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A review on activities of different extracts of *Leucas aspera*

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Abstract
Traditionally, the medicinal plant *Leucas aspera* has been used to cure a wide range of illnesses. The present review evaluated the *in vitro* antioxidant and anti-inflammatory characteristics of the methanolic extract derived from the whole leaf of *L. Aspera*. The extract's antioxidant capacity was evaluated in macrophage cells by utilising 2, 2-diphenyl-1-picrylhydrazyl, Enzyme linked immuno sorbent assay, and cytokine activity, the anticancer efficacy of silver nanoparticles that were synthesised spontaneously from the leaf extract. The study's findings suggest that the plant extract has potential for enhancing lung function, having anti-hyperlipidaemic benefits and having anti-inflammatory and antioxidant qualities for dental health. Furthermore, it has been demonstrated that the extract inhibits the venom enzymes of the Indian cobra, Naja naja, against properties associated with ophidians.

Keywords: Anti-oxidant, *Leucas aspera*, anti-histaminic, immunosuppression

Introduction
The Plant derived bio-molecules that have been extensively used Globally as a therapeutic traditional medicine. Similarly, the *Leucas aspera*, an herb that grows to a height of 15 to 60 cm, is found throughout India's plains and belongs to the Lamiaceae family. Terpenoids, fatty acids, nicotine, ursolic acid, glucoside, beta-sitosterol, sterols, diterpene, and phenolic chemicals are the main phytoconstituents found in the plants [1-3]. Traditionally the plant *Leucas aspera* can be used to treat psoriasis, chronic rheumatism, and chronic skin eruptions.
Throughout the world, herbal plants are essential to traditional medicine, and even today, the majority of people living in both rural and urban areas use these plants for a variety of everyday needs. Because of their advantages for the environment, economy, and health, natural chemicals are currently the subject of more research than manufactured ones. Phytochemicals are the various chemical substances that plants manufacture for their biological needs, such as defence mechanisms against insects, bacteria, and herbivorous animals. Herbal plants are utilised extensively in medications and are a natural source of several significant compounds [4]. They serve as the foundation of the Siddha and Ayurvedic traditional medical systems in India.

Plant profile [5]
The plant genus *Leucas*, which is part of the *Lamiaceae* family, contains roughly 80 species. Traditional healers all over the world use these plants to treat a wide range of illnesses. *L. aspera* is one of these many species; it is a tiny, upright, herbaceous plant that blooms freely from August to September. This strong-smelling herb is widely found throughout India in highland agriculture fields, roadside ditches, homesteads, and fallow areas. It has been used traditionally to treat colds, coughs, severe swelling, chronic skin eruptions, wound healing, and even as an insecticide. The leaves, roots, flowers, and seeds of this plant have already been used to isolate a variety of chemical compounds that are used in pharmaceutical drugs, including linoleic acid, glucosides, linolenic acid, oleanolic acid, nicotinic acid, oleic acid, palmitic acid, saponins, sterols, stearic acid, tannins, and ursolic acid.

Taxonomy
Kingdom: Plantae, Plant
Subkingdom: Tracheobionta, Vascular plant
Super division: Spermatophyta, Seed plant
Division: Angiosperma

Class: Dicotyledonae
Sub-class: Gamopetalae
Series: Bicarpellatae
Order: *Tubiflorae*
Family: Labiatae
Genus: *Leucas*
Species: *Leucas aspera*

Fig 1: *leucas aspera*

Distribution

L. aspera is a highly prevalent weed and can be found in China, South America, Africa, Asia, and the Pacific Islands. It is spread across all of India, from Ceylon to the Himalayas. In the Philippines and India.

Macroscopic characters

L. aspera is an annual herb with branches and a sturdy, upright, sharply quadrangular stem that grows to a height of 15 to 60 cm. With an entire or crenate edge, the leaves are up to 8.0 cm long and 1.25 cm broad, hairy, and briefly petiolate. The petioles are 2.5–6 mm in height. Bracts are 6 mm long, linear, sharp, bristle-tipped, and ciliate with long, slender hairs. Flowers are white, sessile, tiny, and arranged in terminal or axillary whorls. The calyx is curving, tubular, and contracted above the nutlets, measuring 7–15 mm in length. While the bottom half is often glabrous and membranous, the apical section is ribbed and hispid, with a tiny, highly oblique mouth that is not villous. The corolla measures roughly 1 centimetre in length, with a 5 mm long tube, pubescent above, and an annulated centre. The lower lip is roughly twice as long as the thickly woolly, white upper lip, which measures 3 mm. Each of the lobes are sub-acute and the centre lobe is obviated. Nutlets are a sort of fruit that is 2.5 mm long, brown in colour, smooth on the outside, and has angular on the inside and circular on the exterior.

Microscopical characters

Transverse portion (TS) of the stem has four distinct hairy collenchymatous ridges that are quadrangular in shape. There is a ring of vascular tissue encircling the wide stele, and the cortex is small. According to TS, the epidermis is covered with a thick cuticle that is sporadically broken by stomata and contains simple, multicellular, uniseriate trichomes. The star section is made up of a ring of vascular bundles connected to an interfascicular sclerenchymatous band; the phloem is narrow and parenchymatous, radially arranged around the xylem. The cortex is narrow and parenchymatous, but the area near ridges is collenchymatous. The endodermis is distinct and contains a parenchymatous pericycle. Calcium oxalate crystals in the shape of circles around the parenchymatous pith. On the abaxial side, the TS of the leaf that passes through the midrib is primarily convex, while on the adaxial side, it is slightly flat or grooved. Additionally, it displays a conjoint and collateral meristele centred in the middle, connected to a parenchymatous pericycle layer on the lower side. Lamina's epidermis is covered in a thick layer of cuticle, has stomata, and has trichomes similar to those on the stem. Palisade tissue, which makes up the majority of the spongy parenchyma, is one to two layers thick.

Traditional uses

According to estimates, the majority of people on the planet rely on traditional medicine made from medicinal plants to meet their needs for improved health. who have a cough or cold are treated with flowers and honey. The juices from the leaves work well against scorpion stings, toxic insects, and snakebite injuries. In certain areas, the leaf extracts are also effective as insecticides and mosquito repellents. *L. aspera* leaf extracts are used in Indian traditional medicine to treat psoriasis, chronic rheumatism, and chronic skin eruptions.

Phytochemistry

Numerous other components, including 3-sitosterol, ursolic acid, and oleanolic acid, are present throughout the entire plant. The aerial portions include a variety of compounds such as maslinic acid, asperphenamate, isololiolide, linifolioside, nectandrin B, chrysoeriol, apigenin, myristargenol B, and machilin C, in addition to sterols, nicotine, glucoside, galactose, diterpenes, and isopimarane glycosides. Of the several chemical compounds that were separated and identified from the leaf juices, the most frequently observed were ufarnesene (26.4%), xthujene (12.6%), and menthol (11.3%). It has been found that the two main constituents of the floral extract are isoamyl propionate (14.4%) and amyl propionate (15.2%). Moreover, linolenic acid (0.65%), stearic acid (2.84%), palmitic acid (6.25%), oleic acid (42.07%), and linoleic acid (48.11%) are all examined in relation to seed. Additional unusual compounds found in shoots include 4-(24-hydroxy-1-oxo-5-propyltetracosanyl)-phenol, long chain compounds (1-hydroxytetratriacontan-4-one, 32-methyltetratriacontan-8-ol), aliphatic ketols (28-hydroxypentatriacontan-7-one, 7-hydroxydotriacontan-2-one), β sitosterol, and dotriacontanol. The typical compounds recovered from *L. aspera* and their chemical structures.

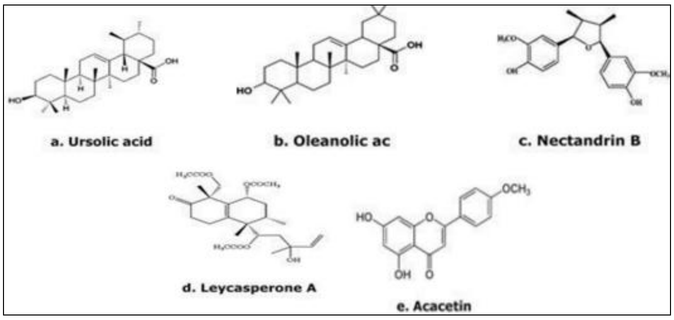

Fig 2: Chemical structure of the constituents

Pharmacological activities

In-vitro antioxidant activity [6]

Free radicals harm healthy cells by causing oxidative stress. These harms are a contributing factor to inflammatory, cardiovascular, cancer, and ageing illnesses. Flavonoids, tannins, and phenolic substances all directly contribute to antioxidant action. Using a variety of in-vitro models, the study sought to assess the phytochemicals found in different solvent extracts made from *Leucas aspera* (Willd) Link leaves (*L. aspera*) and its antioxidant potential. Several in-vitro models, such as DPPH, were used to evaluate the antioxidant and free radical scavenging properties of petroleum ether, ethanol, isopropyl alcohol, ethyl acetate, and chloroform extracts of *L. aspera* leaves.(1,1-diphenyl-2-picrylhydrazyl) To guarantee the plant's pharmacological benefits, tests for radical scavenging capacity, total antioxidant activity, ABTS (2,2, -azinobis (3-ethylbenzoline-6-sulfonic acid) radical scavenging activity, and nitric oxide radical inhibition experiment were performed. Out of all the solvents, petroleum ether extract (a non-polar solvent) had the highest level of antioxidant activity, with IC_{50} values of 18.96 μg/mL for the DPPH assay, 17.22 μg/mL for the total antioxidant assay, 16.00 μg/mL for the ABTS assay, and 11.87 μg/mL for the nitric oxide scavenging assay. On the other hand, ethanol extract (polar solvent) outperformed chloroform, ethyl-acetate, and isopropyl alcohol extracts in terms of DPPH scavenging, ABTS test, and nitric oxide scavenging activities (IC_{50}=19.90, 11.60, and 13.47 μg/mL, respectively). Our current study's findings demonstrated that *L. aspera* leaf is a noteworthy source of phytochemicals with scavenging and antioxidant capabilities. The results of our investigation support a range of pharmacological actions as well as more investigation into the identification and characterisation of the active principle underlying the pharmacological action.

Anti-Diabetic [7]

Nanotechnology is essential to the diagnosis, delivery, and therapy of numerous illnesses and disorders in regenerative medicine. In the past few decades, there has been a significant focus on the biosynthesis of Iron Oxide Nanoparticles (IOP) due to the growing need to develop environmentally acceptable technologies in material creation. Due to the severe side effects of allopathic medication, the society is now searching for alternative treatments for a variety of illnesses. Iron oxide nanoparticles are finding more and more usage in the biomedical field; these applications are crucial for ensuring the particles' biosafety both *in -vivo* and *in- vitro*. Liver damage and renal failure are the primary complications of diabetes mellitus resulting from recurrent lipid peroxidation; however, *Leucas aspera* therapy has a significant impact on these markers, shielding the organs from additional harm. The safety, efficacy, and potency of the leaf extract of *Leucas aspera* against diabetes mellitus in the *in vivo* model, as well as the traditional usage of the plant against cancer and diabetes mellitus, are all supported by the current research. *Leucas aspera* has potential and can be a top pick without causing any negative side effects, according to the overall results.

Anti-cancer activity [8]

Chemotherapy, radiation, and other cancer treatments are efficient in reducing the number of cancer cells in the body. But society is becoming increasingly concerned about their adverse effects. The use of nanotechnology in medicine has the potential to improve treatment outcomes. The anticancer activity of the silver nanoparticles, which were spontaneously synthesised from *Leucas aspera* leaf extract, was examined in this work. Despite the fact that *Leucas aspera* nanoparticles' impact on cancer cell lines was subject matter of multiple publications, the anticancer activity of these particles was not thoroughly examined. Thus, employing HeLa cells as a cancer cell model, the current study investigated the characterization and anticancer potential of *Leucas aspera* nanoparticles. The production of silver nanoparticles was morphologically indicated by a shift in hue from golden yellow to dark brown. Additionally, a distinctive surface absorption peak at 450 nm was found in the UV–visible spectrum analysis. Furthermore, the nanoparticles' size and surface charge were determined using a zeta potential analyser; the results showed that the size was 200 nm and the zeta potential was -55.1 mV. Moreover, the presence of flavonoids and polyphenols was confirmed by Fourier transform infrared spectroscopy (FTIR), which revealed three strong peaks at 3343.705 cm^{-1}, 1636.668 cm^{-1}, and 668.336 cm^{-1}. Subsequently, the SEM investigation using EDS revealed that the nanoparticles were round and 50 nm in size, respectively. The LDH assay was used to measure the cytotoxicity of the nanoparticles; at 100 μg /ml^{-1}, 50% of the nanoparticles were found to be cytotoxic. The DNA fragmentation assay also indicated that the cells were dying due to apoptosis. Moreover, anticancer activity was verified by cell cycle analysis, which revealed 94.2% of apoptotic cells. In conclusion, it has been demonstrated that nanoparticles have a strong cytotoxic effect on cervical cancer cells and cause apoptosis in the cells. Given that the nanoparticles showed cytotoxicity against cancer cells, additional research is necessary to comprehend their intracellular interactions.

Hepatocarcinogenesis [9]

One of the leading causes of death for people worldwide is cancer. Researchers worldwide are concentrating on employing herbal remedies to strengthen the body's defences against cancer. The purpose of this study is to assess the chemoprotective impact of. In Wistar rats, *Leucas aspera* in DEN-induced hepato-carcinogenesis was accompanied by CCl_4 promotion. To promote liver cell proliferation and regeneration, two weeks after the experimental protocol began, all of the rats—aside from the normal control—received a single intraperitoneal dose of CCl_4 (2 ml/kg). Blood samples were obtained at the conclusion of the treatment regimen. Antioxidant characteristics were used to gauge the level of protection, and liver biochemical parameters were evaluated to verify the impact of toxicants on the liver and assess the extracts' capacity for chemoprotection. Animals administered DEN exhibited elevated GGT levels, a sign of hepatic carcinogenesis. These animals also displayed increased ALP activity, which could be the result of altered enzyme production similar to other hepatotoxic situations. When extracts were administered, the serum GGT level returned to normal, the AST and ALT levels decreased, and the hepatoprotective impact and suppression of carcinogenesis were demonstrated. The suppression of pre-cancerous transformation in the liver during hydro-ethanolic and aqueous extract administration in DEN+CCl_4 mice is indicated by a considerable reduction in ALP activity. Accordingly, the outcomes show that both extracts have chemo preventive effects by reducing hepatic nodulogenesis and cell proliferation. The findings unmistakably show that the hydro-ethanolic and aqueous extract of the *Leucas aspera* plant significantly reduced the risk of cancer in rats.

Hepatoprotective [10]

The entire *Leucas aspera* Willd. plant. It has long been utilised to treat liver conditions in Siddha therapy. Its hepatoprotective, antioxidant, and anti-microsomal drug-metabolizing enzyme (MDME)-protective properties were studied. Rats were used to test the hepatoprotective and antioxidant properties of LA aqueous extract (200 and 400 mg/kg, p.o.) in response to d-galactosamine (d-GalN)-induced hepatotoxicity. Studies using biochemistry and histopathology were conducted to evaluate the hepatoprotective effect. The study investigated the preventive impact of LA on MDMEs using a hexobarbitone-induced sleeping duration paradigm. Rats administered with d-GalN developed hepatotoxicity, as seen by elevated levels of total cholesterol, triglycerides, aspartate aminotransferase, alkaline phosphatase, oxidative stress, and total bilirubin. Rats given d-GalN had their livers markedly protected by a pretreatment with *Leucas aspera* extract. Antioxidant enzymes such as glutathione peroxidase, catalase, and superoxide dismutase were greatly increased and liver lipid peroxidation was reduced by *Leucas aspera* extract. The total phenolic and flavonoid content of the aqueous extract of *Leucas aspera* was determined to be 3.96 ± 0.57 rutin equivalent mg/g and 28.33 ± 0.19 gallic acid equivalent mg/g, respectively. *Leucas aspera* extract treatment with CCl_4 at 200 and 400 mg/Kg reduced the amount of time mice spent sleeping after being exposed to hexobarbitone by 56.67 and 71.30%, respectively, suggesting that *Leucas aspera* has a protective impact on hepatic MDMEs. Histological investigations revealed that in rats given d-GalN, *Leucas aspera* at 400 mg/kg reduced the amount of hepatocellular necrosis. Our findings support the traditional application of *Leucas aspera* in hepatic diseases.

Aticoagulant activity [11]

Leucas aspera, often called "Thumbai," is found in all of India, ranging from Ceylon to the Himalayas. Traditionally, the plant was employed as an insecticide and an antipyretic. Its pharmacological properties, including antifungal, antioxidant, antibacterial, antinociceptive, and cytotoxic action, have been demonstrated in medicinal contexts. Subsequent investigations uncover a variety of phytochemical components, primarily flavonoids, alkaloids, saponins, glycosides, tannins, and sugars. The goal of the current study is to assess the potential contribution of *Leucas aspera* leaves and stems' ethanol and aqueous extracts to the blood coagulation cascade. According to this study, *Leucas aspera* has a variety of pharmacological effects and is a source of medicinally active chemicals. As a result, the substance supports the discovery of novel therapeutic uses for it.

Anti-malarial activity [12]

Malaria poses a serious threat to world health and has a detrimental impact on individuals in impoverished nations like Bangladesh. Due to the causal cause *Plasmodium falciparum's* resistance to a number of anti-malarial medications now on the market, including mefloquine, chloroquine, and artemisinin-based combination therapy (ACT), controlling the disease has become extremely difficult on a worldwide scale. Novel anti-malarial chemotherapeutic drugs are desperately needed. The purpose of the current study was to assess the antimalarial activity of methanolic extracts of three medicinal plants from Bangladesh: *Dichapetalum gelonioides*, *Leucas aspera*, and *Acorus calamus*. The plants were tested against strains of *P. falciparum* that were resistant (Dd2) and sensitive (3D7) to chloroquine. An ELISA based on histidine-rich protein 2 (HRP2) was utilised to assess the extracts' *in vitro* inhibitory efficacy. The extract of *D. gelonioides* exhibited both promising (IC_{50} = 10.43 µg/mL) and moderate (IC_{50} = 19.15 µg/mL) activity against the Dd2 and 3D7 strains, respectively. *A. calamus* showed no activity against the Dd2 strain (IC_{50} = 67.81 µg/mL) or the 3D7 strain (IC_{50} = 72.29 µg/mL). At first, *L. aspera* showed little activity against the 3D7 strain (IC_{50} = 60.51 µg/mL); nevertheless, it showed encouraging activity (IC_{50} = 7.693) against the Dd2 strain. This is the first evaluation of these plant components' *in vitro* antimalarial properties. To determine whether new antimalarial medication molecules could be present, more phytochemical investigation of *D. gelonioides* and *L. aspera* is essential.

CNS Depressant activity [13]

In Bangladesh, *Leucas aspera* (*L. aspera*) is frequently referred to as "Darkolos or Dandokolos." Antipyretic, anti-rheumatic, anti-inflammatory, and antibacterial illnesses are treated with the herb. This study looked at the potential depressing effects of methanolic extract of *L. aspera* leaves (MELA) on mice models of the central nervous system (CNS). Tests for the central nervous system (CNS) depression induced by thiopental sodium were conducted, including force swimming, open field, whole cross, tail suspension, and swimming. Diazepam (1 mg/kg, i.p.) used as the reference medication for CNS testing. MELA was given orally in all mouse models at dosages of 250, 500, and 750 mg/kg; in contrast, the control group was given deionized water (0.1 mL/mouse, p.o.). According to the current study, MELA dramatically reduced the locomotor activity of mice in both open field and full cross tests. The force swimming and tail suspension tests both showed a considerable increase in immobility time due to the extract. In the thiopental sodium-induced sleeping time test, MELA significantly (*$p<0.05$) induced sleep at an earlier stage and prolonged the duration of sleeping time. The results of this investigation suggested that the extract from *L. aspera* leaves has CNS depressive properties. Nevertheless, more research is required to assess *L. aspera's* potential for treating CNS depression disorders.

Antihyperlipidemic activity [14]

Natural products derived from plants kingdom play a vital part in preventing or treating various diseases or disorders in humans. Hyperlipidaemia is one of the major pathological factors of cardiovascular diseases and diabetes mellitus. On the other hand, *Leucas aspera Linn*., belonging to the family *Lamiaceae*, was found to possess many pharmacological activities such as anti-inflammatory, antibacterial, and ant plasmodial activities along with cytotoxic effects. The present study is an attempt to investigate its antihyperlipidemic activity by *in vivo* animal model. Hyperlipidaemia model can be induced by administered with dexamethasone in rats with significant increase in serum cholesterol and triglyceride (TG) levels along with increase in the atherogenic index. The ethanolic extract of leaves of *L. aspera Linn*. (200 and 400 mg/kg) treatment has shown significant inhibition against dexamethasone-induced hyperlipidaemia in rats by maintaining the serum levels of cholesterol, TGs and near to the normal levels.

Antiasthmatic activity [15]

An ongoing inflammatory condition affecting the airways called asthma. The need to look for new and better treatment alternatives has been fuelled by the limitations of already available medicines and the adverse effects that go along with them. Therefore, the goal of the current investigation was to assess *L. aspera's* anti-asthmatic properties utilising a variety of experimental animal models. A 100 mg/kg (p.o.) methanolic extract of the dried entire plant of *L. aspera* was produced. To assess the anti-asthmatic activity of the drug, a range of in-vivo models were used, including guinea pigs induced to bronchospasm by histamine, rats exhibiting passive paw anaphylaxis, and mice developing eosinophilia. Additionally, *in vitro* models were used, such as guinea pig tracheal chain and ileum preparations induced to contract by histamine and acetylcholine. In models of histamine-induced bronchospasm, passive paw anaphylaxis, degranulation of mesenteric mast cells, and histamine and acetylcholine-induced contraction in guinea pig tracheal chain and ileum preparations, respectively, the drug's methanolic extract demonstrated a significant bronchodilator and anti-histaminic, anti-inflammatory, mast cell stabilisation, and anticholinergic activity. However, in cases of milk-induced eosinophilia, no discernible anti-allergic impact was found. As a result, *Leucas aspera's* dried whole plant methanolic extract has strong antiasthmatic properties.

Anthelminthic activity [16]

One of the most prevalent illnesses in humans is helminth infection, which affects a significant section of the world's population in underdeveloped nations and contributes to the global disease burden. Earthworms, or *Pherithema posthuma* helminthes, are a common name for the herb *Leucas aspera*, which grows all over India. An anti-helminthic characteristic of

Pherithema posthuma was used as an experimental model to assess *Leucas aspera*. The industry standard was piperazine citrate. The control group's earthworm displayed a paralysis time of 64.33 minutes and a death time of 200 minutes! Among the various concentrations of aqueous extract, the concentration at MGML was tested and shown to be efficient.
ethanol extract shown anthelminthic action at all doses tested; however, the concentration at 250 mg/ml produced significant results, indicating that ethanol extract When compared to an aqueous extract, the extract of *Leucas aspera* shown significant helminthic activity against *Pheretima posthuma*. Also shown to be more effective than the typical medication is the ethanol extract. The ethnomedical assertions that is an anthelminthic herb were validated by this inquiry.

Immunomodulatory activity [17]

In India, *Leucas aspera* is a commonly used ethnomedicinal herb for treating a variety of ailments. In our most recent study, this plant stimulated macrophage cells, which are essential to the immune system, and shown potent anti-cancer action in many cancer cell lines. The goal of the current investigation was to assess the immunomodulatory potential of the *Leucas aspera* aerial parts ethyl acetate extract (EALA). The haemagglutinating antibody titre test, carbon clearance test, neutrophil adhesion test, delayed-type hypersensitive reaction test, and cyclophosphamide-induced immunosuppression test were all used in this investigation. After completing the acute dosage toxicity testing, the oral doses of EALA 200 and 400 mg/kg were chosen for the investigation. Swiss albino mice were used for all of the investigations. In the carbon clearance test, EALA significantly increased the phagocytic index, shown a dose-dependent increase in neutrophil adherence to nylon fibres, and significantly protected against immunosuppression induced by cyclophosphamide. Additionally, both EALA dosages increased the amount of circulating serum immunoglobulins in the haemagglutinating antibody titre test and a rise in the delayed-type hypersensitivity reaction test's foot pad oedema. Based on the aforementioned data, it can be said that EALA can influence both humoral and cell-mediated immunity.

Antibacterial, antifungal and mosquitocidal activities [18]

The antibacterial, antifungal, and larvicidal properties of the different organic extracts from *Leucas aspera* leaves were tested against specific bacterial and fungal strains as well as *Culex quinquefasciatus* mosquito larvae. MIC of the extract was determined using the broth microdilution method, and antimicrobial activity was assessed using the disc-diffusion method. At 1, 2.5, 5 and 10 mg/disc concentrations, the results demonstrated that all of the extracts exhibited antibacterial and antifungal activity against certain microorganisms. Dichloromethane (DCM) leaf extract of *L. aspera* (Willd.) L. showed the maximum zone of inhibitions at 10 mg/disc concentration against *S. aureus* (23.4 ± 2.90 mm), *E. coli* (20.3 ± 1.56 mm), *B. subtilis* (17.1 ± 2.04 mm), *P. aeruginosa* (16.5 ± 1.05 mm), *P. vulgaris* (16.1 ± 2.56 mm), and *K. pneumonia* (15.1 ± 3.66 mm). Significant growth suppression was observed by the DCM extract of *L. aspera* (Willd.) L. against *T. viride* (29.2 ± 2.00 mm), *C. albicans* (24.4 ± 0.80 mm), *A. flavus* (22.8 ± 0.36 mm), and *E. floccose* (19.5 ± 2.17 mm). For bacterial and fungal pathogens, the minimal inhibitory concentration (MIC) is 75.5–425.5 µg/mL and 125–425 µg/mL, respectively. Furthermore, at 1000 ppm concentration, DCM extracts of *L. aspera* (Willd.) L. exhibited 100% larvicidal activity against *C. quinquefasciatus*. The biological activity of the plants may enhance their therapeutic qualities and offer additional scientific validation for the use of traditional medicinal plants in the treatment of various infectious disorders.

Antinociceptive activity [19]

Validating its traditional use, the study examined the antinociceptive effects of *L. aspera* leaf methanolic extract (MELA) in mice models. Standard medications, diclofenac sodium and morphine sulphate, were used in six pain models. Oral doses of 250, 500, and 750 mg/kg of MELA were used. Naloxone was employed as an antagonist in order to confirm that the opioid receptor may have contributed to MELA's central antinociceptive actions. The findings showed that *L. aspera* exhibited significant antinociceptive activity in every tested chemical and heat-induced mouse pain model. The extract at 500 and 750 mg/kg demonstrated significant (*$p < 0.05$) antinociceptive activity in hot plate and tail immersion tests. We saw 33.05%, 59.79%, and 82.74% inhibition in the writhing test. In the formalin test, the extract suppressed licking in the first phase at 50.40%, 62.11%, and 72.35%, and in the late phase at 67.23%, 74.57%, and 84.74%. In the glutamate test, the plant extract demonstrated licking inhibition of 24.39%, 60.05%, and 80.96%. Likewise, nociception induced by cinnamon aldehyde resulted in a significant (*$p < 0.05$) inhibition of 28.07%, 52.19%, and 75%, in that order. Both peripheral and central mechanisms are found to be involved in the antinociceptive action of MELA. Consequently, our findings offer proof in favour of the conventional application of MELA for painful conditions.

Pan oral disorders [20]

In order to treat a variety of oral mucosal conditions, this article sought to discuss the efficacy of creating a new antioxidant and anti-inflammatory product from a natural source, specifically the extract of the *Leucas aspera* plant. The research was an experimental descriptive study. The whole LA plant's dried powder extract was put through a number of tests, including a phytochemical analysis, an antioxidant assay (DPPH), and an evaluation of its anti-inflammatory effect (cytokine activity in RAW 264.7 macrophage cells). The findings were tabulated. The T-test was used to determine the anti-inflammatory activity's significance. According to our analysis, a high level of antioxidant activity (78%), equivalent to 100µg of plant extract, was demonstrated. The study was a descriptive experimental investigation. An antioxidant assay (DPPH), a phytochemical analysis, and an assessment of the dried powder extract of the entire LA plant's anti-inflammatory potential (cytokine activity in RAW 264.7 macrophage cells) were among the tests conducted on the material. The results were totalled. The significance of the anti-inflammatory activity was assessed using the T-test. Our analysis revealed a high level of antioxidant activity (78%), which is comparable to 100µg of plant extract.

Anti-parkinson's [21]

Given that the predicted death toll from Parkinson's disease is expected to rise in the near future, this neurological disorder is receiving a lot of attention in research. The purpose of this study was to examine the impact of ethanolic. *Leucas aspera* extract on mice with Parkinson's disease induced by rotenone. The experimental model chosen for this study was mice with Parkinson's disease induced by rotenone. Along with the biochemical parameters like glutothione, dopamine contents, and malondialdehyde, the behavior parameters like general behavior, catalepsy, and neuromuscular coordination were estimated. The findings show that the extract has a protective effect on both behavioural and biochemical parameters against rotenone-induced Parkinson's disease. The findings were determined to be noteworthy. Parkinson's disease may have oxidative stress in the brain as one of its main causes. Natural sources of flavonoids with strong antioxidant properties may offer a viable treatment for the ailment.

Antipsoriatic activity [22]

Well-known Indian medicinal plants include *Phyllanthus simplex* Retz. *Crotolaria juncea* Linn, *Leucas aspera* Linn and *Vitex glabrata* R.Br. Traditionally, different parts of these plants have been used for medicinal purposes. in the management of psoriasis and a number of other illnesses. This led us to evaluate these plants' antipsoriatic properties. The *in vitro* antipsoriatic activity of petroleum ether and ethanol extracts of the chosen plants—*P. simplex* (whole plant), *C.juncea* (seeds), *L. aspera* (aerial parts), and *V. glabrata* (leaves)—was examined. Using HaCaT cells, the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay was used to assess the extracts' antipsoriatic activity. Approximately 200 milliliters of various test sample concentrations (25, 50, 100, 200, and 400 mg/ml) were prepared in the medium for cell culture and incubated for a full day prior to the MTT assay, which is used to identify viable cells. It was also assessed how these extracts affected the synthesis of nitric oxide (NO) and lipid peroxidation. According to our research, these plants exhibited encouraging antiproliferative activity against skin keratinocytes. Nonetheless, it was discovered that the ethanol extract of *L. aspera* (LAEE) and petroleum ether extract of *C. juncea* (CJPE) both showed notable activity (IC_{50} value ¼ 45.45 and 55.36 mg/ml, in that order The antipsoriatic effect of the extracts was presumably mediated by an antioxidant mechanism, as evidenced by their inhibitory action against lipid peroxidation and NO production in HaCaT cells. These results support the assertions that these plants are used in the therapy for psoriasis.

Anti-ophidian activity [23]

The goal of the current study was to assess *Leucas aspera*, an ethnomedical plant, for its ability to inhibit the venom enzymes of the Indian cobra, Naja naja, against ophidian characteristics. The potential of *Leucas aspera* methanolic extract to suppress the main enzyme activities of Naja naja venom, such as protease, phospholipase A2, hyaluronidase, and haemolytic factors, was assessed *in vitro*. The kinds of phytochemicals found in the sample was analysed. Additionally, mass spectrometry using gas chromatography was used to identify the primary phytoconstituents in the extract. The *L. aspera* methanolic extract totally (100%) eliminated the venom protease and hyaluronidase activities (two isoforms) at a ratio of 1:50 w/w (venom: plant extract), while the venom haemolytic activity was similarly completely eliminated at a ratio of by the plant extract, of 1:80 w/w. Even at the maximum concentration used, the extract was unable to eliminate the activity of phospholipase A2. The extract contained alkaloids, acidic chemicals, flavonoids, steroids, and cardiac glycosides, according to phytochemical analysis. The extract included a total of 14 chemicals, according to GC-MS analysis. Six-octadecenoic acid (32.47%), n-hexadecanoic acid (25.97%), and 17-octadecen-14-yn-1-ol (14.22%) were identified as the main bioactive ingredients. The minor compounds included sitosterol (2.45%) and stigmasterol (2%), which have been previously reported to have antivenom activity. The observed results indicate that *Leucas aspera* methanolic extract has anti-venom efficacy for the first time and may be a possible source of anti-ophidian metabolites.

Table 1: Pharmacological activities of *Leucas aspera*

Sl. No	Extract	Activity	Animals / cell lines/ microbes	Reference
1	Petroleum ether	Antioxidant	NA	Annapandian MV *et al*, 2017 [6]
2	Chloroform extracts			
3	Ethyl acetate			
4	Isopropyl alcohol			
5	Aqueousextract And Hydro-ethanolic	Anti-diabetic	Wistar Albino Rats	Madhu GC *et al*, 2019 [7]
		Anti-cancer	Wistar Albino Rats	Madhu GC *et al*, 2019 [7]
		Hepatocarcinogenesis	Wistar albino rats	Gupta N *et al*, 2015 [9]
6	Aqueous extract and ethanolic extract	Anti- coagulant	Human blood	Subramaniam P *et al*, 2008 [11]
		And Anthelminthic activity	*Pherithema posthuma*	Agarwal S *et al*, 2011 [16]
7	Methanolic extract	Anti-Malarial activity,	*Plasmodium falciparum*	Zamil FM *et al*, 2022 [19]
		CNS depressant activity,	Swiss albino mice	Reza R *et al*, 2018 [13]
		Anti-asthmatic activity	Guinea pig, Albino Wistar rats, Mice	Limbasiya KK, 2012 [15]
		Antinociceptive Activity	Swiss albino mice	Mannan MA *et al*, 2017 [19]
		Pan Oral Disorders	RAW 264.7	Nagarajan KS *et al*, 2019 [20]

		Anti-ophidian	Naja Naja venom enzymes	Gopi K *et al*, 2014 [23]
8	Ethanolic extract	Antihyperlipidemic activity	Male Wister rats	Kumar VG *et al*, 2016 [2]
9	Ethyl acetate extract	Immunomodulatory activity	Swiss albino mice	Dash S *et al*, 2014 [17]
10	Aqueous extract	Hepatoprotective	Wistar albino rats	Banu S *et al*, 2012 [10]
11	Dichloro methane, Hexane, Acetone, Aqueous	Antibacterial, antifungal and mosquitocidal activities	*Bacillus subtilis, Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Proteus vulgaris, Klebsiella pneumoniae, Aspergillus flavus, Candida albicans, Epidermophyton floccosum, Trichoderma viride*	Pavunraj M *et al*, 2017 [18]
12	n-hexane and ethanolic	Antiparkinsonian	Male Swiss albino mice	Ramani R *et al*, 2014 [21]

Conclusion

The plant *Leucas aspera*, part of the Lamiaceae family, is commonly used in traditional medicine in India. It contains various phytoconstituents such as terpenoids, fatty acids, and phenolic chemicals. Traditionally, *Leucas aspera* has been used to treat psoriasis, chronic rheumatism, and skin eruptions. Herbal plants play a significant role in traditional medicine and serve as the foundation of Indian Siddha and Ayurvedic medicinal systems.

Leucas aspera is found in various regions around the world, and its macroscopic characteristics include a sturdy stem, white flowers in terminal whorls, and nutlets as fruits. Microscopically, the stem exhibits collenchymatous ridges, vascular tissue, and simple trichomes. The leaves have a convex shape with palisade tissue and multicellular trichomes. Research has shown that *Leucas aspera* extracts possess various pharmacological activities, including antioxidant, anti-diabetic, anti-cancer, and hepatoprotective effects. The extracts have demonstrated antioxidant potential, anti-diabetic properties, and anti-cancer activity in *in vitro* models. Additionally, the extracts have shown potential in the treatment of hepatocarcinogenesis and liver damage. The extracts also exhibit antibacterial, antifungal, and larvicidal activities. Further studies have explored the plant's anti-inflammatory, antinociceptive, immunomodulatory, and anthelmintic properties. *Leucas aspera* has been shown to have a significant anti-inflammatory effect and antinociceptive activity in mice models.

The plant also exhibits immunomodulatory potential, promoting phagocytic activity and immune response. Additionally, the extracts have been found to have anthelmintic properties against earthworms. Moreover, *Leucas aspera* has demonstrated potential in treating conditions such as asthma, hyperlipidaemia, and various oral disorders. The plant extract has shown promise in improving lung function, anti-hyperlipidaemic effects, and antioxidant and anti-inflammatory properties for oral health. It has also been studied for its potential in treating Parkinson's disease, psoriasis, and ophidian envenomation. Overall, *Leucas aspera* has shown significant potential as a therapeutic traditional medicine, with a wide range of pharmacological activities that support its traditional uses in various cultures. Further research and clinical studies may help validate and expand the use of this herb in modern medicine.

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