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REVIEW ARTICLE

Plant Description, Phytochemical Constituents and Pharmacological Attributes of the Plant *Sida cordata:* A Perspective Review

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Abstract

Sida cordata, a plant species belonging to the *Malvaceae* family, is indigenous to Asia. This review aims to describe the natural growth, plant biology, phytochemical composition and pharmacological properties of *S. cordata*. Different parts (leaves, flower, stem, whole plant) of the plant are abundant in phytochemical components including flavonoids, glycosides, and tannins, it is utilized to treat aphrodisiacs, purgatives, malignant growth, diabetes, and coronary, and hepatoprotective, anti-inflammation and anthelmintic effects have been observed to different extract from multiple portions of *S. cordata*. This plant has constituents, bioactive synthetics, and strong cell reinforcement action, all of which give various restorative benefits for many normal infirmities. The flow survey depicts the assessment of *S. cordata's* phytochemical properties and pharmacological studies to assess inflammation efficacy in *in-vitro* and *in-vivo* research, by using carrageenan induced swelling model, anticancer on CAL-27 and HGF cell lines and MTT assay, antidiabetic activity with alloxan-induced and anthelmintic movement studies on using 96 well rasazarin based microliter dilution method and agar well diffusion method. This spice contains Ephedrine, betaine, choline, oxalic corrosive, flavonoid, vitamin D_3, vitamin E, nonanoic acid, Hypaphorine, phytol, squalene, and phenolic acid.

Major Findings: This study reveals that the extract of *S. cordata* exhibits significant pharmacological properties, with promising potential for therapeutic applications like skin and wound healing, diabetic control, neuropathy, muscle soreness and nerve related disorder.

Keywords: *Ayurveda* Medicine, *Malvaceae*, Pharmacology, Photochemistry, *Sida cordata*

1. Introduction

The whole plant of *S. cordata* called *bhumibala* (heart leaf fanpetal), is esteemed as an ingredient in an Ayurveda custom of Indian medication. It is additionally used in customary clinical practices in Bangladesh, Sri Lanka, Pakistan and India. In India including Tamil Nadu, Kerala, Madhya Pradesh, and Andhra Pradesh utilize this plant to treat different diseases. *Bhumibala* has various native purposes, this plant seems eminently suitable to cure anticancer, mitigating, antidiabetic, antiasthmatic, wound mending, and snakebite, against microbial and

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anthelmintic. Ephedrine, nutrients, and oleic corrosive are undeniably found in the foundations of this plant, which might be utilized to treat a few illnesses[1]. The plant's leaves, stem and seeds are likewise utilized in customary medication for various remedial purposes. This natural plant shows a scope of exercises, including hepatotoxic, adaptogenic and sexual enhancer impacts. The current survey will feature the commitment of *S. cordata* to the advanced arrangement of natural medication for future medication improvement.

This current review aims to fully describe the *S. cordata*'s botanical characteristics, phytochemicals and pharmacological properties while also emphasizing the significant attention in this medicinal plant as a source of herbal treatments. The conventional use of *S. cordata* preparations lends support to skin conditions. Its foundation is the literature compiled from sources such as Science Direct, Scopus, PubMed, Web of Science, and others. However, this work also includes information from more than 60 other papers. Because of this, this review paper may provide an insightful update on the state of knowledge.

2. Terminology and Natural Identification of Plants

The terminology and natural ID of *S. cordata* are frequently found in the wellspring of the famous Indian traditional plant *'bala'* (meaning power in *Sanskrit*). While the name *'Bala'*is said to be generally connected to *Sida cordate* (otherwise called *nagabala*), *Sida cordate* (otherwise called north Indian *bala*), *Sida alnifolia*, and *Sida rhombifolia* (otherwise called south Indian *bala*), the name *Bala* is shared by a few types of *Sida*. *S. cordata* was accounted for as the essential hotspot for *bhumibala* or *nagabala* in *Ayurvedic* formulation.

Common names, for example, *Sida acuta, Sida rhombifiolia*, *S. cordata*, *Sida subcordate*, and *Sida cordifolia* are viewed as substitutes in the comparability of their species like *S. cordifolia*, *Sida myogenesis*, and *S. cordata* have comparable leaf and blossom morphology In any case, perception of propensity (branches following in *S. cordata* root in the other two species), the bloom (bloom in racemes in *Sida myogenesis*; singular in the others), elements of natural products (mericarps around 10, and surpassing calyx in *S. cordifolia*: mericarps about and not surpassing calyx in *S. cordata* and *S. myogenesis*) are useful in the legitimate distinguishing proof of various types of *Sida*[2]. An investigation discovered that the HPTLC markers of the elevated pieces of *S. cordata*, *S. rhombifiolia, S. acuta*, and *S. cordata* were subsequently utilized for the separation of these species. The base of *S. cordata*, *S. acuta*, and *S. cordata* can likewise be separated on their particular HPTLC fingerprints[3], but the HPTLC profiles of the foundations of *S. cordata* show ephedrine content[4].

3. Scientific Categorization and Circulation of *S. cordata*

The *Sida. L.* (*Malvaceae*) kind examines over 250 species that are primarily found in hill-side forests (Tables 1 and 2). Around 20 types of *Sida* are available in India and 13 species are found in Tamil Nadu alongside subspecies. The types of *S. cordata* happen normally in a specific spot in India, Pakistan, Bangladesh, and Sri Lanka.

3.1 Vernacular Names

Table 1. Common regional names of *S. cordata*

Tamil	*Kurunthotti, Palampasi, Mayrimanikkam.*
Common names	*long stalk-Sida, country mallow, flannel weed mand heartleaf petals, heart leaf Sida.*
Hindi	*Bhuinii*
Marathi	*Bhumi petari, Bhoybal*
Malayalam	*Kuruntotti, Nela vaga*
Telugu	*Benda, Gayapaku, Tirunala*
Kannada	*Bekkinathale gida*
Sanskrit	*Bhumibala, Nagabala.*

3.2 Scientific Classification[5]

Table 2. Scientific Taxonomy of *S. cordata*

Kingdom	*Plantae*
Subkingdom	*Viridiplantae*
Infra kingdom	*Streptophyta*
Super division	*Embryophyte*
Division	*Tracheophyta*
Subdivision	*Spermatophytes*
Class	*Magnoliopsida*
Superorder	*Rosanae*
Order	*Malvales*
Family	*Malvaceae - mallows, mauves*
Genus	*Sida L. – fanpetals*
Species	*S. cordata (Burm f) bros' walk - heartleaf fan petals*

3.3 Botanical Description

This describes a sprawling or somewhat upright spice plant that can grow up to 80cm tall. The base branches out a lot, and all parts of the plant are covered in fine, star-shaped hairs, sometimes mixed with regular straight hairs (Figure 1).

The leaves are 1-5.5 cm long and 1-5 cm wide. They can have smooth or slightly wavy edges with rounded teeth. The base of the leaf can be heart-shaped or rounded, and the tip comes to a point. The underside of the leaf is covered in star-shaped hairs, while the top has both star-shaped and straight, bristly hairs. Small, thread-like structures (stipules) are at the base of the leaf stalk, which is 1-4 cm long.

Flowers grow individually or in small clusters in the leaf axils (where the leaf meets the stem) or at the ends of branches. The flower stalk is 1.5-2.5 cm long but can reach 3.5cm in the fruit. The sepals (calyx) are fused halfway up and about 4-5 mm long and wide. The petals are pale yellow and about 7-8 mm across. The stamen (male part of the flower) is 2-3 mm long and has straight, hairy filaments.

The fruit is a round capsule that splits open when ripe. It's about 3-4 mm wide and hairy on top. Inside, there are 5 sections (mericarps) that are triangular in cross-section with sharp points. These sections are dark, with a net-like pattern on the sides and back. They have short (up to 2mm) awns that point in different directions and are hairless. Each section contains a single, brown, kidney-shaped seed that is smooth and hairless[6,7].



Figure 1. *Sida cordata* (Burm f) bros' walk.

3.4 Distributions of the Plant

Country mallow of the *Malvacea* family is broadly conveyed alongside different species that are normal all through the tropical and subtropical fields all over India and Sri Lanka up to an elevation of 1050 developing wild along the side of the road.

3.5 Part Utilised

Whole plant, leaves, stem, blossoms, seed, root.

3.6 Macroscopic Characters: Stem-Pubescent with Straight-forward Stellate Hair

Leaves - 6x5 cm extensively praise, serrate - crenate, 5 to 7 veins, Blossoms - 8-10 mm measurement, orange-yellow, lone, axillary, and 2-bent at the pinnacle. Seed - Tanish dark, 2mm long, glabrous. Blossoming and fruiting season: Over time, predominantly during September – November.

3.7 Microscopic Characters[8]

Stem: cross-segment of the stem rows round frame with trichomes, the epidermis is radially prolonged, the slight walled cortex is chlorenchymatous with 4-6 layers, statement of calcium oxalate and tannins, vessels are lesser in the stem, xylem and enormous essence are displayed in *S. cordata*.

Leaves and epidermal hair: Epidermal stripping of the leaf shows biaxial trichomes and undulations in the epidermal cells, stomata are anisocytic. The foliar trichomes of epidermal hair force peltate, stellate forked followed and capitate trichomes.

Root: bark is meagre with a stopper comprising of 4-7 columns of slim-walled extraneously stretched cells. The cortex is restricted, containing 3-4 layers, calcium oxalate gems and starch grains are in cortical cells, vessels are more modest in size, lesser in number with a more number tracheid and xylem parenchyma cells vessel contain starch grains.

4. Phytochemical Constituents of *S. cordata*

The plant *S. cordata* has important substances like sugars, proteins, fixed oil, and fats. It also has other substances like alkaloids, flavonoids, saponins,

phenolic compounds, tannins, terpenoids, glycosides, and volatile oils. These substances are found in the whole plant, including the leaves and stems[9]. Researchers studied the plant extract using different solvents such as pet ether, chloroform, ethyl acetate, ethanol, water, n-butanol, and n-hexane. The analysis revealed that the types and amounts of these chemical constituents varied depending on the solvent used. The initial study of the plant extract revealed the existence of these chemicals, suggesting their role in the plant's physiological processes.

4.1 Alkaloids

Alkaloids were discovered in the whole plant and leaf extracts but were completely absent in the stem extract. Finding alkaloids in the plant extract suggests that it has the potential to prevent blood platelet and clot formation. Recent studies found that the alkaloids isolated from the plant extract induce antiplatelet activity. This action is different from aspirin, which inhibits cyclooxygenase and blocks various clot formation[10].

4.2 Phytosterol

The presence of phytosterol has extraordinary medical advantages, particularly in the decrease of coronary illness hazard and bringing down of cholesterol levels in blood plasma and it shows harmfulness to Brest, colon, prostate lungs, and stomach disease cells. In this way, phytosterol contains a concentrate that cures cancer[11].

4.3 Saponins

Saponins were identified in the extracts from both leaves and stems, specifically in liquid and ethanol extracts of both parts. They were also found in extracts from the entire plant in ethyl acetate, ethanol, and water. The presence of saponins suggests some initial evidence of their potential effectiveness against the Coronavirus. Studying saponin production and extraction could be important for treating infections like HIV, HSV, Rotavirus, and for developing medical treatments[12].

4.4 Tannins

Tannins were discovered in both the leaf and stem extracts, specifically in the stem extract using ethyl acetate and ethanol. In the entire plant, all extracts had tannins except for chloroform. Tannins have an anti-inflammatory effect by slowing down the production of Nitric Oxide (NO) and prostaglandin-E2 (PGE2). The extract with tannins has antioxidant properties that can help prevent heart diseases. Additionally, tannins may also prevent viral infections like HIV, Bovine Adeno-related Virus (BAAV), and norovirus[13].

4.5 Flavonoids

Flavonoids were found in the whole plant, including the leaves and stems. The presence of flavonoids helps reduce oxidative stress in the body. They help to slow down the ageing process by shielding the body from the harm that reactive oxygen species and free radicals can cause[14].

4.6 Glycosides

The glycosides found in the plant extract have potential anti-inflammatory and pain-relieving effects. Researchers are paying more attention to the plant extract's phytochemicals because they could be useful as pain relievers. This is because they can influence specific biochemical pathways involved in both inflammatory and pain-relieving responses, particularly in COX and LOX pathways[15].

4.7 Catechins

Catechins were discovered in all extracts of the entire plant, except for chloroform and ethyl acetate. In the stem extract, they were only found in the liquid extract, while in the leaf, they were present in all extracts. Catechins play a role in promoting cell activation by reducing harmful effects on cells caused by reactive oxygen species. This helps in maintaining cell viability and multiplication. Catechins also have properties that can fight against the flu, support cells during oxidative stress, and enhance the skin's barrier function. Additionally, catechins improve the absorption of beneficial nutrients from healthy foods when applied in cosmetics, making them more effective for the body and skin[16].

4.8 Emodin

Emodin was only found in the ethanol extract of the leaf and was not present in the stem extract. In the entire plant, all extracts contained emodin except for

chloroform. Emodin has the potential to act as an anticancer agent against various types of human cells by affecting multiple signalling pathways. It influences processes like cell cycle regulation, apoptosis, metastasis, and angiogenesis in cancer cells. Emodin has a harmful effect on cancer cells by disrupting their cell cycle and inducing apoptosis. Additionally, emodin has the potential to act as a neurotherapeutic agent, impacting various signalling pathways. It may be beneficial for patients with Alzheimer's disease, Parkinson's, cerebral ischemia, schizophrenia, and other neurological disorders[17].

4.9 Coumarins

Coumarins were found in all extracts of the entire plant and only in the ethyl extract of the leaf. The presence of coumarin suggests that it can act against radicals and has allelopathic effects, including insecticidal activity[18].

4.10 Anthraquinones

Anthraquinones were found in all concentrates of the entire part and only in the ethanol and liquid concentrate of the leaf, but not in the stem extract. Anthraquinones can either activate or inhibit many enzymes. They exhibit lipotropic activity on lipase enzymes, meaning that all anthraquinone groups can either inhibit or activate lipase[19].

4.11 Anthocyanins

Anthocyanins were discovered in the ethanol and aqueous concentrate of the leaf, but they were not present in the stem extract. In the entire plant, they were missing in chloroform and ethyl acetate extracts. Anthocyanins have shown effectiveness in reversing ageing and addressing deficiencies in several brain and behaviour parameters. They are powerful in combating reactive oxygen species, inhibiting lipoprotein oxidation, and preventing platelet aggregation[20].

4.12 Phenol

The water and ethyl acetate extracts of the leaf and stem both contained phenols. In the entire plant, phenol was present in all extracts except for petrol ether. Phenol is typically present in both consumable and non-consumable plants and has antioxidant, antibacterial, and hepatoprotective effects[21].

5. *Sida cordata* Unveiled: Exploring the Phytochemical Constituents and their Estimated Biological Functions

This review highlights the presence of various phytochemicals in *S. cordata*. Analysis using a technique called GC-MS (gas chromatography-mass spectrometry) confirms the presence of structured compounds in the plant, suggesting its potential as a source of medicine with eco-friendly applications. These compounds may also be effective against various diseases studies show that the ethanol extract of *S. cordata* is particularly rich in these compounds, with 38 identified. Additionally, a preliminary investigation revealed the presence of various active ingredients in extracts made with water, ethanol, ether, ethyl acetate, and chloroform. This suggests that *S. cordata* is a promising source of various bioactive compounds, including esters, alcohols, steroids, alkaloids, terpenes, and sugars. These findings pave the way for future clinical studies to explore their potential use in treating various human diseases.

5.1 Alcoholic Compounds and Aline

The other name of 1-Hexadecanol is cetyl alcohol, it exhibits skin protection properties against skin irritations caused by rashes, bites, and stings[22] **(1)** 1-Heptatricotanol has an action against anti-mycobacterium tuberculosis activity[23] **(2)** Z, Z-2-5-Pentadecadien-1-ol has anticancer effect in humans[24] **(3)** 1-Hexadecanol,2-methyl- identified from endophytic fungus needs to investigate a repository and explore the bioactive potential of compounds and it also has analgesic activity[25] **(4)** 3,7,11,15-Tetramethyl-2-hexadecan-1-ol,[26] **(5)** Ephedrine, **(6)** N-methyl pseudoephedrine, **(7)** N-methyl ephedrine **(8)** shows that these agents effective against SARS-COV-2[27] and 1-2-Methylamine-1-phenyl propanol used to treat Parkinson diseases. N-methyl pseudoephedrine, interacts with 3 adrenergic receptors to influence lipolysis and thermogenesis and inhibits lipogenesis-related transcription factors to decrease fat storage[28]. The quinoline compounds vasicine **(9)** and vasicinone **(10)** have bronchodilator, antitussive, expectorant, and anti-asthmatic properties[29]. Antimicrobial properties are present in 2-piperidinone, N-[4-bromo-n-butyl][30] **(11)** (Figure 2).

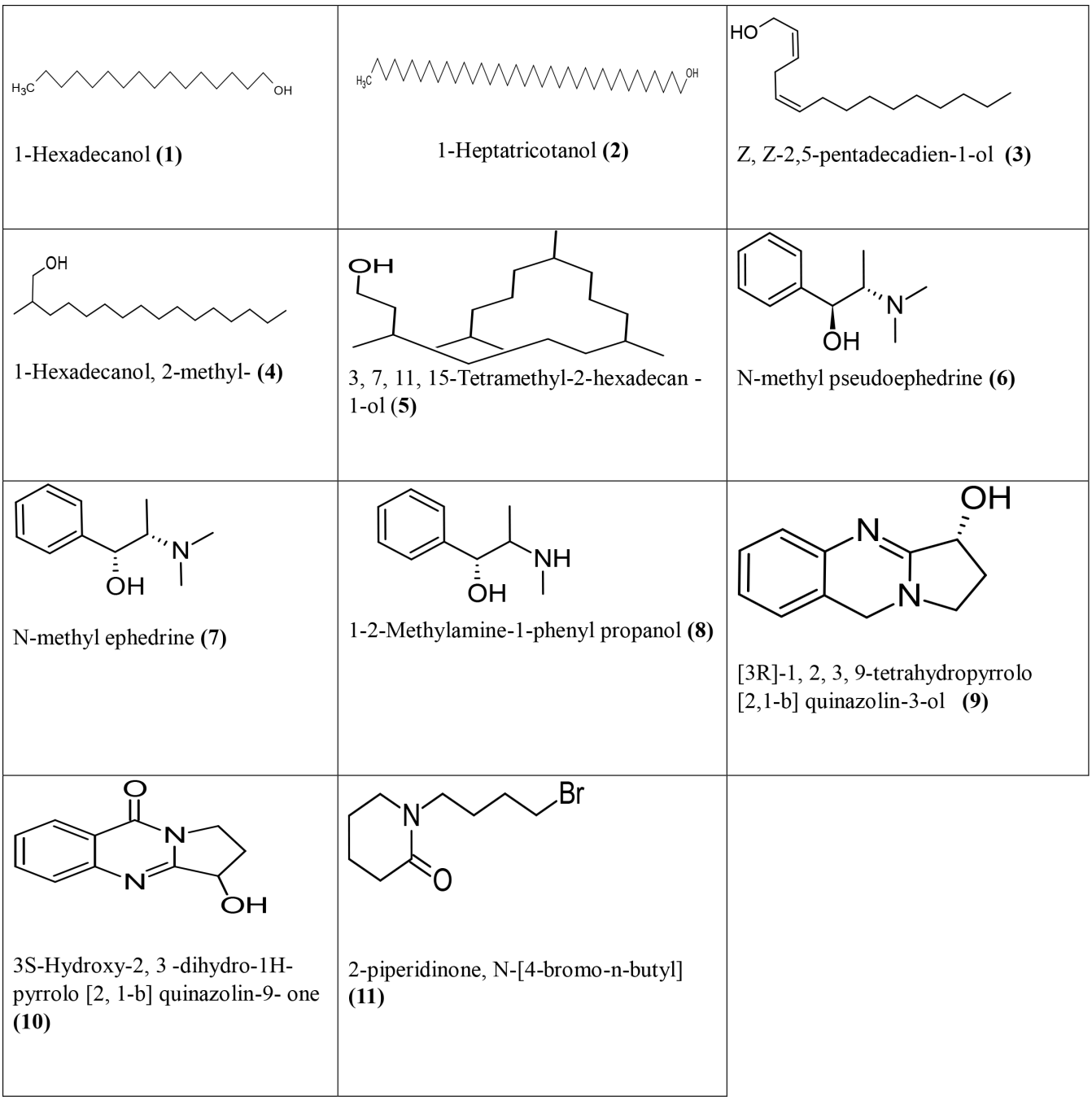


Figure 2. Chemical structures of alcoholic compounds and Aline in *Sida cordata*.

5.2 Olefin and Dicarboxylic Acids

Dodecane, 2, 6, 10-trimethyl, is a drug used to cure cancer cells[31]. **(12)** Octadecane,1-(ethenyloxy)- used to treat HIV-1[32] **(13)** 1-Iodo-2-methylundecane is used to address urinary sex pheromone, psychiatric conditions, and disorders of mood[33]. **(14)** 1,2-Benzenedicarboxylic acid, mono(2-ethlhexyl) ester has phytotoxic and antibacterial activity[34] **(15)** (Figure 3).

5.3 Ester and Fatty Acids

Diethylene glycol monododecyl ether is used as a Disinfectant and Lubricant **(16)** Oleic acid has been reported to penetrate the skin permeability with the lipophilic nature of compounds[35]. **(17)** The liver uses beta-oxidation to metabolize nonanoic acid, resulting in ketone bodies. There is no indication of chain elongation of acid storage in tissue in rats, which leads

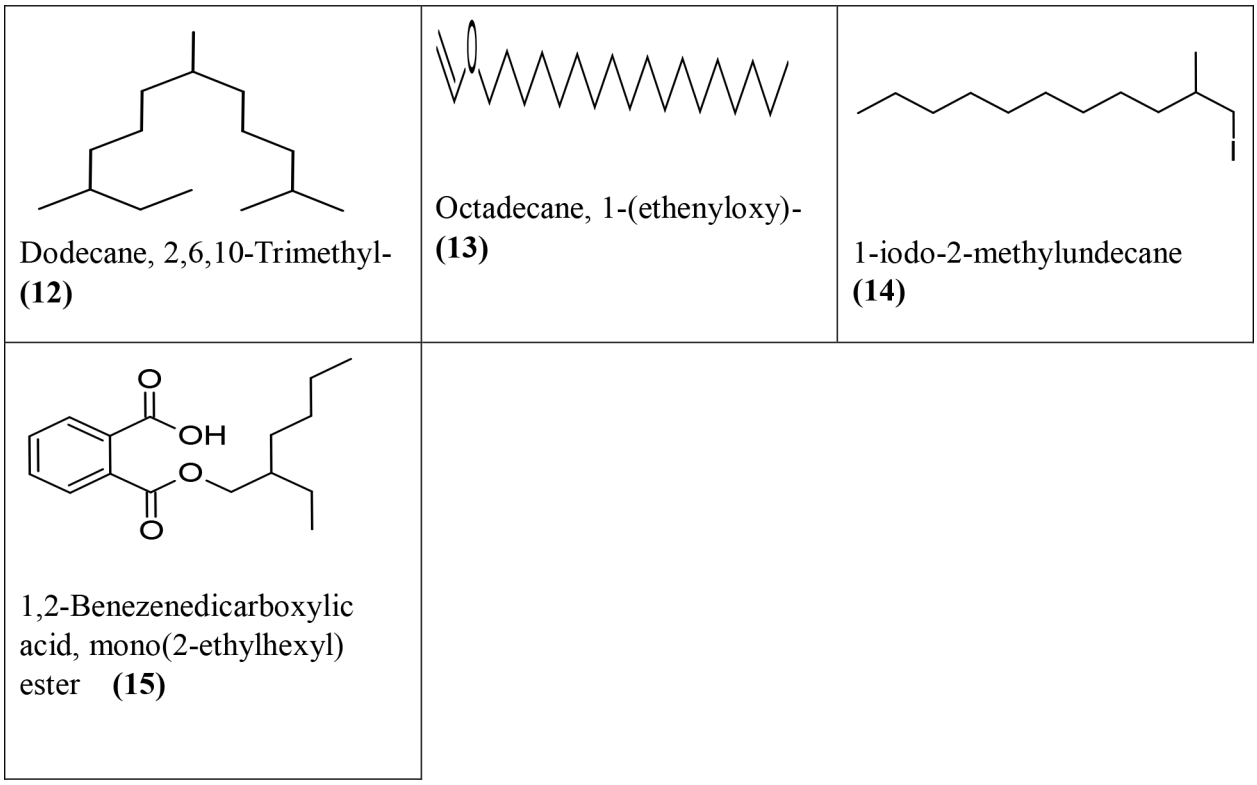


Figure 3. Chemical structures of olefin and dicarboxylic acid in *Sida cordata*.

to greater production of glucose and glycogen[36]. **(18)** A strong affinity for the potassium channel is indicated by methyl acetic acid, 4-tetradecyl ester[37]. **(19)** Human blood cholesterol levels are decreased by octadecanoic acid, ethyl ester[38]. **(20)** Antioxidant properties of 9, 12-octadecadienoic acid, methyl ester, (E, E)[39]. **(21)** Endometriosis is present in 9, 12, 15-octadecadienoic acid, methyl ester (Z, Z, Z)[40] **(22)** 2, [(trimethylsilyl) o2, [-9, 12, 15-octadecatrienoic acid-1-[[trimethylsilyl) oxy] methyl] ethyl ester (Z, Z, Z) for the treatment of arthritis[41] **(23)** (Figure 4).

5.4 Flavonoids and Terpenoids

2H-pyran,2-(7-heptadecynyloxy) tetrahydro- used as important antioxidants Haemoglobin[42]. **(24)** Squalene boosts LOX inhibition and immunostimulants[43] **(25)** 2 methylene-cholestane-3-ol (3a,5a) heals asthma and anti-arthritis **(26)** Spiro[androst-5ene-17,1-Cyclobutane]-2-one,3-hydroxy-, (3a,17a)-Antimicrobial agents and cytotoxic[43]. **(27)** The life-support hormonal system is strengthened by Cis-Z-a-Bisbolene epoxide **(28)** Beta-sitosterol reduce anxiety[44] **(29)** (Figure 5).

5.5 Other Compounds

Anti-nephrotoxic and anti-oxidant properties have been found in 3-trifluoroacetoxypentadecane[45]. **(30)** a-D-glucopyranoside, O-a-D-glucopyranosyl-(1. fwdard.3) -a-D-fructofuranosyl composed Antimicrobial[46] **(31)** 2-Hexadecycloxycarbonyl-5-(2-hydroxyethyl) -4-methylimidazolium ion contains antifungal and antibacterial[47]. **(32)** Diepoxy hexadecane (1, 2,15,16) has an antibacterial action[48]. **(33)** Anticataract and anti-stroke vitamin E (47). **(34)** Preventing diabetes, influenza, and autoimmune illnesses with vitamin D_3[49] **(35)** Cholesterol **(36)** The primary metabolite of phytol, which has anti-cancer, anti-inflammatory and antioxidant properties, is found in tissue and cellular locations. **(37)** Stigma sterol had the potential to cure osteoarthritis (Figure 6).

6. Pharmacological Activities

According to the literature survey of *S. cordata* understand its effects on the body and other natural functions, including activities like liver protection, cell protection, anti-free radical capabilities,

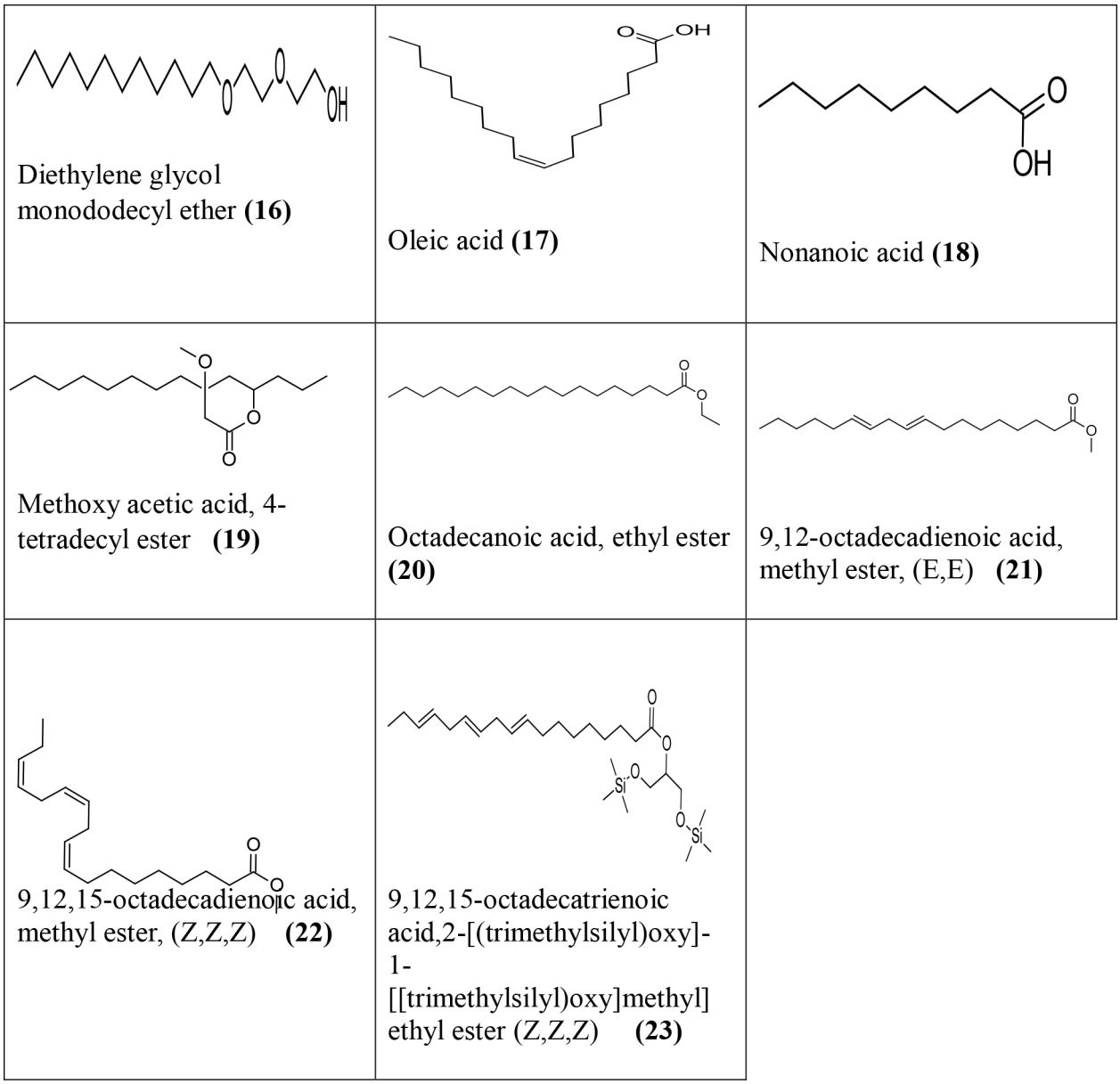


Figure 4. Chemical structures of ester and fatty acid in *Sida cordata*.

anti-inflammatory properties, pain relief, and anti-ulcer potential. In recent animal studies on rodents, researchers explored the effects of various extracts from *S. cordata*. These extracts showed potential in healing wounds, adapting to stress, preventing pregnancy, fighting against microbes, expelling worms, protecting the liver, inducing labour, combating tumours, and even treating snake bites.

6.1 Anti-inflammatory

When tested on rodents using a carrageenan-induced swelling model, the decoction (extract) from the entire *S. cordata* plant showed anti-inflammatory effects. After 2 h, the groups of rodents that received a higher dose of methanolic extract (200 mg/kg) demonstrated a significant anti-inflammatory effect ($p<0.01$), which was nearly identical to the effect of the standard indomethacin treatment (10 mg/kg). The maximum level of inflammation inhibition was observed in the methanolic extracts (200 mg/kg), achieving a 27.06% reduction. In comparison, indomethacin showed a 33% inhibition. This suggests that *S. cordata* could be considered a therapeutic plant for complementary anti-inflammatory treatment[50].

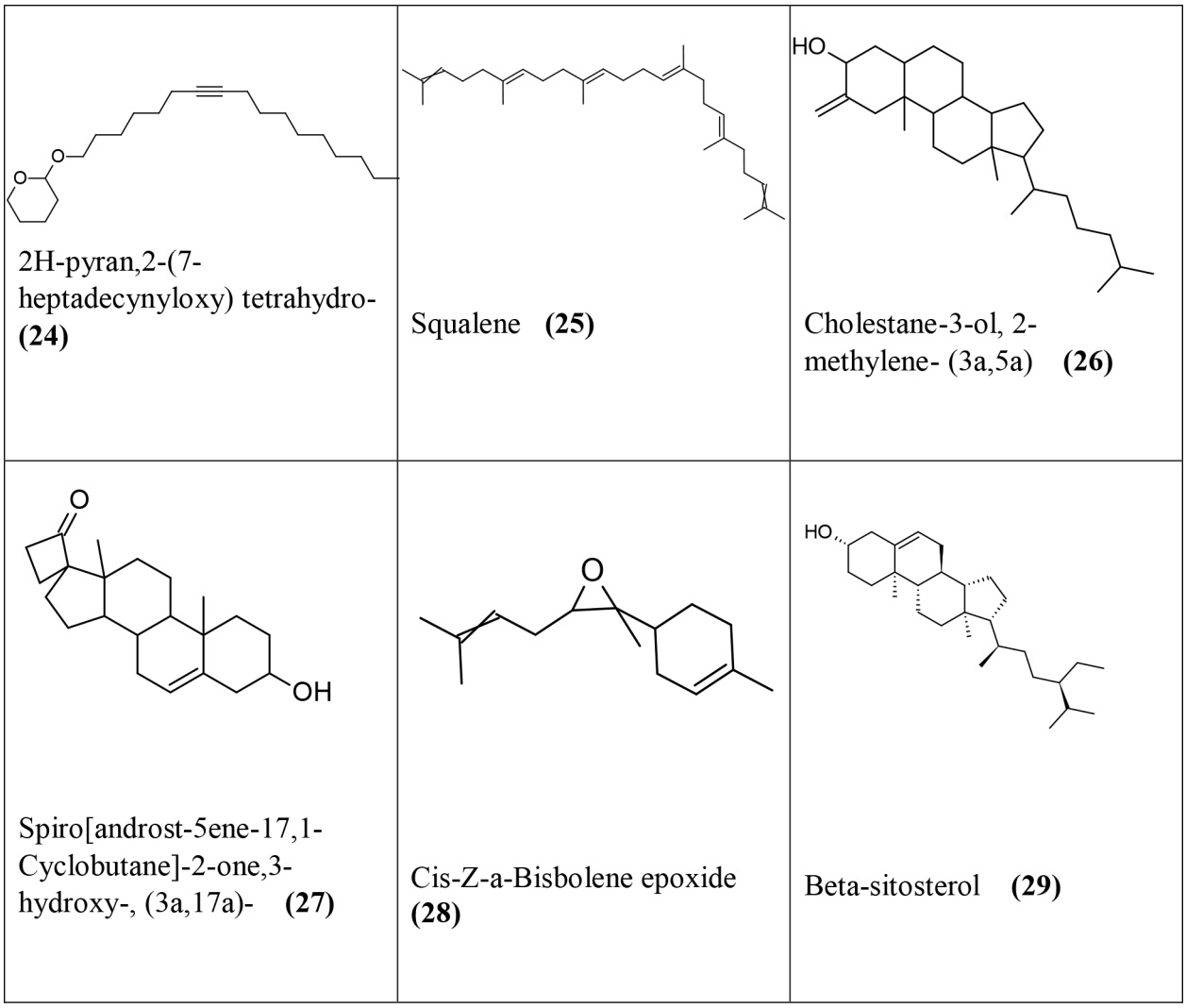


Figure 5. Chemical structures of flavonoids and terpenoids in *Sida cordata*.

6.2 Anti-cancer Properties

A study compared various extracts of *S. cordata* with the standard drug Cisplatin to assess their potential in fighting Human Gingival Fibroblast (HGF) and human tongue squamous cell carcinoma (CAL-27) cell lines to study oral cancer. The MTT test revealed that, among the different extracts examined, leaf extracts significantly reduced cell viability. The highest inhibition occurred in the ethanol extract (87.5%), followed by water (85%), at a concentration of 200 g/min. Additional TUNEL studies indicated that *S. cordata* extracts trigger apoptosis, suggesting potential anti-cancer effects[51].

6.2 Antioxidant Action and Cell Toxicity

This study mainly focused on the methanolic extract of *S. cordata* and its antioxidant and cytotoxic properties. The DPPH assay was used to measure radical neutralizing ability. The estimation of phenol and flavonoid was calculated, and the brackish water shrimp lethality test was employed to assess cytotoxic properties. The IC_{50} for free radical scavenging was 190 g/ml, compared to the IC_{50} of 10 g/ml for ascorbic acid. The total phenolic content, based on the dry weight of the extract, ranged from 145.45 mg/g to 130 mg/g, expressed as gallic acid equivalents. The quercetin concentrations in the estimation of flavonoid content varied 110 to 103.33 mg/g. The lethal concentration (LC_{50}) for the crude extract used to measure cytotoxicity was 263.02 g/ml[52].

6.4 Anti-diabetic Effects

An investigation of *S. cordata's* potential anti-diabetic effects in animals with alloxan-induced diabetes

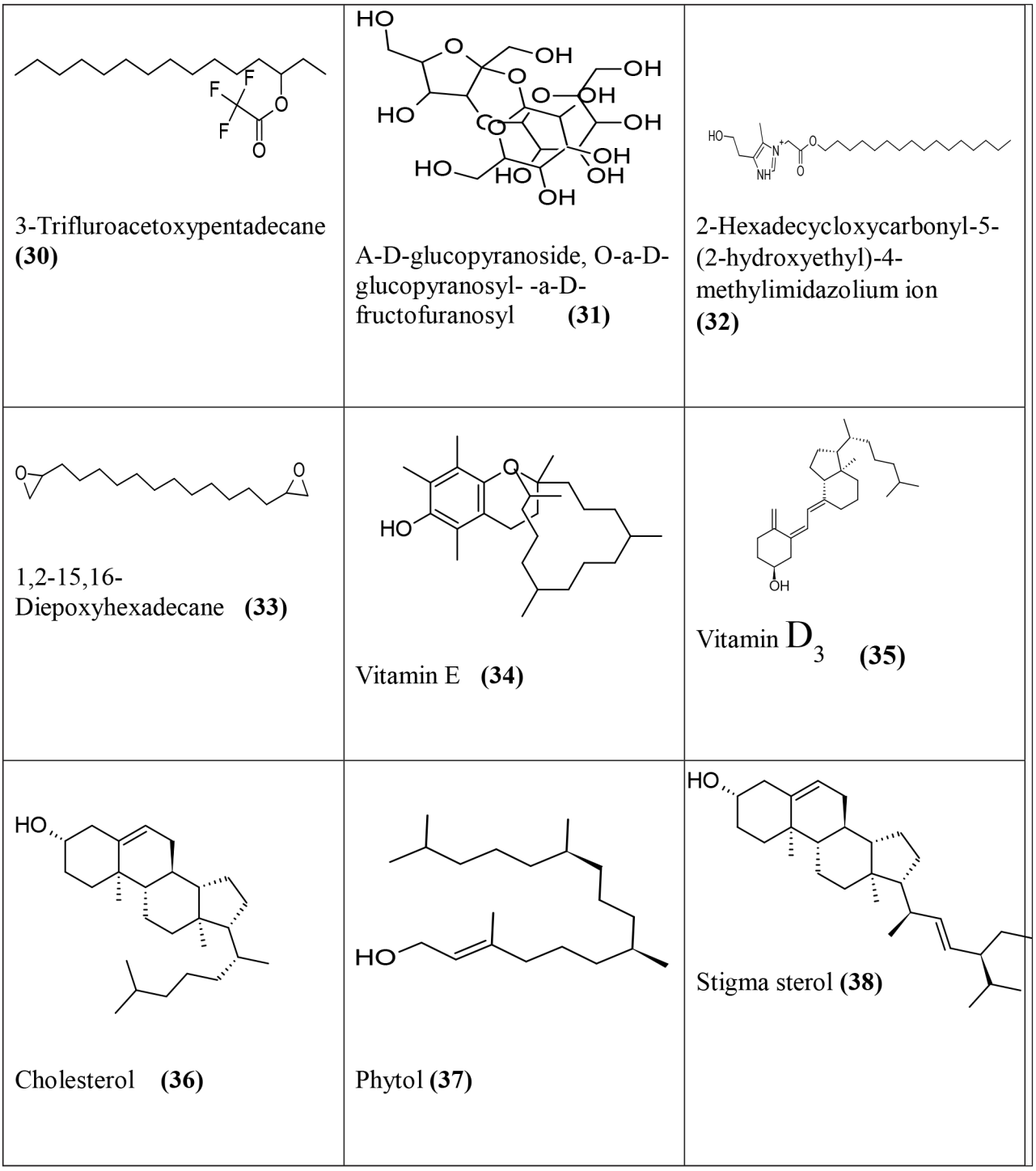


Figure 6. Chemical structure of other compounds present in *Sida cordata*.

was carried out. According to this study, an alloxan dose of 120 mg/kg caused a reduction in insulin levels, hyperglycemia, total lipids, triglycerides, and cholesterol, as well as a drop in high-density lipoproteins. After inducing diabetes, administering *S. cordata* extract for 15 days corrected hyperglycemia, restored the lipid profile, decreased the rise in lipid peroxidation and nitric content, and increased GSH synthesis in the organs of the rodents treated with alloxan[53].

6.5 Antimicrobial and Anthelmintic Movement

In this research, *Escherichia coli* and *Staphylococcus aureus* were used as test subjects to assess antimicrobial activity. The MIC assay was evaluated through a 96-well Resazurin microtiter assay, and the agar well diffusion technique was employed for *Lactobacillus, Pseudomonas aeruginosa*, *Candida albicans*, and *Aspergillus niger*. The liquid extract exhibited significant antibacterial activity, followed by the ethanolic extract. All five extracts showed dose-dependent activity, with the aqueous dose exhibiting the highest level of activity when used against *Pheretima posthuma* (Indian worm). The duration of paralysis and time to death were also examined, and activity was compared with albendazole as the reference standard[54].

6.6 Hepatoprotective Impact

A comparative investigation aimed to assess whether the ethanolic concentrate *Sida veronicaefolia* of and aqueous concentrate of *Sida veronicaefolia* leaves extracts derived from *Sida* leaves offer any protective qualities against ethanol-induced liver damage in rodents. The hepatoprotective potential of ethanolic (500 mg/kg) and aqueous (500 mg/kg) was gauged using serum analysis and liver function tests. The findings revealed that both extracts exhibited a beneficial impact by increasing total protein levels while concurrently decreasing the level of alkaline phosphatase and total bilirubin were analysed. The effects of ethanol and aqueous concentrate were similar to those of silymarin[55].

6.7 Liver Protection Potential

Sida cordata has been found to exhibit potential liver protection effects. In an experiment, a watery and ethanol extract of *S. cordata* leaves was given to rats orally at a 500 mg/kg dosage. The evaluation included liver function tests and serum profiles. Both extracts from the plant showed significant liver protection effects by not only reducing serum transaminase (SGPT and SGOT), alkaline phosphatase, and total bilirubin but also increasing the level of total protein. The effects of the watery and ethanol leaf extracts of *S. cordata* were comparable to the standard medicine silymarin[55]. Additionally, when a 95% ethanolic extract of leaves was orally administered at various dose levels (100, 200, and 400 mg/kg), it increased the levels of serum enzymes affected by CCl_4 and facilitated recovery in the control group of animals. These leaf extracts demonstrated hepatoprotective effects, with the dose of 400 mg/kg being more effective and comparable to the standard medicine silymarin at 100 mg/kg[56].

6.8 Nephroprotective Potential

The phytochemical analysis and nephroprotection potential of *S. cordata* were studied in rodents treated with CCl_4. Researchers observed an increase in the count of hematuria and white blood cells, urea level, blood creatinine level, urinary urobilinogen, and urine density. They also noticed that creatinine clearance decreased. CCl_4 treatment significantly increased serum levels of biochemical parameters were significantly reduced. However, an increased concentration of malondialdehyde (lipid peroxidation) substances and histopathological damage were seen in the kidneys of rodents after CCl_4. Ethanolic extract of *S. cordata* (SCEE) at different doses effectively preserved the changes in the measured parameters in animals at concentrations of 150 and 300 mg/kg weight[57].

6.9 Pain Relieving Property

Sida cordata ethanolic extract at doses of 100 and 200 mg/kg was administered using the oral method. In the hot plate test, both doses considerably increased the reaction time relative to the control group. In the abdominal constriction test, both doses considerably decreased the quantity of writhing in contrast to the control group. The action of *S. cordata* in both models was similar to that of the appropriate reference control. Based on these results, *S. cordata's* ethanolic extract demonstrated notable pain-relieving activity in experimental animal models, supporting its traditional uses for this intended purpose[58].

6.10 Wound Healing

An *in vivo* wound healing treatment using the ethanol extract of *S. cordata* demonstrated an acceleration in wound closure and an increase in tensile strength in both excision and incision wounds in rodents. Tensile capacity, hydroxyproline content, wound contraction, epithelization duration, and histological features were among the parameters that were compared with the effects of regular medication. Sulfadiazine[59].

6.11 Abortifacient Property

An ethanolic extract of *Sida veronicaefolia*, known for its potent uterine stimulation effects, was investigated for its fetal expulsion in gravid rats. Oral doses that induced fetal expulsion doses of 32 ml/kg given between the 15th to the 17th day of pregnancy showed similar action to intravenous doses of 23 ml/kg. With the smallest effective oral dose of 32ml/kg, only 40 percent of animals stayed pregnant until birth, and their progeny were fewer and smaller on average.at double that dose, only ten percent stayed pregnant and the progeny were weaker. The effects of extract through an IV caused similar but they were stronger and more intense[60].

6.12 Cell Stabilizing Effect and Antioxidant Activity

Sida cordata leaf extract is known for its membrane-stabilizing activity. An erythrocyte membrane study was conducted, and it was found that the hemolysis of erythrocytes induced by a hypotonic solution was inhibited by *S. cordata*. When combined with the standard drug Aspirin, which exhibited the best membrane-stabilizing effect at a concentration of 62.78% at 2000 g/ml, the methanolic concentrate of *S. cordata* demonstrated enhanced membrane-stability performance at 51.3% intensity. The optimal value of antioxidant activity for the methanol extract of *S. cordata* leaves is 81.93 at 500 g/ml[61].

6.13 Adaptogenic Activity

A concentrated extract from *S. veronicaefolia*, previously noted for its strong oxytocic properties, was studied for its ability to induce abortion in pregnant rats. Oral doses of 332 ml/kg given between the 15th and 17th day of pregnancy led to abortion. Comparable outcomes were seen with an IV of 23 ml/kg. At the lowest effective oral dose of 32 ml/kg, only 40% of the rats successfully carried the fetuses to full term, and their litters showed reduced average numbers and weights. Doubling this dose resulted in only 10% of the rats carrying to term, with further weakening of the litters. The effects of IV administration of the extract were similar with potent action[62].

7. *Sida cordata* Medicinal Uses

Leaves: Demulcent, ophthalmia Whole plant: gonorrhoea, rheumatism, spermatorrhoea; roots: astringent diuretic; seeds: laxative, piles. *Sida cordata* is a plant that can be eaten for a normal delivery, the soup from this plant should be consumed in the last 10 days of pregnancy. When administered between days 15 and 17, it has an abortifacient effect. It also has muscarinic activity and the leaves have an anticancer effect. A paste made from the plant's leaves is typically painted on boils. The plant's fruit and blossom help treat a burning urination feeling.

8. Toxicity Studies

To understand how plants can harm living things, we do toxicity studies. It's important to check if a plant has been tested for safety and if it's a bit harmful but still safe for health. This particular plant medicine has been used for a long time and is considered somewhat harmful but generally safe. However, it contains a substance that can cause problems like nausea, diarrhoea, stomach pain, and weakness. The plant extract from *S. cordata* has been tested on animals, showing its ability to act as a natural antioxidant and protect the liver and kidneys from damage caused by certain chemicals[63]. Impact of *S. cordata* leaflet extract in shielding rodents from sudden liver damage produced by CCl_4. *S. cordata*'s nephroprotective properties and phytochemical analysis in rats. People often use this plant as a remedy, but it's not recommended for long-term use, especially for those who are already sick. More research is needed to fully understand how this plant can be harmful and to identify the specific parts of the plant that are important for its toxicity. It's crucial to be cautious when using this plant for medicinal purposes, and further research is necessary to enhance the comprehension of its safety[64].

9. Conclusion and Perspective

Sida cordata, a plant used in traditional medicine, has various biological effects, making it a potential candidate for herbal medicine. The chemicals in the plant are seen as beneficial for health. To fully realize the plant's potential in herbal medicine and develop new drugs for treating diseases, the scientific community needs to conduct further research through toxicological studies and clinical trials. *S. cordata* contains valuable bioactive compounds with effects on wellness. Some of these compounds, such as antioxidants, hepatoprotective agents, anti-inflammatory substances, and others, have

been extensively studied. However, the appropriate concentrations of these compounds for therapeutic use and their pharmacokinetics are not yet fully understood. Despite being considered generally safe in traditional medicine, moving from conventional to well-established use requires well-designed clinical trials with the emergence of new diseases like COVID-19 and the lack of sufficient clinical evidence for treatments, the passage recommends future research on the effectiveness of *S. cordata* in treating various symptoms. It emphasizes the need for scientific tests to ensure the safety and efficacy of these plant-based treatments. This herbal plant also highlights the importance of preserving ancestral wisdom in using plants for medicinal purposes, especially in rural areas where people rely on them for healthcare.

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11. Authors Contribution

Dr. Sangeetha Mani guided the research framework. Mahesh Kumar conceptualized the review, conducted the literature studies, analyzed and drafted the manuscript. Dr. Alan M. Punnoose Proofread and analyzed the paper, Dr. Ethayaraja Mani contributed to manuscript editing, supervision, and final revisions. All authors read and approved the final manuscript.

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