, p-hydroxybenzoic acid, phydroxybenzaldehyde, scopoletin, N-transferuloyltiramine, N-cis-feruloyltiramine, β-sitosterol, stigmasterol, β-sitostenone and stigmasta-4-dien-3-one. | Chen et al. [129]                |
| H. tilliaceus    | Chloroform                  | Triterpene     | 27-oic-3-oxo-28-friedelanoic acid                                                 | Li et al. [134]                  |
| H. vitifolius    | Ethanol                     | Flavonoids     | Flavonol bioside                                                                  | Kunnumakkara et al. [135]        |
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. subtilis*, *E. coli*, *Salmonella sp.*, *P. aeruginosa* | Highest zone of inhibition is recorded against *B. subtilis* and *E. coli* as (18.86±0.18) and (18.00±1.63) mm respectively shown by methanol extract.                                                         | Ruban et al. [136]    |
| *H. rosa-sinensis*  | Leaves           | Hexane, Ethylacetate, Methanol and Aqueous | *Staphylococcus aureus*, *B. subtilis*, *Streptomyces albogentes*, *Micrococcus luteus*, *S. epidermis*, *Pseudomonas aeruginosa*, *Bordetella bronchiseptica* | Methanol extract is best solvent showing maximum anti-bacterial activity.                                                                                                                                   | Patel et al. [137]    |
| *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. [138]   |
| *H. rosa-sinensis*  | Leaves           | Aqueous and Methanol         | *Bacillus subtilis*, *S. aureus*                                              | Methanol extract had highest zone of inhibition 18.82±0.18 mm against *B. subtilis*.                                                                                                                        | Udo et al. [139]      |
| *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. [140]    |
| *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. [141]    |
| *H. rosa-sinensis*  | Leaves and Silver and gold nanoparticles | Deionized water             | *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Micrococcus luteus*, *S. aureus*, *S. epidermidis*, *Enterobacter aerogenes*, *E. coli*, *S. pneumoniae*, *Aeromonas hydrophila* | Plant extract shows antibacterial activity against test organisms in conc. dependant manner.                                                                                                                  | Tyagi et al. [142]    |
| *H. rosa-sinensis*  | Leaves           | Ethanol                      | *Aeromonas hydrophila*                                                        | Highest inhibition zone is 11 mm. Maximum inhibition zone is 24 mm at 50% concentration.                                                                                                                       | Vijayaraj et al. [143]|
| *H. rosa-sinensis*  | Leaves           | Aqueous                      | *Aeromonas hydrophila*                                                        | Maximum inhibition zone is 24 mm at 50% concentration.                                                                                                                                                       | Amita et al. [144]    |
| Species         | Part used       | Solvent used for extraction              | Test organism                                           | Observation                                                                 | Author and year |
|-----------------|-----------------|------------------------------------------|--------------------------------------------------------|-----------------------------------------------------------------------------|-----------------|
| *H. rosa-sinensis* | Leaves          | Ethanol, methanol and distilled water    | *S. aureus* and *E. coli*                              | Methanol extract with 10% and 5% conc. Had antibacterial activity against all the test organisms. | Vastrad et al. [64] |
| *H. rosa-sinensis* | Flowers         | Methanol, water and ethyl acetate        | *E. coli*, *B. subtilis* and *S. aureus*               | Methanolic extract show more activity than other two solvents against all three bacteria. | Vijayakumar et al. [145] |
| *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 antibacterial activity than Ethanolic extracts. | Singh et al. [146] |
| *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, *Serratia marcescens*, Proteus vulgaris and Proteus rettgeri | Extract shows largest inhibition zone against *Micrococcus luteus*. | Adebisi et al. [147] |
| *H. sabdariffa*   | Calyces         | 80% aqueous methanol                    | *E. coli*                                              | The maximum Zone of inhibition was 12.66mm for 10%, 10.75mm for 5% and 8.9mm for 2.5% conc. | Fullerton et al. [148] |
| *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. [149] |
| *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. [150] |
| *H. sabdariffa*   | (roselle)       | Aqueous and Ethanol extract              | *E. coli*, *Staphylococcus aureus*, *Salmonella typhi*, *Shigella dysenteriae*, *Streptococcus mutans* | Ethanol extracts have better activity as compared to aqueous extract against all the tested organisms. | Edema et al. [151] |
| *H. sabdariffa*   | Calyces         | Water and ethanol                        | *Bacillus subtilis*, *S. aureus* and *E. coli*         | Ethanol extract exhibit slightly higher activity against *B. subtilis* and *S.* | Jung et al. [152] |
| Species          | Part used      | Solvent used for extraction | Test organism                                                                 | Observation                                                                                           | Author and year |
|------------------|----------------|------------------------------|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-----------------|
| *H. sabdariffa*   | Calyces        | Petroleum ether and ethanol  | *Klebsiella pneumoniae, Staphylococcus aureus, B. cereus, Lactobacillus brevis* | aureus than that of water extract, however, Roselle water extract has more activity against *E. coli*.   | Das et al. [153]|
|                  |                |                              |                                                                              | Extracts made in Petroleum ether were most effective against bacteria like *Bacillus cereus, Klebsiella pneumoniae, Staphylococcus aureus* and *Lactobacillus brevis*. |                 |
| *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. [154]|
| *H. sabdariffa*   | Leaves         | Aqueous                      | *Escherichia coli, Klebsiella pneumonia, Staphylococcus aureus aureus and Pseudomonas aeruginosa.* | Extract conc.200μg/mL has maximum activity against *P. aeruginosa.*                                   | Sulaiman et al. [155]|
| *H. sabdariffa*   | Leaves         | Methanol                     | *S. typhi, E. coli and S. aureus*                                           | Extract exhibit maximum antibacterial activity against *S. aureus.*                                    | Adamu et al. [156]|
| *H. sabdariffa*   | Calyx          | Hexane, Ethyl acetate and Methanol | *E. coli (ATCC25922), S. aureus (ATCC29213), Pseudomonas aeruginosa (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. [157]|
| *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. [158]|
| *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. [159]|
| *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. [160]|
| *H. sabdariffa*   | Leaves and seeds | Phosphate buffer               | *Staphylococcus sp.*                                                         | Extract showed maximum zone of inhibition of 9mm.                                                   | Thiripurasudari et al. [161]|
| *H. sabdariffa*   | Calyces        | 80%methanol                  | *Escherichia coli ATCC25922*                                                 | The maximum antibacterial activity of                                                                 | Abdallah et al. [162]|
| Species          | Part used     | Solvent used for extraction | Test organism                                                                 | Observation                                                                                                                                           | Author and year |
|-----------------|---------------|----------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| *H. sabdariffa* | Calyx         | Methanol                   | *Salmonella enteric* ATCC5174, *Klebsiella pneumonia* ATCC27736, *Proteus vulgaris* ATCC49132, and *Pseudomonas aeruginosa* ATCC27853, *Staphylococcus aureus* ATCC25923, *Staphylococcus epidermidis* ATCC49461 and *Bacillus cereus* ATCC10876. | *H. sabdariffa* calyces extract was recorded against *S. aureus* (18.5±0.5mm).                                                                     | Garbi et al. [5]|
| *H. sabdariffa* | Calyx         | Hot and cold aqueous       | *Corynbacterium diphtheria*, *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.                                         | Salmon et al. [163]|
| *H. sabdariffa* | Calyces       | Methanol                   | *E. coli* (ATCC25922), *P. aeruginosa* (ATCC27853), *K. pneumonia* (ATCC15380), *S. typhi* (ATCC4561), *B. subtilis* (NCTC8236), *S. aureus* (ATCC25923) | The cold aqueous extract at concentration 40mg/mL was exhibiting the maximum antibacterial activity against tested bacteria. Maximum activity was reported against *B. subtilis*. | Youns et al. [164]|
| *H. sabdariffa* | Flower        | Methanol                   | *Aeromonas hydrophila*                                                       | Roselle flower extract had antibacterial activity against *A. hydrophila* in a conc. depenedent manner.                                                  | Bariyyah et al. [165]|
| *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. [166]|
| *H. syriacus*   | Leaves        | Petroleum ether, Benzene, Chloroform, Methanol and | *Bacillus cereus*, *Staphylococcus epidermis*, *Klebsiella* | Methanol extracts show maximum zone of inhibition against all the test                                                                                 | Punasiya et al. [167] |
| Species                  | Part used                      | Solvent used for extraction | Test organism                                                                 | Observation                                                                                     | Author and year |
|-------------------------|--------------------------------|-----------------------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-----------------|
| *H. tiliaceus*          | Leaves and bark                | Aqueous extracts            | *pneumonia*, *Bacillus subtilis*                                               | Bark extract has maximum antibacterial effect against *S. aureus* and *S. epidermidis* among all the test organisms. | Abdul et al. [168] |
|                         |                                | Ethanol                     | *Staphylococcus aureus*, *S. epidermidis*, *S. saprophyticus*, *S. pyogenes*, *Plesiomonas shigelloides*, *Shigella dysenteriae*, *S. flexneri*, *S. boydii*, *S. sonnei*, *Pseudomonas aeruginosa*, *Vibrio cholera*, *Salmonella typhi* |                                                                                               |                 |
|                         |                                |                             |                                                                               |                                                                                               |                 |
|                         | Fruits, leaves and twigs       | Methanol and chloroform, methanol and ethyl acetate fractions | *Pseudomonas eruginoasa*                                                       | The strongest anti-bacterial activities were exhibited by the chloroform fraction of fruits at a conc. of 80%. | Andriani et al. [169] |

**Table 3. 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) 80% methanol | DPPH                            | IC50 value for stem extracts is 44μg/mL. Calyx extract had higher % inhibition (53.33-0.25%) against DPPH radical than leaf extract (36.33-0.45%). Methanol extract of flower (71.84%) exhibit maximum DPPH activity. | Abdooulaye et al. [170] Gbadamosi et al.[171] |
| *H. asper*              | Leaves and calyx               |                             | DPPH                            |                                                                                                   | Ryu et al. [172] |
| *H. cannabinus*         | Leaves, bark, flowers and seeds| Water                      | DPPH                            | IC50 value for ethanol extract is 44.48μg/mL. Ethanol extract shows radical scavenging activity in conc. dependent manner. | Rusmini et al. [173] Saravanan et al. [174] |
| *H. cannabinus*         | Leaves                         | Ethanol                     | DPPH                            |                                                                                                   | Ryu et al. [172] |
| *H. platanifolius*      | Leaves                         | Ethanol and Aqueous         | Reducing power and hydrogen peroxide scavenging assay | Ethanol extract shows radical scavenging activity in conc. dependent manner. | Ryu et al. [172] |
| *H. rosa-sinensis*      | Flower                          | Methanol                    | DPPH                            | IC50 value for methanol extract is 43.9μg/mL. Crude extract of leaves exhibits potent antioxidant activity against all the studied assay. | Falade et al. [175] |
| *H. rosa-sinensis*      | Leaves                         | 80%ethanol                 | Ferric thiocyanate, Hydrogen peroxide scavenging, DPPH, ABTS radicals’ cations and Super oxide an ion radical scavenging by riboflavin methionine illuminate |                                                                                                   | Mandade et al. [176] |
| Species          | Part used           | Solvent used for extraction | Assay performed                          | Observations                                                                                                                                   | Author and year |
|------------------|---------------------|-----------------------------|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| H. rosa-sinensis | Flower              | Ethanol                     | SOD, GPx, CAT                           | Ethanol extract at 250mg/kg conc. was more effective than other two doses.                                                                    | Sankaran et al. [177] |
| 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. [178] |
| 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. [179] |
| H. rosa-sinensis | Flowers             | Methanol                    | DPPH                                     | 100µg/mL varies between 30.95 to 55.11% scavenging effect.                                                                                   | Sheth et al. [180] |
| 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. [181] |
| H. rosa-sinensis | Petals              | Ethanol and ethyl acetate fraction | DPPH                                      | IC50 value for ethanol extract is 36±1.7 µg/mL.                                                                                               | Pillai et al. [182] |
| 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. [183] |
| 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. [184] |
| 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. [185] |
| H. rosa-sinensis | Flowers             | Methanol                    | DPPH, hydrogen peroxide 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. [186] |
| H. rosa-sinensis | Flower              | Ethanol                     | Hydrogen peroxide scavenging assay       | The flower extract exhibits a concentration dependent hydrogen peroxide radical scavenging activity                                     | Ghosh et al. [187] |
| H. rosa-sinensis | Leaves              | Aqueous and Ethanol         | DPPH, NO, FRAP and H2O2                  | DPPH 11.8mg/g, NO 66.8, FRAP 15.4, H2O2 23.04mg/g.                                                                                           | Prasanna et al. [188] |
| Species          | Part used          | Solvent used for extraction | Assay performed                        | Observations                                                                 | Author and year |
|------------------|--------------------|-----------------------------|----------------------------------------|-------------------------------------------------------------------------------|-----------------|
| *H. rosa-sinensis* | Leaves             | Mucilage from leaves        | FRAP, DPPH, hydroxyl, superoxide,     | The mucilage showed antioxidant potential against all the assays, but it was detected to be lower as compared to the standards used. | Kapoor et al. [189] |
|                  |                    |                             | nitric oxide and hydrogen peroxide    |                                                                               |                 |
|                  |                    |                             | scavenging assay.                     |                                                                               |                 |
| *H. rosa-sinensis* | Flower             | Methanol and Ethanol extract | DPPH                                   | IC50 value for methanol extract is maximum i.e.19.54µg/mL.                    | Vignesh et al. [189] |
| *H. rosa-sinensis* | Flower             | Ethanol extract             | DPPH                                   | IC50 value for the ethanol extract is 231.110±1.59µg/mL.                       | Wahid et al. [190] |
| *H. sabdariffa*   | Calyces            | Methanol                    | DPPH                                   | IC50 for the extract is 230.01±2.40µg/mL.                                     | Luvongal et al. [191] |
| *H. sabdariffa*   | Leaves             | Ethanol                     | DPPH                                   | Anti radical power 0.41mg DPPH/mg.                                            | Zhang et al. [190] |
| *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. | Kurna et al. [192] |
| *H. sabdariffa*   | Calyces            | Water and ethanol extract   | DPPH                                   | Dose dependent activity is shown by both the extracts.                        | Jung et al. [192] |
| *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. [153] |
| *H. sabdariffa*   | Petal              | Methanol                    | DPPH                                   | IC50 is 0.24mg/mL.                                                            | Obouayeb et al. [193] |
| *H. sabdariffa*   | Calyx              | Ethanol extract             | DPPH                                   | At a conc.250µg/mL calyx extract has maximum 86% scavenging activity.        | Sirag et al. [194] |
| *H. sabdariffa*   | 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. [195] |
| *H. sabdariffa*   | Leaves and calyx   | Methanol extract            | DPPH                                   | IC50 for leaves is 43.48 and for calyces is 37.15±g/mL.                      | Formagio et al. [196] |
| *H. sabdariffa*   | 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 was 0.784±0.01mg ascorbic acid equivalent/g. | Ghosh et al. [197] |
| *H. sabdariffa*   | Calyx and callus   | Methanol                    | DPPH                                   | Calyx extract shows more antioxidant activity as compared to callus extract.  | Kouakou et al. [198] |
| *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. [158] |
| *H. sabdariffa*   | Leaves             | Ethanol                     | DPPH                                   | IC50 value is 184.881g/Ml at a conc.50.01g/mL.                               | Subhaswaraj et al. [199] |
| *H. sabdariffa*   | Flower             | Methanol                    | DPPH, ABTS, FRAP                       | IC50 for DPPH is 195.73µg/mL, ABTS is Widowati et al. [200]                 |                 |
| Species            | Part used                  | Solvent used for extraction | Assay performed | Observations                                                                                                                                                                                                 | Author and year |
|-------------------|----------------------------|-----------------------------|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| H. sabdariffa L.  | Silver nanoparticles from bark extract | Methanol                    | assay           | 74.58 and 46.24µM Fe (II)/µg for FRAP. DPPH and ABTS assays have IC50 31.74±2.06 and 15.45±2.72µg/mL respectively.                                                                                           | Islam et al. [201] |
| H. sabdariffa     | Calyces                    | Methanol                    | DPPH            | Percentage inhibition activity shown by the extract is 53±0.09%.                                                                                                                                           | Youns et al. [164] |
| H. sabdariffa     | Calyx                      | Methanol                    | DPPH            | DPPH radical scavenging activity was reported maximum in genotype 4920 i.e.95.09%.                                                                                                                      | Jamini et al. [202] |
| H. schizopetalus  | Flower                     | Methanol                    | DPPH            | IC value 50 is 38.2± 0.08µg/mL. Flower extract showed 80.70% antioxidant activity.                                                                                                                      | Zahid et al. [203] |
|                   | Leaves                     | Methanol                    | DPPH            | IC 50 is 58.9± 0.13µg/M. Leaf extract showed 75.2% antioxidant activity.                                                                                                                                   |                 |
|                   | Flower                     | Methanol                    | Nitric oxide    |                                                                                                                                                |                 |
|                   | Leaves                     | Methanol                    | Nitric oxide    |                                                                                                                                                |                 |
| H. syriacus L.    | Leaves                     | Methanol                    | DPPH, Superoxide radical scavenging activity in NBT system, 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. [204] |
### 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. [205]          |
| *H. rosa-sinensis* | Flower    | Acetone                     | *Candida albicans,* *Aspergillus niger,* *Tricoderma viride,* *Rhizopus microsporus* | Maximum zone of inhibition for *Candida albicans* is 20mm, *Aspergillus niger* is 16mm, *Trichoderma viride* is 12mm, and *Rhizopus microsporus* is 21mm. | Durga et al. [206]        |
| *H. sabdariffa*   | Calyces   | 80% ethanol                 | *Candida albicans*                          | Zone of inhibition for *Candida albicans* is 45.0±0.4 mm.                                                | Edema et al. [151]        |
| *H. sabdariffa*   | Calyx     | Hexane, Ethylacetate, Methanol | *Candida albicans*                      | The ethyl acetate fraction exhibited most significant antifungal activity against *Candida albicans* at MIC of 16μg/mL. | Ajoku et al. [207]        |
| *H. sabdariffa*   | Calyx     | Aqueous and hydroethanol 30% | *Candida albicans*                          | Hydro ethanol extract is more potent antifungal extract.                                                  | Mensah et al. [158]       |
| *H. syriacus*     | Calyces   | Methanol                    | *Candida albicans*                          | Extract has maximum inhibition zone of 21mm against *Candida albicans*.                                   | Youns et al. [164]        |
| *H. syriacus*     | Root      | Methanol                    | *Trichophyton mentagrophytes*              | Methanolic extract of *H. syriacus* gogoma exhibited four times higher activity than its parent against *Trichophyton mentagrophytes*. | Jang et al. [208]         |

### Table 5. Anti cancerous activity of various species of genus *Hibiscus*

| Species          | Activity          | Part used               | Organism used                  | Observations                                                                                                 | Author and year          |
|------------------|-------------------|-------------------------|--------------------------------|---------------------------------------------------------------------------------------------------------------|--------------------------|
| *H. cannabinus*  | Cytotoxicity      | Seeds extract and seed oil | Human cancer cell lines        | Seed extract exhibited a greater cytotoxic activity as compared to seed oil.                                  | Wong et al. [209]         |
| *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. [210]        |
| *H. rosa-sinensis* | Anti cancer activity | Flower                 | Hela cell lines                | Flower extract exhibited potent anti cancer activity against helacell lines.                                  | Durga et al. [206]        |
| *H. sabdariffa*  | Cytotoxicity      | Fruits                  | Brine shrimp lethality bioassay | LC value for fruit extract is 5.082±12 μg/mL. Percentage inhibition against helacell lines reached upto 83.67±3.07% at 20μg/mL concentrations. | Mamun et al. [149]       |
| *H. sabdariffa L.* | Anti-tumour activity | Seeds                | Human cervical hela cells      |                                                                                                               | Zhang et al. [195]        |
| *H. sabdariffa*  | Anti-tumor activity | Leaves and calyx        | Leukaemia line k-562           | Methanol extract from calyx show significant antitumor activity.                                             | Formagio et al.[196]      |
### Table 6. Other medicinal activities of various species of genus *Hibiscus*

| Species           | Activity                        | Part used   | Organism used                        | Observations                                                                 | Author and year     |
|-------------------|---------------------------------|-------------|--------------------------------------|-------------------------------------------------------------------------------|---------------------|
| *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. [211] |
| *H. sabdariffa*   | Anti-proliferative              | Calyx       | Caco-2, hepG-2, HCT8 and A549 cell lines | Calyx extract has significant cytotoxic activity.                            | Maciela et al. [212] |
| *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. [213] |
| *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. [214] |
| *H. tiliaceus*    | Cytotoxic effect                | Leaves and bark | Brine shrimp                      | Leaf extract of plant has moderate cytotoxic activities with LC50 is 20 μg/mL while bark has low cytotoxic effect LC50 is 50 μg/mL. | Abdul et al. [168] |
| *H. vitifolius*   | Cytotoxic activity              | Flowers     | Hela cell lines                     | IC50 value agains thella cell lines is 81.27 μg/mL.                          | Nishitha et al. [215] |

#### 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 150 mg/kg helps to decrease the increased biochemical parameters in all diabetic rats.                                                                             | Saravanan et al. [174] |
| *H. rosa-sinensis*| Lipid lowering effect           | Flower petals | Albino Rats   | After administration of flower extract, the levels of free fatty acids, phospholipids TG, VLDL, LDL and HDL cholesterol were back to nearly normal.                                                          | Gomathi et al. [216] |
| *H. rosa-sinensis*| Hypoglycaemic and hypolipidemic activity | Flower | Rats          | 500 mg/kg/day dose showed potent hypoglycaemic and hypolipidemic activities, 500 mg/kg dose of methanol extract showed decrease in levels of cholesterol, triglyceride, and low-density lipids. | Bhasker et al. [217] |
| *H. rosa-sinensis*| Anti-hyperlipidaemic activity    | Leaves     | Mice          | The decreased levels of blood glucose, carbohydrate metabolizing enzymes, TBARS, and lipid profiles were found after the administration of flower extract.                                                          | Mishra et al. [218] |
| *H. rosa-sinensis*| Hypoglycaemic and hypolipidemic activity | Flowers | Rats          |                                                                                                                                                                                                              | Sankaran et al. [177] |
| Plant          | Activity                        | Part       | Animals  | Description                                                                                                                                                                                                 |
|---------------|---------------------------------|------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| *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. |
| *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. |
| *H. rosa-sinensis* | Hypolipidemic properties        | Flower     | Albino Wistar Rats | 240mg/kg dose has significant hypolipidemic activity.                                                                                                                                                    |
| *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 malonaldehyde. |
| *H. sabdariffa*   | Hypolipidemic activity          | Leaves     | Hyperlipidic rats | 300 mg per kg dose possessed the best hypolipidemic activities.                                                                                                                                              |
| *H. sabdariffa*   | Hyperglycaemia, hyperinsulinemia, and hyperlipidaemia activity | Calyces    | Rat      | A dose of 200mg/kg showed significant results against 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.                                                          |
| *H. sabdariffa*   | Hypolipidemic effect            | Calyces    | Albino rats | Administration of plant extract lowers the serum lipid levels.                                                                                                                                              |
| *H. schizopetalus* (Mast) Hook | Hypolipidemic activity | Flowers and leaves | Rats     | Cholesterol and triglycerides levels were significantly decreased after the administration of plant extracts.                                                                                       |
| *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 sulphydryl sowing to its hepatoprotective activity. |
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. [227]  
H. sabdariffa | Hepato-renal toxicity | 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. [228]  
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. [229]  
H. sabdariffa | Hepato-protective activity | Leaves | Albino rats | Increase the levels of blood in dose dependent manner. | Joshua et al. [230]  
H. sabdariffa | Ethanol induced hepatotoxicity | Leaves | Rats | Levels of SGOT, SGPT and bilirubin were decreased after the treatment with leaf extract. | Olarewaju et al. [231]  
H. vitifolius (Linn.) | Hepato-toxicity activity | Root | Albino rats | The extracts were found to be safe up to a dose of 2000mg/kg but higher than this was toxic. | Samuela et al. [232]  

| 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. [233]  
H. cannabinus | Anti-inflammatory | Seeds | Mice | Maximum effect at 400mg/kg dose was observed. | Chaudhari et al. [234]  
H. rosa-sinensis and H. rosa-sinensis alba | 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. [235]  
H. sabdariffa | Anti-inflammatory | Calyx | Wistar rats | All the administered doses revealed anti-inflammatory effect. | Saptarini et al. [236]  
H. sabdariffa | Anti-inflammatory | Seeds | Rats | Extract showed a significant dose dependent anti-inflammatory activity. | Ali et al. [237]  

| 6.4. Analgesic activity  
H. cannabinus | Analgesic activity | Seeds | Mice and rats | Seed extracts had central and peripheral analgesic activities. | Chaudhari et al. [234]  
H. rosa-sinensis | Analgesic potentials | Roots | Albino rats | Root extracts showed significant dose dependent activity. | Soni et al. [238]  
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. [239]  
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. [240]  

| 6.5. Haemato-toxicity |
| Plant Species       | Activity Type          | Part Used         | Species          | Description                                                                 |
|--------------------|------------------------|-------------------|------------------|-----------------------------------------------------------------------------|
| H. cannabinus      | Haematonic activity    | Leaves            | Rats             | A Significant increase in the red blood count, haemoglobin concentration and pack cell volume was observed after extract administration. |
| H. rosa-sinensis   | Haemato-protective     | Flowers           | Rats             | Exhibit significant Haemato-protective activity. The extract had the ability to reduce hydrogen peroxide induced haemolysis. |
| H. rosa-sinensis   | Anti-haemolytic activity | Flowers         | Venous blood samples | After administration of extract increased levels of RBC, haemoglobin and decreased levels of WBC were observed. |
| H. sabdariffa      | Haemato-toxicity       | Calyces           | Rats             |                                                                                     |
| H. platanifolius   | Anti-diabetic activity | Stem              | Rats             | Ethanolic extract of stems at 250mg/kg dose revealed a decrease in blood glucose level. |
| H. rosa-sinensis   | Anti-diabetic          | Leaves            | Rats             | Upon treatment with leaves extract Diabetic rats blood glucose was elevated to normal values. |
| H. rosa-sinensis   | Effect on diabetes     | Flower            | Rats             | Administration of flower extracts decreased blood glucose levels. |
| H. sabdariffa      | Anti-diabetic          | Leaves, stem, roots | Rats         | Leaf extract Reduce sugar level in rats more significantly than stem and root extracts. |
| H. syriacus        | Anti-diabetic          | Leaves            | Rats             | Treatment with leaves extract showed a decrease in blood glucose level. |
| H. sabdariffa      | Anti-hypertensive      | Calyces           | Rats             | Extract administration helps to reduce hypertension. |
| H. sabdariffa      | Hypertension           | Leaves            | Wistar rats      | Extract revealed ameliorative effect against hypertension. |

6.6. Anti-diabetic activity

6.7. Anti-hypertensive activity
flowers, seeds etc have been well worked out for exploring the antioxidant potential following different assays like DPPH, FRAP, ABTS, H₂O₂, 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.syriacus* were found suggesting further explorative studies. The details of the same have been mentioned in Table 3 along with the plant part used, assay followed and observations.

2.2.3 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*.

2.2.4 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 5.

3. 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.

4. 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.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.
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