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A Review On Phytochemical And Pharmacological Studies Of *Caesulia Axillaris* Roxb

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Abstract: A comparatively small but important group of plants known for their exceptional adaptations to wetland ecosystems and unique morphological characteristics makes up the genus *Caesulia*, which belongs to the *Asteraceae* family. Native to tropical Asia, including India, Bangladesh and Nepal. *Caesulia axillaris* is one of the best-known species in its genus. It is well-known for its structural adaptations and ecological importance. Furthermore, its cultural significance is highlighted by its historical usage in medicine, where different plant components have been used for generations to cure a variety of ailments. Recent scientific research has discovered a wide range of bioactive molecules in *C. axillaris*, which contribute to its pharmacological effects. The physical features, bioactive components and therapeutic benefits of *C. axillaris* are comprehensively covered in this review. It highlights the plant's capability as a valuable source of medicine and emphasizes the need for further investigation to fully comprehend its therapeutic benefits.

Index Terms **-** *Caesulia axillaris, Asteraceae,* Wetland adaptations, Bioactive compounds, Pharmacological activities**.**

I. INTRODUCTION

The genus *Caesulia* is a rather tiny one, belonging to the *Asteraceae* family, but it is distinguished by its specialized adaptations to wetland environments and unique morphological traits. The herbaceous growth patterns and propensity for members of this genus to flourish in aquatic or semi-aquatic habitats distinguish them[1-5]. The plant's fruit, which is meant to be spread by the wind, guarantees its spread across a wide range allowing it to persist in favorable environments. By stabilizing soil and aiding in water purification processes, the presence of *C. axillaris* in wetland ecosystems supports the general health of the environment and offers food and shelter for a variety of insects, including pollinators like bees and butterflies[6-9]. Its significance is further highlighted by its use in traditional medicine and possible pharmacological effects, calling for on-going research and conservation initiatives.

The *Asteraceae*, often known as the aster, daisy, composite or sunflower family is a very diverse and numerous groups of blooming plants. There are currently accepted over 23,000 species in the group, distributed among 1,620 genera and 12 subfamilies[10-14]. Only the *Orchidaceae* has more species than the *Asteraceae*, although it is impossible to say which of the two families is genuinely larger because we don't know the precise number of species in each. A defining feature of this family is the composite inflorescence, characterized by capitula

(flower heads) encircled by a series of protective in volucral bracts[15,16]. The family's most well-known genus, Aster, is the source of the name "*Asteraceae*". It originates from the Greek term for star and is associated to its inflorescence's star shape. Concerning the word "*Compositae*," Although it is older and still valid, it clearly alludes that the family is few angiosperm families with composite blooms[17-19]. This gives it significant ecological and economic value. In many parts of the world, the *Asteraceae* family can account for up to 10% of the plant life. Although the majority of *Asteraceae* family members are herbaceous, many are also trees, vines or bushes. The family is found all over the world with the majority of members residing in barren and semiarid zones of sub-tropical and lower calm latitudes. The *Asteraceae* are a family of plants that are economically significant. Some members sell goods like lettuce, sunflower seeds, artichokes, cooking oils, herbal teas, coffee replacements and sweetening ingredients. The horticultural community loves a number of genera, such as marigolds, pot marigolds (also known as calendula), cone flowers, numerous daisies and colourful blooms[20-22]. Chrysanthemums, dahlias, zinnias, heleniums and fleabane, chrysanthemums. The Grindelia, Echinacea, yarrow and a number of other members of the *Asteraceae* family are essential to herbal medicine[23,24].

1.1 Geographical area

Caesulia species are well suited to changing water levels and can endure submersion and they are typically found in marshes, riverbanks and other wet environments. With *Caesulia axillaris* being one of the best known, this genus includes a number of species. This species is indigenous to tropical Asia, notably India, Bangladesh and Nepal and is well-known for its unique morphology and ecological importance[25]. It is well-suited to its wetland habitat. Due to its structural features, such as its upright and branching stems, it can flourish in flood-prone locations and its axillary blooms allow for optimal pollination even in thick flora. The only species in the monotypic genus *Caesulia* is *Caesulia axillaris*, sometimes known as the pink node flower. It may grow on damp ground or float in water bodies. It is not often weedy but in certain places, it grows in rice fields[26].

1.2 Agriculture importance

Groundnuts are a low-cost, nutrient-dense source of fat, protein and vitamins. The most important are India, China, the United States and West Africa, but they are cultivated commercially in the majority of the world's tropical and subtropical regions. Around 10% of all food grains in India are lost after harvest due to unscientific storage, pests, rodents, microbes and other factors[27-30]. The main financial harm brought on by grain-infesting insects is not always the real substance they eat; it is also the amount that their faces contaminate, rendering it unsuitable for human use. There are around 500 different insect species that have been linked to stored grain goods. Economic losses are caused by about 100 different species of insect pests of stored goods[31-34].

1.3 Medicinal use

In tropical and subtropical regions, herbal raw materials are especially vulnerable to fungal infection during post-harvest treatment and storage[35-38]. The majority of these fungi are toxic, producing micro toxin, therapy and impacting the quality of the herbal raw materials as well as the herbal composition[39,40]. As well as antimicrobial activity. Researchers from all over the globe have conducted extensive studies with favorable outcomes on the effects of plant extracts on bacteria and fungi. The antibacterial activity of various plants was documented. Against B. cereus, S. epidermis, S. aureus etc[41]. Antioxidants serve as a storehouse of antibacterial, antifungal, anti-inflammatory and anti-carcinogenic effects. A variety of plant substances are thought to have antifungal properties without harming people or animals[42,43]. The anti-microbial activity of *Caesulia axillaris* Roxb against pathogens in laboratory conditions has been studied by taking into account their folk medicinal properties.

In recent years, several antimicrobials derived from microorganisms have been shown to be effective against dermatophytes[44-46]. the plants that are empirically employed to treat skin disorders. These medications validity may be tested in several areas of fungal pathology. Regrettably, there is not much scientific and methodical study done on green plants to determine their antifungal effectiveness against ringworm[47,48].

Whole plant paste with camphor and mustard oil is applied on chest and throat to cure cold, cough and nasal congestion. Paste of the inflorescence with black pepper and cow milk is given to cure dysentery. Whole plant extract is given to cure malaria[49].

II. PLANT PROFILE

The genus *Caesulia* is part of the family *Asteraceae* and is a relatively small genus, yet it is notable for its special adaptations to wetland ecosystems and its unique morphological characteristics. Species within this genus are identified by their herbaceous growth forms and their ability to flourish in aquatic or semi-aquatic settings. Usually located in marshes, along riverbanks and in other saturated regions, *Caesulia* species are adapted to variable water levels and can withstand submersion. This genus comprises several species, with *Caesulia axillaris* being among the most recognized. This species is indigenous to tropical areas in Asia, especially in nations such as India, Bangladesh and Nepal is celebrated for its unique morphology and ecological importance[50,51]. It is highly adapted to its wetland habitat. Its structural features, which include erect and branched stems, enable it to prosper in regions susceptible to flooding, while its axillary flowers promote effective pollination even amidst dense foliage [52].

Figure 1. *Caesulia axillaris* Roxb

Figure 2. Flower of *Caesulia axillaris*

Table 1. Toxiconomical classification of *Caesulia axillaris* Roxb

Family	*Asteraceae*
Order	Asterales
Species	*Caesulia axillaris* Roxb
Kingdom	Plantae
Genus	*Caesulia* Roxb
Class	Magnoliopsida
Clade	Angiosperms

APPEARANCE[53,54]

Common name- Pink node flower, Kala Maka, Erra gobbi, Gathila.

Habit: Glabrous, erect or decumbent herb.

Stem: 15-45 cm tall.

Leaves: 5-15 cm long, lanceolate-oblong or narrowly lanceolate, semi-amplexicaul.

Flowers: Light blue, lilac or white in globose, compound heads.
Fruits: Achenes obovoid, dark brown, ribbed, flattened.

2.1 Description

C. axillaris a yearly herb, flourishes in wetland environments such as marshes, riverbanks and other saturated regions. It is highly suited to these surroundings and plays a crucial role in the local ecosystem[55-58](Figure 1).

Stems: The stems are upright and branched. This branching usually occurs from the base or lower portions of the stem, giving the plant a somewhat bushy look. Plants attain heights of up to 45 cm although they may differ based on specific growing conditions and environmental influences. They are smooth and frequently display a green hue, sometimes with a slight reddish tint near the base.

Leaves: The leaves are positioned alternately along the stem. They are lanceolate to elliptic, offering a streamlined and effective shape for photosynthesis. Leaf margins are entire but may occasionally be slightly serrated, contributing to their variability.

Flowers: The flowers are generally purple to blue, which can vary slightly in tone. Each flower is tubular and small, typical of many members of the *Asteraceae* family. The tubular form is made up of numerous tiny florets. Flowers are clustered in axillary formations, meaning they arise from the axils (Figure 2).

Fruits: The fruit is a tiny, single-seeded achene. An achene is a kind of simple dry fruit that remains closed at maturity and does not open to free the seed.

2.2 Traditional use

Caesulia axillaris Roxb., commonly known as 'Kala-Maka', is a herbaceous plant belonging to the *Asteraceae* family. In traditional medicine, particularly in certain regions of India, its leaves are utilized for promoting hair health. A common practice involves boiling fresh, healthy leaves in coconut oil to create a preparation that is applied to the scalp to encourage healthy and rapid hair growth[59].

Additionally, Members of the *Asteraceae* family, such as *Caesulia axillaris* are recognized for producing secondary metabolites like phenolics, flavonoids and triterpenes. These bioactive compounds are associated with several pharmacological effects, including antioxidant, anti-inflammatory and anti-microbial activities[60-62].

There has been a growth in interest in many traditional natural products in order to identify their phytochemical and anti-microbial properties. It has been proposed that aqueous and ethanol extracts from plants used in allopathic treatments are potential sources of anti-viral and anti-microbial compounds. This results in the discovery of anti-microbial potential among the native and wild flora. In traditional Indian medicine, the *Asteraceae* family's *C. axillaris* Roxb is known to treat goiter and baldness. A common weed that thrives in Indian rice fields. It has been reported that its essential oil is effective against several insect pests that cause food commodity deterioration. *Axillari* has undergone testing to see how well it works at inhibiting aflatoxin B1 and against the fungus that breaks down the raw ingredients of herbs. Additionally, animal trials have been conducted to assess the oil's safety profile in order to determine its effectiveness as a preservative for herbal raw materials. But in this study, the chemically defined oil of *C. axillaris* is analyzed for the first time. The primary goal of the current study was to identify the fungi that cause the biodegradation of the stored raw materials[63-66].

III. PHYTOCHEMICAL STUDIES

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, anti-microbial, analgesic and gastro-protective effects. The on-going study of these bioactive compounds continues to reveal the potential therapeutic benefits of *C. axillaris*. *Caesulia axillaris* Roxb contains several chemical constituents identified through phytochemical analyses[67]. The notable compounds include:

3.1 γ-Asarone: A phenyl derivative constituting approximately 63.09% of the essential oil extracted from the leaves[68-70].

3.2 Limonene: A monoterpenoid making up about 30.85% of the leaf essential oil[71].

3.3 Flavonoids & Phenols: Present in various parts of the plant, including leaves, stems, and seeds, across different solvent extractions[72-74].

3.4 Steroids: Detected in leaves, stems and seeds, with presence varying depending on the solvent used for extraction[75].

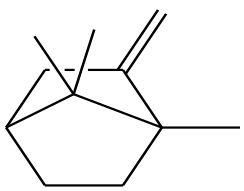
3.5 Tannins: Identified in certain plant parts, with their presence varying based on the solvent system employed during extraction[76].

Some secondary metabolite also presents such as Alkaloid, Fats & Oil, Vitamins, Amino acid, Glycoside[78-79].

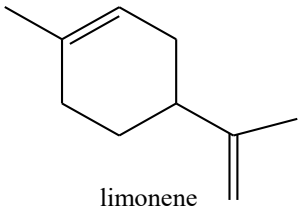
3.6 Composition of the leaf oil *Caesulia axillaris* Roxb[67-79]

Table 1. a= retention time, b= MS, c= 1HNMR, d=IR

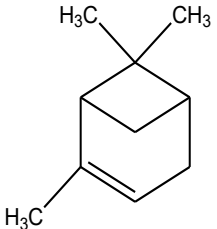
Constituents of leaf oil	Method of identification
α -pinene	a,b
camphene	a,b
limonene	a,b,c,d
p-cymene	a,b,c
terpinen-4-0l	a,b,c
p-cyrnen-7-01	a
terpinen-4-yl acetate	a,b
α -terpineol	a,b
p-menth-8-en-1β,2α-diol	b,c,d
eugenol	a,b
y-asarone	a,b,c,d
myristicin	a,b
2,4,5-trimethoxy benzaldehyde	a,b,c,d
2-methoxy-4,5-methylenedioxy cinnamyl alcohol	b,c,d
terpinolene	a,b



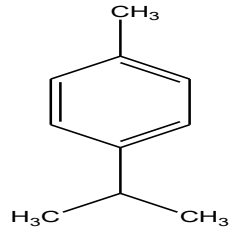
camphor



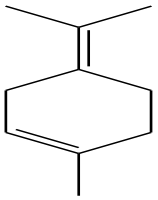
limonene

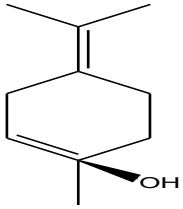


alpha-pinene

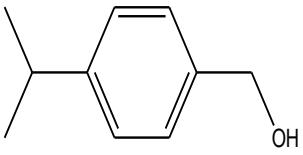


p-cymene

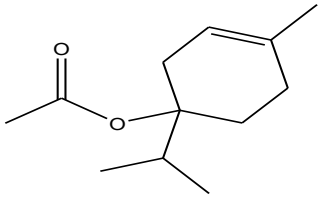

terpinolene



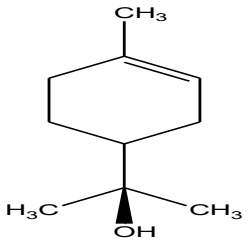
terpine-4-ol



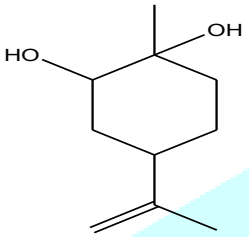
p-cymen-7-ol



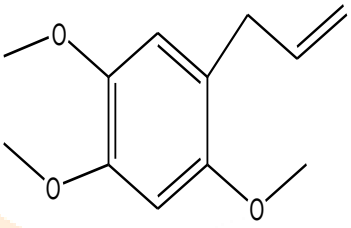
1-terpinen-4-yl acetate



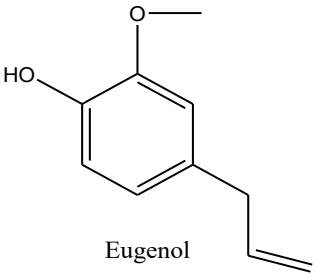
alpha-terpineol



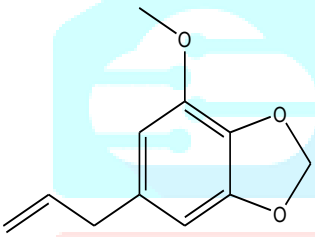
p-menth-8-ene-1,2-diol



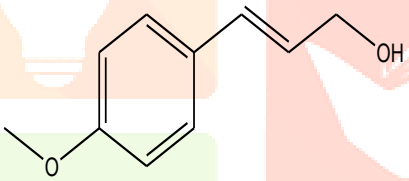
asarone



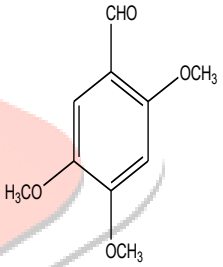
Eugenol



Myristicin



4- Methoxycinnamyl alcohol



2,4,5-tri-methoxy benzaldeyde

IV. PHARMACOLOGICAL STUDIES

- **Anti-microbial Activity**: 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[80,81].
- **Antioxidant Activity:** 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[82-84].
- **Antifungal and Antiaflatoxigenic Efficacy:** The essential oil of *C. axillaris* has been evaluated for its antifungal and antiaflatoxigenic 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[85-87].
- **Anti-inflammatory Activity:** 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[88,89].
- **Antipyretic Activity:** The antipyretic effect is attributed to compounds such as flavonoids and saponins. These compounds are believed to interfere with the body's production of prostaglandins, which are involved in the fever response[90-91].
- **Analgesic Activity:** 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[92-94].

- **Gastro protective Activity:** 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[95,96].

V. CONCLUSION

Caesulia axillaris exemplifies the remarkable synergy between ecological adaptation and medicinal utility within the genus *Caesulia*. Its structural resilience in wetland habitats, coupled with its rich pharmacological profile, positions it as a multifaceted resource worthy of conservation and exploration. Traditional knowledge of its medicinal properties finds contemporary validation through scientific inquiry, revealing various bioactive compounds with diverse therapeutic potentials. The antioxidant, anti-inflammatory, antimicrobial, analgesic, antipyretic and gastro-protective activities attributed to *C. axillaris* underscore its relevance in modern pharmacology. As research progresses, the elucidation of its bioactive constituents and pharmacological mechanisms opens avenues for the development of novel therapeutic agents.

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