A comprehensive review of phytochemistry and pharmacological potentiality of *Hemigraphis colorata*

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Abstract

Herbal remedies have become an integral part of our medical system to treat illness. Because of the medicinal plants' low risk of side effects, high efficacy and safety, researchers around the world are utilizing these plants. However, there are still many medicinal plants with powerful remedies which are yet to be explored. This tempted the researchers to validate scientifically various folklore uses so that they can be beneficial to mankind. One of these plants, *Hemigraphis colorata (H. colorata)* plays a significant role in the medical care system and has had a notable impact on the remedy of traditional diseases. Bloody diarrhea, haemorrhoids, wound healing, bacterial infections, and fungal infections have all been treated with this herb. In addition to these, numerous pharmacological investigations indicate that the plant also possesses strong antibacterial, anti-inflammatory, anticancer, anti-diabetic, anti-diarrheal, and other biological effects. Such widespread biological activities may be attributed to the diverse phytochemicals present including alkaloids, glycosides, steroids, tannins and flavonoids. The goal of the current review is to compile all information related to the plant under consideration which can be helpful to the researchers for further validation of folklore use.

Keywords: Acanthaceae, *Hemigraphis colorata*, pharmacological roles, phytochemistry, traditional applications.

1. Introduction

Before the invention of manufactured medications, human relied on the curing properties of medicinal plants. A few people hold this opinion of these plants because they still hold the antiquated belief that plants

were created to provide man with food, medical treatment, and other benefits. Plants are a key source for medication discovery and development, according to studies conducted by numerous experts. The presence of chemical compounds with varying compositions that exist as secondary metabolites gives medicinal plants their therapeutic abilities. Alkaloids, glycosides, coumarin, flavonoids, cortcosteroids and essential oils are the categories they belong. Natural ingredients make up more than half of all contemporary clinical pharmaceuticals and are crucial to the creation of new medications. Numerous pharmacological actions have been demonstrated by several of the phytoconstituents bioactive substances from medicinal plants[1].

It is estimated that 5.2 billion people reside in less developed nations, and the World Health Organization estimates that about 80% of these individuals rely solely on routine medication to meet their basic human needs. Traditional drugs' "spine" is composed of beneficial plants, which shows that more than 3.3 billion individuals in developing nations regularly use beneficial plants[2].

An unusual plant native to India called *H. colorata* is an adaptable tropical perennial spice that grows up to 6 inches. When grown on the ground, it grovels and spreads with the established stems, and when supported by hanging bushels, it falls flawlessly. Hemigraphis actually refers to "half composition" due to the fact that the exterior stamen's fibre bear brooms[3].

2. Botanical description

A multipurpose tropical low-creeping perennial herb, *H. colorata* (Blume), extend up to a height of 15 to 30 cm. When cultivated on the ground, it prostrates and extends with stems that are rooted, and when it is grown in hanging baskets, it cascades over attractively. Because of its lovely and vibrant leaves. When cultivated on the ground, it prostrates and spreads with stems that take root, and when grown in hanging vase, it gracefully surges over. It is also utilized as decoration. The plant has a good tolerance for the tropical climate. The plant is also referred to as the "Aluminum Plant," "Metal Leaf," "Cemetery Plant," "Java Ivy," "Red Flame Ivy," and "Waffle Plant," ~among other names. It is referred to as "murian pacha" or "murkootti" in Kerala[3,4].

3. Taxonomical description

Kingdom: Plantae

Phylum: Spermatophyta

Subphylum: Angiospermae
Class: Dicotyledonae
Order: Scrophulariales
Family: Acanthaceae
Genus: *Hemigraphis*
Species: colorata

4. Common names:

English - Metal leaf, Aluminium plant, red flame ivy, Cementry plant, Tincture plant
Malayalam - Murikooti
Kannada - Tincture ghida
Sanskrit - Vranaropani[5]

5. Morphology

5.1 Leaves - The leaves have well-defined veins, are opposite, oblong to cordate, serrate-crenate, having 2 to 8 cm length with 4 to 6 cm width.

5.2 Flowers - Small (1 to 1.5 cm in diameter), 5 lobed, bell-shaped flowers with imbricate petals are present. These come in terminal spikes that are 2 to 10 cm long and are white in colour with very slight purple markings inside. In the tropics, it blooms erratically all through the year.

5.3 Capsules - The pale green, round, compact, slender capsules have a linear shape.

5.4 Seeds - Seeds are tiny, flat and having white color.[6,7]

Figure 1: Leaves and flowers of *Hemigraphis colorata*

6. Phytochemistry

Plant phytoconstituents can be used for a variety of medicinal objectives. By examining the unrefined of the plant were identified. Phenols, flavonoids, tannins, sugars, tannins, terpenoids, carboxylic corrosive, coumarins, alkaloids, xanthoproteins, steroids, proteins, and sterol are among the phytoconstituents[8]. Low sodium and high potassium levels, flavonoids, polyphenols, and tannins were found in the leaves; saponins and tannins were found in the stem; and flavonoids and polyphenols were found in the roots. These phytochemicals have therapeutic qualities. Benzene extract of *H. colorata* leaf was demonstrated efficacy against *Streptococcus aureus* and *Acinetobacter species*. According to several researches, beta carotene may be the major chemical found in *H. colorata*[9].

Table. 1. List of phytoconstituents present in the *H. colorata*

H. colorata's leaves were purple on the anterior (lower) side and green on the dorsal side. The majority of the time, particularly in

the tropics, permanently red to violet coloring of the anterior leaf surfaces was found in highly shadowed understory plants. Uncertainty persists regarding the functional importance of anterior anthocyanin coloration, especially its involvement in photosynthetic adaption[10].

7. Traditional applications

The ancient population of India was dependent heavily on homoeopathic medical practices that use plants and their extracts as their primary therapeutic agents. *H. colorata* was previously used to adorn fish tanks and aquariums. However, the plant had incredible healing abilities that can soothe vitiated pitta, fresh wounds, cuts, ulcers, inflammations, and skin issues. Most commonly, leaves were used to treat wounds and gallstones. It also functions as a diuretic. In Indonesia, leaves were used to cure haemorrhoids and bloody diarrhoea[11]. The green concoction used for skin issues. Leaf paste was used for anaemia, as well as to halt bleeding and speed up healing in newly cut wounds[12]. Fresh leaf juice was administered as a coagulant to stop blood loss and occasionally as an oral contraceptive to stop pregnancies.

8. Pharmacological activities

Anti-oxidant activity

The dried leaves were extracted using acetone, n-hexane, ethanol, and chloroform and the results demonstrated strong antioxidant activity. The antioxidant activity of the leaf ethanolic extracts was concentration-dependent. By scavenging DPPH free radicals and having the potential to reduce ferric, the crude extracts demonstrated outstanding antioxidant activity. Additionally, it demonstrated the existence of considerable polyphenolic content, including flavonoids, flavonols, and phenolic compounds. The phenolic acids found in the plant, including chlorogenate, cinnamate, coumarate, gallate, and ferulate, operated as pro-oxidants and had free radical scavenging properties[13].

Anti-inflammatory activity

The existence of flavonoids in the leaf of *H. colarata* was reported in a study. Researchers investigated the plant's anti-inflammatory effects on carrageenan-induced oedema model and came to the conclusion that the flavonoids in the test drug were what cause the drug's notable anti-inflammatory activity. In another research, In-vitro anti-inflammatory activity utilising the Human RBC Membrane Stabilizing technique was

found to be significantly higher in ethanolic leaf extracts of *H. colorata* than in standard drug diclofenac.

The ethyl acetate and methanolic extracts of *H. colorata* leaves demonstrated considerable anti-inflammatory activity in the Xylene-induced ear oedema test and the cotton pellet-induced granuloma development[14].

The key enzyme in the inflammatory pathway was COX, and substances that blocked the enzyme can be used to make anti-inflammatory medications. LOX, in addition to COX, are essential components of the inflammatory pathway. Anti-inflammatory drugs can be produced using substances that block COX and LOX simultaneously[15.]

Wound healing activity

In 2011 and 2012, the unprocessed leaf paste aids in the healing of excision wounds. Although oral treatment was unsuccessful, the leaf paste speed up wound contraction and epithelialization in mice. According to research using incision and excision wound models, methanolic extract was equivalent to the accepted reference drug Vokadine. According to research in 2013, the herbal scaffold built from chitosan might be used to treat infectious wounds.By employing the well diffusion method and a concentration range of 25–100µg, methanolic extraction of *H. colorata* exhibited wound healing properties against bacteria that cause wounds, such as *Klebsiella pneumoniae* and *Escherichia coli*. Reetha K. reported that the activity might be caused by the existence of antioxidants. The paste made from the plant's fresh leaves demonstrated possible wound healing activity by accelerating healing process and epithelialization[16].

Antibacterial activity

The benzene extraction of the *H colorata* leaves showed possible antibacterial action against *Streptococcus aureus*, and they also came to the conclusion that this was because the benzene plant extract included phenolic compounds[17].

Also several crude extracts of *H. colarata* leaves were powerful antibacterial agents. They proved this by using the agar diffusion method to kill *E. coli* gram negative and *B. subtilis* gram positive bacteria[18].

Anthelmintic activity

The various extractions of *H. colorata* demonstrated anthelmintic efficacy over earthworms under concentrations of 20

mg/ml, 40 mg/ml, and 80 mg/ml. In contrast to the greater concentrations of ethanolic and aqueous extracts, which exhibited their effects at 28 and 43 minutes, respectively, the standard. albendazole (80mg/ml) revealed the impact at ten minutes and the fresh juice extract's 80mg/ml concentration at 21 mins[19].

Anti-diabetic activity

In a study it was found that 100 mg/kg body weight of rat concentration of the *H. colorata* n-hexane and ethyl ethanoate extract revealed potential anti-diabetic action against alloxan induced rat model. They also came to the conclusion that the impact might be caused by the fact that the extract included steroids and coumarins[20].

Anti-nociceptive activity

In a study, mice were used in a formalin-induced paw licking model while being exposed to dried leaves of H. colorata. The dried leaf extracts in methanol and ethyl ethanoate, according to the study, displayed potent antinociceptive properties. By blocking inflammatory mediators, the extract was effective in both the acute and late periods. Results from an acetic acid-induced writhing test revealed that the medicine considerably decreased the occurrence of writhing; it was also observed that this may be because prostaglandin pathways were blocked or endogenous mediators were suppressed[21].

Anti-diarrheal activity

H. colorata's methanol & ethyl acetate extract have anti-diarrheal properties when tested on mice who had castor oil-induced anti-diarrhea. In a dose related manner, the therapy lengthened the induction period and reduced the rate of defecation [21].

Anticancer activity

The anti-cancer efficacy of *H. colarata* extracts on Normal cell HEK-293 and skin cancer cell line-A431 exhibited cytotoxic effect. It was determined that nuclear damage and apoptosis were the main causes of cell toxicity. *H. colorata*, a widely accessible medicinal plant, was used to successfully create gold nanoparticles using a straight forward green synthesis method. At ambient temperature, purple coloured HAaNP was acquired within 5 s. Due to the effects of both plants and gold nanoparticles on cancer cell lines, green manufacturing of gold nanoparticles had the potential to be used in the treatment of cancer. The effectiveness of the plant's cancer-curing powers was increased by the presence of secondary

metabolites in the form of alkaloids, flavonoids, sterols, etc[22].

Anti-elasticity activity

The crucial connective tissue protein elastin can be broken down by a class of serine proteases known as elastase. Elastin is essential for maintaining the body's flexibility in various areas, including the elasticity of the skin and the lungs. Elastase blockers have been used to treat illnesses associated with human neutrophil elastase.

Aqueous and alcoholic extracts of H. colorata effectively inhibited porcine pancreatic elastase, with corresponding IC 50 values of 0.109 and 1.485 mg/ml. The inhibitory action was also increased dramatically with increasing doses of aqueous and alcoholic extracts. Aqueous extract had a greater impact. This suggests that the plant's polar components were what give elastase its inhibitory effect.

Elastase inhibitors were also beneficial for anti wrinkling and anti ageing activities[23].

Antifungal activity

By counting the area of the inhibition zone, the antifungal effect was estimated. The leaves of the plant *H. colorata* were extracted using aqueous and hydroalcoholic techniques. For antifungal activity, both extracts were utilised at doses of 20, 40, 60, and 80mcg/ml. Fluconazole 5 mcg/ml was the standard medication used. The extracts were examined for their ability to suppress the growth of *Candida albicans, Candida tropicalis, Rhizophus*, *Trichoderma*, and *Aspergillus niger*. While the aqueous extract had antifungal action against *C. albicans*, there was no specific activity against *A. niger, Rhizophus*, or *Trichoderma* with either extract. The hydroalcoholic combination extract showed the highest zone of inhibition against *C. tropicalis*. The secondary metabolites found in the leaves of *H. colorata*, including caffeic acid, quercetin, catechin, and gallic acid, were responsible for the antimycotic activity[24].

Antidiuretic activity

The Lipcshitz test procedures were used to evaluate the diuretic properties of the hydroalcoholic extract of *H. colorata*. A 24-hour period was used to collect and measure urine excretion. Titration and flame photometry (Na + and K +) were used to measure the excretion of electrolytes. A digital pH metre was used to measure the total pH of the urine. Based on the known

electrolytic content, the effects of natriuretic, saluretic, and carbonic anhydr ase reduction were determined. Calculations were made about urine volume, diuretic index, and Lipschitz value. According to the findings, the herbal extract exhibited diuretic effect at all doses within 24 hours, and the strength of this activity appeared to be dose dependent[25].

Table 2. Several phytoconstituents of *H. colorata* and their pharmacological activities

9. Additional uses

As reducing agent

The flower extraction of H. colorata was used to successfully create Ag NPs by acting as a green reducing agent. The generation of Ag NPs was verified by the characterisation techniques. Ag NPs that were crystallised have a modest level of toxicity for pathogenic bacteria and fungus. The extract from H. colorata was a well-known producer of flavonoid and phenolic chemicals. The water-soluble substances found in the *H. colorata* floral extract are thought to function as both reducing and stabilising agents. The method and extract utilised to create spherical nanoparticles were recognised as an appropriate way to control the size and shape of the particles[26].

Phytoremediation

When individuals were exposed to volatile organic compounds (VOCs) in indoor settings, such as benzene, hexane, heptane, xylene, octane, decane, methylene chloride, and trichloroethylene they have been documented to induce a variety of ailments. According to studies, H. colorata's photoremediation, also known as VOC removal, had the maximum removal rates[27].

As a natural dye

The purpose of the study was to investigate the potential applications of the dye obtained from *H. colorata* as a light absorber. The dye was suitable for photovoltaic applications because it has a potent absorption in the visible range (530 nm), according to the UV-Visible spectral analysis. The micro-Raman spectroscopy investigation revealed that the extracted pigment contains anthocyanin and beta carotene[28].

As a mild steel corrosion inhibitor

In the current study, a brand-new green diluted extract of *H. colorata* leaves demonstrated a significant corrosion

inhibitory activity in 1 M HCl. The concentration-dependent

protection inhibition effectiveness of the HC leaves extract was discovered through electrochemical experiments. Higher concentrations and higher temperatures increased the HC leaf extract's ability to inhibit more effectively. As it avoids the negative effects of non-aqueous solvents, aqueous extract *hemigraphis colorata* leaf was regarded from an environmental perspective as a unique, non-toxic, renewable, economical, enviroment friendly mild steel green corrosion inhibitor in 1 M HCl. The biodegradability and eco-friendliness of HC leaves extract have drawn a lot of interest in terms of its ability to prevent corrosion. Evidence for the formation of a protective layer of HC leaf extract on a mild steel surface, shielding the mild surface of steel from direct contact with the acidic environment, was revealed by SEM and EDX examination[29].

10. Conclusion

H. colorata is an ethnical plant that contains a high concentration of bioactive compounds, making it possible to use these species as a source of potential pharmaceuticals. Anti-inflammatory, anti-diarrheal, anti-nociceptive, antibacterial, antidiabetic, wound-healing, and antioxidant characteristics are only a few of its many attributes. This species is a promising injury-healing promoter, but further phytochemical and pharmacological research is needed to open up new therapeutic avenues for this plant. Since this plant is easily accessible and developed, there can never be a shortage of unprocessed samples for the phytochemical analysis.

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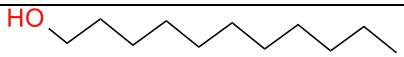
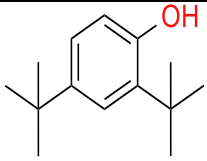
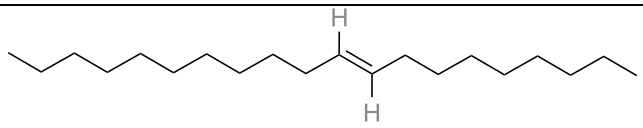
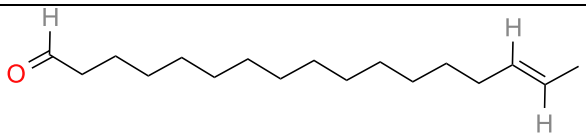
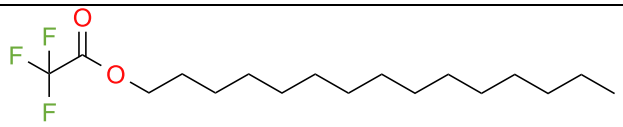
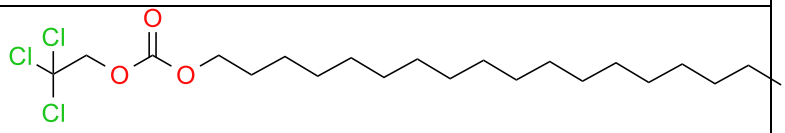
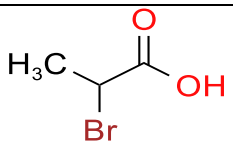
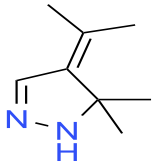
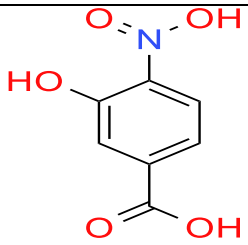
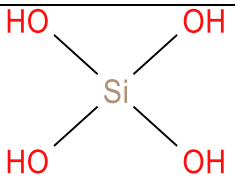
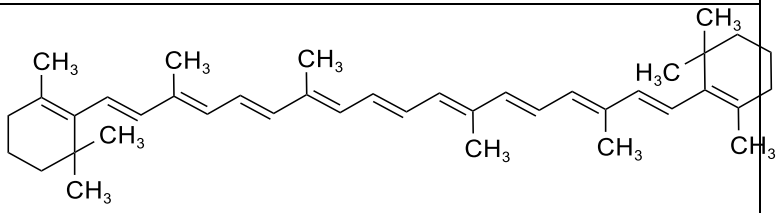
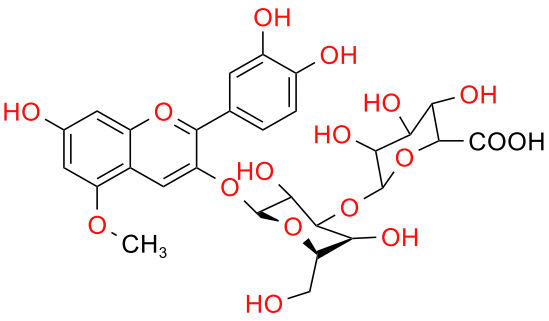
Tables and Figures

Table. 1. List of phytoconstituents present in the *H. colorata*

S.NO.	Name	Structure
1.	1-undecanol	
2.	Phenol-2,4-bis-1,1-dimethylethyl	
3.	9-Eicosene, (E)-	
4.	E-15-Heptadecenal	

5.	Trifluoroacetoxy hexadecane	
6.	Carbonic acid, octadecyl 2,2,2-trichloroethyl ester	
7.	2-Bromopropionic acid	
8.	1H-Pyrazole, 4,5-dihydro-5,5-dimethyl-4-isopropylidene(Isophorone)	
9.	3-Hydroxy-4-nitrobenzoic acid	
10.	Silicic acid	
11.	β-Carotene	
12.	5-O-methylcyanidin 3-O-(300-(b-glucuronopyranosyl)-b-glucopyranoside)	

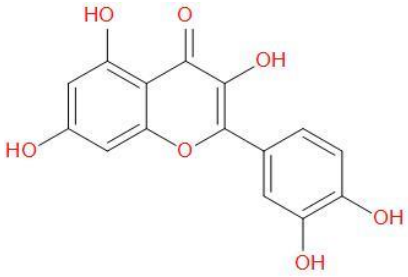
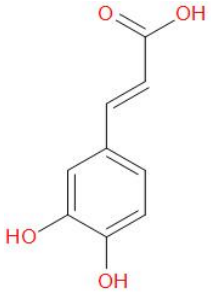
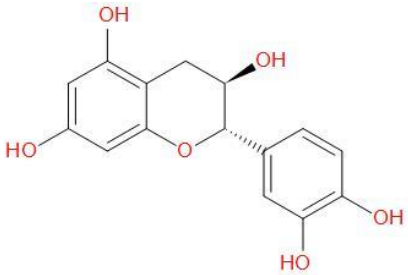
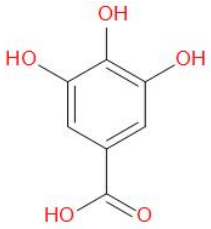
13.	Quercetin	
14.	Caffeic acid	
15.	Catechin	
16.	Gallic acid	

Table 2. Several phytoconstituents of *H. colorata* and their pharmacological activities

Phytoconstituents for biological activities	**Pharmacological activities**

Flavonoids	Antiinflammatory
Phenolic compounds	Antibacterial
Phenolic acids- chlorogenate, cinnamate, coumarate, gallate, and ferulate	Antioxidant
Steroids and coumarins	Antidiabetic
Quercetin, caffeic acid, catechin, and gallic acid	Antimycotic
Flavonoids, gallic acid, polyphenols and chlorogenic acid	Antidiuretic
Saponins, tannins, polyphenols	Antidiarrheal
Flavonoids, alkaloids, sterols	Anticancer

Figure 1: Leaves and flowers of *Hemigraphis colorata*