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Research Article

Emilia Sonchifolia-A Critical and Comprehensive Review of its Diverse Medicinal Potential and Future as Therapeutic

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ABSTRACT

Emilia sonchifolia (L.) DC, it belongs to the family Asteraceae or Compositae, is conventionally used in ethnomedicine, and acquires various medicinal properties. This plant has been regarded as one of the widespread traditional vegetable salads in Malaysia, Bangladesh, and India. In addendum to its avail as a vegetable, the plant has been documented with several medicinal benefits in the extravagance of night blindness, epilepsy, malaria, asthma, burns, breast abscesses, and inflammatory diseases. On scrutinization of their pharmacological properties, it has been revealed that they possess numerous notable biological properties such as antimicrobial, analgesic, anti-inflammatory, antioxidant, hepatoprotective, antianxiety, and anticataract, as well as anticonvulsant activities. Concrete evidence suggests the presence of potential phytochemicals in this plant with a wide range of unknown applications. In this current review, we discuss the phytochemicals present in the plant *Emilia sonchifolia* and emphasize the therapeutic and pharmacological activities reported so far concerning this plant.

Key words: *Emilia sonchifolia,* Phytochemicals, Medicinal plant, Anti-inflammatory, Anti-tumour.

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INTRODUCTION

Plants are an affluent resource of natural products. They outline significant elements of ingredients in virtually all systems of therapeutics. Pharmaceutical industries encourage the search for new phytochemicals and massive research in this area, especially on plants collected from rainforests and other places for their impending medicinal values. The modern allopathic system of medicine is also based on plants and herbs. Medicinal plants are germane in both developing and developed nations of the world as the basis of drugs or herbal extracts for several chemotherapeutic purposes, which persists in playing a dominant role in the conservation of human health ever since antiquities.[1,2] Over 50% of all advanced clinical drugs are of natural product origin, and natural products play a crucial role in drug development programs of the pharmaceutical industry. In the furtherance of this stratagem of new drug discovery, we have deliberately looked after several parts of the plant for their antibacterial, anti-inflammatory, antitumor activity, and antioxidant properties against other disease-causing conditions. Gayathri (2012)[3] presented that current clinical drugs of natural products play a significant role in pharmaceutical industries; chemicals naturally in plants are converted traditionally and medicinally into substances that control human fertility. Some secondary compounds fashioned by plants could be very effective against parasites and pathogens, such as pawpaw, mango, citrus, and *Emilia sonchifolia*.[4]

Emilia sonchifolia is an herbaceous plant that gets taller to about 10 – 40cm in height with simple lyrate-pinnate leaves with a wide terminal lobe and purplish flowers with corymbose heads.[5] The fruits are oblong and have many seeds in them. Advanced ripe fruits are formed between August to October; the flowers are hermaphrodite and are pollinated; the plant is pantropic and perhaps instigated from South Asia.[6] *Emilia sonchifolia* (Lin.) is a shaggy annual herb disseminated primarily in Asian countries.[7] The plant can be found in wastelands and open fields.[5] It has been used as an imperative medicinal plant in tropical and subtropical countries comprising the South-South region of Akwa Ibom State, Nigeria. Globally, a ballpark of 3.3 billion people was at risk of malaria in 2011, with populations living in sub-Saharan Africa having the highest menace of obtaining malaria.[8] It has also been annotated to possess anti-fever activities,[9,10] antimicrobial activity,[11] analgesic and anti-inflammatory activities;[12-14] anticancer activities;[15-17] antioxidant activities;[18-21] anti-diabetic;[22] anti-cataract activities[23-26] anticonvulsant activity[27] and antinociceptive effect.[28] Compounds akin to similar, beta-sitosterol, stigmasterol, palmitic acid, and honey acid were attained from the whole plant of *E. Sonchifolia*.[29] Modest pyrrolizidine alkaloids, senkirkine, and drones were also reported from the aerial parts of this plant.[5]

This plant is one of Kerala's ten sacred flowers, identified as 'Dasapushpam,' mainly employed in Ayurveda. Injuries to the skin or other body tissues are known as wounds; punctured skin, cuts, scratches, and scrapes are among them. In India, tribals and folklore traditions use a variety of herbs and plant extracts to cure wounds.[8] To treat wounds, plants/active constituents obtained from plants must be discovered and formulated, and a number of plant medications are now being researched in this regard.[30] Plants offer many potentials in wound healing, which is the body's natural response to tissue damage (Smitharani *et al.*, 2017). Healing results from a complicated chain of cellular activities that leads to the restoration of health.[5] The herb can cure fevers and tonsillitis, and the juice; these to treat infections in the eyes, Cough, bronchial trouble, piles, worm infections, diarrhea, edema, and diabetics people with diabetes from the plant.

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Universal names of *Emilia sonchifolia:*

General Name: *Emilia sonchifolia*

English Name: Lilac Tassel flower

Botanical Name: *Emilia sonchifolia*

Hindi Name: Hiranakhuri

Chinese Name: Yang TI Cao

Ideal scientific name

Emilia sonchifolia (L) DC. (1838)

Favored common name

Red tassel flower

Other scientific name

Cacalia sonchifolia L (1753)

Emilia purpurea Cass (1826)

Emilia rigidula DC (1838)

Emilia scabra DC (1838)

Senecio sonchifolius Moench

International common name

English: consumption weed; cupids paintbrush; cupids shaving brush; Flora`s paintbrush; purple sow thistle; red groundsel

Spanish: borlitas; clavel chino; huye que te cojo; pincel de amor; pincelillo de poeta; yebra socialista

French: cacalie a feuilles de laiteron; herbe a lapin; manger lapin; salade a lapin

Portuguese: Bela-emilia; serralha

Taxonomic classification of *Emilia sonchifolia:*

Domain: Eukaryota

Kingdom: Plantae

Phylum: Spermatophyta

Subphylum: Angiospermae

Class: Dicotyledonae

Order: Asterales

Family: Asteraceae

Genus: Emilia

Species: *Emilia sonchifolia* (Figure 1)

Phytochemical constituents of *Emilia sonchifolia*

Edagha *et al.* (2014)[31] reported that the phytochemical compounds present in *E. sonchifolia* displayed alkaloids, flavonoids, saponins, tannins, terpenes, and cardiac glycosides at varying degrees of lowly, moderately, and highly present (Table 1).

Hardly a few components have been reported from this plant. The aerial parts were provided with two pyrrolizidine alkaloids, recognized as senkirkine and doronine.[26] Senkirkine and doronine, pyrrolizidine alkaloids are und in the aerial portion, and vitamins like riboflavin and niacin are also present.[32] In humans, phenobarbitone is a well-known anticonvulsant medication used to treat all types of epilepsy (particularly status epilepsy at 10-20 mg/kg), except absence seizures.[23]

Figure 1: [A]- *Emilia sonchifolia* habit [B]- *Emilia sonchifolia* habitat.

Table 1: Phytochemical constituents of *Emilia sonchifolia* (Trease and Evans (1989); keys: + = lowly present, ++ = moderately present, +++ = highly present, - = absent).

Phytochemical	Emilia sonchifolia
Alkaloids	+++
Flavonoids	++
Phlobatannins	-
Saponins (Frothing`s test)	+
Saponins (Fehling`s solution+ Na_2CO_3)	++
Tannins	++
Terpenes	+
Anthraquinones	-
Deoxysugar	-
Cardiac glycosides	++

Table 2: Antimicrobial activity of methanolic root extract of *Emilia sonchifolia*.
(data reproduced from Duraipandiyan et al., 2006; Girish et al., 2008; Tekeli et al., 2011; Saradha et al., 2012)

S.No	Microorganisms	Extract Concentrations (Zone of inhibition in mm)				
		Control	25	50	75	100
Bacteria						
Gram positive						
1	*Staphylococcus aureus*	13±0.21	7±0.061	8±0.07	10±0.64	14±0.36
2	*Bacillus cereus*	20±0.37	8±0.34	8±0.46	9±0.24	21±0.72
3	*B.subtilis*	12±0.17	-	-	8±0.051	10±0.06
4	*Streptococcus faecalis*	15±0.64	6±0.42	7±0.25	7±0.08	12±0.83
Gram negative						
5	*Salmonella typhi*	13±0.70	5±0.36	8±0.86	12±0.86	13±0.57
6	*Pseudomonas aeruginosa*	15±0.43	13±0.56	7±0.16	13±0.68	-
7	*Shigella dysenteriae*	13±0.75	-	-	-	10±0.07
8	*Klebsiella pneumoniae*	12±0.34	-	8±0.78	9±0.72	12±0.46
Fungi						
1	*Aspergillus niger*	15±0.73	6±0.75	8±0.48	12±0.68	14±0.87
2	*Candida albicanc*	16±0.89	-	-	7±0.012	10±0.30
3	*Tricoderma viride*	13±0.65	6±0.82	7±0.12	10±0.46	11±0.48
4	*Azospirillum lipoferum*	15±0.03	5±0.19	6±0.87	8±0.072	10±0.74
5	*Mucor racemosus*	18±0.44	-	5±0.57	12±0.97	12±0.53

Data represent mean ±SD of three replicates per treatment * P <0.01.

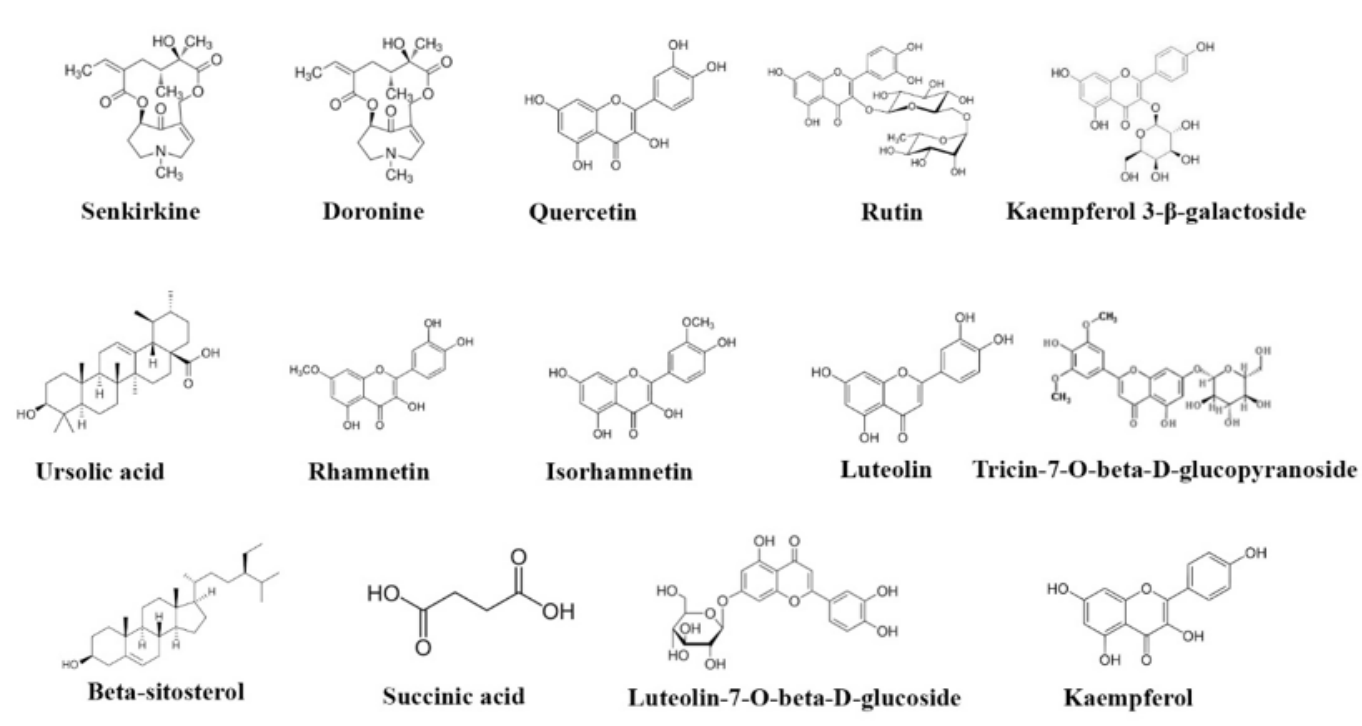

Figure 2: Major phytochemical compounds present in the seeds of *Emilia sonchifolia* DC.

Srinivasan and Subramanian (1980)[33] accounted for quercetin, rutin, kaempferol 3-β-galactoside, ursolic acid, n-hexacosanol, and tricotane in the aerial parts of the plants. Although the Etsy however, fraction of 90% extract of aerial parts produced rhamnetin, isorhamnetin, luteolin, tricin-7-O-beta-D-glucopyranoside,8-(2"-pyrrolidinone-dimethoxyflavone-2'-O-beta-D-glucopyranoside, succinic acid, fumaric acid, p-hydroxybenzoic acid, 4-hydroxy isowedelolactone, and uracil respectively.[34] Gao *et al.* (1993)[25] isolated similar beta-sitosterol and palmitic acid from the whole plant. Yadava and Raj (2012)[35] informed the existence of flavones glycoside 3,7,3'4'-tetrahydroxy-flavone-3-O-beta-D-xylopyranosyl-(1-3)-O-beta-D-galactopyranosyl-(1-4)-O-alpha-L-rhamnopyranoside along with two other recognized compounds. Luteolin-7-O-beta-D-glucoside and Isoptin 5'-methyl ether in the seeds. Yadava and Raj (2011)[35] reported the presence of 3 major compounds in the seeds of *Emilia sonchifolia*. These three compounds are Kaempferol 3-O-α-L-rhamnopyranosyl- (1→2)-β-D-glucopyranoside; Mearnsetin-3-O-α-L-rhamnopyranose and Gehuain (isoflavone) (Figure 2).

Medical benefits of the *Emilia sonchifolia* in ethnomedicine

Ethnomedical reports from Asian countries emphasize the traditional and folklore medical aspects of *Emilia sonchifolia.* In Malaysia, the plant was generally acknowledged as 'Setumbakmerah' and considered one of the prevalent ingredients of traditional vegetable salads 'Ulam.' The flowers are fried with batter, and the leaves are eaten raw and are reported to possess antioxidant properties.[36] The leaves are suitable for eating and utilized as a traditional salad in Bangladesh.[37] The plant's fresh stem and leaves are eaten as a salad or cooked vegetable in India. It is considered one of the "Ten Sacred Flowers" of Kerala state in India, which the traditional healers primarily use in healing cancer and other malignant conditions.[38] The Plant is acknowledged in ethnomedicine to occupy medicinal benefits in treating diarrhea, night blindness and sore throat,[39] rashes, measles, inflammatory diseases, and eye and ear ailments,[34] gastrointestinal cancers, malaria and also used for the treatment of dysentery. Decoction of E. *sonchifolia* is employed as a bowel compliant and febrifuge in infantile tympanites. A distinctive section of the plant E. *sonchifolia* was utilized in the therapeutics of diseases such as inflammation, asthma, intermittent fever, ophthalmia, breast cancer, wounds, and cuts; some of the diseases like sore throat, eye inflammation, and night blindness can be cured by leaf extract of the E. *sonchifolia* plant.[40] The liquid extract of the aerial part of the plant has been known for its antinociceptive property. Anti-anxiety, hepatoprotective, anti-cataract, and anti-convulsant properties have also been documented for the plant. Tribes use the juice of a whole crushing plant to make medicine.[41] The existence of analgesic principles obtained by the chemical elements of the extracts functioning with the prostaglandin pathways could explain the considerable pain reduction of plant extracts.

Pharmacological activities of *Emilia sonchifolia*

Anti-inflammatory activity

Inflammation is a complex protective response of the body, to various external stimuli, such as allergens and injury to any part of the body. A wide range of ailments such as allergies, cardiovascular issues, gastrointestinal disturbances, metabolic syndrome, autoimmune diseases, and cancers are primarily brought on by uncontrolled inflammatory responses. The conditions put a significant cost risk on both people and society.[42]

Steroids, nonsteroid anti-inflammatory drugs, and immunosuppressants are just examples of the many pharmaceuticals available for regulating and reducing inflammatory episodes; nevertheless, they are all known to have negative consequences. While in reality, we strive to use the minimum amount of medication necessary to get better efficacy and minimum side effects.[43]

The action of Cyclooxygenase inhibition is necessary for the creation of prostaglandins, which mediate the inflammatory response (COX). In order to find new anti-inflammatory drugs, suppression of COX

isoforms (COX-1 and COX2) is therefore being researched. Doronine, a pyrrolizidine alkaloid found in Emilia sonchifolia, binds to COX-2 in molecular docking studies, suggesting that it may be an alternative to currently available anti-inflammatory medications.[44]

Antimicrobial activity

In several previous investigations, the antimicrobial activities of *E. sonchifolia* root extracts against the test microorganisms were qualitatively assessed by a zone of inhibition and minimum inhibitory concentration. The results were compared with the standard drugs, oxacillin and tetracycline, for bacteria and fungi, respectively (Table 2).

Emila sonchifolia root extract had significant activity against the bacteria *Staphylococcus aureus, Bacillus cereus, Streptococcus faecalis*, and *Salmonella typhi,* as well as the fungal species *Mucor racemosus* and *Aspergillus niger* root extract had moderate activity *against Salmonella typhi, Mucor racemosus*, and *Pseudomonas aeruginosa.*[40] The specificity of bacterial and fungal strains may explain the varying degrees of inhibitory activity of methanolic extract of the root of the investigated species. Phytochemicals with adequate antibacterial effectiveness are expected to treat microbial illnesses.[32] Various species in the Asteraceae family have been observed to have a superior inhibitory impact against bacteria and fungi, even at low concentrations.[40]

They have been utilized from the beginning of time and are mentioned in Ayurvedic texts such as Vaidya Manorama and Arogya kalpadruma. Herbal preparations of whole plants or their various sections, as well as polyherbal combinations, can renew the body and cure various ailments, and are used in many Ayurvedic formulations.

These results were similar to that of Nwadinigwe and Alfreda (2011),[35] who also recorded that 100mg/mL of stem extract of *Bryophyllum pinnatum* had significantly inhibited the growth of these bacteria. Nevertheless, the inhibitory activity of the methanol extract of the root part of *E. sonchifolia* was also significantly higher against the other bacteria and fungi tested. Several studies support that methanol extracts of many medicinal plant species have higher antimicrobial activities than any other alcoholic solvents.[46-49] Antimicrobial properties of cytotoxic and aqueous extract, anti-Dalton′s lymphoma ascites (DLA), and anti-Ehrlich ascitic carcinoma (EAC)) properties of alcohol-based extracts are noted.

Antioxidant activity

The antioxidant defense mechanism covers the unavoidable generation of reactive oxygen species (ROS) in a biological system and the oxidative damage. At the same time production of ROS can be imperative in various cellular processes (e.g., defense against infection, cellular signaling); the poise of ROS is more often connected with damage to cellular components such as proteins, lipids, and nucleic acids.[50] Humans have advanced highly complex antioxidant systems (enzymatic and nonenzymatic), which work synergistically, and an amalgamation with each other to safeguard the cells and organ systems of the body against free radical damage. The antioxidants can be endogenous or acquired exogenously, as a part of a diet, or as dietary supplements. Some dietary compounds that do not counterbalance free radicals but augment endogenous activity may also be classified as antioxidants. The most effective enzymatic antioxidants involve SOD, CAT, and GPx. Nonenzymatic antioxidants include vitamins E and C, thiol antioxidants (glutathione, thioredoxin, and lipoic acid), melatonin, carotenoids, natural flavonoids, and other compounds.

Plants have enlarged various systems to protect themselves against oxidative stress. Antioxidative enzymes play a significant role in this kind of protection. The most commonly studied is SOD, which indulges in the first line of defense.[51] The majorly important enzymes protecting plants from oxidative stress belong to a family of diverse SODs.[52] SOD is positioned in several cell compartments and catalyzes the disproportionation of two O_2^- radicals to H_2O_2 and O_2.[53] CAT is a principal H_2O_2 scavenging enzyme and is mainly associated with removing hydrogen peroxide in peroxisomes, thus defending the cells against oxidative stress.[54] AO is principally located in chloroplast and cytosol, and it is the key enzyme of the ascorbate-glutathione cycle that utilizes ascorbate as a reducing substrate for H_2O_2 detoxification. AO uses two molecules of ascorbate to reduce H_2O_2 to H_2O, with the coexistent generation of two molecules of dehydroascorbate. In the aqueous extract of E. *sonchifolia*, studies reported that it works similarly to phenobarbitone, and the presence of flavonoid metabolites could explain the superiority of E. *sonchifolia* extracts in scavenging free radicals.[34] Antioxidant activity was higher in glycosides with more hydroxyl groups than in kaempferol.[30] As a result, the greater rutin and quercetin concentration in E. *sonchifolia* plants may have contributed to their more excellent antioxidant activity, which counterbalanced unfavorable influences and protected them from oxidative damage.[25]

Erythropoietic and hepatoprotective activity

The reports from the hematological studies by Edagha *et al.* (2014)[55] signify that experimental animals treated with *E. sonchifolia* (650 mg/kg. B.wt.) revealed reduced hemolytic activity compared with normal control animals. They have also reported that this activity might be due to saponins in the plant extract. Saponins enhance the hemolysis of RBC by augmenting the water transport by the water channel aquaporin rather than acting on the lipid phase.[56] It proceeds to owe to structural changes in the membrane of RBC by instigating a decrease in the level of cholesterol which therefore influences the susceptibility of the RBC membrane.[57]

Nevertheless, flavonoid has been recognized *in vitro* studies to have antidiarrheal and antioxidant activity,[58] anti-allergic, antiinflammatory,[59] antimicrobial (antibacterial),[60] anti-cancer,[61] antiviral and antifungal.[60] Consequently, there emerges a dynamic interplay of both agonistic and synergistic effects from the extract. Alkaloid is also affluently present in the extract, and most plants contain various alkaloids. Their mixture is extracted first, and then particular alkaloids are separated.[51] Various alkaloids are still utilized in medicine, regularly in the form of salts, containing the following: Quinine as antipyretics, antimalarial; Morphine as an analgesic; Reserpine as antihypertensive; Codeine as cough medicine, analgesic; Ergot alkaloids as a sympathomimetic, vasodilator, antihypertensive; Caffeine as Stimulant, diuretic, Adenosine receptor antagonist recent to indicate. Although, most of the recognized functions of alkaloids are related to protection.[62]

According to the research, E. *sonchifolia* can improve immunological parameters, induce stem cell proliferation and differentiation, and increase antibody responses in a well-controlled manner, all of which could be mediated by numerous cytokine molecules.[63] Studies have declared that the plant's immunomodulatory activity was due to a combination of humoral and cell-mediated immune responses.[64] Furthermore, the extract increases CTL activity in tumor-bearing animals, implying increased participation of the cell-mediated immune system in tumor defense.[64] As a result, the plant has the potential to operate as a nontoxic immunomodulator; in comparison to the untreated group of rats, E. *sonchifolia* as an immunomodulator does not seem to boost immunity but instead delivers a stimulated and optimized immunological response. Clinical research provides significant scientific support for its traditional and conventional therapeutic usefulness in treating various diseases by controlling the body's defense mechanism against pathological symptoms. Furthermore, the plant's immunopharmacological capabilities could be owing to the synergistic action of multiple active components or to the unique activity of certain chemicals that are abundant in the plant.[65]

Antiviral, antitumor activity, and gastrointestinal disorders

Yadava and Raj (2012)[35] described the antiviral activity of isolated flavones glycoside 3,7,3'4'-tetrahydroflavone-3-O-β-D-xylopyranosyl-(1-3)-O-β-D-galactopyranosyl-(1-4)-O-α-L-rhamnopyranoside against Japenese Encephalitis virus *in vitro* (Vero cells). The compound revealed 50% antiviral activity at 62.5µg/ml.

Cibin *et al.* (2006)[12] informed the antioxidant and antitumor properties of the flavonoid fraction secluded from the whole plant of *E. sonchifolia*. The capability of the flavonoid fraction to restrain Cu^{2+} provoked lipoprotein oxidation in human serum, and superoxide production was measured to evaluate the antioxidant property compared to Quercetin. The results exposed the potent antioxidant and anticancer effects of the flavonoids that exist in the plant. A study examined apoptosis induction and molecular mechanisms in human colorectal cancer cells treated with the methanol extract *in vitro*. The extract persuaded cell growth inhibition in a concentration and time-dependent manner, insinuating that both extrinsic and intrinsic apoptotic pathways may be engrossed in extract-provoked apoptotic death in the cancer cells.

Emilia sonchifolia has been initiated to be very effective in treating gastrointestinal disorders, especially diarrhea and dysentery.[66] In Africa, *Emilia sonchifolia* leaves have been used for the preparation of herbal tea and are widely used as a folklore medicine for treating dysentery. Essien *et al.* (2009)[67] reported that the roots of this plant exhibit an anti-diarrhoeal effect, and also the flower buds could alleviate the pain caused due to oral tooth decay. A wide range of flavonoids, terpenes, and alkaloids contribute to these effects, and further investigations are needed to strongly substantiate the role of these compounds on the mode of action.

CONCLUSION

The phytochemical assessment of *Emilia sonchifolia* displayed a broad range of chemical ingredients that are conscientious for their promising multidimensional pharmacological activities, such as antimicrobial, analgesic, anti-inflammatory, antioxidant, anticancer, antidiabetic, hepatoprotective, antianxiety, and other several activities. Nevertheless, the primary concern was the presence of pyrrolizidine alkaloids because the plant has been considered edible and principally used as a central component in salads in various Asian countries and other countries. Molecular docking studies of pyrrolizidine alkaloids like senkirkine and doronine in *Emilia sonchifolia* demonstrate promising inhibitory effects on cyclooxygenase 2 (COX2) is a critical enzyme in inflammation.[44] Pyrrolizidine alkaloids are considered hepatotoxic in the increased dose and could result in hepatic damage, and toxicity signs result from impaired liver function. Hence further investigations are necessary to study the plant's toxicity in detail before its usage in ethnomedicine and rationalize its use as a health food. This review gives a clear picture of its traditional usage and other plant activities before its implementation in ethnomedicine.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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