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## Therapeutic potential of *Plectranthus amboinicus* (Lour) in respiratory disorders

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#### Abstract

The usage of medicinal plants with therapeutic characteristics is increasing day by day. The plant *Plectranthus amboinicus*, also known as the Mexican mint, naturally occurs in tropical and warm climates like Australia, Africa, and Asia. Despite being a relatively common condition, respiratory diseases are frequently not adequately treated. Mexican mint is a perennial herb that has historically been used for therapeutic reasons. Its medicinal potential has been intensively researched in recent years, notably in the field of respiratory illnesses. The active substances exhibit anti-inflammatory, bronchodilatory, and immunomodulatory properties, implying their potential medicinal utility in the prevention and treatment of respiratory illnesses. The plant, otherwise known as Indian oregano, has been found to relieve respiratory symptoms such as coughing, wheezing, and shortness of breath in illnesses such as asthma, bronchitis, and chronic obstructive pulmonary disease (COPD), and its ayurvedic uses are discussed in the paper. It has also been shown to help with upper respiratory tract infections, shortening the length and intensity of symptoms because it is an excellent expectorant as it contains carvacrol and thymol compounds. The leaves are also often eaten raw or used as flavoring agents in preparations of traditional foods and medicinal items. In this review, the compounds that cause respiratory disorders, their therapeutic as well as the potential benefits of Mexican mint in preventing them are discussed.

**Keywords:** Mexican mint, Indian borage, phytochemical, therapeutic effects

#### Introduction

Respiratory disorders such as asthma, chronic obstructive pulmonary disease (COPD), and bronchitis are significant health concerns worldwide, affecting millions of people and causing substantial morbidity and mortality. The rising incidence of chronic respiratory illnesses, along with the negative side effects of traditional treatments, has fueled interest in alternative and complementary therapy. The use of traditional herbal treatments is one such alternative therapy that has gained popularity (Maste and Saxena, 2020) <sup>[11]</sup>.

Plant-based medications are now widely employed in various sorts of public health sectors because of their high level of safety and cost-effectiveness; traditional medical systems with a strong focus on plants include Siddha, Ayurveda, folk medicine, Unani, etc. Because traditional therapies are readily available from the environment, according to a WHO research survey, 80% of the world's population still relies on them (Prasad *et al.*, 2020) <sup>[19]</sup>.

*Plectranthus amboinicus* (Lour) Spreng, also known as Indian Borage, has been used in Indian medicine for many years. Its name is derived from the Greek words "plectron" and "anthos," which refer to blooms with spur-like petals. It is a member of the Lamiaceae family and is often referred to as country borage in English. *Plectranthus amboinicus* or *Coleus aromaticus* is also known as Mexican mint, is a delicate perennial plant in the Lamiaceae family with heart-shaped leaves that are green and shrubby that is used in Japan as an aesthetic pot plant. Africa's southern and eastern regions were home to this species. Because of its alluring perfume (aroma) and simplicity in cutting propagation, it has recently become widely grown. A paleotropical genus called *Plectranthus* has 300 or more annual or perennial plants or subshrubs, many of which are succulent. There were several problems with taxonomic nomenclature that resulted in inappropriate placement in species of closely related genera like *Englerastrum* *Coleus* and *Solenostemon* due to a lack of thorough and accurate understanding of external traits to distinguish between species of the genus *Plectranthus*. However, a classification scheme that makes use of the NIRS methodology, which aids in identifying a plant variety by the spectral fingerprints of leaves, has been proposed to allow for the differentiation of the medicinal plant varieties (Satheesh *et al.*, 2022) <sup>[21]</sup>.

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Mexican mint is among the most popular plants and has a number of health advantages. In different regions of India, country borage has been known by many vernacular names, including "Pathachur" in Hindi and Bengali, "Karpooravalli" in Tamil, "Kanikkorkka, Panikoorkka" in Kerala, etc. Spanish thyme, Cuban oregano, and Oregano brujo are just a few of the many names used to describe Indian Borage. With 200 genera and 3200 species included under the Lamiaceae family, which is divided into herbs, shrubs, and trees. These plants are used as a source of food and pharmaceutical preparations, which is a major highlight (Shubha and Bhatt, 2015) [33]. It is being found in tropical regions of the world, so *Plectranthus amboinicus* is considered a pantropical genus. *Plectranthus amboinicus* was previously classified by Loureiro in 1790 in the genus *Coleus*, but Sprengel later moved it to the *Plectranthus* genus. Although its origin is still unclear, most of the studies found that it is found and grown in practically all tropical regions of both hemispheres in India and Africa. The drought-resistant *Plectranthus amboinicus* may even thrive in cooler climates. It is a succulent perennial herb with hairy leaves that have a distinctive scent and keep their place at all times (Satheesh *et al.*, 2022) [22].

The leaves of *Plectranthus amboinicus* contain various bioactive compounds that are responsible for its medicinal properties. These include essential oils, phenols, flavonoids, triterpenoids, and tannins. Some of the specific compounds found in the leaves of *Plectranthus amboinicus* are carvacrol, thymol, ursolic acid, rosmarinic acid, luteolin etc. Carvacrol and thymol is a phenol compound found in the essential oil of *Plectranthus amboinicus* and has been shown to have anti-inflammatory, antimicrobial, and antioxidant properties (Wanna and Kwang-Ngoen, 2019) [34]. Ursolic acid is a triterpenoid compound, Rosmarinic acid is a phenol compound, Luteolin: This is a flavonoid compound found in the leaves of *Plectranthus amboinicus*. These compounds have been studied extensively for their potential therapeutic effects in respiratory disorders such as asthma and COPD. The anti-inflammatory, bronchodilatory, and immunomodulatory effects of these compounds suggest their potential therapeutic use in respiratory disorders (Pavla *et al.*, 2009) [16].

It is widely used in folk medicine to treat conditions like cold, asthma, constipation, headache, cough, fever, and skin diseases (Spreng, 2016) [41]. In addition to its recently reported pharmacological properties, such as urolithiasis, antiepileptic, anti-tumorigenic, antimutagenic, radioprotective effect, antiviral, antifungal, and neuropharmacological properties, *Plectranthus amboinicus* has been shown to have nephroprotective, anti-inflammatory, and antioxidant effects in both healthy and disease states (Bolaji *et al.*, 2018) [4]. The plant's leaves are frequently consumed raw, employed as flavorings, or utilized as components in the making of traditional foods. The literature review identified 76 volatiles and 30 non-volatile compounds, including monoterpenoids, diterpenoids, triterpenoids, sesquiterpenoids, phenolics, flavonoids, esters, alcohols, and aldehydes. These compounds belong to several groups of phytochemicals. Additionally, it has been shown to be helpful in treating illnesses of the digestive, urinary, oral, cutaneous, and cardiovascular systems. However, many more traditional applications might benefit from scientific confirmation, particularly in order to identify and validate new bioactive components from this plant. In India, during pathogen-induced diarrhea, the leaves

of *Plectranthus amboinicus* are taken together with buttermilk, yogurt, etc. (Spreng, 2016) [41].

This paper aims to provide an overview of the therapeutic potential of *Plectranthus amboinicus* in respiratory disorders. We will explore its traditional use in preventing and treating respiratory issues and examine the current scientific evidence on its efficacy in alleviating respiratory symptoms and preventing respiratory infections. Additionally, we will discuss the potential mechanisms by which *Plectranthus amboinicus* may exert its therapeutic effects in respiratory disorders.

Mexican mint comes under the plant kingdom, and its scientific name is *Plectranthus amboinicus*. It is a eukaryotic plant, and it is magnoliopsida class. *Plectranthus* is the genus, and species is the amboinicus (Kumar *et al.*, 2020) [10].

**Name:** Mexican mint/Indian borage/Country borage

**Scientific name:** *Plectranthus amboinicus*

**Domain:** *Eukaryota*

**Division:** *Magnoliophyta*

**Kingdom:** *Plantae*

**Clade:** *Angiosperms*

**Class:** *Magnoliopsida*

**Order:** *Lamiales*

**Family:** *Lamiaceae*

**Genus:** *Plectranthus*

**Species:** *Amboinicus*

**Synonyms:** *Coleus amboinicus* Lour (KUMAR *et al.*, 2020)

**Table 1:** Colloquial names of Indian borage

Origin of the plant	Colloquial names of the plant in respective regions
Bengali	Paatharchur, Paterchur, Amarkuchi
Gujarati	Ovvapaan
Punjabi	Patharachur
Marathi	Panova, Pathachur
Malayalam	Kanikoorkka, Panikkurukka, Navarayilla, Panikoorka
Sanskrit	Parnayavini, Karpuravalli, Sugandhavalakam
English	Country Borage, Indian Borage, Indian Mint, <i>Mexican mint</i>
Indonesia	Daun kutjing
Germany	Jamaika thymian
Philippines	Suganda, Toronjil de limón
French	Oreille, ti baume

(Satheesh *et al.*, 2022) [21]

### Plant morphology

Herbs are incredibly aromatic perennial plants that are 3–10 years old. This plant can grow to a height of about 1 meter. It has thick, thin, light blades of green leaves that are arranged in an opposing pattern (2.5–3 cm long). The leaves are often triangular or oval in form. The undersides of the leaf's crenate

surfaces are coated with many glandular hairs to create the winter trunk, which bears tomatoes (densely covered with soft short hairs). Flowers feature a bell-shaped calyx, a smooth interior, two lips, one of which is thin and elliptical and the other of which has four slender teeth (Dwivedy, 2012) [27]. The corolla has a slender tube, an inflated neck, and small lips. It is pale purple in colour and five times longer than the calyx. It is a type of large, juicy plant with a pleasant scent that grows wild and is rather prevalent. The leaves are thick and juicy and smell like mint when they are crushed or pressed (Kumar *et al.*, 2020) [10].

The morphology of Leaves is detailed as being simple and thick. The leaf has a blunt tip and is oblong to suborbicular in shape. A lot of glandular hairs can be observed on the underside of the leaves. The hairs in place give the impression of being nurtured. In addition to having a delicious flavour, leaves have a pleasing scent. The blossom has a drab violet hue. They are found at the short stem, which has a thick whorl and a short pedicel. Fruit nutlets are light brown in colour and measure 0.7 mm in length and 0.5 mm in breadth. They are slick. It is exceedingly challenging to gather these plants' seeds and blossoms (Prasad *et al.*, 2020) [19].

*Plectranthus amboinicus* is a succulent shrub with a penchant for climbing or creeping. This spreading, huge succulent plant is juicy and very fragrant. This leaf has a lovely scent and a flavor that is fragrant and reviving. Flowers are on a short stem (shortly pedicelled), pale purple, in dense whorls spaced far apart in a long, thin raceme. The corolla has a short tube, an expanded neck, and small lips. It is five times longer than the calyx and has a pale purple color (Spreng, 2016) [41]



Fig 1: Mexican mint (*Plectranthus amboinicus*).

### Cultivation

Fast-growing *Plectranthus amboinicus* is often propagated via stem cuttings. Because it hardly ever seeds or lays seed, vegetative techniques are favoured for proliferation. The herb thrives in a well-drained, somewhat shaded environment. It has been discovered to thrive in tropical and subtropical environments (Bhatt *et al.*, 2013) [36]. It was also discovered that if cultivated in a container and kept indoors or moved to a warm, protected area during winter, it would adapt well to cooler climes. Watering the plant should be done in moderation. Rich, composted soil with a neutral pH and high humidity are ideal growing conditions for *Plectranthus amboinicus*, but if there is too much water in the ground, its roots may begin to rot. However, because it has a lot of water stored in its juicy flesh, it can withstand severe droughts.

Although it thrives in both intense shade and extreme heat, its growth is most favorable in partial shade (Monzote *et al.*, 2020) [30]. Due to all of these factors, it is relatively simple to grow indoors, which contributes to its increasing popularity as a house plant in northern Europe. *Plectranthus amboinicus* is strained even in colder than 10 °C temperatures and cannot endure temperatures below 0 °C. The techniques/practices employed for the commercial cultivation and harvesting of this plant are often extremely poorly documented (Spreng, 2016) [42].

### Nutritional profile

*Plectranthus amboinicus* has a potent supplement in the human diet since it has a high concentration of minerals viz calcium and potassium and other compounds such as zeaxanthin, neoxanthin, leptin, violaxanthin and carotene. Additionally, it is a good source of total fatty acids, including 83.4–84% unsaturated and 15.1-16% saturated fatty acids, respectively (Bhatt *et al.*, 2013) [36]. It is a nutrient-dense plant that includes both macronutrients (such as carbs, proteins, fats, and fiber) and micronutrients (including vitamins A, B1, B2, B3, B5, B6, and C) as well as minerals (Ca, Mg, Fe, P, Na, K, Zn, Mn, Cu, and Se). Carvacrol, a substance found in *Plectranthus amboinicus*, contributes to food's enhanced flavour and longer shelf life. Numerous biomolecules have also been found in studies, suggesting the possibility of use as a functional food component and the rise of nutraceuticals (Rodríguez-Cámara *et al.*, 2016) [20]. The biological activities are attributed to a large number of different bioactive chemicals that are present in both plant extracts and essential oils. It includes monoterpenoids, diterpenoids, triterpenoids, sesquiterpenoids, phenolics, flavonoids, and esters, with 70 volatile phytochemicals and 30 non-volatile phytochemicals also present (Arumugam *et al.*, 2016) [1].

Due to the existence of possible terpenoids, including carvacrol, p-cymene, terpinene-4-ol, and thymol that function as supplementary to conventional pesticides, essential oil extracted from Indian borage is utilized as a botanical insecticide (Manjamalai and Berlin Grace, 2012) [28]. Carvacrol, a monoterpene, has a broad spectrum of insecticidal and fumigant action against a variety of agricultural pests, stored goods, and medicinal insect pests. By encouraging joint regeneration, the linolenic acid in Indian borage is said to lessen the discomfort associated with arthritis. The plant works well to strengthen the immune system due to its high ascorbic acid concentration. Additionally, the presence of carotenoids and vitamin A enhances eyesight, lessens oxidative stress on the eyes, and even helps to stave off macular degeneration (Satheesh *et al.*, 2022) [21].

The health benefits of a lot of herbal plants are associated with nutritional content. *Plectranthus amboinicus* is therefore a highly important source of substances that aid in enhancing the flavour and shelf life of the food (Nurafifah *et al.*, 2018) [31]. According to the study, there is a significant amount of calcium and potassium present. These minerals enhance bone density and improve the performance of various crucial organs, including the kidney, heart, nerves, and muscles. *Plectranthus amboinicus* has a considerable amount of iron in it (0.262%). Iron is a component of haemoglobin, which aids in the RBC's ability to transport oxygen throughout the body. Haemoglobin makes up about two-thirds of the iron, and a lack of this substance results in anemia. The plant also



includes carotene, leptin, violaxanthin, zeaxanthin, and neoxanthin. As a result, *Plectranthus amboinicus* can be considered a very effective dietary supplement (Prasad *et al.*, 2020) [19].

The three primary amino acids found in the leaves were glycine, glutamic acid, and aspartic acid. Non-essential amino acids were the most commonly found ones. From the

findings, it was possible to infer that *Plectranthus amboinicus* (Lour.) Spreng is a valuable edible plant that may be used as a multivitamin supplement or as a herbal nutrition supplement for people who are vitamin deficient or have a limited diet. This might account for its historical usage as a food or food additive (El-Hawary *et al.*, 2012) [7].

**Table 2:** This might account for its historical usage as a food or food additive

Compounds	Amount	References
<b>Proximate Analysis</b>		
Protein	0.6-9.5%	(Spreng, 2016) [41] (El-Hawary <i>et al.</i> , 2012) [7] (Chandra <i>et al.</i> , 2013) [42] (Wadikar & Patki, 2016) [24]
Ash	1.43 g/100 g	(Satheesh <i>et al.</i> , 2022) [21] (Arumugam <i>et al.</i> , 2016) [1]
Moisture	93 g/100 g	(Satheesh <i>et al.</i> , 2022) [21] (Arumugam <i>et al.</i> , 2016) [1]
<b>Vitamins</b>		
Ascorbic acid	0.003-0.1%	(Chandra <i>et al.</i> , 2013) [42] (El-Hawary <i>et al.</i> , 2012) [7] (Spreng, 2016) [41] (Wadikar & Patki, 2016) [24]
Thiamine	0.00008%	(Chandra <i>et al.</i> , 2013) [42] (Spreng, 2016) [41] (Wadikar & Patki, 2016) [24]
<b>Minerals</b>		
Calcium	0.158%	(Chandra <i>et al.</i> , 2013) [42] (Wadikar & Patki, 2016) [24]
Phosphorous	0.016%	(Chandra <i>et al.</i> , 2013) [42] (Spreng, 2016) [41]
Potassium	0.138%	(Chandra <i>et al.</i> , 2013) [42] (Spreng, 2016) [42] (Wadikar & Patki, 2016) [24]
Sodium	0.0047%	(Spreng, 2016) (Wadikar & Patki, 2016) [24]
Magnesium	0.088%	(Chandra <i>et al.</i> , 2013) [42] (Spreng, 2016) [41] (Wadikar & Patki, 2016) [24]
Iron	0.262%	(Chandra <i>et al.</i> , 2013) [42] (Wadikar & Patki, 2016)
Zinc	0.0003%	(Spreng, 2016) [41] (Wadikar & Patki, 2016) [24]
Copper	0.00012%	(Chandra <i>et al.</i> , 2013) [42] (Spreng, 2016) [41]
Chromium	0.000022%	(Chandra <i>et al.</i> , 2013) [42] (Spreng, 2016) [41] (Wadikar & Patki, 2016) [24]

### Toxicity profile

(Pillai *et al.*, 2011) [18] were done a study on Healthy male and female albino mice weighing 20- 35 gm that were acclimatized for 14 days. Standard settings and room temperature ((25±2 °C) were employed to keep the animals. Male and female albino mice were used in the toxicity investigation (20-35 g). The limit test dosage of 2000 mg/kg of methanolic extract from *Plectranthus amboinicus* (Lour) Spreng leaves was employed in the acute toxicity experiments, which were carried out in accordance with OECD standards 420 (OECD 2000). The animals were split into two groups; a control group and a treatment group, each with 10 animals (5 males and 5 females). For a period of seven days, observations were performed at 2, 4, and 8 hours to measure body weight, treatment-related variations in respiration and heart rate, and behavioral indicators such as apathy and decreased locomotor activity. As a result, the current research shows that *Plectranthus amboinicus* (Lour) Spreng's methanolic extract is not acutely hazardous. As a result, this analysis shows that *Plectranthus amboinicus* (Lour) Spreng's methanolic extract does not have any acute toxicity. Strong evidence from toxicology tests shows that *Plectranthus amboinicus* (Lour) Spreng's methanolic extract has no harmful effects. These findings clarified the widespread usage of the plant in traditional medicine and demonstrated the safety of using *Plectranthus amboinicus* (Lour) Spreng extract (Asiimwe *et al.*, 2014) [25].

### Therapeutic potential in respiratory disorders

The rise of many new diseases which affect on the respiration like coronavirus disease and air pollution, has given rise to the population suffering from respiratory disorders. Many studies and research have been carried out to check and prove the capability of the Mexican mint (*Plectranthus amboinicus*) in the prevention of respiratory diseases. The Indian medical system has been in the use of *Plectranthus amboinicus*.

Several medical conditions are treated using a decoction of the leaves, notably respiratory conditions, including bronchitis, sore throat, and congestion (Bhatt *et al.*, 2013) [36]. This herb can be included in a regular diet to treat upper respiratory infections, which primarily affect cough, sinusitis, sore throat, pharyngitis, and lung inflammation (Moyeenudin & Thiruchelvi, 2021) [12]. Borage acts as a potent expectorant, removing phlegm and mucus from the respiratory system, making it a particularly effective therapy for asthma, whooping cough, chest congestion, sore throats, and other respiratory conditions (Satheesh *et al.*, 2022) [21].

In India and the Caribbean Islands, *Plectranthus amboinicus* is commonly recommended for the treatment of persistent coughs, asthma, bronchitis, and sore throats. Accordingly, guinea pig tests on *Plectranthus amboinicus* leaves revealed that they showed good bronchodilator action. Asthma is treated in Eastern Cuba with essential oil extracted from *Plectranthus amboinicus* aerial parts. To manage asthma, decoction or juice produced from leaves is also given orally together with other medicines. In order to eliminate the excessive build-up of thick phlegm or mucus in an airway or cavity of the body, this decoction is also used to treat catarrhal infections (Manjamalai and Berlin Grace, 2012) [28]. Together, the high concentrations of carvacrol and thymol in the plant's essential oil may be the cause of this. Excellent expectorants, carvacrol and thymol are used to treat a variety of respiratory conditions. *Plectranthus amboinicus* juice or decoction has been recommended as a worthwhile treatment for throat issues, bronchitis, and flu. The plant has demonstrated a variety of biological qualities and has been successful in treating respiratory disorders (Spreng, 2016) [41].

Infusions of *Plectranthus amboinicus* leaves or fragrant syrup are reported to be particularly efficient cough suppressants. Only in the Zulu medicine is its use documented; the specifics of this are not disclosed. The plant's leaves are used to flavour cuisine. Additionally, cattle are treated with this species for

conditions like a sore throat, a stuffy nose, congestion, aching sinuses, etc. After chewing, leaves provide comfort because they contain chemical components that function as effective expectorants and expel mucus and phlegm from the body, clearing the sinuses. Additionally, it stops the growth of germs and other infections, boosting immunity (Kumar *et al.*, 2020) <sup>[10]</sup>.

*Plectranthus amboinicus*, a powerful anti-inflammatory compound with anti-inflammatory effect in virus-infected tissues, is also used to treat respiratory disorders. According to the literature, research on *Plectranthus amboinicus* against COVID-19 is essential as this infection is linked to respiratory issues and inflammation (Maste & Saxena, 2020) <sup>[11]</sup>.

A human experiment was conducted at The Center for Drug Research and Development (CIDEM, in Spanish) in Havana to examine the Mexican mint's potential as a cold-prevention aid. Acute and mild inflammation of the upper respiratory tract's mucous membranes is what is known as a common cold (Especially nose and sinuses). An exploratory, randomized, double-blind, placebo-controlled clinical trial was conducted at the "Dr. Luis Daz Soto" Hospital, Natural and Traditional Medicine Service, Havana, Cuba. All patients supplied their voluntarily written informed permission for the study prior to enrolment because the trial was conducted on humans. Cuban individuals of both sexes, older than 18 years old, who visit the clinical location with upper respiratory tract infections made comprised the study population. Using a list of random numbers produced by a computer, three treatment groups were constructed. One group was given Mexican mint (orally) three times daily at a dosage of 100 mg each for a period of 15 days. The second group was given a daily dosage of 600 mg, broken up into three 200 mg doses. The third group was given a placebo along with the same course of therapy. Patients had physical examinations, including checks of their vital signs, in the beginning, seven days, and the conclusion of treatment to measure their symptoms (15 days). In this study, Mexican mint was demonstrated to be a quick, efficient, and safe treatment for patients with a common cold, lowering cough and enhancing expectoration after just seven days of treatment. The daily dose was 600 mg, split into 200 mg every eight hours. Increased expectoration results in increased bronchial secretions and stimulation of the body's natural elimination processes, both of which assist the patient's clinical conditions. In that regard, individuals who had stopped coughing continued the expectoration process. At the same time, results with daily doses of 300 mg of the same natural substance and a placebo were noticeably inferior and the same. Given that 600 mg per 24 hours is the effective dose, Mexican mint pills therefore demonstrated a more significant therapeutic impact (reversion of the original symptoms) than symptomatic therapy. These findings show that the *Plectranthus amboinicus* (Lour.) Spreng leaves' dry extract may affect the respiratory system by altering secretion and bronchial motility, which in turn lessens cough severity (Rodríguez-Cámara *et al.*, 2016) <sup>[20]</sup>.

(Pillai *et al.*, 2011) <sup>[18]</sup> were done a study on Healthy male and female albino mice weighing 20- 35 gm that were acclimatized for 14 days. Standard settings and room temperature ((25±2 °C) were employed to keep the animals. Male and female albino mice were used in the toxicity investigation (20-35 g). The limit test dosage of 2000 mg/kg of methanolic extract from *Plectranthus amboinicus* (Lour) Spreng leaves was employed in the acute toxicity

experiments, which were carried out in accordance with OECD standards 420 (OECD 2000). The animals were split into two groups; a control group and a treatment group, each with 10 animals (5 males and 5 females). For a period of seven days, observations were performed at 2, 4, and 8 hours to measure body weight, treatment-related variations in respiration and heart rate, and behavioral indicators such as apathy and decreased locomotor activity. As a result, this research which was done by Pillai and his research team shows that *Plectranthus amboinicus* (Lour) Spreng's methanolic extract is not acutely hazardous. Strong evidence from toxicology tests shows that *Plectranthus amboinicus* (Lour) Spreng's methanolic extract has no harmful effects. These findings clarified the widespread usage of the plant in traditional medicine and demonstrated the safety of using *Plectranthus amboinicus* (Lour) Spreng extract extract (Asimwe *et al.*, 2014) <sup>[25]</sup>.

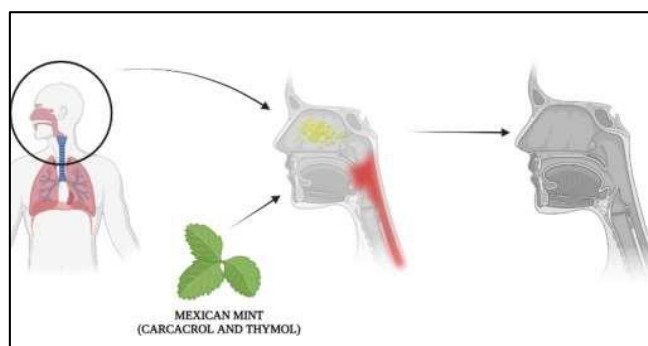
### Potential compounds responsible for respiratory relief

The leaves of *Plectranthus amboinicus* contain several bioactive compounds which is responsible for its respiratory relief effects. *Plectranthus amboinicus* be high amounts of Carvacrol (Singh *et al.*, 2002) <sup>[22]</sup> and Thymol (Nagoor Meeran *et al.*, 2017) <sup>[14]</sup> contained in the plant's essential oil. Carvacrol is a phenolic compound that has been shown to have potent anti-inflammatory, antioxidant, and antimicrobial effects. It has also been reported to exhibit bronchodilatory effects, which can help in the management of respiratory disorders such as asthma and COPD (Singh *et al.*, 2002) <sup>[22]</sup>. Thymol is also a phenolic compound that has been shown to possess antimicrobial, anti-inflammatory, and antitumor properties. Thymol has also been reported to exhibit bronchodilatory effects, which can help in the management of respiratory disorders (Nagoor Meeran *et al.*, 2017) <sup>[14]</sup>. Excellent expectorants, carvacrol and thymol are used to treat a variety of respiratory conditions (Spreng, 2016) <sup>[41]</sup>. Carvacrol (70%) and Thymol (3%) are the two main ingredients of Mexican mint (Murthy *et al.*, 2009) <sup>[13]</sup>. The aerial portions, leaves, and flowers of the plant contain both of these elements. Gas chromatography-Mass spectrometry (GC-MS) can be used to extract it (Spreng, 2016) <sup>[41]</sup>. Both of these are effective expectorants, which are drugs that facilitate breathing by assisting in the removal of mucus or sputum from the upper and lower airways, including the lungs, bronchi, and trachea. It causes an increase in bronchial secretions, and mucolytics aid in liquifying viscous secretions (Kagan *et al.*, 2009) <sup>[8]</sup>. In order to facilitate easier removal of mucus by coughing, expectorants lessen the thickness or viscosity of bronchial secretions, whereas mucolytics alter the chemical makeup of mucus molecules. As the mucus thins, it may be coughed up and out more readily. Their mechanism of action is that expectorants irritate the stomach vagal receptors that stimulate fluid in the respiratory tract, increasing the volume while lowering the viscosity of the respiratory tract secretions, making breathing easier (Boards *et al.*, 1944) <sup>[3]</sup>.

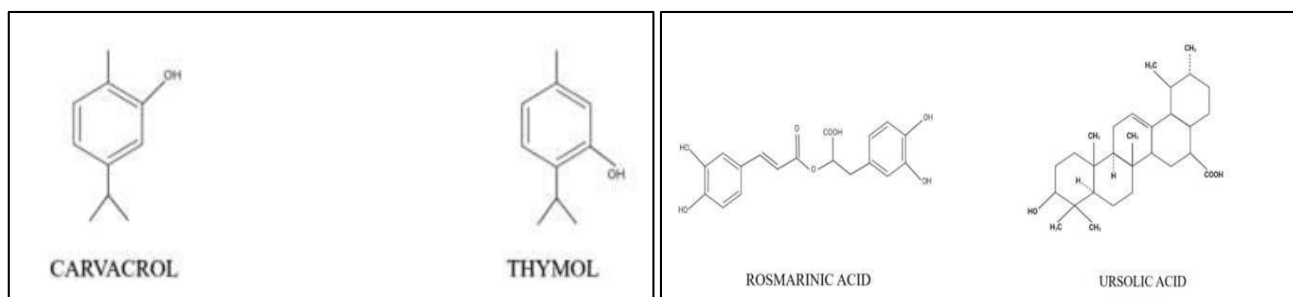
In addition to carvacrol and thymol, *Plectranthus amboinicus* leaves also contain the compounds like rosmarinic acid, Ursolic acid etc. Rosmarinic acid is a phenolic compound that exhibits potent antioxidant and anti-inflammatory properties. It has been reported to reduce inflammation and oxidative stress in the lungs, which can help in the management of respiratory disorders. Ursolic acid is a triterpenoid compound found in *Plectranthus amboinicus* leaves, and has also been

reported to possess anti-inflammatory and antioxidant properties. It has been shown to reduce inflammation in the lungs and improve lung function, which can be beneficial in the management of respiratory disorders (Rodríguez-Cámbara *et al.*, 2016) [20].

Overall, the bioactive compounds found in *Plectranthus amboinicus* leaves have shown promising potential for the relief of respiratory disorders (Nagoor Meeran *et al.*, 2017) [14].



Mode of action



Chemical structure of compounds

### Ayurvedic Use

*Plectranthus amboinicus* is also one of the most common species used in traditional Indian Ayurvedic medicine since ancient times (Palareti *et al.*, 2016) [15]. Many *Coleus* species have been utilized by ayurvedic doctors to treat conditions like calculus, gonorrhoea, heart disease, fever, piles, and dyspepsia. Since the beginning of time, the plant has been extensively explored for its potential uses in the treatment of ailments. These uses include cancer prevention, cancer therapy, and past biochemical antimutagenic properties. Plant extracts and essential oils having antibacterial properties have been used in traditional medicine for thousands of years. They are being researched for potential use as complementary treatments for infectious disorders. There have been reports of this plant's oil and extract having antimicrobial properties. According to traditional medical practitioners, this ancient medicinal plant has antibacterial properties, the ability to combat fungus, the ability to prevent malaria, and the ability to lower fever (Kumar *et al.*, 2019) [9]. *Plectranthus amboinicus* leaves are high in essential oils, which are thought to provide several health advantages. Traditional Ayurveda applications of *Plectranthus amboinicus* include digestive health, respiratory health, wound healing, stress and anxiety alleviation, and immune system support. In ancient days, the leaves of the Mexican mint is consumed orally to prevent many types of diseases like respiratory disorders, easy digestion etc. In Ayurveda, the leaves are used externally for wound healing and other skin diseases (Moyeenudin & Thiruchelvi, 2021) [12]. In ancient days, this plant was mainly used to prevent respiratory disorders like cough, sour throat, throat infection etc. Furthermore, the prevention is mainly

done by consuming the leaves orally, by mixing the leaves in the boiling water, or by making paste-like texture by using the ancient grindstone (Eisa, 2017) [6].

### Conclusion

*Plectranthus amboinicus* is an essential plant for keeping better health since it has the potential to be an aromatic medicinal herb when it is filled with many nutrients and bioactive components, which can provide health advantages. The essential oils in *Plectranthus amboinicus* have expectorant and decongestant properties like carvacrol, thymol, etc making it useful for treating respiratory disorders such as asthma, bronchitis, and cough. Some studies suggest that *Plectranthus amboinicus* has significant anti-inflammatory and antioxidant effects, which can help protect against chronic respiratory diseases, hence, mexican mint could be a reasonable alternative to other symptomatic treatments in patients with respiratory disorders. The plant has enormous biological relevance since it is an effective expectorant and is also used to treat cardiovascular, oral, digestive, urinary, skin diseases and as a natural remedy for insect bites and stings. The essential oils and a wide variety of bioactive substances of this plant are thought to contribute to these biological traits. It is reasonable to assume that this plant will be able to satisfy future worldwide demand for more affordable and secure bioactive chemicals. While existing research has shed light on the therapeutic potential of *Plectranthus amboinicus*, there is still much to be explored regarding its mechanisms of action, potential side effects, and optimal dosages. Therefore, future studies are needed to further investigate the plant's therapeutic potential.



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