An All-encompassing Phytopharmacological Narration on Most Versatile Therapeutically Enriched Climbing Shrub – Giloy/ Guduchi *Tinospora crispa* (Linn.) Mier ex Hook F. & Thorns *(Menispermaceae)*

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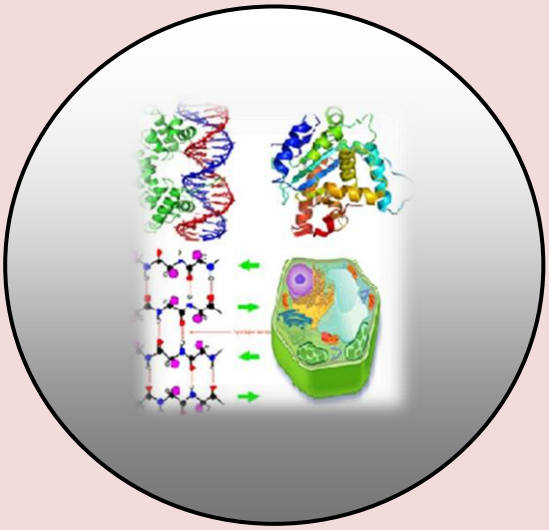
ISSN 2319-3077 Online/Electronic
ISSN 0970-4973 Print

UGC Approved Journal No. 62923
MCI Validated Journal
Index Copernicus International Value
IC Value of Journal 82.43 Poland, Europe (2016)
Journal Impact Factor: 4.275
Global Impact factor of Journal: 0.876
Scientific Journals Impact Factor: 3.285
InfoBase Impact Factor: 3.66

J. Biol. Chem. Research
Volume 36 (1), Part C, 2019 Pages No. 274-289



Journal of Biological and Chemical Research

An International Peer Reviewed / Referred Journal of Life Sciences and Chemistry

Indexed, Abstracted and Cited in various International and National Scientific Databases

Published by Society for Advancement of Sciences®

J. Biol. Chem. Research. Vol. 36, No. 1: Part C, 274-289, 2019
(An International Peer Reviewed / Refereed Journal of Life Sciences and Chemistry)
Ms 36/02/7646/2019

ISSN 2319-3077 (Online/Electronic)
ISSN 0970-4973 (Print)

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REVIEW ARTICLE

Received: 01/05/2019 Revised: 04/06/2019 Accepted: 04/06/2019

An All-encompassing Phytopharmacological Narration on Most Versatile Therapeutically Enriched Climbing Shrub – Giloy/ Guduchi *Tinospora crispa* (Linn.) Mier ex Hook F. & Thorns *(Menispermaceae)*

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ABSTRACT

The innumerable medicinal qualities and therapeutic uses of Tinospora cordifolia (Willd.) Miers ex Hook. & Thoms. (Giloy) as well as its phytochemical investigations prove its importance as a precious pharmaceutical plant. Its main part stem is bitter, stomachic, diuretic, stimulates bile secretion and cures jaundice. It has low fat. It is considered an essential herbal plant of Indian system of medicine and has been used in the treatment of fever, urinary problem, dysentery, skin diseases leprosy, diabetes, and many more diseases. The plant reported containing chemical compound including diterpenoid lactone, aliphatics, alkaloids, terpenoids, lignans, steroids and glycosides. The chief Phytoconstituents of T. cordifolia are diterpenoid furano lactone, cordifolide, cordifol, heptacosanol, tinosporide, β-sitosterol, tinospo-rine, clerodane furano diterpine, tinosporaside, and columbin respectively. Alkaloid such as magniflorine, Berberine, palmatine, non-glycoside gilonin gilosterol, tembertarine, choline and tinosporin has been reported from the stem part of the T. cordifolia. Due to presence of major and minor essential minerals such as P, Cr, Zn, Mn, K, Ca, Fe, Co, Ni and Cu and proteins and fibres in T. cordifolia parts, it helps in health restoration and in alleviation of degenerative processes in diabetes. The present review highlights the pharmacological importance viz. antioxidant activity, antimicrobial activity, antibacterial activity, antifungal activity, anti-diabetic activity, antistress activity, hypolipidaemic effect, hepatic disorder, anticancer anti HIV potential, antiosteoporotic effects, antitoxic effects, wound healing, anticomplementary activity, and immunomodulating activity, systemic infection and Parkinson's disease.

Special emphasis to summarize pharmacological potential of T. cordifolia along with the phytoconstituents accountable for its pharmacological attributes has been dilneated in this review paper.

Keywords: Alkaloids, Terpenoids, Lignans, Steroids, Anti-diabetic activity, Antistress activity, and Hypolipidaemic effect.

INTRODUCTION

Giloy [*Tinospora cordifolia* (Willd.) Miers ex Hook. & Thoms.] which is commonly known as Heart-leaved moonseed, and giloy thrives well in the tropical areas of Bangladesh, India, Myanmar, and Sri Lanka belonging to the family Menispermaceae, is a large, deciduous, deciduous, extensively spreading climbing shrub with several coiled branches with a different type of morphology. The stem of the plant is filiform, fleshy and climbing in nature; bark is white to gray. It is a glabrous, succulent, woody climbing shrub native to India. It is also found in Burma and Sri Lanka. It often attains a great height, and climbs up the trunks of large trees. The stem is gray or creamy white, deeply cleft spirally and longitudinally, with the space between spotted with large rosette-like lenticels. The wood is white, soft, and porous, and the freshly cut surface quickly assumes a yellow tint when exposed to air. Long threadlike aerial roots come up from the branches. Leaves of this plant are simple, alternate, long-petioled; round, pulvinate, heart-shaped, twisted partially and halfway around. Greenish yellow flowers are unisexua. The male flowers of racemose panicles are found in clusters whereas female flowers are solitary The root is thread-like, aerial, squairshin, sometimes continuously lengthening touch the ground , aerial roots are characterized by tetra to penta arch primary structure . Giloy or Guduchi is a rejuvenating herb for the body. The plant is also known as Gilo, Gulancha, Guduchi (Hindi), Amrita (Sanskrit), Guduchi, Gulancha (Bengali), Gado , Galo (Gujarati), Gulvel (Marathi), Duyutige , Teppatige (Telugu), Amrutha balli (Kannada), Shindila kodi (Tamil) and Heartleaf moonseed (English). The roots and stems contain several secondary metabolites having curative properties. of presence of various kinds of phytochemicals in Giloy, it has found applications in pharmaceutical chemistry due to its antiosteoporetic, hepatoprotective, immunomodulatory, antihyperglycemic, anti-tumor, anti-HIV properties. Tinospora cordifolia is one of the noncontroversial and extensively used herbs in

A myriad of biologically active compounds have been isolated from different parts of the plant body. These compounds have been reported to have different biological roles in disease conditions. The chemical constituents of T. Cordifolia belong to different classes such as alkaloids, glycosides, steroids, phenolics, aliphatic compounds, polysaccharides, leaves are rich in protein (11.2%), calcium and phos-phorus. The stem contains clerodane furono diterpene glucoside (amritoside A, B, C, and D) and the structure has been established by different spectroscopic studies. The plant is a powerful rasayana mentioned in Indian Ayurvedic literature. It is considered as a bitter tonic and powerful immuno modulator. Giloy acts as a memory booster, develops intelligence and promotes mental clarity. It is described as one of the Medhya Rasayana (mental rejuvenative) in the Charak Samhita. Powder of the stem is creamish brown or dark brown, characteristic odor, bitter taste and is used in dyspepsia, fever, and urinary diseases. The starch obtained from the stem known as “Guduchi-satva.” It is highly nutritive and digestive. It has long been used in India as a medicine and in the preparation of a starch known as giloe-ka-sat or as palo which is said to be a tonic, antiperiodic, and a diuretic. Tinospora cordifolia (Giloy) is used in folk and Ayurvedic medicines throughout India since ancient times. The innumerable medicinal qualities and therapeutic uses of Giloy as well as its phytochemical investigations prove its importance as a valuable medicinal plant. It is reported to possess anti-inflammatory, anti-oxidant, anti-spasmodic, anti-allergic, anti-HIV and anticancer properties. Its main part stem is bitter, stomachic, diuretic, stimulates bile secretion and cures jaundice. This present review article put special emphasis on pharmacological potential of T. cordifolia along with the phytochemials responsible for its pharmacological properties.

Figure 1. Climbing Giloy shrub & its various parts viz. Leaves, fruits, flowers.

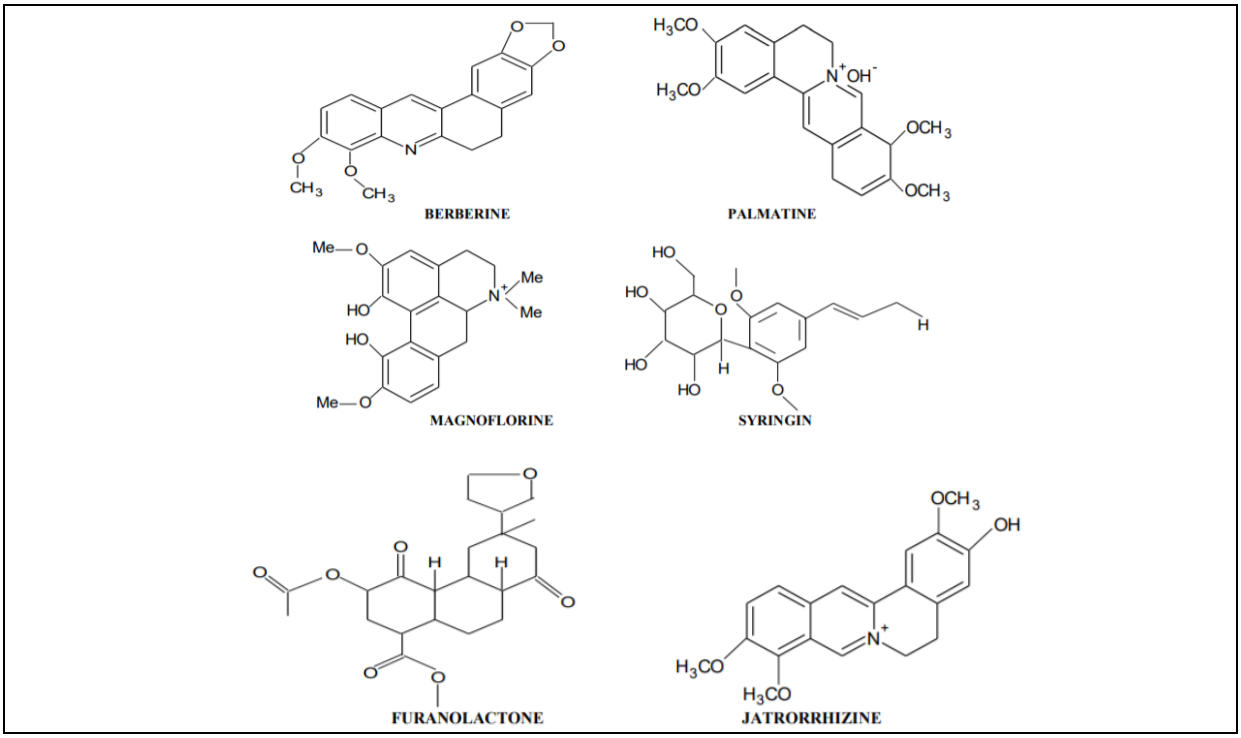
In Sushurta Samhita, under Tikta-SakaVarga, it is traditionally claimed for the treatment of several diseases like Svasa (asthma), Maha Jvara (fever), Aruci (anorexia) and kustha (leprosy). In context of Ashtang Hridaya and Charak Samhita, there is also a great evidence for the treatment of different diseases like Jvara (fever), Vat Rakta (gout) and Kamala (jaundice). In Bhavya Prakash, it is considered as diuretic, astringent, bitter tonic and potential curative and aphrodisiac against jaundice, diabetes, chronic diarrhea, dysentery and skin infections. In Dhanvantri Nighantu, it has been depicted for treatment of bleeding piles, curing itching, erysipelas and promoting longevity. Additionally, guduchi has been shown as: Deepanam (kindles digestive fire), Laghu (light), Dhatukrit (builds the seven bodily tissues), Chakshushyam (good for the eyes), Bayasthaapankarakam (maintains youthfulness and longevity) and Medhayam (rejuvenating for the mind). According to Ayurvedic literature T. cordifolia is a major constituent of formulations used for the treatment of several disease such as dyspepsia, urinary related diseases debility and fever[10-11]. A related species Tinospora crispa is used in Ayurveda for treating a large spectrum of diseases. Traditional healers of Thailand, Malaysia, Guyana, Bangladesh and the southern Indian province of Kerala use this plant in the treatment of diabetes. Many diterpenes, triterpenes, phytosteroids, alkaloids and their glycosides have been isolated from T. crispa. Tinospora cordifolia, the versatile medicinal plant is the unique source of various types of compounds having diverse chemical structure. Very little work has been done on the biological activity and plausible medicinal applications of these compounds and hence extensive investigation is needed to exploit their therapeutic utility to combat diseases. Quite a significant amount of research has already been carried out during the past few decades in exploring the chemistry of different parts of Tinospora cordifolia. While Tinospora cordifolia has been used successfully in Ayurvedic medicine for centuries, an extensive research and development work should be undertaken on Tinospora cordifolia and its products for their better economic and therapeutic utilization. This review can be used for further research as well as clinical purpose. This review focuses on phytopharmacology and traditional uses of T. Cordifolia[12].

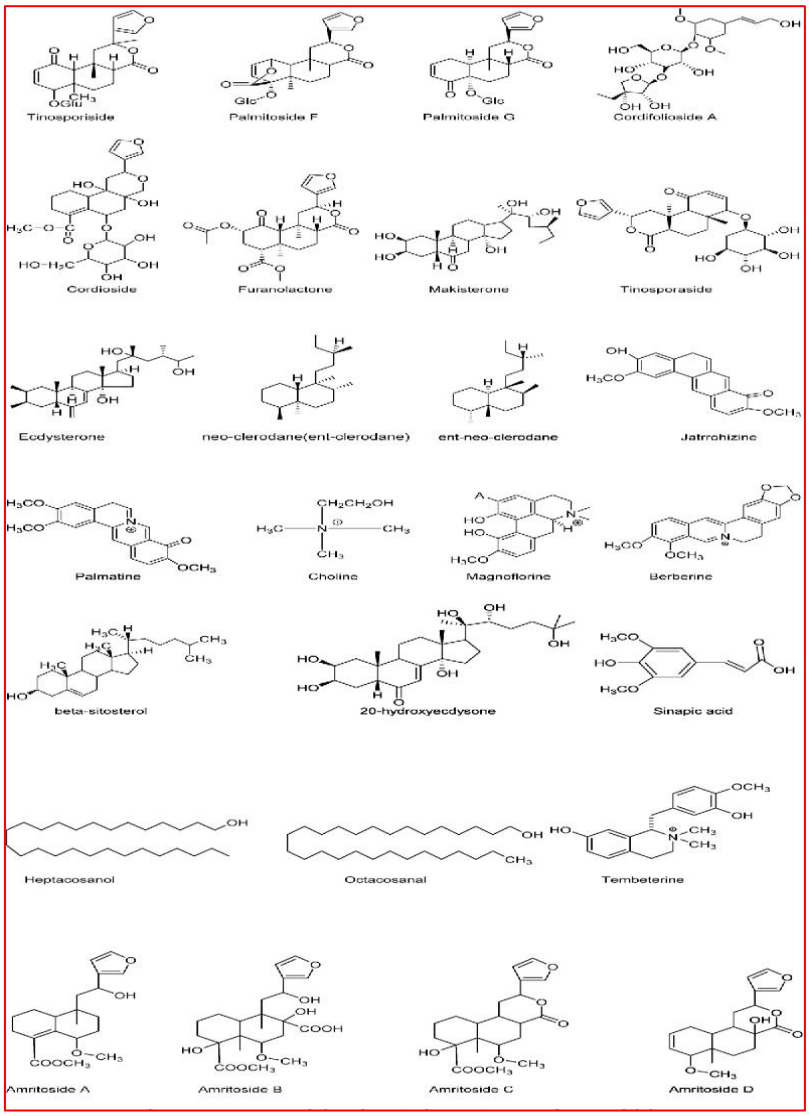
Ayurvedic Traditional practices

Giloe which is a Hindu mythological term that refers to the heavenly elixir that has saved celestial beings from old age and kept them eternally young[13]. In Ayurveda, it is designated as *Rasayana* drug recommended to enhance general body resistance and promote longevity and as antistress and adaptogen. The fact that it is called “Amrita” signifies its use for revitalization and its importance in Ayurveda. This significant plant is also mentioned in important Pharmacopoeias. Several reports on its chemical constituents, medicinal properties, and validation of therapeutic claims have already been published. *T. cordifolia* is reported for adaptogenic, anticancer, anti-inflammatory, antiallergic, antidiabetic, antioxidant, antipyretic, hepatoprotective, immunomodulator, and diuretic activities and is also found useful for the protection against the toxicity of cancer chemotherapy. Major constituents, namely, alkaloids, cardiac glycosides, flavonoids, lignans, saponins, steroids, tannins, terpenoides, and so forth are reported from *T. cordifolia*. Berberine is an isoquinoline alkaloid reported to have anticancer, antidiabetic, and immunomodulatory properties. Starch of *T. cordifolia*, commonly known as “Giloe Satva,” is reported as immunomodulator and antimetastatic . Tinosporaside is reported for antihyperglycemic activity[15-17].

Herbal extracts in various forms like infusion, decoction, strong decoction, tinctures, syrups and maceration etc. are commonly used since ancient time for medicinal effects. Cold infusion of Giloy prepared using stem is given in chronic conditions of fever. The juice extract from the stem of Giloy is highly effective for treatment of gout as it helps to neutralise the increased uric acid levels in the body. Strong decoction of Giloy with basil leaves offer resistance against swine-flu Anti-diabetic potential of T. cordifolia parts. Because of presence of various kinds of phytochemicals in Giloy, it has found applications in pharmaceutical chemistry due to its antiosteoporetic, hepatoprotective, immunomodulatory, antihyperglycemic, anti-tumor, anti-HIV properties.

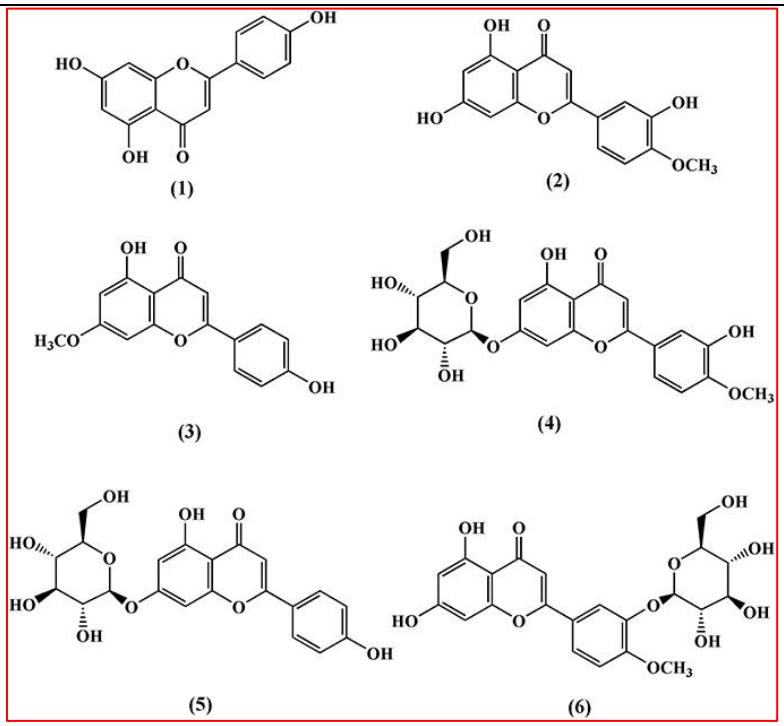
The leaves are baked in fire and applied externally over the ulcers[18-21]. The decoction prepared by the samoolam is an effective remedy for fever. For better results parpadakam, chandanam, chukku, koraikizhangu can be used for preparation of this decoction. An effective Siddha preparation called Seenthil sarkarai or Seenthil uppu is a very effective remedy for venereal diseases, diabetes, skin diseases, spleenomegally, jaundice, cough etc. Seethil leghyam is an effective remedy for suram (fever), diarrhoea, venereal diseases etc. Seenthil choornam and Seethil uppu is found to bring excellent results in the condtions like chronic skin ailments, bone disorders and infertility. ome of the imperative formulations prepared from T. cordifolia are: Guduchi taila, Sanjivani vati, Kanta-Kari avaleha, Guduchyadi churna, Chyavnaprasha, Guduchu ghrita, Guduchi satva, Brihat guduchi taila, Amrita guggulu, amritashtaka churna and many more.T. cordifolia is the mostly used herbs of Ayurvedic medicine that, has been widely used by folks and tribal as a remedial herb for the treatment of various diseases. T. cordifolia is highly valuable in Ayurveda for its numerous medicinal properties like rejuvenating, immune-boosting, anti-rheumatic and detoxifying properties[22-24].



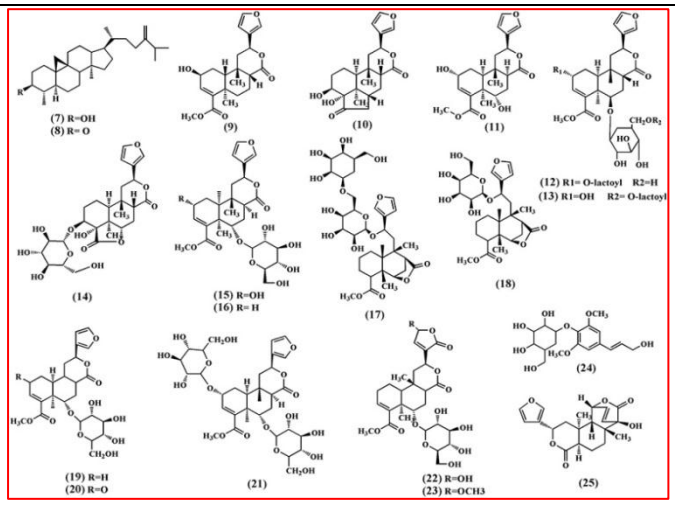


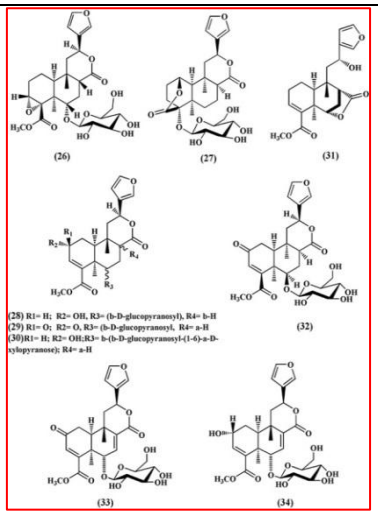
Phytochemical and Phytopharmacological characteristics

The plant mainly contains alkaloids, glycosides, steroids, sesquiterpenoids, aliphatic compounds, essential oils, mixture of fatty acids and polysaccchrides. The alkaloids include berberine, bitter gilonin, non-glycoside gilonin gilosterol. The major phytoconstituent in Tinospora cordifolia include tinosporine, tinosporide, tinosporaside, cordifolide, cordifol, heptacosanol, clerodane furano diterpene, diterpenoid furano lactone, tinosporidine, columbin, b-sitosterol. Berberine, palmatine, tembertarine, magniflorine, choline and tinosporin are reported from the stem of the plant. A rearranged cadinane sesquiterpene named tinocordiside, consisting of tricyclic skeleton with a cyclobutane ring, has been isolated from the aqueous fraction of T. Cordifolia[25-27]. The new clerodane furano diterpene 2 with the molecular formula has been isolated from the stems of the plant. A new daucane type sesquiterpene, tinocordifolin, has been isolated from the stem of Tinospora cordifolia. The new sesquiterpene has been named as tinocordifolin together with tinocordifolioside, N-trans-feruloyl tyramine . Phytochemical investigation of the methanol extract of Tinospora cordifolia aerial parts led to the isolation of four new and seven known compounds. The structure of the new aporphine alkaloids, N-formylasimilobine 2-O-β-Dglucopyranosyl –(1-2)-β-D-glucopyranoside (tinoscorside A) and N-acetylasimilobine 2-O- βD- glucopyranosyl –(1-2)-β-D-glucopyranoside (tinoscorside B), a new clerodane diterpene, tinoscorside C and a new phenylpropanoid , sinapyl 14-O- β-D-apiofuranosyl-(1-6)-O- β-Dglucopyranoside (tinoscorside D)[28-30].



Chemical structures of Flavonoids



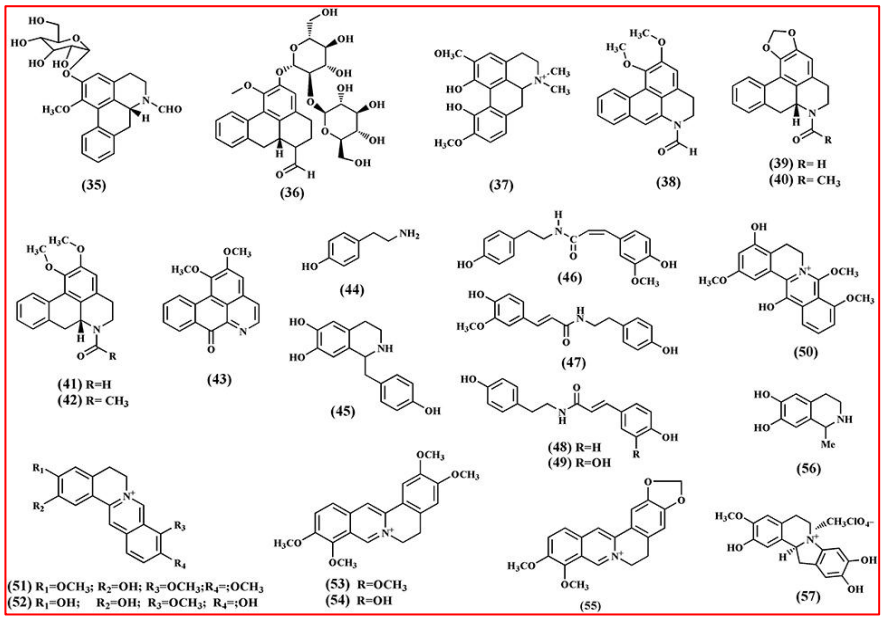


Chemical structures of Terpenoids

Stem and root part of T. cordifolia contain alkaloids as active constituents. These are tembetarine, choline, magnoflorine, berberine, tinosporin, isocolumbin, palmetine, jatrorrhizine, aporphine alkaloids, tetrahy-dropalmatine which showed anti-cancer, anti-diabetes, anti-viral, anti-inflammatory, anti-psychiatric and immunomodulatory action. Further, whole plant of T. cordifolia contain furanolactone, diterpenoid Lactones, Cleodrane derivatives [(5R, 10R)-4R-8R-dihydroxy-cleroda-13(16), 14-dieno-17, 12S:18, 1S-dilactone], columbin tinosporides, tinosporin, jateorine.

They showed biological actions such as Vasorelaxant, anti-inflammatory, anti-microbial, anti-hypertensive and anti-viral.27-31 Shoot part of T. cordifolia contains Steroids (B-sitosterol, δ-sitosterol, 20 β-hydroxyecdysone, giloinsterol, Makisterone A, Ecdysterone). Stem part of T. cordifolia contain Glycosides. Their active constituents are 18-norcleodrane glucoside, Tinocordifolioside, Cordioside, cordifo-lioside A, B, C, D and E, Furanoid diterpine glucoside, Syringin, preg-nane glycoside Syringing-apiosylglycoside, palmatosides[31-36]. Whole plant of T. cordifolia contain aliphatic compounds. The active constituents are Octacosanol, Nanocosan-15-one dichloromethane, Heptacosanol. They showed anti- nociceptive and anti-inflammatory activity. They also inhibit TNF-α from binding to the DNA and provide protection against 6-hydroxydopamine induced Parkinsonism in rats.42-44Stem part of T. cordifolia contain Sesquiterpenoids and Tinocordifolin which exhibits an antiseptic activity.45 The other parts of T. cordifolia con-tain active constituents such as Jatrorrhizine, Tinosporic acid, 3, (a, 4-di hydroxy-3-methoxy-benzyl)-4-(4- hydroxy-3-methoxy-benzyl) tetrahy-drofuran, N-trans-feruloyltyramine as diacetate, Giloin. They showed a protective effect against HIV[36-38].

T. cordifolia has been recognised as most extensively used plant since ages in traditional system of medicine for its spasmolytic, allergen-free and anti-diabetic property. The plant significantly improves immune system. This plant possesses many useful properties. Its root part is known for its stress relieving and antimalarial properties while its stem is being used as bitter stomachic and diuretic. It stimulates biliary secre-tion, enrich the blood and cure jaundice. It has the magical potential of lowering the blood sugar level in human beings. An alkaloid isoquinoline 'berberin' is reported to be highly effective for curing human diabetes. It lowers elevated glucose level as effectively as metformin. Besides, tinosporin, isocolumbin, palmatine, tinocordiside, cordioside and βsitosterol compounds present in stem and root are also reported to possess ant diabetic, antihyperlipidemic and antioxidant properties[39-43].



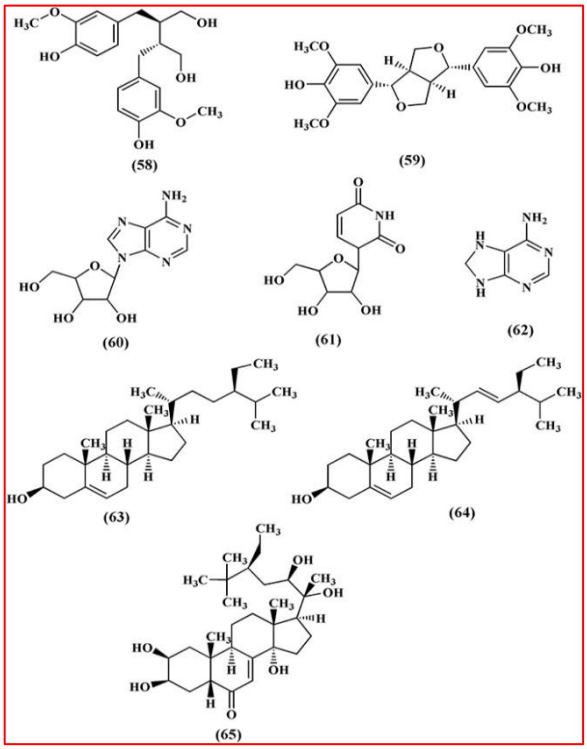
Chemica structures of Alkaloids

Till date, three flavones and three flavone glycosides have been identified from the stem of *T. crispa*, namely, apeginin (1), diosmetin (2), genkwanin (3), luteolin 4′-methyl ether 7-glucoside (4), genkwanin 7-glucoside (5), and luteolin 4′-methyl ether 3′-glucoside (6).A number of terpenoids (7–33), classified as triterpenoids (7–8), and diterpenoids (9–34), have been isolated from different parts of *T. crispa*.

The triterpenoids, cycloeucalenol (7) and cycloeucalenone (8) were also isolated from the stem. Diterpenoids and their glycosides are the main terpenoids in T. crispa and the most common are the clerodane-type furanoditerpenoids. Diterpenoids, tinocrispol A (9), borapetol A (10), borapetols B (11), were isolated from the ethanol extract of T. crispa vines (44-50).

Diterpenoid glycosides, 2-O-lactoylborapetoside B (12), 6'-O-lactoylborapetoside B (13), borapetoside A (14), borapetoside B (15), borapetoside C (16), borapetoside D (17), borapetoside E (18), borapetoside F (19) (Martin et al., 1996), borapetoside G (20), borapetoside H (21), rumphioside A (22), rumphioside B (23), rumphioside C, rumphioside F, rumphioside I, syringin (24), columbin (25), tinocrisposide A, tinocrisposide B, tinocrisposide C, and tinocrisposide D were isolated from the methanol extract of *T. crispa*.

Nine new cis clerodane-type furanoditerpenoids, from aerial parts of T. crispa, viz. (3R,4R,5R,6S,8R,9S,10S,12S)-15,16-epoxy-3,4-epoxy-6-O-(β-D- glucopyranosyl)-cleroda-3,13(16),14-trien-17,12-olid-18-oic acid methyl ester (26), (1R,4S,5R,8S,9R,10S,12S)-15,16-epoxy-4-O -(β-D-glucopyranosyl) -cleroda-2,13(16),14-triene-17(12),18(1)-diolide (27), (2R,5R,6R,8R,9S,10S,12S)-15,16-epoxy-2 -hydroxy-6-O-(β-D-glucopyranosyl)-cleroda-3,13(16),14-trien-17,12-olid-18-oic acid methyl ester (28), (5)R,6R, 8S,9R,10R,12S)-15,16-epoxy-2-oxo-6-O-(β-D-glucopyranosyl)-cleroda-3,13(16),14-trien-17,12-olid-18-oic acid methyl ester (29), (2R,5R,6R,8S,9S,10S,12S)-15,16-epoxy-2-hydroxy-6-O-{β-D-glucopyranosyl-(1-6)α-D-xylopyranosyl}-cleroda-3,13(16),14- trien-17,12-olid-18-oic acid methyl ester (30), rumphiol E (31), (5R,6R,8S,9R,10S,12S)-15,16-epoxy-2-oxo-6-O-(β-D-glucopyranosyl)-cleroda-3,13(16),14-trien-17,12-olid-18-oicacidmethylester (32), (5R,6S,9S,10S,12S)-15,16-epoxy-2-oxo-6-O-(β-D-glucopyranosyl)-cleroda-3,7,13(16),14-tetraen-17,12-olid-18-oic acid methyl ester (33), and (2R,5R,6S,9S,10S,12S)-15,16-epoxy-2-hydroxy-6-O-(β-D-glucopyranosyl)-cleroda-3,7,13(16),14-tetraen-17,12-olid-18-oic acid methyl ester (34) have also been depicted (51-54).



Chemical tructure of Lignans, Nucleosides, and Sterols

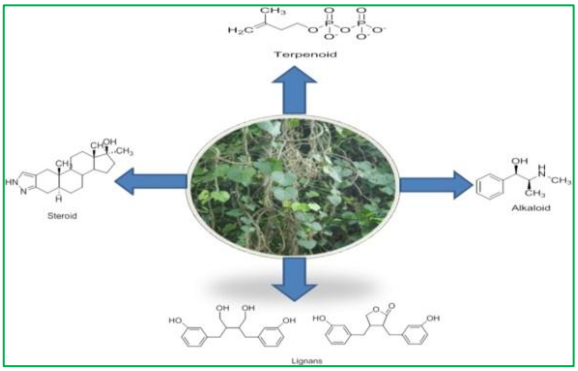
Alkaloids are important secondary metabolites from the plant. To date, 21 quaternary alkaloids have been isolated (35-57) and classified into protoberberine, furonoquinolone, and aporphine alkaloids. The most common alkaloids found in T. crispa are aporphines. These include N-formylasimilobine 2-O-β-D-glucopyranoside (35), N-formylasimilobine 2-O-β- D-glucopyranosyl-(1 → 2)-β-D-glucopyranoside (tinoscorside A) (36), magnoflorine (37), N-demethyl-N-formyldehydronornuciferine (38), N-formylanonaine (39), N-acetylanonaine (40), N-formylnornuciferine (41), N-acetylnornuciferine (42). and lysicamine (43). The furquinolone alkaloids isolated from T. crispa comprise tyramine (44), higenamine (45) (Praman et al., 2012), N-cis-feruloyltyramine (46), N-trans-feruloyltyramine (47), paprazine (48), and N-trans-caffeoyltyramine (49). The protoberberine alkaloids include 4,13-dihydroxy-2,8,9-trimethoxydibenzo[a,g]quinolizinium (50), columbamine (51), dihydrodiscretamin (52). palmatine (53), jatrorrhizine (54), and berberine (55) (Bisset and Nwaiwu, 1983). Salsolinol (56) (a tetrahydroisoquinoline) and (−)-Litcubinine (57) (a dibenzopyrrocoline type alkaloid) were identified from n-butanol fraction of T. crispa stem (55-56).
Lignans are group of compounds that arise from the shikimic acid pathway. Secoisolariciresinol (58) and syringaresinol (59) are lignans isolated from the methanol extract of *T. crispa.* Adenosine (60), uridine (61), and adenine (62) are the nucleosides isolated from the n-butanol fraction of T. crispa stem. Sterols like β-sitosterol (63), stigmasterol (64) and makisterone C (65) have also been isolated from *T. crispa*.

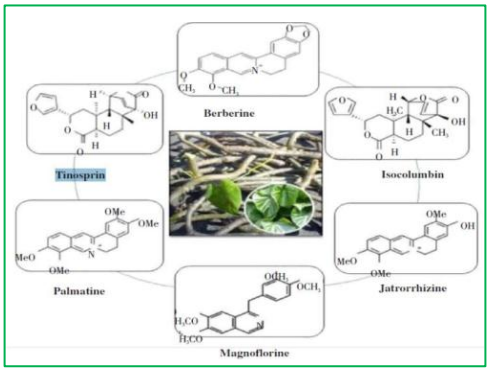
Other health benefits

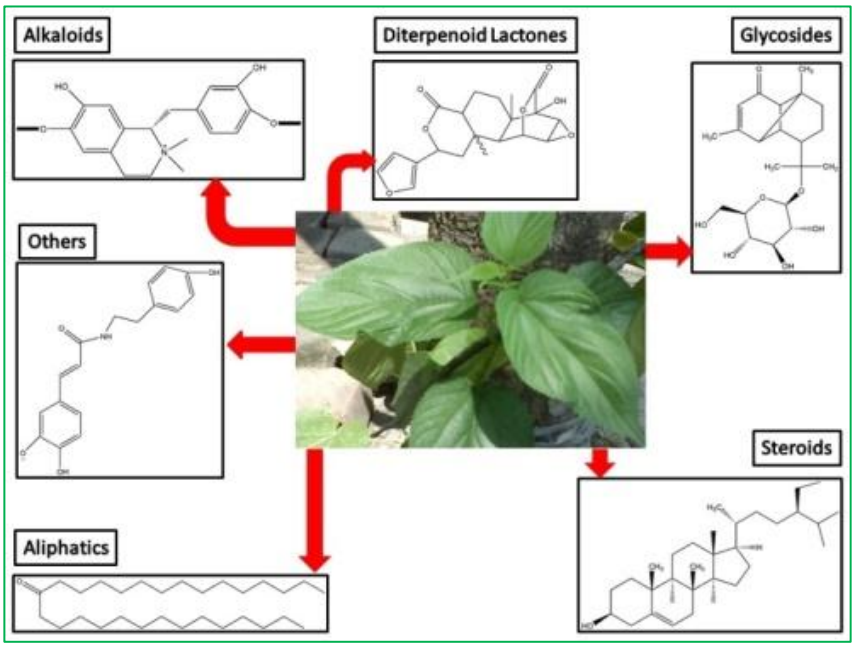
Tinospora contains diverse phytochemicals, including alkaloids, phytosterols, glycosides, and mixed other chemical compounds. Columbin, tinosporaside, jatrorhizine, palmatine, berberine, tembeterine, tinocordifolioside, phenylpropene disaccharides, choline, tinosporic acid, tinosporal, and tinosporon have been isolated from T. cordifolia. The stem and root's extract are used in traditional medicine to treat various disorders. It is often called *Amrita*, which in Sanskrit means 'divine nectar'. A plant with as diverse a role as Tinospora cordifolia is a versatile resource for all forms of life. There are reports as already discussed that the plant extracts have active compounds in the form of alkaloids, glycosides, lactones and steroids. All these active compounds have immunomodulatory and physiological roles of different types, thereby demonstrating the diverse versatility of the plant. Tinospora cordifolia is widely used medicinal plant in Ayurvedic system for its general tonic, antiperiodic, anti-spasmodic, anti-inflammatory, antipyretic, anti-arthritic, anti-lepritic, anti-allergic and anti-diabetic properties. The plant is used to improve the immune system and the body resistance against infections. The root of this plant is known for its anti-stress and antimalarial activities. The stem is bitter, stomachic, diuretic, stimulates bile secretions, allays thirst, enriches the blood and cures jaundice. The extract of the stem is useful in skin problems. The root and stem of Tinospora cordifolia is prescribed in combination with other drugs as an antidote to snakebite and scorpion. The plant is also used in the treatment of wounds, pneumonia, asthma and cough. Tinospora cordifolia has anti-cancer, immune stimulating, nerve cell protecting, antidiabetic, cholesterol-lowering and liver-protective actions. Tinospora cordifolia is also responsible for decreasing the tissue damage caused by radiation, the side effects of some forms of chemotherapy and speeding healing of diabetic foot ulcers. There has been an increase in demand for the phytopharmaceuticals all over the world because of the fact that the allopathic drugs have more side effects. This forms a good basis for the selection of plant for further phytochemical and pharmacological investigation. The pharmacological and clinical studies reported in the present review confirm the therapeutic value of Tinospora cordifolia. Presence of chemical compounds indicates that the plant could serve as "lead" for development of novel agents for disorders in the coming years. In this regard, further studies need to be carried out to explore Tinospora cordifolia for its potential in preventing and treating diseases. Is an aphrodisiac, It has an immunomodulating effect. It is an excellent antioxidant. Effective with general weakness. It has a rejuvenating effect on the body, as it actively normalizes the liver.

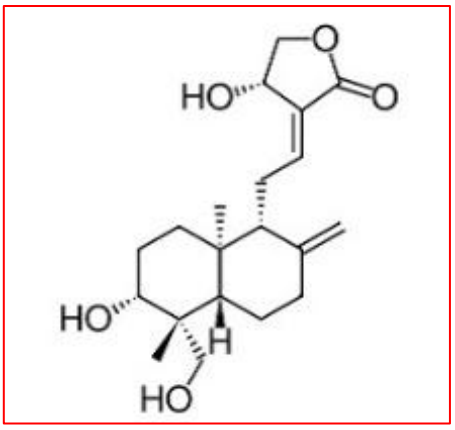
Improves blood quality and cleanses the body of toxins. Controls blood glucose in diabetes. Effectively helps in the treatment of hepatitis and jaundice. Promotes hematopoiesis in case of anemia. Used in the treatment of tuberculosis, etc. Slows down organ wear and premature aging. Helps to get rid or significantly improve the condition in chronic diseases, as it has the ability to repair damaged organ tissues. Alleviates the condition in cases of: – chronic and acute viral fever, – urinary tract infections, – spermatogenesis disorders, – bleeding, – arthritis and arthrosis. It helps with skin problems such as acne, psoriasis, leprosy, eczema, lichen planus, erysipelas, itchy rashes and others, as it is a natural blood purifier. Anticancer effect – It can be used as an aid in chemotherapy for cancerous tumors. T. cordifolia (guduchi) has such a powerful effect that it helps to improve mental activity. All this makes it an excellent preventive and therapeutic tool against stress, anxiety and depression. In the recent times, this plant has gained a lot of popularity among researchers across the globe because of its medicinal properties which include anti-diabetic, anti-periodic, antispasmodic, anti-inflammatory, anti-arthritic, antioxidant, anti-allergic, anti-stress, antiepileptic, anti-malarial, hepatoprotective, immunomodulatory and anti-neoplastic activities[57].

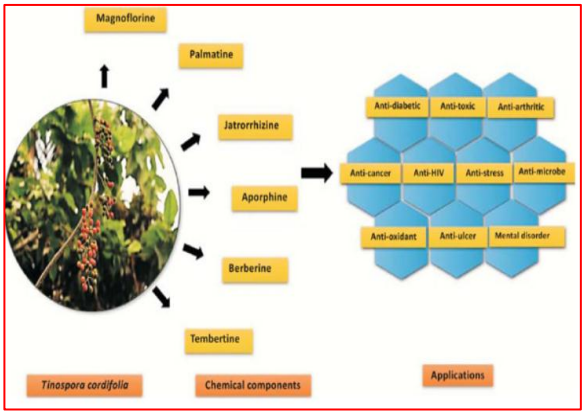
Tinospora cordifolia active compounds include 11-hydroxymustakone, N-methyl-2-pyrrolidone, N-formyl annonain, tinocordiside, and syringin are reported to have potential immunomodulatory cytotoxic effects.These active components are reported to boost the phagocytic activity of macrophages.They produce reactive oxygen species (ROS) in human neutrophil cells.They enhance nitric oxide production by stimulation of splenocytes and macrophages which indicates anti-tumour effects.Its aqueous extracts have been reported to influence the cytokinesis production, mitogenicity, stimulation and immune effector cells.Giloy dry stem crude extracts with a polyclonal B cell mitogen are reported to enhance the immune response.They are also synergistic effects of compounds in the immunomodulatory activity. Giloy stem is widely used as a therapy of diabetes by regulating blood glucose levels in Indian traditional medicine.It mediates its anti-diabetic potential through mitigating oxidative stress which promotes insulin secretion.It also inhibits gluconeogenesis and glycogenolysis which regulates blood glucose. Alkaloids, tannins, cardiac glycosides, steroids are major phytoconstituents which play an important anti-diabetic role.The root extract decreases the levels of glycosylated haemoglobin.They reduce GSH and vitamin C in the blood. They also reduce urine glucose and lipids in the serum. It significantly counterbalances diabetes in the liver by lowering the levels of malondialdehyde.Giloy extracts scavenge radicals generated during aflatoxicosis.It exhibits protective effects by lowering thiobarbituric acid reactive substances.Alkaloids such as tinosporin, choline, isocolumbin, and magnoflorine show protection aflatoxin induced nephrotoxicity.Anti-arthritic, anti-osteoporotic effects. Giloy with ginger has been used for the treatment of rheumatoid arthritis treatment in olden days in Indian medicine.It shows effects on the proliferation, differentiation and mineralization of bone-like matrix on osteoblast model systems which helps in an anti-osteoporotic agent.It stimulates the growth of osteoblasts while increasing the differentiation of cells into the osteoblastic lineage. It also increases the mineralization of bone-like matrix.Giloy extracts help in significantly increasing the thickness of joint cartilage. Giloy helps in a significant reduction in eosinophil count, stimulation of B lymphocytes, macrophages and polymorphonuclear leukocytes which have great Anti-HIV effects.It shows radioprotective activity by an increase in body weight, testes-body weight ratio, tissue weight and tubular diameter.It inhibits the harmful effects of gamma radiation.Its active compounds help to reduce dark spots, pimples, fine lines, and wrinkles.It helps you to achieve flawless complexion which aspired by everyone[58-59].











Diterpenoid lactone

CONCLUSION

Tinospora cordifolia is a well known medicinal plant in traditional medicinal system and recent scientific studies have emphasized the possible use of Tinospora cordifolia in modern medicine. The plant finds us in traditional ayurvedic medicine and has several therapeutic properties such as jaundice, rheumatism, urinary disorder, skin diseases, diabetes, anemia, inflammation, allergic condition, anti-periodic, radioprotective properties, etc.

The root of Giloya (T. cordifolia) is used as potent emetic and for bowel obstruction. Tinospora cordifolia is an important drug of Indian systems of medicine and used in medicines since times immemorial. The drug is well known Indian bitter and prescribed in fevers, diabetes, dyspepsia, jaundice, urinary problems, skin diseases and chronic diarrhoea and dysentery. It has been also indicated useful in the treatment of heart disease, leprosy, and helmenthiasis. The starch obtained from the stem is highly nutritive and digestive and used in many diseases. The starch of this plant serves a beneficial household remedy for chronic fever, relieves burning sensation, increases energy and appetite. Giloya is useful in the treatment of helminthiasis, heart diseases, leprosy, rheumatoid arthritis, support the immune system, the body's resistance to infections, supports standard white blood cell structure, function, and levels. It also helps in digestive ailments such as hyperacidity, colitis, worm infestations, loss of appetite, abdominal pain, excessive thirst, and vomiting, and even liver disorders like hepatitis This pharmacological activities of the plant is due to its chemical constituents like diterpenoid lactones, glycosides, steroids, sesquiterpenoid, phenolics, aliphatic compounds, essential oils, a mixture of fatty acids, and polysaccharides and is present in a different part of the plant body, including root, stem, and whole part. Tinospora cordifolia contains different bioactive compounds such as alkaloids, diterpenoid lactones, glycosides, sesquiterpenoid; alipathic compounds phenolics, polysaccharides, steroids like tinosporine, tinosporides, tinosporaside, cordifolide, cordifol, hepatacosanol, clerodane, furano diterpen, diterpenoid furano lactone tinosporidine, columbin and beta-sitosterol. Leaves of the plant are rich in protein and are fairly rich in Ca and P. Tinospora cordifolia has been used in Indigenous Systems of Medicine, as indicated in various classical texts of Ayurvedic System of Medicine, viz. Charak, Sushrut and Ashtang Hridaya and other ancient treaties. It also finds a special mention for its use in tribal or folk medicine in different parts of the country.The present review aims to document the medicinal properties of Tinospora cordifolia and its potential prospects for the further scientific investigation for the developments of effective therapeutic phytoconstituents.

ACKNOWLEDGEMENTS

Authors are greatful to the Department of Agroforestry of CAZRI (Central Arid Zone Research Insititute), Jodhpur, Rajasthan for providing valuable information concerning to availability of literature for compiling this current comprehensive review manuscript. We are also thankful to SASs (Society for Advanvement of Sciences)), Lucknow, UP for accepting our humble request for providing concession in publication charges.

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