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Eryngium foetidum L.: A Comprehensive Review of Phytochemistry, Pharmacological Properties, Ethnobotanical Uses, and Economic Potential with Special Reference to Northeast India

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ABSTRACT

Eryngium foetidum L., commonly known as long coriander or "Awaphadigom" in Manipur, is a tropical aromatic herb widely used for culinary and medicinal purposes. Though native to Central and South America, it has become naturalized in several parts of Asia, including the North Eastern region of India. In traditional medicine systems, especially in Manipur and other North-Eastern states, *E. foetidum* is employed for treating fevers, respiratory conditions, digestive disorders, wounds, and menstrual irregularities. This review presents a comprehensive analysis of the phytochemical constituents, pharmacological potential, ethnobotanical uses, and economic viability of the species with a special focus on Manipur and Northeast India. Phytochemical investigations have identified a range of bioactive compounds, including essential oils rich in aliphatic aldehydes (e.g., E-2-dodecenal), flavonoids (e.g., quercetin, kaempferol), phenolic acids, tannins, and saponins. These constituents contribute to the plant's broad pharmacological spectrum—antimicrobial, antioxidant, anti-inflammatory, hypoglycemic, and gastroprotective. The review also documents various traditional preparation methods, such as leaf decoctions, root infusions, and topical applications, supported by scientific validation of these ethnomedicinal practices. Beyond its pharmacological significance, *E. foetidum* has

substantial economic potential. Its adaptability to local agroclimatic conditions, high market demand, and low input requirements make it a viable candidate for commercial cultivation in Northeast India. The plant's integration into local agroeconomy could enhance rural livelihoods, especially among women and indigenous farmers. To fully harness its potential, the paper recommends further pharmacological research, standardization of cultivation practices, and policy-level support to promote its value-added products in regional and global markets.

1. Introduction

Eryngium foetidum L., commonly referred to as long coriander, Mexican coriander, or "Awaphadigom" in Manipur, belongs to the family Apiaceae and is a perennial tropical herbaceous plant. Although indigenous to Central and South America, it has become widely naturalized in tropical and subtropical regions across Asia, including Southeast Asia, the Pacific Islands, and the Indian subcontinent. In India, particularly in the North-Eastern states like Manipur, Mizoram, Nagaland, and Assam, *E. foetidum* has found a well-established place in both local culinary traditions and indigenous medical systems.

Morphologically, *E. foetidum* is characterized by its rosette of lanceolate leaves with spiny margins, a central flowering stalk, and a strong aroma reminiscent of coriander (*Coriandrum sativum*), which explains its widespread use as a culinary substitute. Its flavour profile is more intense and persistent than that of coriander, and it remains stable even after cooking, making it ideal for preparing soups, stews, chutneys, and fermented dishes. In Manipur, the leaves are commonly used in ethnic dishes such as fish curry, meat curry, *singju*, *eromba*, and *kangsoi*, among others.

Beyond its gastronomic appeal, *E. foetidum* has long been valued for its therapeutic potential. Traditional healers and indigenous communities in Northeast India utilize different parts of the plant to treat a range of ailments, including fevers, respiratory tract infections, digestive disorders, skin diseases, and postpartum complications. Its leaves are commonly decocted, consumed as teas, or applied as poultices, while the roots are sometimes used in tonics or infused in water for medicinal purposes. These uses align with ethnopharmacological practices documented in other tropical regions, indicating a shared understanding of its medicinal properties.

Scientific interest in *E. foetidum* has grown in recent decades, driven by preliminary pharmacological studies validating its antimicrobial, anti-inflammatory, antioxidant, antidiabetic, and analgesic effects. The plant is rich in bioactive compounds such as aliphatic aldehydes (e.g., E-2-dodecenal), flavonoids (e.g., quercetin, kaempferol), phenolic acids (e.g., caffeic and ferulic acid), saponins, tannins, and essential vitamins and minerals. These phytochemicals are believed to underpin its therapeutic potential, offering avenues for drug discovery and development, particularly in the domains of infectious diseases, metabolic disorders, and chronic inflammation.

In addition to its culinary and medicinal uses, *E. foetidum* presents substantial economic potential for small-scale farmers and rural entrepreneurs. Its adaptability to local agroclimatic conditions, low cultivation cost, and year-round demand in local markets make it a viable cash crop in the North-Eastern region. Moreover, the global shift toward plant-based therapeutics and traditional medicine has opened new possibilities for its commercialization as a high-value medicinal and aromatic plant (MAP).

Despite its multifaceted utility, *E. foetidum* remains under-researched compared to mainstream medicinal plants. There is a pressing need for a comprehensive and systematic exploration of its phytochemistry, pharmacological properties, traditional uses, and economic viability, particularly in the context of Northeast India where traditional knowledge systems and biodiversity coexist. This review aims to fill that gap by consolidating existing research and highlighting the plant's potential for integration into sustainable health care and livelihood strategies.

2. Phytochemical Constituents

Phytochemical studies of *Eryngium foetidum* L. have identified a rich array of secondary metabolites that contribute to its therapeutic efficacy. These include essential oils, flavonoids, phenolic acids, tannins, saponins, and a variety of vitamins and minerals. The following subsections detail these classes of compounds and highlight some major constituents along with their chemical structures and biological relevance.

2.1 Essential Oils

The essential oils derived from *E. foetidum* leaves and roots are responsible for its strong aroma and antimicrobial properties. Gas Chromatography-Mass Spectrometry (GC-MS) analysis reveals a dominance of aliphatic aldehydes.

1. **E-2-Dodecenal**

- **Structure**:

- **Molecular formula**: $C_{12}H_{22}O$
- **Properties**: Strong antimicrobial and antifungal activity.
- **Occurrence**: Major component (~60%) of the essential oil.

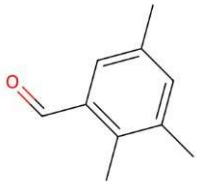
2. **E-2-Decenal**

- **Structure**:

- **Molecular formula**: $C_{10}H_{18}O$
- **Function**: Contributes to antimicrobial activity

3. **2,3,6-Trimethylbenzaldehyde**

- **Structure**:



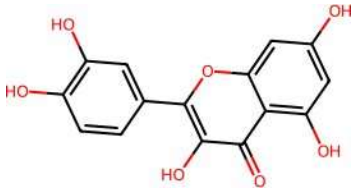
- **Molecular formula**: $C_{10}H_{12}O$
- **Activity**: Possesses antimicrobial and antioxidant potential.

2.2 Flavonoids

Flavonoids are polyphenolic compounds known for their antioxidant, anti-inflammatory, and cardiovascular benefits.

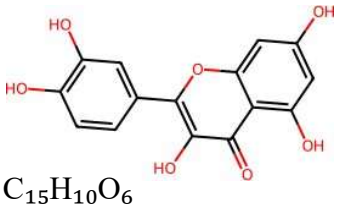
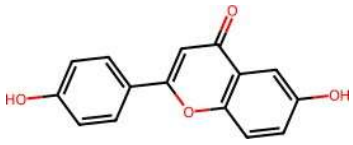
1. **Quercetin**

- **Structure**:



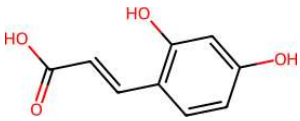
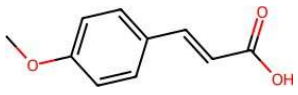
- **Molecular formula**: $C_{15}H_{10}O_7$

- **Properties**: Antioxidant, antihypertensive, and antiviral.

2. **Kaempferol**
   - **Structure**:
   
   - **Molecular formula**: $C_{15}H_{10}O_6$
   - **Biological role**: Antioxidant and anti-cancer properties.
3. **Apigenin**
   - **Structure**:
   
   - **Molecular formula**: $C_{15}H_{10}O_5$
   - **Uses**: Anti-inflammatory, sedative, and estrogenic effects.

2.3 Phenolic Acids

Phenolic acids contribute to the plant's antioxidant and antimicrobial properties.

1. **Caffeic Acid**
   - **Structure**:
   
   - **Molecular formula**: $C_9H_8O_4$
   - **Activity**: Antioxidant, anti-inflammatory.
2. **Ferulic Acid**
   - **Structure**:
   
   - **Molecular formula**: $C_{10}H_{10}O_4$

- **Function**: UV absorber, anti-aging compound in cosmetics.

2.4 Tannins and Saponins

Though specific chemical structures of Tannins and Saponins in *E. foetidum* are less studied, their presence has been confirmed via qualitative phytochemical screening.

- **Tannins**: Polyphenolic compounds that exhibit astringent, antimicrobial, and anti-inflammatory properties.
- **Saponins**: Glycosides known for their surfactant properties, immune modulation, and cholesterol-lowering effects.

2.5 Vitamins and Minerals

Nutritional analysis of *E. foetidum* reveals:

- **Vitamin C** (ascorbic acid): Powerful antioxidant and immune booster.
- **Carotenoids**: Including β-carotene, contributing to vision and skin health.
- **Minerals**: High content of **iron**, **calcium**, **magnesium**, and **potassium**.

Summary Table of Major Phytoconstituents

Compound	Class	Activity
E-2-Dodecenal	Aldehyde	Antimicrobial
Quercetin	Flavonoid	Antioxidant, anti-inflammatory
Kaempferol	Flavonoid	Cardioprotective, antioxidant
Caffeic Acid	Phenolic Acid	Antioxidant, antibacterial
Ferulic Acid	Phenolic Acid	Anti-aging, UV protection
Tannins	Polyphenol	Antiseptic, anti-diarrheal
Saponins	Glycoside	Cholesterol-lowering, immunomodulatory

3. Pharmacological Properties

The growing interest in *Eryngium foetidum* as a medicinal plant is supported by both traditional knowledge and modern pharmacological studies. The presence of a wide range of phytochemicals—especially aliphatic aldehydes, flavonoids, phenolic acids, saponins, and tannins—has led to scientific investigations that validate many of its traditional uses. This section outlines the key pharmacological properties that have been experimentally documented or reported through ethnopharmacological evidence.

3.1 Antimicrobial Activity

One of the most extensively studied properties of *E. foetidum* is its antimicrobial potential. Essential oils extracted from the leaves have demonstrated broad-spectrum antibacterial activity against both Gram-positive and Gram-negative bacteria. Notably, compounds such as E-2-dodecenal and E-2-decenal exhibit potent inhibitory effects against *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Salmonella typhi*. Studies have also reported antifungal activity against *Candida albicans* and other dermatophytes, making it a potential candidate for topical formulations against skin infections. The antimicrobial efficacy is attributed to the disruption of microbial cell membranes and inhibition of essential enzymatic pathways by aldehydes and polyphenolic compounds.

3.2 Anti-inflammatory and Analgesic Effects

Traditional use of *E. foetidum* for the treatment of body aches, arthritis, and fevers has been supported by animal model studies that show its anti-inflammatory and analgesic potential. Ethanolic extracts of the leaves have been found to inhibit the production of inflammatory mediators such as prostaglandins, nitric oxide (NO), and cyclooxygenase-2 (COX-2). These effects are largely attributed to the presence of flavonoids like quercetin**,** kaempferol, and apigenin, which have well-documented roles in modulating inflammatory pathways. When tested in animal pain models (e.g., hot plate, acetic acid-induced writhing), the plant extracts demonstrated significant analgesic activity comparable to standard drugs like aspirin.

3.3 Antioxidant Activity

Oxidative stress is a key factor in the pathogenesis of many chronic diseases, including cancer, cardiovascular disorders, and neurodegenerative conditions. The rich content of polyphenolic compounds in *E. foetidum*, especially caffeic acid, ferulic acid, and flavonoids, contribute to its strong antioxidant activity. DPPH (2,2-diphenyl-1-picrylhydrazyl) and ABTS (2,2′-azino-bis-3-ethylbenzothiazoline-6-

sulfonic acid) free radical scavenging assays have shown that leaf extracts of *E. foetidum* effectively neutralize reactive oxygen species (ROS). The antioxidant capacity not only enhances its therapeutic efficacy but also suggests potential applications in cosmetic and food preservation industries.

3.4 Antidiabetic and Hypoglycemic Effects

Although still in preliminary stages, several studies have explored the hypoglycemic potential of *E. foetidum*. Animal models have demonstrated reduced blood glucose levels after administration of aqueous or methanolic extracts. The mechanism is believed to involve inhibition of α-glucosidase and enhancement of insulin sensitivity, mediated by bioactive compounds such as polyphenols and saponins. The plant's traditional use for managing fatigue and weakness may be linked to its blood sugar-regulating properties, although further clinical studies are required to confirm its efficacy in diabetic patients.

3.5 Gastroprotective and Digestive Aid

In many parts of Northeast India, *E. foetidum* is traditionally used to alleviate digestive complaints such as indigestion, flatulence, diarrhoea, and intestinal worms. The leaves are often boiled into decoctions or consumed fresh. These traditional uses are supported by pharmacological evidence indicating antispasmodic activity on gastrointestinal smooth muscle, antimicrobial effects against enteric pathogens, and anti-inflammatory properties that reduce intestinal irritation. Flavonoids and tannins are particularly effective in strengthening gut lining and modulating intestinal motility.

3.6 Wound Healing and Dermatological Uses

Crushed leaves of *E. foetidum* are commonly applied topically on cuts, burns, and insect bites in traditional medicine. Preliminary in vivo and in vitro studies indicate that the plant promotes faster wound contraction, collagen synthesis, and epithelial regeneration. The antimicrobial and anti-inflammatory components contribute to reduced infection and enhanced healing. These properties make it a suitable candidate for incorporation into herbal ointments and antiseptic creams.

Taken together, these pharmacological properties confirm the multi-targeted therapeutic potential of *Eryngium foetidum*. While traditional knowledge provides a valuable foundation, further in-depth studies, including human clinical trials, are necessary to standardize doses, isolate specific active compounds, and evaluate safety profiles. The existing data, however, clearly position *E. foetidum* as a promising plant for integrative and evidence-based healthcare systems, especially in regions like Northeast India where it is already embedded in local practices.

4. Traditional Uses in Manipur and Northeast India

Eryngium foetidum L., locally known as "Awaphadigom" in Manipur, occupies a prominent place in the ethnobotanical heritage of Northeast India. Its extensive use in traditional healthcare systems, indigenous rituals, and regional cuisines underscores its cultural and medicinal importance. The plant is deeply embedded in the daily life of many tribal and non-tribal communities, particularly in the states of Manipur, Nagaland, Mizoram, Meghalaya, and Assam.

4.1 Medicinal Uses in Traditional Healing

Across Northeast India, *E. foetidum* is traditionally regarded as a “panacea herb,” attributed with a range of healing properties. Various parts of the plant—leaves, roots, and sometimes the whole plant—are used to treat multiple ailments:

- **Fever and Respiratory Ailments**: Leaf decoctions are widely consumed to manage fever, flu, cold, sore throat, and chest congestion. In Manipur, these preparations are often prescribed during seasonal transitions when respiratory infections are prevalent.
- **Gastrointestinal Disorders**: The herb is commonly used for treating stomach pain, flatulence, indigestion, diarrhoea, and parasitic infections. Aqueous extracts of the leaves are administered orally for quick relief from gastrointestinal discomfort. In some tribal practices, *E. foetidum* is boiled with other medicinal herbs as part of a polyherbal remedy for cholera and food poisoning.
- **Postpartum Recovery and Women’s Health**: Among Meitei and tribal communities in Manipur, the roots are boiled to prepare a tonic consumed by postpartum women. This decoction is believed to restore uterine health, enhance lactation, and accelerate recovery. It is also given during menstruation to alleviate cramps and fatigue.
- **Wound Healing and Skin Infections**: Crushed fresh leaves are applied directly to cuts, burns, boils, insect bites, and skin rashes. The antimicrobial and anti-inflammatory nature of the plant helps prevent infection and promote healing. In Nagaland and Meghalaya, it is used in combination with turmeric or lime in topical formulations.
- **Anti-inflammatory and Analgesic**: Leaf paste or boiled water extract is applied to joints and muscle areas to reduce swelling and relieve pain, especially in conditions like rheumatism and arthritis.

- **Other Uses**: The plant is used traditionally for treating urinary problems, jaundice, and even epilepsy in some hill districts. Its inclusion in daily meals is often advised for elderly people to maintain vitality and improve digestion.

4.2 Culinary and Nutritional Role

Apart from its medicinal value, *E. foetidum* is a staple ingredient in many traditional cuisines of Northeast India:

- In Manipur, it is added to dishes like *eromba* (a fermented fish and vegetable mash), *kangsoi* (a soupy stew), *Fish Curry, Red Meat Curry*, and *singju* (a spicy vegetable salad).
- In Mizoram and Nagaland, the leaves are often mixed into chutneys and pickles or used to flavour smoked meat preparations.
- The nutritional content of the leaves—rich in vitamin C, iron, and carotenoids—supports its use in everyday meals to boost immunity and general health.

The leaves are preferred over coriander in traditional households because they retain flavour after cooking and are available throughout the year, especially in backyard gardens and forest margins.

4.3 Ritualistic and Cultural Significance

Among certain tribal communities, *E. foetidum* holds cultural and spiritual value:

- It is used in cleansing rituals or purification ceremonies where the plant is sprinkled with holy water to ward off negative energy.
- In village healing practices, traditional shamans or herbalists often incorporate it into ritualistic bundles for protection against illnesses or malevolent spirits.

Such practices, though symbolic, often coincide with the plant's genuine antimicrobial and health-boosting effects, thus reflecting an intuitive understanding of its properties.

4.4 Preservation of Traditional Knowledge

The traditional knowledge surrounding *E. foetidum* is typically passed down orally through generations of healers, elderly women, and farmers. In many rural areas, especially in the hill districts of Ukhrul,

Chandel, Senapati, and Churachandpur in Manipur, home remedies using *E. foetidum* remain common due to limited access to modern healthcare.

However, with increasing modernization and changes in food habits, such indigenous knowledge is at risk of erosion. Ethnobotanical documentation and community-based research are therefore essential to preserve this valuable cultural asset. Recent surveys conducted by local researchers and NGOs in the region have started cataloging these uses as part of traditional medicine registers and community herbariums.

The widespread traditional use of *Eryngium foetidum* in Manipur and Northeast India reflects its deep ethnobotanical roots. Its integration into food, medicine, and culture highlights the plant's multipurpose role in local livelihoods. Acknowledging and validating these traditional practices through scientific research will not only strengthen healthcare options in rural communities but also contribute to the sustainable utilization and conservation of this important medicinal herb.

5. Economic Viability and Commercial Potential

The increasing recognition of *Eryngium foetidum* L. as a medicinal, culinary, and aromatic herb has opened promising avenues for its commercial exploitation, especially in biodiversity-rich and agriculturally dependent regions like Northeast India. Its economic viability lies not only in its established role in traditional health care and culinary practices but also in its potential for high-value applications in the nutraceutical, pharmaceutical, cosmetic, and food-processing industries. This study examines the factors that contribute to the commercial appeal of *E. foetidum*, focusing on its agricultural advantages, market demand, value-added possibilities, and the role of policy support in enhancing its livelihood potential.

5.1 Agronomic Advantages and Adaptability

Eryngium foetidum is a robust, fast-growing, and low-input plant species well suited for the tropical and subtropical climates of Northeast India. It thrives in partially shaded, moist environments and is adaptable to both garden and wild conditions. The plant can be propagated easily from seeds and requires minimal chemical inputs, making it suitable for organic cultivation and sustainable agriculture systems.

Farmers in states like Manipur, Nagaland, and Assam already grow *E. foetidum* on a small scale in kitchen gardens or intercropped with vegetables and spices. Its perennial growth pattern allows for multiple harvests within a year, ensuring year-round supply and reducing seasonal market dependency.

Furthermore, its resilience to pests and diseases minimizes crop loss and reduces reliance on pesticides, lowering production costs.

5.2 Market Demand and Trade Potential

There is a growing domestic demand for *E. foetidum* leaves in fresh, dried, or powdered forms due to its culinary importance in regional diets. In urban markets such as Imphal, Kohima, Aizawl, and Shillong, the herb commands premium prices compared to other leafy vegetables, particularly in organic produce stalls and farmers' markets.

Besides local consumption, there is significant scope for inter-state and international trade. The plant is used extensively in Caribbean, Southeast Asian, and Latin American cuisines, creating potential export markets for processed or dried forms of the herb. Diaspora communities and gourmet food industries in countries such as the U.S., U.K., and Canada have shown rising interest in "exotic herbs," including long coriander. With appropriate packaging, branding, and certification (such as organic or GI tagging), *E. foetidum* products from Northeast India could tap into this global demand.

5.3 Value Addition and Cottage Industry Opportunities

Value addition holds the key to maximizing the economic benefits of *E. foetidum*. Several products can be developed, such as:

- **Essential oils**: The leaf and root oils are rich in bioactive aldehydes with proven antimicrobial properties. These can be distilled and marketed as herbal remedies, natural preservatives, or cosmetic ingredients.
- **Herbal teas and supplements**: Given its antioxidant, digestive, and anti-inflammatory properties, the leaves can be dried and blended into functional teas or capsules.
- **Traditional food products**: Integration into ready-to-eat ethnic foods, sauces, and condiments presents an avenue for small-scale food entrepreneurs.
- **Topical formulations**: Based on its wound-healing and skin-soothing effects, creams, balms, and soaps infused with *E. foetidum* extract could be developed.

Women-led self-help groups (SHGs), tribal cooperatives, and rural entrepreneurs can be trained and supported in processing and marketing such products, thereby enhancing rural employment and financial independence.

5.4 Institutional and Policy Support

Government agencies such as the National Medicinal Plants Board (NMPB), North Eastern Region Community Resource Management Project (NERCORMP), and Mission Organic Value Chain Development for North Eastern Region (MOVCDNER) can play a vital role in promoting the cultivation and commercialization of *E. foetidum*. Financial support, capacity-building programs, and access to quality planting materials and post-harvest technologies are essential for scaling up production.

Inclusion of *E. foetidum* in state horticulture missions, AYUSH herbal gardens, and school kitchen garden schemes can further raise awareness and create steady markets. With the right support mechanisms in place, the herb can be integrated into broader development programs focused on sustainable agriculture, health, and nutrition.

5.5 Challenges and Way Forward

Despite its potential, several challenges must be addressed to fully commercialize *E. foetidum*:

- Lack of standardized cultivation practices and certified planting material.
- Limited access to market linkages, particularly for rural growers.
- Inadequate awareness among policy-makers and agricultural planners.
- Post-harvest losses due to the perishable nature of fresh leaves.

To overcome these constraints, collaborative efforts involving agricultural universities, local NGOs, tribal councils, and government bodies are essential. Pilot projects and demonstration farms could showcase best practices, while farmer producer organizations (FPOs) can facilitate aggregation, branding, and marketing.

Eryngium foetidum represents a valuable underutilized resource with substantial economic potential. Its ability to integrate seamlessly into local farming systems, combined with its diverse applications and increasing market demand, makes it a promising crop for sustainable livelihood generation in Northeast India. Promoting its cultivation and commercialization not only adds economic value but also helps preserve traditional knowledge systems and biodiversity.

6. Conclusion

Eryngium foetidum L. stands as a multifaceted plant with immense potential in the domains of traditional medicine, nutrition, and rural economics, especially in the context of Northeast India. Its widespread ethnobotanical use—ranging from treatment of fevers, digestive issues, and postpartum recovery to culinary applications—demonstrates the plant's versatility and cultural relevance. Phytochemical investigations have validated many of these traditional claims, revealing a diverse array of bioactive compounds such as flavonoids, phenolic acids, aldehydes, and essential oils that contribute to its antioxidant, antimicrobial, anti-inflammatory, and digestive properties.

In regions like Manipur, where local healthcare often depends on plant-based remedies, *E. foetidum* plays a critical role. Moreover, its agronomic suitability, minimal cultivation requirements, and strong local and export market demand render it economically promising for smallholder farmers and community-based enterprises. Despite its potential, gaps remain in terms of clinical validation, standardized cultivation practices, and organized commercial frameworks.

Therefore, an integrated approach combining traditional knowledge, modern pharmacological research, policy support, and market development is essential. Promoting *E. foetidum* as a nutraceutical and phytotherapeutic resource could lead to sustainable health, economic empowerment, and biodiversity conservation in Northeast India and beyond.

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