Published online in http://ijam.co.in ISSN No: 0976-5921

International Journal of Ayurvedic Medicine, Vol 13 (2), 313-320

Sida Acuta Burm. fil. : Potential benefits

Review Article

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Abstract

For masses of years, flora and herbs had been an amazing supply of meals and medication. Surveys performed in indigenous locations discovered that the *Sida acuta* had many regional conventional usages. This broom weed is a perennial plant that produces slightly woody stems and is harvested from the wild as a source of local medicine and fiber. In tropical countries, indigenous people used this plant to treat common illnesses which include fever, headache, and various infections. Scientifically, *Sida acuta* has already been studied for several potential benefits. Studies reveal that roots of *Sida acuta* can be chewed to relieve toothache and leaves are soaked in water to make hair conditioner or shampoo to treat scaly skin. Apart from these benefits, it is also being known for repressing the potential of parthenium (poisonous herb) species through an allopathic control over it. . This review article mainly focuses on therapeutic applications of *Sida acuta* and in addition, its components, advanced usages, bioactive compounds, and essential micronutrients are also discussed.

Keywords: Medicinal Plant, Broom weed, Allopathic, Therapeutic Applications, Bioactive compounds and micronutrients.

Introduction

Medicinal plants have been used by humans for their nutritional and therapeutic value since the dawn of human civilization. For thousands of years, nature has been a source of medicinal agents and from natural resources impressive number of drugs have been isolated (1). A wide range of different human diseases can be treated by a rich source of bioactive molecules provided by natural products. A large number of lead compounds provided by these products are used in the development of new drugs. Aromatic polyketides, polyethers, coumarins, flavonoids, terpenoids, alkaloids, and aminoglycosides are natural product drugs (2).

The oldest way to cure diseases and infectious diseases is the use of traditional medicine,and in different parts of the world, for the treatment of human diseases and infectious diseases various plants have been used. Also, the different plant parts are used for various forms of diseases and infections. Plants with medicinal properties are known to be healing to certain biological agents present in plant parts. The chemicals such as terpenes, flavonoids, bioflavonoids, benzophenones, xanthenes as well as some metabolites such as tannins, saponins, cyanates, oxalate, and anthrax-quinones are referred to as active phytochemical substances. Distinct parts of plants have also been used to treat various diseases and infections (3).

About *Sida acuta*

Sida acuta is a malvaceous, tropical weed which belongs to crops, meadows, roadsides and wastelands. Globally, *S. acuta* is dispensed in pantropical areas **(4)**. It is a woody taproot, hairy, upright, branched perennial shrub up to 1m high and is reproduced from its seeds. When the plant is young, stem appears to be rounded, slender, woody, fibrous and hairy. It has simple alternating leaves with stems which are 1.3 cm long, about half of them are articulated. Solitary and axillary inflorescence is present. *Sida acuta* has yellow flowers which contain five petals, 5-6 carpels and capsuled fruit. (3).

Most of the flowering plants belong to the family Malvaceae of which around 2300 species of more than 200 genera are known. Mallow plants are known for their main economic uses such as a source of natural fibers, food, beverages, wood, traditional medicine, and horticulture. Studies conducted at indigenous sites have found that the plant has many traditional uses that vary from region to region (5).

Figure1. Sida acuta **(40)**

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Advantages

The whole plant of *S. acuta* is widely used as traditional medicine by the indigenous tribes Embera, Wounaan, Cunas, and Katios in Colombia, and also prepared as drinks, ointments, and external baths against snakebite in other regions of Antioquia. In addition, it is also used as a stomachic, diaphoretic and antipyretic. In Indian traditional medicine, it is known as an astringent and tonic which is useful in the treatment of diuretic diseases, blood diseases (stopping blood loss), biliary tract, liver, and neurological diseases (sedative). It is smoked as an alternative to marihuana in Mexico and is also known for treating inflammation of the renal system, asthma, cold, gonorrhea, fever, bronchitis, plasmodial infection, diarrhea, headache, dysentery, abortion, breast cancer, epidermal infections, hemorrhoids, insects' bites, erectile dysfunction, elephantiasis, ulcers, and rheumatism. It has aphrodisiac properties. The juice extracted from the roots of the plant is applied to wounds and the barks of the plant are used for measles. *S. acuta* is most commonly used for the treatment of hypertension in Nigeria by preparing different extracts of its leaves, seeds, and stems **(5)**. Studies revealed that juice extracted from leaves of *Sida acuta* has anthelmintic properties against intestinal worms. It is also known for its uses of spiritual practices.

Compounds present in Sida acuta

Alkaloids

Alkaloids occur in the plants belonging to the indoloquinolines family. Cryptolepine and its derivatives include quindoline, quindolinone, cryptolepinone, and 11-methoxy-quindoline are the major alkaloids. Among these compounds, cryptolepine 5- methylindolo (2-3b) - quinoline has been used widely for studies because of its clinical properties against malaria, colic, and stomach ulcers (6).

According to Bonjean et.al., Dassonnevielle et.al., Giattat et.al., and Lisgarten et.al., cryptolepine 5-methylindolo (2-3b) - quinoline has also been known for its cytotoxic activity which ultimately gives rise to an idea for production of anticancerous drugs (7, 8, 9).

Steroids

Ecdysterone, beta-sistosterol, stigmasterol, and ampesterol are the plant's major steroids.

Phenols

Phenolic compounds such as evofolin-A, and B, scopoletin vomifoliol, loliolid, and 4-ketopinoresinol have already been isolated and studied (1).

Table-1: **Advancement and studies of *Sida Acuta***

Used Part	Advanced Uses of *Sida acuta*	References
Leaves	Green synthesis of silver nanoparticles by using *Sida acuta* against mosquitoes.	Veerakumar, K., Govindarajan, M., & Rajeswary, M. **(10)**
Leaves	Used as a therapeutic agent in the management of renal and hepatic disorders.	Ogunmoyole, T., Falusi, O. O., & Oderinde, F. **(11)**
Leaves & Stems	Useful in inhibition of corrosion of mild steel induced by an acid.	Eduok, U. M., Umoren, S. A., & Udoh, A. P. **(12)**
Leaves	It can be used as an alternative of guar gum for production of sustained release matrix of Ibuprofen tablet.	Akpabio, E. I., Uwah, T. O., Effiong, D. E., & Godwin, J. **(13)**
Leaves	The hydrogel made from powdered dried *Sida acuta* leaves could be used in a variety of medication delivery systems.	Okafo sinodukoo eziuzo, Chukwu amarauche. **(14)**

Applications in Pharmacology

1. Antiplasmodial Activity

Karou et al. were the first to report the plant's antiplasmodial activity in vitro (2003). The activity could be due to the plant's alkaloids. Different molecules may be responsible for antimalarial action or maybe active compounds that share the same solubility in chloroform and water. Alkaloids were isolated because they are known to be soluble in organic solvents and water depending on pH, as well as potential antimalarial agents. The plant's ethanolic extract was compared to ethanolic extracts from the other four plants' species. *S. acuta* was the most active plant as compared to other plants in the study (IC50 = 4.37 g/mL), its extract was separated into three fractions by liquid-liquid separation using petroleum ether, chloroform, and water. When parasites were examined by these fractions, it was discovered that the chloroformic and aqueous fractions exhibited equal antiplasmodial activities, whereas the ether fraction had none. This can be concluded that alkaloids of the plant may be responsible for the activity (15).

2. Antifungal activity

Antifungal activity of the flavonoid extracts of *S. acuta* was recorded in terms of inhibition zone and activity index. A total of eight extracts from different parts of the plant were tested for their bioactivity against *C. albicans*, among which seven of them showed remarkable activity against test fungi. The presence of free flavonoids was observed with more anticandidal potency as compared to bound flavonoids (16).

According to B.R. Hoffman et. al. *Sida acuta* manifests adequate activity against one of the fungi, A. fumigatus with very magnificent partially cleared zones. Although it was also observed that fungal growth was distinctly hampered, still the presence of some dispersed growth was also observed (17).

3. Antimicrobial activity

An experimental study done by Karou et. al. (2007) revealed the great medicinal property of *Sida acuta* i.e. the leaves of the plant *Sida acuta* contain the tannins in large amounts which are highly vigorous in nature while alkaloids, saponins anthraquinones, cardiac glycosides are found in reasonable quantity. However, it was observed that flavonoids are present in trace amounts. A significantly higher antimicrobial activity has also been observed in ethanolic extracts than in the aqueous extracts (15).

A study conducted by B.R. Hoffman et.al. revealed that the extract of *Sida acuta* has a more quantifiable zone of inhibition i.e. ZOI (10.3mm) in comparison with the drug ciprofloxacin (used to treat bacterial infections) having ZOI of 38.2mm against *E.coli* (17).

4. Antiulcer activity

A study by P.Malairajan, Geetha Gopala Krishnan, et. al. shows that extract of *S. acuta* can be a possible source for the treatment of ulcers. According to their study, the presence of alkaloids and flavonoids in an extract contributes to the antiulcer activity of the plant itself. The study has also revealed that in gastric ulcers caused by aspirin plus pylorus ligation, ALSA displays a remarkable reduction in gastric volume, a score of ulcer, and free acidity. The extract of *S. acuta* owns antisecretory and cytoprotective mechanisms also. Estimation of anti-ulcer activity was estimated by using the ulcer index parameter (18).

Another study was conducted by S. Akilandeswari et. al. where they stimulated the gastric section of a rat model by using the Pylorus ligation method. The potency of *Sida acuta's* ethanolic extract and notable effects against peptic ulcers was revealed by the study. The extract reduced the secretory volume of gastric, acidity, and ulceration like famotidine (used for the treatment of ulcers) by betraying antisecretory and antiulcer properties in the rat model (19).

5. Antimalarial Activity

It is very well known that Malaria is one of the most common parasitic diseases which is caused by a protozoan, a genus named Plasmodium. The most virulent or fatal *Plasmodia* species is *Plasmodium falciparum*. Damintoti Karou, et. al. collected four different plants of traditional medicine in order to find out fine new antimalarial activities in Burkina Faso. Those four plant species were: *Combretum micranthum, Khaya senegalensis, Pterocarpus erinaceus, and Sida acuta,* and testing was done in vitro against the latest *Plasmodium falciparum's* isolates. In this study, researchers extracted alkaloids of *Sida acuta* by following the traditional practice of alkaloid extraction. According to Karou et. al., the solubility of alkaloids in organic solvent and water according to pH was the reason behind the extraction of alkaloids. In addition, they are also known for their activities against malaria. The acquired IC_{50} of *Sida acuta* and *Pterocarpus erinaceus* reveals that the leaves of *Pterocarpus erinaceus* are lacking alkaloids (20).

Another study to elucidate the antimalarial activity of *Sida acuta* was performed by Narasimhan, Kadarkarai Murugan, et. al. They actually prepared methanolic extracts (roots and leaves) of two plant species- *Sida acuta* and *Vetiveria zizanioides*. Out of these two, *Sida acuta* is more potent than *Vetiveria zizanioides* against malaria. This biological activity of *Sida acuta* is allocated due to the presence of alkaloids, flavonoids, phenols, and steroids in its leaves. According to the study, all these compounds collectively fabricate mortality and morbidity effects in *P. berghei* and *A. stephensi* (21).

6. Antihistaminic Activity

Several studies of *Sida acuta's* phytochemical content have disclosed the presence of various phytochemical constituents- tannin, saponins, flavonoid, cardio glycoside, and terpenoids. Besides these phytochemical constituents, many vitamins and minerals are also present as zinc, magnesium, calcium, steroids, phenolic compounds, sesquiterpene, alkaloid cryptolepine, quindoline quindolinone, and fixed oil. Krishnaveni, Iyappan, et. al. used a hydroalcoholic extract of *Sida acuta* to determine the antihistamine activity of a plant. According to their study, hydroalcoholic extract of *Sida acuta* (1µg/ml) exhibited 60.6% hindrance on histamine-induced contraction in contrast to chlorpheniramine (1µg/ml) 69.69%. Their study regarding the activity of *Sida acuta* against histamines inference that the presence of various phytonutrients is responsible for the modest antihistaminic activity of hydro-alcoholic extract of *S. acuta*. (22).

7. Anti-mycobacterial Activity

A bacterium named *Mycobacterium tuberculosis* is responsible for spreading an infectious disease called Tuberculosis (TB). It has been categorized under acid-fast bacillus because of its resistance to acidic solutions. According to Papitha et.al, Lucifer reporter phage assay is an easier, speedy, and cheap methodology to determine the antimycobacterial activity of a compound. When 50% reduction is observed in relative lights units (RLU) only then a compound can be categorized under antitubercular agent (23).

According to Mr. B. Ezhilarasan, 99% antimycobacterial activity was exhibited due to the hydroalcoholic extract of *Sida acuta* as compared to isoniazid and rifampicin. Isoniazid and rifampicin are antibiotics that are given together to treat tuberculosis (22).

8. Hepato-protective Activity

The liver plays a crucial role in regulating the internal chemical environment of the human body. C.D. Sreedevi et. al. used Wistar albino male rats and Swiss albino male mice for their study. Rats and mice were divided into different groups. Some of them were pretreated with root extract of Sida acuta and then followed by an overdose treatment of paracetamol. Paracetamol has been considered an antipyretic agent

because it is very high dose can cause hepatotoxic effects in the human body. The presence of ferulic acid, which is known to be a hepatoprotective agent, was confirmed by C.D. Sreedevi et al. in their study, because in the groups that were treated with an extract of *Sida acuta*, lower serum levels of glutamate pyruvate transaminase, glutamate oxaloacetate transaminase, bilirubin, and alkaline phosphatase were observed (24).

A study performed by Mgbemena et. al. concluded that fractions of *Sida acuta's* n-hexane and ethyl acetate possess hepatoprotective activity that works in opposition to thioacetamide (TAA). Adult male albino rats were selected and were grouped into seven (A-G) groups. Out of seven groups, four groups of rats were treated with thioacetamide because this compound is having carcinogenic activity and mutilates the liver. It has been detailed in various researches that chronic ingestion of TAA causes cirrhosis in rats. Perhaps, TAA is considered a hepatotoxin. Mgbemena et. al. reported that ingestion of TAA caused declination in albumin levels of rats which voluntarily reduced the synthetic function of liver cells (25).

9. Antioxidant Activity

According to the research performed by Sengul Uysal, et. al, it has been observed that *Sida acuta's* methanolic and water extracts which were exposed to multiple bioassays and which were cell-free exhibited the highest removal capacity for free radicals. Free radicals are important to be removed because the presence of a large number of free radicals causes DNA damage as well as lipid and protein damage.

During this study, DPPH (2, 2-diphenyl-1-picrylhydrazyl) and ABTS (2, 2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid)) assays were used to predict antioxidant activities (26).

10. Anticancer Activity

Cancer is known as a "silent killer" and is one of the important causes of mortality. Breast cancer is more common among women these days and has also secured the first position in the list of cancers.

2.3 million Cases and 6, 85,000 deaths were recorded globally due to breast cancer. The report: Race, Ethnicity and Breast Cancer by Susan G. Komen revealed that a high rate of breast cancer can be seen among white and black women as compared to American, Indian, and Alaska Native women.

Chemical agents used for the treatment of cancer cells may cause harm to normal cells of the body. So, due to this concern, Sengul Uysal, et. al. studied the role of *Sida acuta* extracts against MDA-MB-231(cancer cells). After 48 hours of treatment, it has been found that *Sida acuta's* methanolic extract played a vital role in defeating cancer cells with an IC_{50} value of 102.4µg/ml.

Involved Constituents: According to the study, the elements of Sida acuta (methanolic extract) that have potential against cancer cells are 3, 4, 5-tricaffeoylquinic acid, O-deohyhexosyl-hexosyl-luteolin, N-coumaroyl tyramine (+) ESI, and vomifoliol (-) ESI. The operative component that has been observed by Sengul Uysal et. al. is Vomifoliol which was cultured in Hepa lclc7 cells of mice (26).

Another study was conducted by C.A. Pieme. Et.al. demonstrated that the inhibitory effect of *Sida acuta* (methanolic extract) became notable after 48 hours of incubation i.e. 51.62% against HepG- 2 cells (liver cancer cell lines in humans) (27).

11. Enzyme Inhibitory Activity

A study conducted by Sengul Uysal et.al. showed that water and methanolic extracts of *Sida acuta* have the potential to harmonize the action of enzymes that are objected to cope with mental deterioration i.e. Alzheimer's disease (acetylcholinesterase & butyrylcholinesterase), hyperpigmentation of skin (tyrosinase) and diabetes type II i.e. adult-onset diabetes (α- amylase & α- glucosidase) **(26)**.

12. Cardiovascular Activity

The effects of herbs collected from Western Ghats of India (*Sida acuta*) were studied on heartbeat rate (HBR) and flow of blood (systole & diastole) by Rajaretinam Rajesh Kanna et. al. As their model organism, they employed zebra fish embryos. According to their study, methanolic extract of *Sida acuta* reduces the HBR in embryos of zebrafish. Indistinguishable results were also observed for propranolol (used to treat high blood pressure).

During this study, micro videography was used to observe each cardiac cycle in treated embryos of zebrafish. Cardiac mutations without any effect were also observed due to the methanolic extract of *Sida acuta* (28).

13. Wound Healing Activity

A study was conducted by Akilandeswari et. al. to explore the percutaneous potential of *Sida acuta* extract (methanolic) against wounds. During this study, two types of rats were used as wound models: (i) the excision and (ii) the incision wound model. As a result, it has been observed that in excision models, treated wounds can heal faster as compared to control whereas in incision models, an increase in tensile strength has been observed which facilitates the healing process. The drug named nitrofurazone (used to treat skin infections) was used as a reference drug (1).

Adewale Adetutu and others studied the effects of Sida acuta (ethanolic extract) on wounds using Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, and Bacillus subtilis as test models. Their study demonstrated that ethanolic extract of *Sida acuta* (leaves) displays low wound healing activity against gram-positive species. It has also been stated that the wound healing potential of plants like *Sida acuta* can also be achieved by anti-inflammatory, antioxidant, or antibacterial mode of action (29).

14. Antipyretic Activity

To investigate the antipyretic effect of *Sida acuta* in Wister strain albino rats, Rakesh Sharma et al. synthesized four extracts from the collected samples of *Sida acuta's* leaves: petroleum naphtha i.e. petroleum

ether, acetone, ethanolic, and aqueous extracts. Pyrexia was induced by injecting a 12 percent w/v yeast suspension (1ml/100gm) bodyweight hypodermically. All the substances used for control, standard, and test were given to animals via gastric tube.

They discovered that all four extracts were able to lower the temperature of rats over time, although the ethanolic extract's antipyretic action was recognized within $1^{1/2}$ hours, compared to the other extracts (30).

15. Neuropharmacological Activity

Neuropharmacological effects like sleeping time induced by Sodium pentobarbital, Anxiolytic i.e. anti-anxiety activity, Open Field Test (OFT), test for effects of muscles, seizures induced by PTZ (Pentylenetetrazole), and normal body temperature were studied by Dora M. Benjumea et. al. to discover potential benefits of *Sida acuta* ethanolic extract (leaves & stem). Male CD1 albino Swiss mice were used as model organisms.

Sodium pentobarbital-induced sleeping time: Rodents were grouped into six groups out of which four groups were treated with extract, one with diazepam (a drug used to treat anxiety and seizures), and the control group was treated with NaCMC (Sodium Carboxy Methyl Cellulose), used as a vehicle. It has been observed that extracts of *Sida acuta* increase the time of sleeping (T2) and reduce the dormancy of sleeping (T1) in rodents. Similar results were obtained for rodents treated with diazepam (5).

Anxiolytic Activity: A total of four mice groups were treated with a dose of vehicle, *Sida acuta,* or diazepam. EPM (Elevated Plus Maze) test was used to analyze anxiolytic activity and it has been recorded that rodents treated with extracts of *Sida acuta* exhibited a higher number of entries with an increment of time in EPM's open arm (5).

According to Park et. al., the high percentage of entries and time in open arms means the lower levels of anxiety (31).

Test on the Open Field: Carlini and colleagues stated that this test is performed to evaluate the practicable sedative or stimulative animals' activity (32). When rodents were treated with *Sida acuta*, reduction in the moved distance (cm), their velocity (cm/s), and rearings (f) were observed. No effects were observed in rodents treated with diazepam (5).

Tests for muscle effects: Three tests were performed to study the effects of muscles- Rota-rod Test (RRT), Traction Test (TT), and Chimney Test (ChT). These tests were performed to estimate muscle relaxant, motor coordination, and strength of model organisms treated with stimulants or depressants. Results suggested that rodents treated with *Sida acuta* did not experience any myorelaxation nor any alteration in motor coordination, which are absolutely unfortunate effects of Benzodiazepines (used as reference drug) (5).

Pentylenetetrazole (PTZ) - induced seizures: Anticonvulsant effects have been recorded in epilepsy's PTZ model in mice because the dosage of *Sida acuta* (50mg/kg) was proved to be more effective against PTZ induced seizures. The anti-epileptic effects of benzodiaepines were accompanied by sleepiness and decreased motor activity. (5).

***Sida acuta's* Essential Micronutrients:**

The study conducted by Raimi, et. al. quantified the composition of *Sida acuta's* micronutrients (minerals and vitamins) by employing standard analytical methods. They quantified the vitamin composition (ascorbic acid, niacin, riboflavin, and β-carotene) by using a method described by Okwu and Josiah and the quantification of minerals (calcium, iron, phosphorus, sodium, and magnesium) was done by the method described by Gafar et. al. in their study. Raimi et. al. stated that the leaves of Sida acuta consist of β-carotene (precursor of fat-soluble Vitamin A) and ascorbic acid, niacin, thiamin, and riboflavin (water-soluble vitamins).

• Vitamin A deficiency can induce keratinization of the skin, night blindness, and xeropthalmia because of its specific roles, which include gene expression regulation and cell differentiation. Thiamin, niacin, and riboflavin are energy-releasing vitamins that are present in *Sida acuta* **(33)**. According to J.L. Jain et. al., deficiency of niacin may lead to pellagra and is identified by irritation in exposed parts, mental illness i.e. dementia, and diarrhea. The inadequacy in levels of Riboflavin (also known as Vitamin B_2) can cause glossitis, Keratitis, corneal vascularization, seborrheic dermatitis, and cheilosis **(34)**. According to a study conducted by S.G. Chaney et al., symptoms of thiamin deficiency vary depending on the severity of the levels of deficiency: mild level of deficiency (appetite loss, fatigue, constipation), moderately severe level of deficiency (mental confusion, ophthalmoplegia), and the severe level of deficiency (mental confusion, ophthalmoplegia) (dry and wet beriberi) **(35)**.

Raimi and colleagues determined the following compositions from Sida acuta mineral analysis: 85.00.0mg/10mg calcium, 4.870.06mg/100g iron, 65.00.0mg/100g phosphorus, 1100.0mg/100g sodium, and 24.50.0mg/100g magnesium **(33)**. J.Omale et. al. in their study stated that calcium is a crucial requirement for important biological functions to happen which involve functions of nerve, structural support to the skeletal system, blood coagulation, and also enhances growth and vigority by regulating metabolism. Phosphorus is an important mineral required for growth, maintenance, and cell-tissue repair **(36)**. Most importantly, Phosphorus also aids in the production of DNA and RNA according to the study conducted by V.A. Ajibade and E.D. Fagbohun **(33)**.

Results from an experiment performed by B. Moyo, Et. al. reported that iron is a major constituent of hemoglobin and myoglobin which helps in transportation of oxygen, cell growth, and division. Iron has also been found as an essential trace element that aids in the oxidation of carbohydrates, proteins, and fats and regulates CNS **(37)**. J. Alinnor and R. Oze stated that sodium is a crucial mineral present in body fluid and it is important in maintaining electric potential in tissues of body. They also observed that magnesium regulates blood pressure and the release of insulin **(38)**.

According to V.A. Ajibade and E.D. Fagbohun, magnesium plays an important role in the synthesis of cellular energy, nucleic acids and proteins.

Raimi et al. stated that *Sida acuta* could be used for medical purposes since it contains necessary food elements in amounts equivalent to those found in green vegetables, which are often taken for healthy nutrition **(33)**.

Sida acuta's Bioactive Compounds

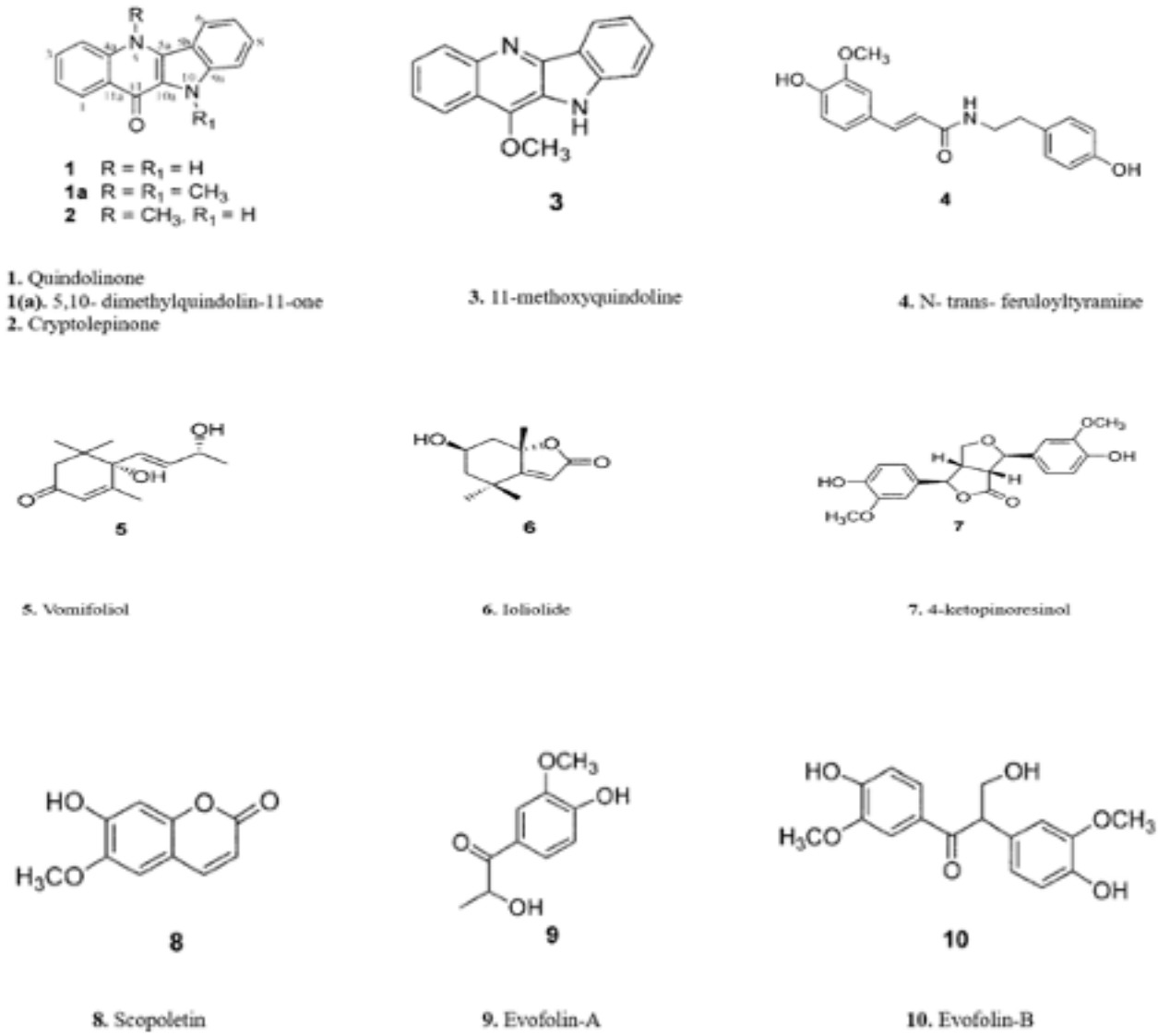
Dae Sik Jang et. al. isolated ten compounds from EtOAc- a soluble fraction of *Sida acuta* with the help of OR induction assay- bioassay-guided fractionation. Isolated ten compounds were: Quindolinone **(i)** (Crouch et al., 1995), cryptolepinone **(ii)** (Fort et al., 1998; Martin et al., 1998), 11-methoxyquindoline **(iii)** (G6rlitzer and VentzkeNeu, 1997), N-trans-feruloyltyramine **(iv)** (Fukuda et al., 1983; Hussain et al., 1982), vomifoliol **(v)** (Lida et al., 1983), Ioliolide **(vi)** (Tanaka and Matsunaga, 1989), 4-ketopinoresinol **(vii)** (Otsuka et al., 1989), scopoletin **(viii)** (Kang et al., 1998), evofolin-A **(ix)**, evofolin-B **(x)** (Han et al., 1983).

Along with ten active compounds, five inactive compounds were also isolated: ferulic acid, sinapic acid, syringic acid, (+)-syringaresinol, and vanillic acid was derived as a new derivate from the m synthesis of quindolinone **(39)**.

To identify various novel chemopreventive agents (phytochemicals derived from plants), QR (quinone reductase) inducers and cultured mouse Hepa lclc7 cells were used. To inhibit 7, 12-dimethylbenz[a]anthracene (DMBA) - induced preneoplastic lesions in an organ culture of mouse mammary model, Mehta and Moon, 1991, Dae Sik Jang et al. used the schematic protocol described by Jang et al., 2002. According to this study, it has been evaluated that five isolated compounds **(i-v)** and one derived compound **(ia)** exhibited inhibitory activity against preneoplastic lesions induced by DMBA in mouse mammary glands in organ culture (MMOC).

Among these compounds, cryptolepinone **(ii)** is highly potent in MMOC assay at 10µg/mL (83.3% inhibition). Therefore, cryptolepinone **(ii)** has been proved as a cancer chemo-protective agent through biological evaluation studies **(39)**.

Fig. 1: Chemical structures of bioactive compounds present in *Sida acuta* **(39)**



Conclusion

Sida acuta has long been utilized as a traditional medicine to deal with several illnesses of the human body. *Sida acuta's* all components including leaves, bark, root, seeds, and flowers are known to be the healers from the past. Antiplasmodial, antibacterial, antifungal, antihistaminic, anticancer, wound healing, hepatoprotective, antipyretic, and cardiovascular activities have all been examined in *Sida acuta*. These studies discovered wonderful effects of *Sida acuta* without showing any negative effects on activities. The healing values of plants' life depend upon their chemical additives which produce unique pharmacological applications for the human and animal bodies. *Sida acuta's* elements are full of bioactive compounds that have effective benefits for health. The presence of bioactive ingredients such as alkaloids, saponins, coumarins, steroids, tannins, phenolic compounds, cardiac glycosides, sesquiterpene, and flavonoids inside the plant extract contributes to its more than one application and makes it more useful to be used as medicine. Apart from this, *Sida acuta* is rich in minerals and nutrients which certify its excessive dietary value. Various advancements in therapeutic applications of *Sida acuta* can also be observed in recent studies.

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