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A Comprehensive Review of Hemigraphis Alternata

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ABSTRACT: Hemigraphis alternata, commonly known as Red Flame Ivy or Purple Waffle Plant, is a perennial herb native to Malaysia that is widely cultivated in tropical regions1. Traditionally, it has been used for wound healing and treating various ailments. Its leaves contain bioactive compounds such as flavonoids, alkaloids and phenols. Recent studies have highlighted its antioxidant, antibacterial and anti-inflammatory properties. The plant grows in warm and humid environments and is highly valued for its ornamental effects. In this review, we investigate its phytochemical composition, traditional uses, and pharmacological activity and highlight its potential in modern medicine**.**

KEYWORDS: Hemigraphis alternate (H.alternata) ,wound healing, phytoconstituents, traditional medicine, leaf extract.

I. INTRODUCTION

Hemigraphis alternata (H. alternata) belongs to the mushroom family and is native to East Malaysia and has adapted to the Indian region. It is commonly known as red ivy, purple wavy plant and murikooti. H. alternata is an annual creeping herbaceous perennial that grows to a height of 28-30 cm. The leaves are positioned opposite one another and have serrated edges. The leaf blades are silvery above and reddish brown below, and the stems are erect and reddish brown. Traditionally, the leaves of this plant have been used to heal wounds and treat anemia, red diarrhea, kidney stones, and bleeding. In addition, leaf extracts can be applied to fresh cuts to speed up wound healing. H. alternata has been reported to contain phytoconstituents such as carbohydrates, steroids, alkaloids, flavonoids, triterpenes, phenols, and amino acids. Several studies have reported that H. alternata exhibits antioxidant, analgesic, antibacterial, and anti-inflammatory activities.

In traditional medicine, the leaves are ground into a paste and applied to fresh cuts to help heal wounds. The growths that resemble brushes on the outside threads of the stamens are called "hemigraphis," or half-writing. The plant is known by many common names such as metal leaf, red flame ivy, waffle plant, aluminum plant, graveyard plant, Java ivy, etc. Further research at the molecular level, in addition to biochemical and analytical evidence, it is crucial to confirm the healing properties of this herb. In this study, H. alternata was detected in in vitro cell line and animal model experiments using Hemigraphis alternata leaf extract.

PLANT DESCRIPTION

Hemigraphis alternata is a herbaceous plant that typically reaches about 30 cm in height. The stems are purple and tend to be flattened, especially at the nodes. The leaves are arranged opposite the stem, finely hairy, and one leaf is significantly larger than the other. The upper surface of the leaves is dark green, while the underside appears light green or purple. Also known as the graveyard plant, purple wafer plant, or murikooti, in Ayurvedic medicine it is called Vranaroopani, meaning "healer of wounds". In Kerala, India, it is commonly called Muriyan Pacha, reflecting its traditional use for wound healing. The plant is native to tropical regions, especially tropical Malaysia and Southeast Asia, and is found in abundance in countries such as China, Indonesia, India, and Japan.

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Binomial name:
Strobilanthes alternata

Vernacular name:

- **Kannada**: Tincture ghida
- **English:** Cemetery plant, Aluminium plant, red flame ivy, Metal leaf, Tincture plant.
- **Sanskrit:** Vranaropani
- **Malayalam**: Murikooti

Synonyms:

- Blechum cordatum Leonard
- Goldfussia colorata (Blume) Moritzi
- Hemigraphis alternata (Burm.f.) T.Anderson
- Hemigraphis colorata W.Bull
- Hemigraphis colorata L.
- Hemigraphis colorata (Blume) Hallier f.
- Ruellia alternata Burm.f.
- Ruellia colorata Blume

Taxonomical classification:

- **Kingdom**: Plantae,
- **Phylum**: Spermatophyta,
- **Subphylum**: Angiospermae,
- **Class**: Magnoliopsida – Dicotyledons
- **Subclass**: Asteridae
- **Order**: Scrophulariales
- **Family**: Acanthaceae Juss. - Acanthus family
- **Genus**: Hemigraphis Nees - Hemigraphis
- **Species**: Hemigraphis alternata

GEOGRAPHICAL SOURCE

Native to Indonesia and Malaysia, H. alternata (Meyer & Lavergne, 2004; USDAARS, 2016) has been widely cultivated and used as an ornamental plant in tropical and subtropical regions of Asia, the Americas, the Caribbean, and various islands of the world, as well as in the Indian and Pacific Oceans (Daniel, 2001, 2005; Meyer & Lavergne, 2004; Acevedo-Rodriguez & Strong, 2012; PIER, 2016). After H. alternata disappeared from cultivation, it became naturalized and invasive in several places, especially in the Indian and Pacific islands (PIER, 2016). The plant was first introduced to Reunion Island in 1862 and to Fiji in 1928 (Meyer & Lavergne, 2004). It has also been observed in Hawaii, where herbarium records indicate that it was introduced in 1927 (Wagner et al., 1999). In Niue, Samoa, and Tahiti, H. alternata forms widespread ground cover in the understory of moist secondary forests at low and mid-elevation (Meyer & Lavergne, 2004). In Central America, including Honduras, El Salvador, Panama, and Nicaragua, H. alternata is recognized as an ornamental plant that has disappeared from cultivation. The species has now become naturalized and spread throughout natural areas, disturbed sites, and along trails and roads (Daniel, 2001, 2005; Correa et al. 2004).

ECOLOGICAL ROLE

Hemigraphis alternata, often called the purple waffle plant, belongs to the mushroom family and is highly valued in ornamental plant breeding. Its interactions with other species can be studied from different perspectives: ecological role, competitive dynamics and mutualism. Ecological interactions Pollinators: The flowers of Hemigraphis alternata are designed to attract specific pollinators such as honeybees. These pollinators help in cross-pollination, which is important for the plant's reproductive process. Plant communities: In garden environments, Hemigraphis alternata can interact with other ornamental plants. Although it is commonly used as a ground cover, it can affect the growth of neighboring plants as they compete for important

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resources such as light, water, and nutrients. Soil Microorganisms: Plant root systems interact with soil microorganisms, influencing the growth and health of the entire plant. For instance, mycorrhizal fungi establish mutually beneficial relationships with plant roots, enhancing the absorption of nutrients.

HABITAT PREFERENCE

1. Climate: Hemigraphis alternata thrives in environments characterized by warmth and high humidity. It is suitable for tropical and subtropical regions with consistently high yearly temperatures.
2. Light: This plant grows best in bright, indirect light. It can adapt to lower light levels, but it grows best in full sun or partial shade. Direct sunlight can cause leaf burn.
3. Soil: A key requirement for Hemigraphis alternata is well-drained soil. It prefers a soil composition that retains moisture while allowing excess water to escape. A mix of potting soil and organic matter or perlite is often recommended for optimal growth.
4. Humidity: Constant humidity is essential for this plant, but it is important to avoid overwatering. Hemigraphis alternata grows best in conditions where the soil is kept moist without becoming waterlogged.
5. Temperature: The ideal temperature range for Hemigraphis alternata is between 15°C and 24°C. The plant is frost-sensitive and should be protected from low temperatures to avoid damage.

CULTIVATION

1. Propagation: Hemigraphis alternata can be propagated by cuttings or division. For cuttings, select a healthy stem, apply a rooting hormone and plant in a well-draining medium. Alternatively, when replanting, the nplant parts can be divided into difeerent parts so tghat each part has a good root system and sufficient number of stems2. Planting Medium: This plant thrives in a light, well-drained soil mix. Mixing regular potting soil with perlite or coarse sand will improve soil aeration and drainage, helping to prevent problems like root rot.
3. Watering: Maintain consistent moisture in the soil, but be sure not to overwater. Wait until the top layer of soil has dried slightly before watering again. In cooler weather, it is important to adjust watering frequency to accommodate the reduced growth of the plant.
4. Light requirements: Hemigraphis alternata prefers bright indirect light. It should be placed in full sun or partial shade, as direct sunlight can damage the leaves. 5. Temperature and Humidity: The ideal temperature for this plant is 15°C to 24°C. It benefits from high humidity so keeping it in a moist environment or using a humidity tray will help it grow.
6. Fertilization: Feed every 4-6 weeks with a balanced water-soluble fertilizer during the growing season, which usually includes spring and summer. When plant development slows down in the fall and winter, fertilize sparingly.
7. Pruning: Regular pruning helps shape the plant and promotes denser growth. Remove dead or discolored leaves and cut back overly long stems for a more compact, lush appearance.

TRADITIONAL USES

- Ornamental Value: Historically, Hemigraphis alternata was valued primarily for its distinctive, decorative leaves. This decorative effect makes it popular for indoor and outdoor use. Unlike some plants with extensive medicinal or practical uses, it serves primarily as an ornamental plant, rather than for therapeutic or practical purposes.
- Wound Healing: Various plants in the mushroom family have traditionally been used for their wound healing properties. These practices are usually based on local knowledge and include using plant extracts or creating poultices to treat wounds and aid in skin regeneration.
- Ornamental value: Hemigraphis alternata is highly valued in the ornamental plant field for its unique and eye-catching leaves. It is often used in houseplant displays, as an outdoor ground cover, and incorporated into decorative landscapes. Its high popularity increases its economic value in nurseries and garden centers.
- Market demand: The plant's bright color and suitability for indoor use have made it increasingly popular among private and commercial users. Its low maintenance requirement makes it popular with many plant enthusiasts and landscape gardeners, enhancing its economic attractiveness.
- Trade and cultivation: Hemigraphis alternata is cultivated in various locations as a popular ornamental plant and is part of international trade networks. This commercial activity supports the economic vitality of nurseries and export companies operating in the floriculture industry.

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HERB DESCRIPTION

Leaves:

Shape and Arrangement: The leaves of Hemigraphis alternata are generally broad and elliptical or oval. They have a distinctive vein pattern reminiscent of fish bones, from which the common name is derived. These leaves are arranged alternately on the stem.

Size: The dimensions of each sheet usually range from 5-12 cm in length and 3-8 cm in width.
Color: The upper side of the leaf is usually deep green, while the underside of the leaf is a lighter shade. Leaf edges often have jagged or wavy patterns.
Texture: The upper side of the leaf is smooth and shiny, giving it a vibrant and attractive appearance. In contrast, the underside of the leaf may be slightly hairy or covered with fine hairs.
Veneration: The veins are prominent and form a distinctive network, which is a notable feature of this plant. Flowers:
Inflorescence: The plant produces delicate, small inflorescences or clusters that grow from the leaf axils. These inflorescences are often not very noticeable.

Flowers:

The flowers are small and tubular, usually about 1-2 cm long, and range in color from white to pale lavender or purple.

Structure: Each flower has a tubular corolla that spreads slightly at the ends, and the calyx is small and sometimes greenish in color.
Flowering Period: Flowering periods can vary, but usually occur during the warm season or throughout the growing season.

Stem: It is often reddish or purple and is covered with a soft, velvety texture.
The stems usually grow along the ground or paths, promoting a sprawling growth pattern for the plant. They also tend to root at nodes in contact with the soil, which increases the plant's vegetative reproductive potential.

It is a creeping herb with purple, elongated, heart-shaped leaves, 3.5-15 cm long and 1.6-6 cm wide.

Roots:

Hemigraphis alternata has a fibrous root system characterized by a shallow and spreading nature. Roots grow mostly near the soil surface and effectively absorb nutrients and moisture from the upper soil layers.

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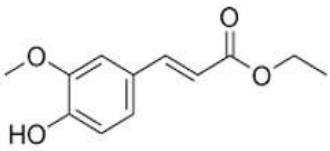
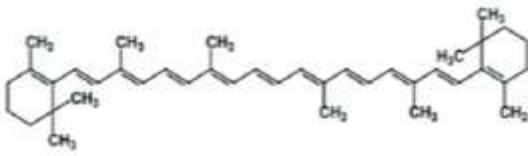
They are fine and delicate and often form a dense network around the base of the plant. In addition, plants can develop adventitious roots at the nodes where the stem touches the ground, which promotes vegetative propagation and improves plant stability.

PHYTOCHEMISTRY

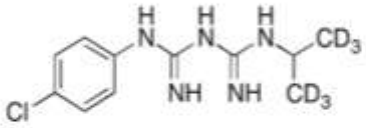
Phytochemicals have historically been used for their healing properties, particularly for wound treatment, dyes, and food preservation. It is categorized as secondary metabolites, these compounds offer a range of medicinal advantages. The plant is rich in primary and secondary metabolites, including flavonoids, terpenoids, coumarins, carbohydrates, phenols, saponins, carboxylic acids, xanthoproteins, tannins, proteins, alkaloids, steroids, and sterols. Studies have identified carotenes as the main phytochemicals in Hemigraphis alternata.



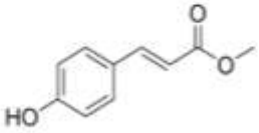
Ferulate



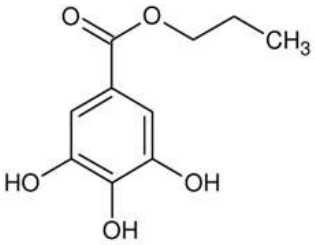
β- Carotene



Chloroguanide



Coumarate



Gallate

EXTRACTION

Pharmaceutical extraction is the process of isolating biologically active compounds from natural substances or synthetic mixtures and is essential for developing new drugs or purifying existing ones. This process is essential to the creation of new drugs and to guaranteeing their quality.

Solvent extraction:

Solvent extraction is a classical method that uses a solvent to selectively dissolve and separate certain compounds from a mixture. The type of solvent and extraction conditions, such as

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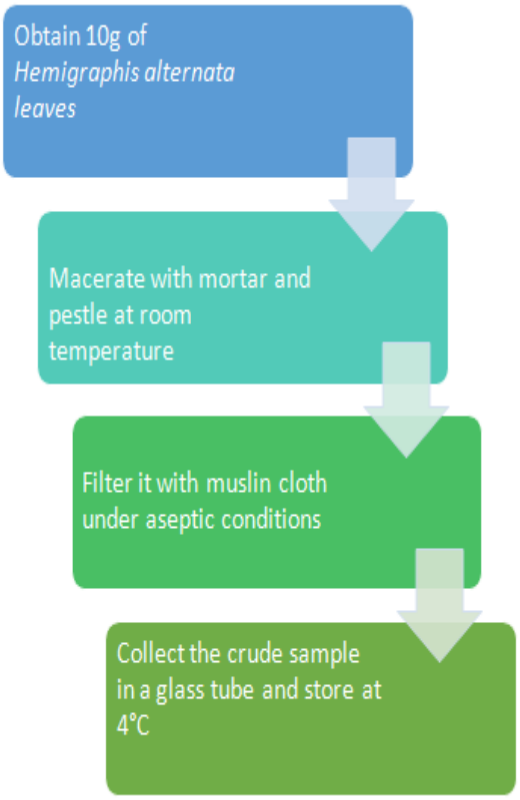
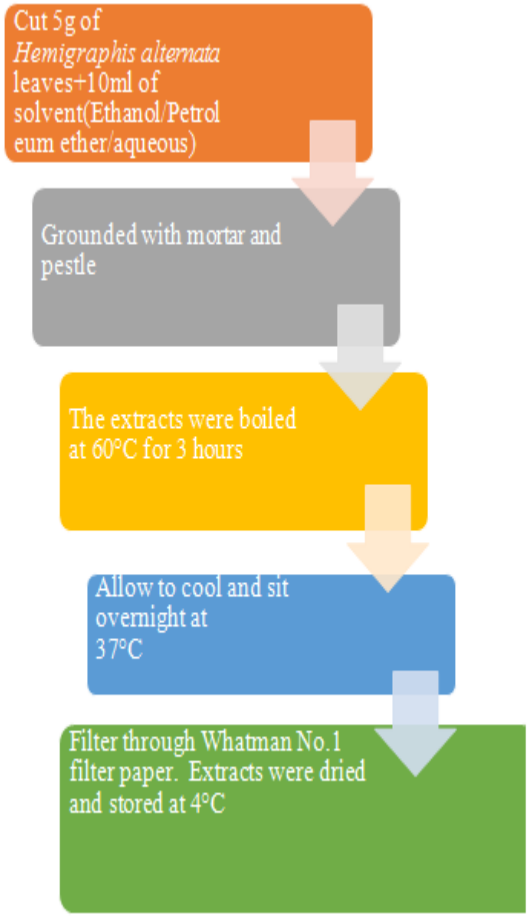
temperature and time, impact the efficiency and precision of this method.

METHOD-1



- Approximately 10 grams of fresh H.alternata leaves were ground at room temperature using a mortar and pestle.
- The mixture was then filtered through a muslin cloth under sterile conditions.
- The resulting crude filtrate was collected in freshly sterilized glass tubes and stored at 4 °C for later use.
- About 10 grams of fresh H. alternata leaves were ground at room temperature using a mortar and pestle. The mixture was then filtered through a muslin cloth under sterile conditions.
- The resulting crude filtrate was collected in freshly sterile glass tubes and stored at 4 °C for future use.

METHOD-2



- Cut 5g of Hemigraphis alternata leaves.
- Prepare 10ml of solvent(Ethanol/Petroleum ether/aqueous).
- Grounded with mortar and pestle.
- The extracts were boiled at 60°C for 3 hours.
- Allow to cool and sit overnight at 37°C.
- Filter through Whatman No.1 filter paper.
- Extracts were dried and stored at 4°C.

PHYTOCHEMICAL SCREENING

A. **Carbohydrate Test (Molisch Test):** Approximately 500 mg of crude extract was dissolved in 5 ml of distilled water and filtered. A few drops of Molisch's reagent, consisting of α-naphthol (10% w/v) in 90% ethanol, were then added to the filtrate. Then, 1 ml of concentrated sulfuric acid (H2SO4) was cautiously poured down the inside of the test tube. Following 120 seconds, 5 milliliters of distilled water were included. The presence of carbohydrates was indicated by a positive

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result observed as a dull purple or red color at the interface between the two layers.

B. **Fehling's test for reducing sugars**: To perform the Fehling's test, 2 mg of plant extract was dissolved in 1 ml of distilled water and filtered. Subsequently, 1 ml of a mixed solution of Fehling's A and Fehling's B (mixed in a 1:1 ratio) was added to the filtrate. The mixture was then heated in a water bath for a few minutes. The appearance of a brick-coloured precipitate indicated the presence of reducing sugars.

C. **Mayer's test for alkaloids**: To perform the Mayer's test, one or two drops of Mayer's reagent (a solution of potassium mercuric iodide prepared by dissolving 1.36 g of mercuric chloride and 5 g of potassium iodide in 100 ml of distilled water) were added to the test tube, which was obtained by dissolving 50 mg of the filtrate in 5 ml of 1% aqueous hydrochloric acid. The reagent was cautiously poured down the edge of the tube. The presence of alkaloids was confirmed by the appearance of a white, creamy precipitate.

D. **Foam test for saponins**: For the foam test, stock solutions were prepared by dissolving 100 mg of plant extract in 10 ml of methanol. These stock solutions were then diluted to a concentration of 0.5 mg/ml by adding 20 ml of distilled water. The resulting solutions in test tubes were shaken vigorously for 15 minutes. The presence of saponins was indicated by the formation of bubbles on the surface of the liquid.

E. **FeCl3 test for tannins**: To perform the FeCl3 test, 50 mg of crude extract was dissolved in 5 ml of distilled water. A few drops of 5% iron chloride solution (FeCl3) were then added. The bluish-black color indicates the existence of tannins.

F. **Alkalinity test for flavonoids**: To conduct the alkalinity test, 1 mL of the filtered stock solution (made by dissolving 100 mg of extract in 10 mL of methanol) was mixed with a small amount of 5% sodium hydroxide (NaOH) solution. Upon addition of NaOH, a deep yellow color appeared. This color changed or disappeared upon addition of dilute hydrochloric acid (HCl), confirming the presence of flavonoids.

G. **Salkowsky test for triterpenoids**: To perform the Salkowsky test, 2 mg of crude extract was mixed with 1 ml of chloroform ($CHCl_3$). After shaking, a few drops of concentrated sulfuric acid (H_2SO_4) were added along the sides of the test tube. The development of a reddish-brown hue at the boundary of the two layers suggested the existence of triterpenoids.

H. **Keller-Kiliani test for glycosides**: For the Keller-Kiliani test, 1 ml of extract was mixed with 1 ml of glacial acetic acid and a few drops of 2% ferric chloride (FeCl3). Concentrated sulfuric acid (H2SO4) was then added to the mixture. The appearance of a brown ring at the interface indicated the presence of glycosides.

I. **CuSO4 Test for Fats and Fatty Oils**: In the CuSO4 test, 5 drops of solution (made by dissolving 0.25 g of sample in 25 ml of solvent) were combined with 1 ml of 1% copper sulfate solution (CuSO4). Then, a few drops of 10% sodium hydroxide (NaOH) were added. The presence of fats and fatty oils was confirmed by the formation of a clear blue solution.

PHYTOCHEMICAL SCREENING

TESTS FOR PHYTOCHEMICAL SCREENING	PROCEDURE	RESULTS FOR PRESENCE
Test for carbohydrates (Molisch's test)	• Dissolve 500 mg of extract in 5 mL distilled water; filter. • Add Molisch's reagent (α-naphthol in ethanol) to the filtrate. • Carefully add 1 mL concentrated sulfuric acid (H_2SO_4) along the test tube wall. • After 2 minutes, add 5 mL distilled water.	Dull violet or red color at the interface between the two layers.

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Fehling's Test for Reducing Sugars	• 2 mg extract in 1 mL distilled water; filter. • Add 1 mL Fehling's A and B (1:1) to filtrate. • Use water bath and heat for few minutes.	Brick red precipitate
Mayer's Test for Alkaloids	• Add 1-2 drops of Mayer's reagent to 2 mL filtrate (50 mg extract in 5 mL 1% HCl). • Add reagent along the test tube wall.	Creamy precipitate
Frothing Test for Saponins	• Dissolve 100 mg extract in 10 mL methanol (stock solution). • Dilute stock to 0.5 mg/mL with 20 mL distilled water. • Shake vigorously for 15 minutes.	Formation of foam on the surface
FeCl3 Test for Tannins	• Dissolve 50 mg extract in 5 mL distilled water. • Add a few drops of 5% $FeCl_3$.	Appearance of a Bluish-black color.
Alkali Test for Flavonoids	• Add a few drops of 5% NaOH to 1 mL of filtered stock solution (100 mg extract in 10 mL methanol). • Look for deep yellow color. • Add dilute HCl	Deep yellow color changes or disappears
Salkowski's Test for Triterpenoids	• Mix 2 mg extract with 1 mL $CHCl_3$; shake. • Add a few drops of concentrated H_2SO_4 along the test tube wall.	Formation of a red-brown color at the interface between the two layers.
Keller-Kiliani Test for Glycosides	• Mix 1 mL extract with 1 mL glacial acetic acid and a few drops of 2% $FeCl_3$. • Add concentrated H_2SO_4.	Appearance of a brown ring at the interface
$CuSO_4$ Test for Fats and Fixed Oils	• Start with a solution where 0.25 g of extract is dissolved in 25 mL of a suitable solvent. • Combine 5 drops of this extract solution with 1 mL of a copper sulfate solution that has a 1% concentration. • Add a few drops of a sodium hydroxide solution with a 10% concentration.	Formation of clear blue solution

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PHYTOCONSTITUENTS PRESENT IN DIFFERENT EXTRACTS

COMPOUNDS	HEXANE	BENZENE	PETROLEUM ETHER	CHLOROFORM	ETHANOL	AQUEOUS
ALKALOIDS	-	-	-	+	-	+
PHENOL	-	+	+	+	+	+
FLAVONOIDS	-	-	+	+	+	+
SAPONINS	-	+	+	+	+	-
STEROIDS	+	+	+	+	+	+
TANNINS	-	+	+	-	+	-
CARBOHYDRATES	+	+	-	+	+	+

(+) – Indicates presence of **Phytoconstituents**
(-) – Indicates absence of **Phytoconstituents**

PHARMACOLOGICAL ACTIVITIES

1.Wound healing property:

It is well-known for having potent wound-healing abilities. In this work, a global metabolite profile of both aqueous and ethanolic extracts from H. alternata leaves is carried out utilizing mass spectrometry. Out of 24,203 spectra, including both positive and negative ionization modes, the study found 2,285 metabolites. These metabolites fall into several groups, including primary aliphatic amines, ketones, carboxylic acids, and their derivatives. 124 human proteins were found to be viable targets for these compounds by network pharmacology analysis. Interestingly, a few of these proteins—including fibroblast growth factor receptor 1 (FGFR1), prothrombin (F2), and alpha-2A adrenergic receptor (ADRA2A)—are connected to the mechanisms involved in wound healing. A gene ontology study emphasized these target proteins' functions in glucose metabolism, platelet activation, membrane organization, and damage response. An additional illustration of the possible molecular networks involved in wound healing was provided by pathway enrichment analysis. Furthermore, robust binding interactions between H. alternata metabolites and the indicated protein targets (F2 and PTPN11) were shown by in-silico docking investigations. Targeted investigation employing multiple reaction monitoring demonstrated the role of important metabolites in wound healing.

The following formula was used to calculate the percentage inhibition of granuloma formation:

Inhibition (%) = [1-{weight of granuloma (extract or standard drug)/weight of granuloma (normal control)}] x 100.

2. Antidiarrheal property:

Antidiarrheal test with castor oil:

A modified version of the Shoba and Thomas method which is frequently used to evaluate antidiarrheal effects—was employed to conduct the castor oil-induced antidiarrheal test. Initially, the animals were given 0.5 ml of castor oil orally to identify those that became ill so they could be examined further. Then, thirty diarrhea-displaying mice were divided into three groups at random: a positive control group that received loperamide HCl at a dose of 3 mg/kg body weight; a control group that received 10 ml/kg body weight of distilled water; and two test groups that received doses of 200 mg/kg and 400 mg/kg body weight,

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respectively, of methanol extract and ethanol extract. Every group had five mice in it. The mice were given access to water during their roughly 16-hour fast. Animals in the control, positive control, and test groups were given oral loperamide hydrochloride (3 mg/kg), methanolic and ethanolic extracts (200 and 400 mg/kg body weight, respectively), or distilled water (10 ml/kg) after the fasting period. Each mouse received 0.5 ml of castor oil orally to cause diarrhea thirty minutes later. After that, each mouse was given a separate cage with blotting paper; this was done once per hour. For a 4-hour observation period, the quantity of diarrheal feces was counted. The percentage inhibition of defecation for animals in each group was calculated using the following formula: Inhibition (%) = [1-] x 100 {number of feces (standard drug/extract drug)} x 100.

II. CONCLUSION

Many plants' medicinal qualities have been well-documented by the ancient Indian medical system, Ayurveda. Over the past 10 years, there has been a surge in interest in plants as possible sources of treatment for human ailments due to the substantial research conducted by researchers worldwide on the effects of plant extracts. These results suggest that H. alternata has potential medical benefits and may play a key role in the discovery of bioactive natural compounds, which could act as lead molecules for the development of novel drugs to treat unmet therapeutic needs. To forecast lead molecules and drug-like qualities, it is critical to screen natural organic compounds and discover active compounds early in the drug development process. This study's results indicate that H. alternata may be important in the development of new drugs, as it contains a significant proportion of bioactive compounds, suggesting it could be a potential source of new medicines.

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