

# Diverse Phytochemical Moieties and Pharmacological Properties of *Caesulia axillaris* Roxb: An Updated Review

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## ABSTRACT

The genus *Caesulia* belongs to the family Asteraceae and is a relatively small genus but notable for its unique adaptations to wetland habitats and its distinctive morphological features. The present review was based on the diverse phytochemical moieties and pharmacological properties of *Caesulia axillaris* Roxb. The leaves and stems are often used to reduce fever [6]. The plant's antiseptic properties help prevent infections and support the healing process. Topical applications of the leaf extracts can help soothe irritated skin [9]. Whole plant extract of *Caesulia axillaris* are frequently used by the coastal tribes of Odisha to cure malaria [10]. Leaf oil of *C. axillaris* showed diverse phytochemical moieties i.e.,  $\alpha$ -pinene, Camphene, Limonene, p-cymene, Terpinen-4-ol, p-cymen-7-ol, Terpinen-4-yl acetate,  $\alpha$ -terpineol, p-menth-8-en-1 $\beta$ , 2 $\alpha$ -diol, Eugenol,  $\gamma$ -asarone, Myristicin, 2,4,5-trimethoxy benzaldehyde, 4-Isopropylbenzyl alcohol, Terpinolene, 4-Carvomenthenol, 3-Cyclohexen-1-ol, 4-methyl-1-(1-methylethyl), acetate, d-Borneol and Linalyl acetate etc. It concluded that *Caesulia axillaris* exhibited the antioxidant, anti-inflammatory, antimicrobial, analgesic, antipyretic, anti-fungal and gastroprotective activities which is due to presence of wide variety of phytochemical moieties. As research progresses, the elucidation of its bioactive constituents and pharmacological mechanisms opens avenues for the development of novel therapeutic agents.

**Keywords:** *Caesulia axillaris*, biochemical moieties, biological properties, myristicin, antioxidant.

## 1. INTRODUCTION

*Caesulia* is a relatively tiny genus in the Asteraceae family, but it is well-known for its unusual morphological characteristics and adaptations to wetland settings. The herbaceous growth forms and tendency to flourish in watery or semi-aquatic conditions are characteristics of members of this genus [1]. *Caesulia* species are typically found in marshes, riverbanks, and other wet places. They can withstand submersion and are suited to varying water levels. *Caesulia axillaris* is one of the most well-known species in this genus. Known for its unique shape and ecological relevance, this species is native to tropical regions of Asia, especially in nations like India, Bangladesh, and Nepal [2].

It has adapted to its marsh habitat quite well. Its axillary flowers guaranty efficient pollination even in dense foliage, and its structural features, such as the upright and branched, enable it to flourish in regions vulnerable to flooding [3]. The plant's fruit, which is made for wind distribution, guaranties that it will spread over a large region and continue to exist in appropriate settings. In addition to supporting the

general health of the wetland environment by stabilizing soil and aiding in water purification processes, the presence of *C. axillaris* in wetland ecosystems offers food and habitat for a variety of insects, including pollinators like bees and butterflies [4]. Its role in traditional medicine and its potential pharmacological properties further underscore its importance, warranting continued study and conservation efforts.

### **Botanical Description**

*C. axillaris*, an annual herb, thrives in wetland habitats like marshes, riverbanks, and other waterlogged areas. It is well-adapted to these environments and contributes significantly to the local ecosystem [3][5].

**Stems:** The stems are erect and branched. Branching typically occurs from the base or lower parts of the stem, giving the plant a somewhat bushy appearance. Plants reach heights of up to 60 cm, although they may vary depending on the specific growing conditions and environmental factors. They are smooth and often exhibit a green coloration, sometimes with a slight reddish hue towards the base.

**Leaves:** The leaves are alternately arranged along the stem. They are lanceolate to elliptic, providing a streamlined and efficient shape for photosynthesis. Leaf margins are entire but can occasionally be slightly toothed, adding to their variability.



**Fig 1. *Caesulia axillaris* herb**

**Flowers:** The flowers are typically purple to blue, which can vary slightly in shade. Each flower is tubular and small, characteristic of many members of the Asteraceae family. The tubular structure is composed of numerous tiny florets. Flowers are grouped in axillary clusters, meaning they emerge from the axils.

**Fruits:** The fruit is a small, one-seeded achene. An achene is a type of simple dry fruit that does not open at maturity to release the seed.

## Taxonomy

|         |   |               |
|---------|---|---------------|
| Kingdom | : | Plantae       |
| Order   | : | Asterales     |
| Class   | : | Magnoliopsida |
| Family  | : | Asteraceae    |
| Genus   | : | Caesulia      |
| Species | : | axillaris     |

## Traditional uses

*C. axillaris* is used in traditional medicine across its native range in tropical Asia. Traditional healers have utilized various parts of the plant to treat a variety of ailments, often relying on indigenous knowledge passed down through generations.

- The leaves and stems are often used to reduce fever [6]. Traditional practitioners prepare decoctions or infusions from these parts to help bring down high body temperatures.
- Poultices made from the leaves are applied to inflamed areas, helping to reduce swelling and pain.
- Extract of *C. axillaris* are used to alleviate digestive problems such as stomach aches, dysentery and diarrhoea [7].
- The plant's compounds are believed to have soothing effects on the gastrointestinal tract.
- In some traditions, the plant is used to stimulate appetite and improve digestion, promoting overall gastrointestinal health.
- The plant is also used in the treatment of respiratory conditions like coughs and colds.
- Infusions made from the leaves are taken orally to help relieve symptoms and support respiratory health.
- Some traditional uses include employing the plant's extract as an expectorant to help clear mucus from the respiratory tract.
- The leaves are applied to wounds and cuts to promote healing [8].
- The plant's antiseptic properties help prevent infections and support the healing process.
- Traditional medicine also uses the plant to treat skin conditions such as dermatitis.
- Topical applications of the leaf extracts can help soothe irritated skin [9].
- Whole plant extract of *Caesulia axillaris* are frequently used by the coastal tribes of Odisha to cure malaria [10].

**Table 1. Traditional uses of plants of Asteraceae family**

| Plant species                   | Traditional uses in Odisha  | Other regions of India & Abroad |
|---------------------------------|-----------------------------|---------------------------------|
| <i>Caesulia axillaris</i> Roxb. | Whole plant extract is used | The decoction of whole          |

|                              |                                                                                                                                                                                                         |                                                                                                                                                                                                           |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                              | in cure of malaria [11].                                                                                                                                                                                | plant is given orally three times a day, along with curd to cure amoebic dysentery by the tribes of Madhya Pradesh, India [12].                                                                           |
| <i>Ageratum conyzoides</i>   | Herb infusion is given for gastrointestinal ailments such as diarrhoea, dysentery and intestinal colic with flatulence [13][14]. Cold decoctions from the aerial parts are used to cure malarial fever. | Used as anthelmintic in Cameroon [15]                                                                                                                                                                     |
| <i>Bidens pilosa</i>         | Fresh juice from the aerial parts is used for intestinal worm infections, abdominal pain and stomach ache.                                                                                              | Juice forms the root and whole plant is used for the treatment of malaria (Africa, China) [16]. Whole plant is used by the Bukusu community of Kenya for tick prevention and control on liver stock [17]. |
| <i>Blumea lacera</i>         | fresh leaf juice of this plant for the treatment of all kinds of fever, including malaria                                                                                                               | Leaf juice is used to kill worms in children by the tribes of Madhya Pradesh, India [18].                                                                                                                 |
| <i>Calendula officinalis</i> | Cold decoction of leaf is used for amoebic and bloody dysentery                                                                                                                                         | Flowers are used for the treatment of intestinal worms and amoebal infections in pets and pigs in British Columbia, Canada [19].                                                                          |
| <i>Centipeda minima</i>      | Root decoction is used for the treatment of all kinds of fever [20]. Leaf decoction is commonly used for hookworm and roundworm                                                                         | In China, decoction from whole plant is used for malaria treatment. The seed or dried aerial parts are used as a vermifuge and amoebicide                                                                 |
| <i>Eclipta alba</i>          | Treatment of malaria [20].                                                                                                                                                                              | Leaf decoction is used by the Rakhain tribal healers of Chittagong Division, Bangladesh for the treatment of malaria [21].                                                                                |
| <i>Eclipta prostrata</i>     | Treatment of malaria:                                                                                                                                                                                   | Infusion or juice of the plant                                                                                                                                                                            |

|                               |                                                                                                                                                                                                                              |                                                                                                                                                                 |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                               | decoction of dried leaf with tea leaf tincture is administered orally twice a day for five days [22].                                                                                                                        | mixed with honey is given for the treatment of malaria by the tribal communities of Pakistan [23].                                                              |
| <i>Elephantopus scaber</i>    | Treatment of malaria: paste prepared from fresh root is taken orally once a day for three days. Juice of leaf is used in the treatment of malaria [24].                                                                      | Decoction from aerial parts is used to treat malaria by the tribes of Madagascar [23].                                                                          |
| <i>Sphaeranthus indicus</i>   | Helminths: whole plant paste with a pinch of salt is taken as an anthelmintic [10].                                                                                                                                          | Root and seed powder is given orally to kill intestinal worms in children [25]. Whole plant paste with a pinch of common salt is taken as an anthelmintic [26]. |
| <i>Tagetes erecta</i>         | Cold decoctions of leaf and flower are used for all kinds of worm infections and dysentery                                                                                                                                   | Plants used by native Amazonian groups from the Nanay River (Peru) for the treatment of malaria [26].                                                           |
| <i>Tridax procumbens</i>      | Decoction of <i>Tridax procumbens</i> leaves used in malaria.                                                                                                                                                                | Used for the treatment of malaria by the tribes of Ghana [27], and Kwale community of the Kenyan Coast [28].                                                    |
| <i>Vernonia anthelmintica</i> | Fruit powder is used in malaria fever, and for stomach ache during amoebic dysentery [29]. Seeds are used as an anthelmintic, especially in children (2-5 g with water on an empty stomach twice a day for three days) [30]. | The seeds are used as an anthelmintic against parasitic worm (including tapeworm) infestations [31].                                                            |
| <i>Vernonia albicans</i>      | Filariasis: powdered plant (10-20 g) is advised to be consumed with 125 mL milk (mixed with 5-7 cardamom fruits and 10 g sugar candy) once daily in the morning, on an empty stomach, for about three months [32].           |                                                                                                                                                                 |

|                        |                                                                                                                                                         |                                                                                                                                                                   |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                        | Water-extract of the whole plant is used in the treatment of malaria [33].                                                                              |                                                                                                                                                                   |
| Vernonia cinerea       | Treatment of malaria; root paste is mixed with honey and administered orally twice a day for three days [22]. The plant is also used for elephantiasis. | Leaf and bark are used by the tribes of Equatorial Guinea as febrifuge and vermifuge [34], while the tribes of Tanzania use it for the treatment of malaria [35]. |
| Xanthium strumarium L. | Coastal tribes of Odisha use crushed fresh fruit for the treatment of filariasis                                                                        | Tribes of Bannu district, Pakistan, use it for the treatment of chronic malaria [36].                                                                             |

## Phytochemical compounds

*C. axillaris* is rich in various bioactive compounds that contribute to its pharmacological properties. These compounds include phenolic compounds, flavonoids, alkaloids, terpenoids, saponins, and essential oils, each playing a role in the plant's antioxidant, anti-inflammatory, antimicrobial, analgesic, and gastroprotective effects. The ongoing study of these bioactive compounds continues to reveal the potential therapeutic benefits of *C. axillaris* [37][38].

**$\gamma$ -Asarone:** A phenyl derivative constituting approximately 63.09% of the essential oil extracted from the leaves.

**Limonene:** A monoterpenoid making up about 30.85% of the leaf essential oil.

**Flavonoids & Phenols:** Present in various parts of the plant, including leaves, stems, and seeds, across different solvent extractions.

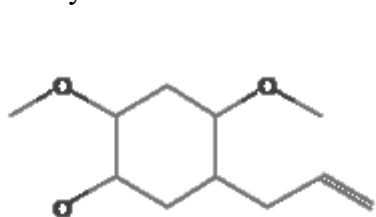
**Steroids:** Detected in leaves, stems and seeds, with presence varying depending on the solvent used for extraction.

**Tannins:** Identified in certain plant parts, with their presence varying based on the solvent system employed during extraction. Some secondary metabolite also presents such as Alkaloid, Fats & Oil, Vitamins, Amino acid, Glycoside.

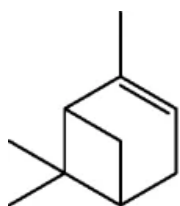
Leaf oil has reported the following chemical constituents:

- $\alpha$ -pinene
- Camphene
- Limonene
- p-cymene
- Terpinen-4-ol
- p-cyrnen-7-ol
- Terpinen-4-yl acetate
- $\alpha$ -terpineol
- p-menth-8-en-1 $\beta$ ,2 $\alpha$ -diol
- Eugenol
- $\gamma$ -asarone
- Myristicin

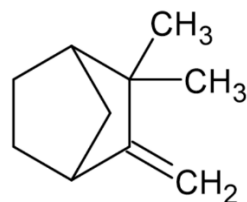
- 2,4,5-trimethoxy benzaldehyde
- 4-Isopropylbenzyl alcohol
- Terpinolene
- 4-Carvomenthenol
- 3-Cyclohexen-1-ol, 4-methyl-1-(1-methylethyl)-, acetate
- d-Borneol
- Linalyl acetate



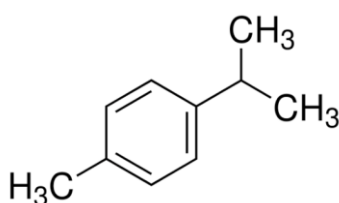
$\gamma$ -Asarone



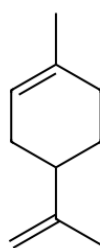
$\alpha$ -pinene



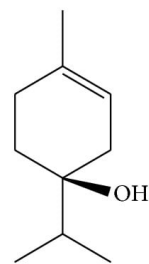
Camphene



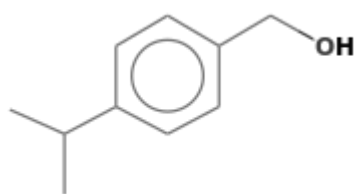
p-cymene



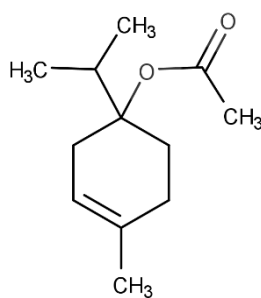
Limonene



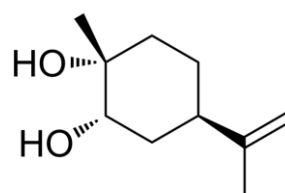
Terpinen-4-ol



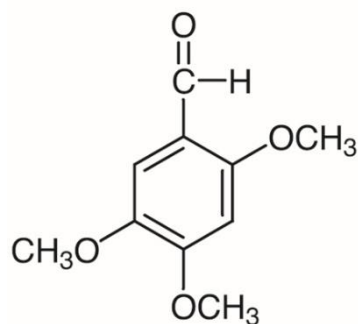
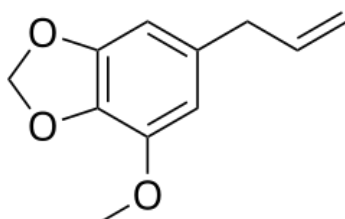
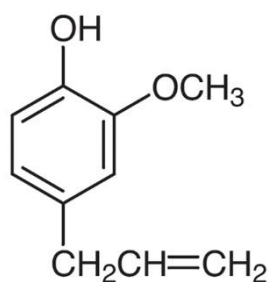
p-cyrenen-7-ol

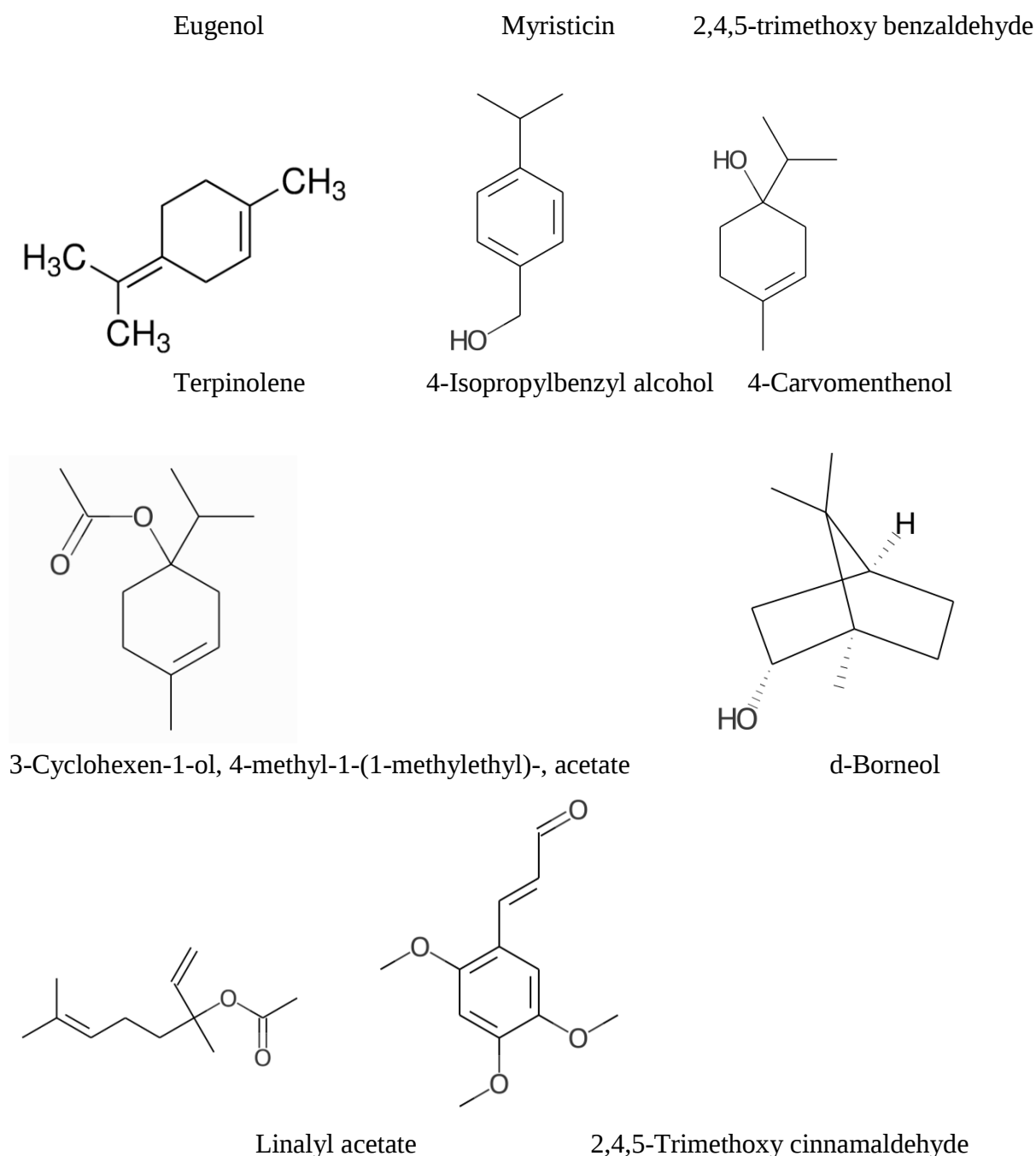


Terpinen-4-yl acetate



p-menth-8-en-1 $\beta$ ,2 $\alpha$ -diol





**Fig 2. Structure of some major phytochemical moieties isolated from *C. axillaris* herb**

## Pharmacological activities

### Anti-microbial

Extracts from different parts of *C. axillaris* have demonstrated antimicrobial properties. Specifically, the leaves exhibited notable antifungal activity at a 2% concentration. These findings suggest that the choice of solvent and concentration plays a crucial role in the effectiveness of extraction and consequently the antimicrobial potential of the plant materials [39][40].

**Antioxidant**

The plant contains various phenolic compounds, flavonoids and other antioxidants. These compounds help neutralize free radicals, thereby reducing oxidative stress and potentially lowering the risk of chronic diseases such as cancer and cardiovascular diseases [41][42].

**Antifungal and Anti-aflatoxigenic**

Among other plant parts and solvents, the antifungal activity of *Caesulia axillaris* leaf in methanol extract exhibits notable maximal control at 2% concentration (then 4%) [43].

The essential oil of *C. axillaris* has been evaluated for its antifungal and anti-aflatoxigenic properties against fungi that deteriorate herbal raw materials. The oil exhibited significant antifungal activity and also demonstrated the ability to inhibit aflatoxin production by *Aspergillus flavus*, highlighting its potential as a natural preservative [44][45].

**Anti-inflammatory**

The presence of anti-inflammatory compounds, such as flavonoids and saponins has been noted. These compounds inhibit the production of pro-inflammatory cytokines and enzymes such as cyclooxygenase (COX), which play a role in the inflammatory process [46].

**Anti-pyretic**

The antipyretic effect is attributed to compounds such as flavonoids and saponins. These compounds are believed to interfere with the body, production of prostaglandins, which are involved in the fever response [47].

**Analgesic**

Flavonoids and other compounds in the plant contribute to its analgesic properties. The compounds likely act by inhibiting pain pathways and reducing the perception of pain [48].

**Gastro protective**

The presence of compounds with protective effects on the gastrointestinal tract has been noted. These compounds may help to strengthen the mucosal barrier, reduce gastric acid secretion, or exhibit antioxidant activity to protect the lining of the stomach [49].

**2. CONCLUSION**

Within the genus *Caesulia*, *Caesulia axillaris* is a prime example of the amazing cooperation between ecological adaptability and therapeutic use. Its complex pharmacological profile and structural stability in wetland ecosystems make it a diverse resource deserving of preservation and investigation. Scientific investigation validates traditional knowledge of its medicinal qualities by identifying a variety of bioactive substances with a range of therapeutic potentials.

It concluded that *Caesulia axillaris* exhibited the antioxidant, anti-inflammatory, antimicrobial, analgesic, antipyretic, anti-fungal and gastroprotective activities which is due to presence of wide variety of phytochemical moieties. As research progresses, the elucidation of its bioactive constituents and pharmacological mechanisms opens avenues for the development of novel therapeutic agents.

**CONFLICT OF INTEREST**

Authors declare for none conflict of interest.

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