

Plectranthus ambonicus and *Plectranthus zeylanicus*: As Promising Medicinal Plants

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Abstract: The genus *Plectranthus* (Lamiaceae) is a significant, prolific and extensively used genus in Asian and African countries due to their valuable medicinal properties and are used to treat a range of ailments, particularly digestive, skin, infective and respiratory problems. *Plectranthus* used as foods, flavours, fodder and materials. Monoterpenoids, sesquiterpenoids, diterpenoids and phenolics have been reported in species of *Plectranthus*. The two species of *Plectranthus ambonicus* and *zeylanicus* play a dominant role in both horticulture and traditional medicine. These species are documented for their use in treating ailments in indigenous medicine. But, these two medicinal plants with taxonomic ambiguity. Even though both plants are similar in appearance, their therapeutic properties are different. Therefore, the incorrect use of these plants in formulating medicines, would lead to unforeseen consequences or the true effect of the medicine will not be available. Thus, this review aims to provide an insight to these valuable medicinal plants and highlights the fact that not enough is known about the chemistry of these two species of *Plectranthus* to exploit their available phytochemicals in diverse array of pharmaceuticals and other natural products.

Keywords: natural products, *Plectranthus ambonicus*, *Plectranthus zeylanicus*, phyto therapeutic traditional medicine

1. Introduction

The family Lamiaceae contains several genera, such as sage (*Salvia*), basil (*Ocimum*) and mint (*Mentha*), with a rich diversity of ethnobotanical uses. Another important genus is *Plectranthus*, a large genus containing about 300 species found in Tropical Africa, Asia and Australia. Currently, around 62 *Plectranthus* species are used all around the world as ornamental plants and as medicines with economic interest, along with a rich diversity of ethnobotanical uses. They have antiseptic, vermifugal, and purgative activities and are used for the treatment of infections, toothache, stomachache, and allergies (Catherine et al., 2006). Some species of *Plectranthus* are difficult to identify because of a lack of clear-cut morphological criteria to discriminate not only among species within the genus but also among the

closely related genera. *Plectranthus ambonicus* (Sin. Kapparawalliya) and *P. zeylanicus* (Sin. Iriveriya), both are two highly important ethnobotanics, which are widely used in Ayurvedic, Unani and Siddha medicines in Sri Lanka and India. Since both plants belong to the same genus and family, most of the morphological characters are similar with taxonomic ambiguity. Due to this similar appearance, people use *P. zeylanicus* instead of *P. ambonicus* and vice versa and use of these plants in herbal formulations incorrectly might adversely effect on therapeutic properties of herbal drugs. Moreover, there are more than 100 written recipes in Sri Lankan Ayurveda pharmacopoeia which contain *P. zeylanicus* and *P. ambonicus* as major ingredients for the treatment of different ailments (Anon, 1979 & Jayaweera, 1982).



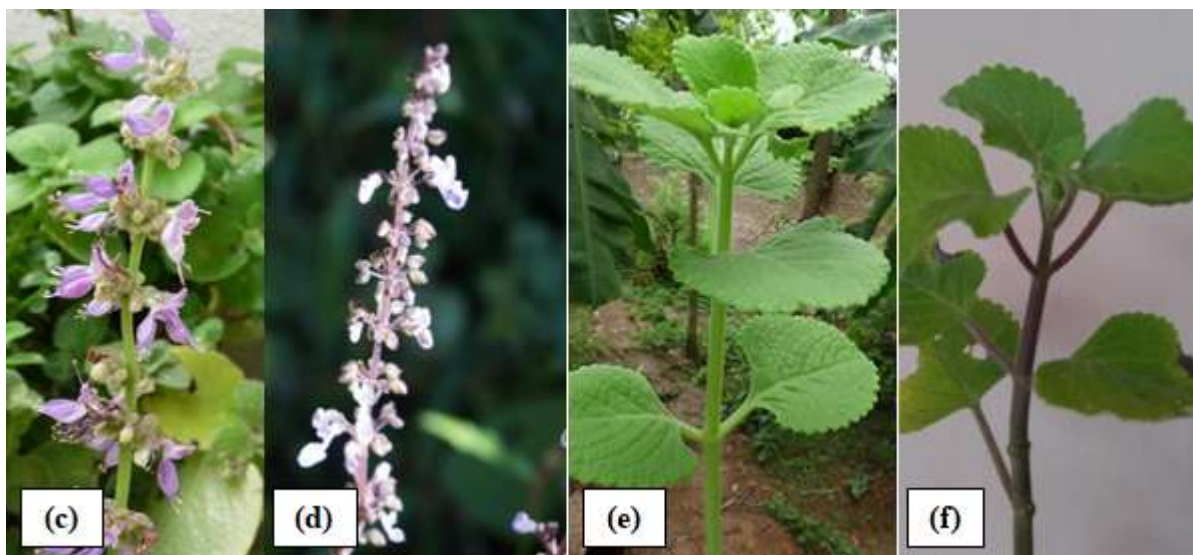


Figure 1: Morphological variations of *Plectranthus amboinicus* and *Plectranthus zeylanicus* [(a) & (b)- well grown *Plectranthus amboinicus* and *Plectranthus zeylanicus*, (c) & (d) - Flowering branches of *Plectranthus amboinicus* and *Plectranthus zeylanicus* (e) & (f)- Twigs of *Plectranthus amboinicus* and *Plectranthus zeylanicus* showing vegetative characters]

2. *Plectranthus amboinicus* (Lour.)

2.1 Classification of *Plectranthus amboinicus*

Kingdom - Plantae
 Division - Dicotyledons
 Order - Lamiales
 Family - Lamiaceae /Labiatae
 Subfamily - Nepetoideae
 Genus - *Plectranthus*
 Species - *Plectranthus amboinicus*
 Other names - Indian borage,

2.2 Geographical Distribution

Plectranthus amboinicus is a perennial, widely distributed in tropical to subtropical conditions and in warm temperate climatic zone on mountains of India, Nepal, Burma, Sri Lanka, Thailand and Africa. It comes up well on the sun exposed dry hill slopes from 300m to 1800m altitude. The herb grows easily in a well-drained, semi-shaded position. It is frost tender and grows well in sub-tropical and tropical locations, but grow well in cooler climates if grown in a pot (Roshan et al., 2010). This plant is commonly cultivated in home gardens throughout India and Ceylon (Jayaweera, 1982 & Catherine, 2006).

2.3 Morphological Characteristics

Plectranthus amboinicus is a succulent herb with a circular stem (Muthukumarana and Dharmadasa, 2014). The leaves are very thick and succulent, grey-green and hairy. The plant grows to around 50cm tall. The leaves are highly aromatic with a strong flavor of mixed herbs. The roots are thick, tuberous, fasciculate up to 20cm long, 0.5-2.5cm thick, conical, fusiform and straight. Racemes are perfect the calyx is toothed and deflexed in the front. Flowers are pale purplish in dense whorls at distant intervals in a long slender raceme. Fruits are orbicular or either ovoid nut lets.

2.4 Pharmacological Properties of *Plectranthus amboinicus*

The leaves of *Plectranthus amboinicus* possess a traditional medicinal use which includes the treatment for cough, sore throat and nasal congestion, but also for a range of other problems such as infections, rheumatism and flatulence. In Indonesia, *Plectranthus amboinicus* is a traditional food used in soup to stimulate lactation for a month or so following childbirth (Morton, 1992). The herb is also used as a substitute for oregano in the food trade and food labeled "oregano-flavored" (Gurgel and Silva, 2009).

Pharmacological activities of *Plectranthus amboinicus* have been investigated by different groups of researchers and found to have anti-tumor and cytotoxic activities (Norazsida et al. 2017). In Eastern Cuba, it is used as herbal mixture as a traditional medicine for treating catarrhal infections (Cano and Volpato, 2004). Application of bruised leaf on burns is also reported, the leaf extract shows regulatory influence on calcium oxalate stone formation in experimental rats. Researchers have also proved that the leaves of *Plectranthus amboinicus* are used to expel kidney stone (Cano and Volpato, 2004). A recent research article has stated that, the leaf extracts has efficient antimicrobial activities (both antibacterial and antifungal properties) (Murthy et al. 2009). Especially, the juice of its leaves is used for curing wounds and an infection since it possesses anti-influenza properties (Cock et al., 2018). Report states that the ethanolic extract of *Plectranthus amboinicus* has anticlastogenic potency against anti-cancer drugs (Arumugam et al. 2016). Leaves are anthilithic, antispasmodic, carminative and stimulant. They are useful in treating urinary diseases and vaginal discharge (Murthy et al. 2009). The leaves juice is carminative when mixed with sugar, given to children incolic (Patel, 2010). It is beneficial for asthma, calculus, chronic cough, dyspepsia, fever, gonorrhea and piles. It is externally used in conjunctivitis and bruised leaves locally applied for headache. The expressed juice is used in epilepsy and other

convulsive disorders and plant extracts used in the treatment of gastrointestinal troubles (Chatterjee et al., 2001).

According to Catherine et al., (2006) in her review report stated that many species of *Plectranthus* are used to treat different conditions. *Plectranthus amboinicus* and *Plectranthus barbatus* are used for treating stiff neck when the leaves are burned little and applied for backache. It is reported to exhibit relaxant activity on smooth and skeletal muscles (Catherine et al., 2006). A recent research showed its inhibitory effect over pro-inflammatory mediators and they found that the plant is having both anti-inflammatory as well as analgesic activity. They stated that it is used in folk-fore medicine for relieving pain and inflammation (Stark et al., 2013).

The results of a most recent research on the study of its neuro protective effect using aluminum induced neurotoxicity in rats strengthen the oxidative stress hypothesis of aluminum-induced neurotoxicity and suggest the beneficial role of the methanolic leaf extract in the management of Alzheimer's disease, oxidative stress and moreover cognitive-enhancing activity of the plant may be exerted through antioxidant mechanism (Rajathi et al., 2013). An earlier research states that the hydro alcoholic extract of the leaves of *Plectranthus amboinicus* (Lour) was found to show anti-inflammatory and anti-tumor activities. The anti-tumor study was carried out using Sarcoma-180 and Erich ascites carcinoma with the dose ranging from 100-300mg/kg (Gurgel and Silva, 2009).

3. *Plectranthus zeylanicus* (Benth.) Roxb.

3.1 Classification of *Plectranthus zeylanicus* (Benth.) Roxb.

Kingdom - Plantae
 Division - Dicotyledons
 Order - Larniales
 Family - Laniaceae
 Subfamily - Nepetoideae
 Genus - *Plectranthus*
 Species - *Plectranthus zeylanicus*

3.2 Geographical Distribution

Since *Plectranthus zeylanicus* is endemic to Sri Lanka, only limited research has been carried out. In the mid and low-country elevation in Sri Lanka, commonly cultivated in most gardens for medicinal purpose as a perennial herb. (Jayaweera, 1982).

3.3 Morphological Characteristics

Plectranthus zeylanicus is also a succulent herb with a quadrangular stem as seen in many other species of genus *Plectranthus* (Muthukumarana and Dharmadasa, 2014) in reddish purple colour. The leaves are very thick and succulent, grey-green and hairy. simple, opposite, aromatic, orbicular to ovate, truncate at base, rounded at apex, coriaceous on both sides, somewhat succulent, dentate, light green on the upper surface, paler below, veins are prominent beneath. Flowers are pale bluish at branched intervals in a

long slender raceme. Flowering occur in May and June (Jayaweera, 1982).

3.4 Pharmacological Properties of *Plectranthus zeylanicus*

P. zeylanicus possesses aromatic, astringent and stomachic properties and is used in many ways. According to the Ayurveda pharmacopoeia, *P. zeylanicus* is incorporated as a main ingredient in more than 50 traditional ayurvedic recipes (Table 2).

Table 2: Main Ayurveda formulae containing *Plectranthus zeylanicus* and their main uses (Ayurveda pharmacopoeia 1979)

Name of the product	Main use/s
Punarnawadyaristaya Dashangaleepaya	Oedema
Ushiradiya	Fever, Burning sensation
Danyapanchaka-kwathaya Pancharnuladee-kwathaya II Fachanamrutha-kwatha Pathasamangadee- kwatha Mulhgadee- kwathaya Mustha-shuntyadeeya Fever Vanrn u thuadee- kashaya Wathsakadee —Kwatha Suwadahotadceya Fever Sun theedaru —kwathaya Saraswathee —churnaya	Fever
Chandanadeekashaya	Burning sensation
Chandrahkanthi oil Nayanakeethakee oil Nayanaharana oil Nawapatala oil Nethrapatalakanthirathna oil	Eye disease
Mahabala oil	Eye disease, Epilepsy
Mahawikara oil Kaladuruadee Kashaya Iramusuadee Kashaya Drakshadeel, II, III Drakshakarchuradeekwatha	Epilepsy
Dashawagaprameha oil	Diabetes
Rathpithkeethakia oil	Sleep apnea
Kantakaryadeekwathaya	Tuberculosis
Maharathhadun —kashaya Sri-pa rnayadee-kashaya	Skin disease
Mahamanjishthadeeya	Sypiles
Valu-kashaya	Psychosis
Vasarnusthakadee-kwathaya	Asthma, Diarrhoea
Shathawareadee-Kwatha	Urinary tract disease
Sulupahadee-kashaya	Fever, Diarrhoea

3.5 Comparison of Essential Oil Content from *P. ambonicus* and *P. zeylanicus*

Essential oils are isolated from different parts of the plants and are complex of volatile mixtures of secondary metabolites. They are responsible for the fragrance, the flavor, as well as the medicinal importance of the plant. Due to these virtues, they highly important in the perfumery, food, and beverage industries, and also in therapeutic applications (Vagionas et al., 2007). Essential oils are generally extracted by distillation. Other processes include solvent extraction. The genus *Plectranthus* of the Lamiaceae, subfamily Nepetoideae, is rich in essential oils

(Cantino& Sanders, 1986). The main constituents of the essential oils of *Plectranthus* species are mono- and sesquiterpenes.

P. amboinicus has been found to rich inessential oils and fatty acids (Murthy et al., 2009). On a fused-silica capillary GC column, the essential oil of *P. amboinicus* was separated into α -pinene, camphene, oct-1-en-3-ol, β -pinene, myrcene, α -phellandrene, D3-carene, α -terpinene, p-cymene, limonene, (Z)- β -ocimene, (E)- β -ocimene, α -phellandrene, γ -terpinolene, linalool, camphor, 1-terpinen-4-ol, α -terpineol, thymol, carvacrol, α -cubebene, β -cubebene, β -elemene, β -caryophyllene, α -bergamotene, (Z)- β -farnesene, α -humulene, β -guaiene, (–)- α -selinene, β -bisabolene, δ -cadinene, caryophyllene oxide, γ -cadinol, α -cadinol, farnesol, calamenol, and (–)-aromadendrane-4 β , 7 β -diol (Vera et al., 1992)6 β , 7 β -dihydroxyroyleanone is present in *Plectranthus zeylanicus* (Mehrotra et al., 1989).

According to the Gas chromatograph, oil of *Plectranthus zeylanicus* was a mixture of more than 100 compounds and most of them were in trace amounts (not detectable). However, around 60 compounds were recorded. P-cymene, Geraniol and Geranylacetate were identified based on boosting authentic standards method and retention time data. Also, 6 β , 7 β -dihydroxyroyleanone is present in *Plectranthus zeylanicus* (Mehrotra et al., 1989). The shoots of *Plectranthus zeylanicus*, resulted in higher percentages of essential oil compounds; Geranyl acetate, Geraniol and P-cymene respectively. Geraniol is an acyclic, doubly unsaturated alcohol which can undergo a number of reactions such as rearrangement and cyclization yielding important chemical compounds like citronellal and citral (Bauer et al., 2018) and of the most important molecules in the flavor and fragrance industries and is a common ingredient in consumer products produced by these industries. In addition to its pleasant odor, geraniol is known to exhibit insecticidal and repellent properties and used as a natural pest control agent exhibiting low toxicity (Surburg & Panten, 2006) and same authors have suggested that geraniol is to represent a new class of chemoprevention agents for cancer. Geranyl acetate is widely used as flavoring agents in food additives, odor agents in industries and World consumption has been estimated at 650 tpa (Surburg & Panten, 2016).

Biologically active mono- and sesquiterpenoids are frequently found in many species of *Plectranthus* but there are little published data that directly link the presence of specific compounds in a species with the traditional uses of that species. Therefore, it is highly required to analyze availability of these compounds in *P. amboinicus* and *P. zeylanicus*, specially the chemical; composition of *P. zeylanicus* due to lack of reliable literature and sources about this species. Other monoterpenes and sesquiterpenes have been reported from different species and many have antimicrobial activity including limonene, linalool, myrcene and thymol from *Plectranthus amboinicus* (Singh et al., 2007).

Essential oil content of different parts of the plants (roots, stems and leaves) of *Plectranthus amboinicus* and *Plectranthus zeylanicus* at 4 months' age with commercial

samples are presented in Table 2. According to the previous studies conducted on chemical composition of *Plectranthus zeylanicus*, it has been found that with increasing maturity of plant parts, the percentage of essential oil compounds increases and at four months' maturity most of the compounds are observed (Betty & Thoppil, 2004). According to the table 2, the highest oil content was reported from roots and as well as commercial samples compared to the stem and leaf. The content of essential oil was varied as leaf< stem<root.

Table 2: Essential oil content of different parts of *Plectranthus amboinicus* and *Plectranthus zeylanicus*

Plant part	Oil content (%)	
	<i>Plectranthus amboinicus</i>	<i>Plectranthus zeylanicus</i>
Leaf	0.49 \pm 0.035	0.71 \pm 0.035
Stem	0.6 \pm 0.016	0.72 \pm 0.028
Root	1.13 \pm 0.021	0.91 \pm 0.035
Commercial sample		
Leaf	0.57 \pm 0.042	0.86 \pm 0.241
Stem	0.84 \pm 0.021	0.78 \pm 0.014
Root	1.20 \pm 0.28	0.84 \pm 0.233

Results are the mean of 3 replicates, \pm = indicates the standard deviation.

3.6 Antimicrobial, antifungal and anti-inflammatory natural products from *Plectranthus zeylanicus*

Plectranthus zeylanicus, a plant claimed as an antimicrobial remedy in traditional medicine and the green synthesis of silver and zinc oxide nanoparticles as effective herbal disinfectants (Soyza et al., 2016). According to a study on biosynthesis of silver and zinc oxide nanoparticles from *P. Zeylanicus* for developing antimicrobial formulations by Soyza et al., 2016, has revealed the potential of developing eco-friendly herbal disinfectant/s and further investigations are required. Also, a study done by (Mashfiya & Haroon 2016)has revealed that the extract of *Plectranthus zeylanicus* possess significant antifungal activity profile against *Aspergillus* showing a highest inhibition activity is present in (75% Hexane: 25% Ethyl acetate) and (80% Ethyl acetate: 20% methanol) fractions. When consider about antioxidant and anti-inflammatory properties of *P. zeylanicus*, theterpenoid fraction efficiently scavenged DPPH, OH \cdot and NO \cdot radicals inferring that theterpenoid fraction seems to be good sources of natural antioxidants (Miguel, 2016).

Phytotherapeutic agents are standardized herbal preparations consisting of complex mixtures of one or more plants which contain as active ingredients plant parts or plant material in the crude or processed state. A marked growth in the worldwide phytotherapeutic market has occurred over the last 15 years. According to the WHO guidelines good Agricultural and Collection Practices (GAP), proper identification of a plant species, quality control and standardization of herbal materials are considered key issues for most plants to guarantee their quality, efficacy and safety. In the present study, we investigated an efficient protocol for commercial scale production and conservation of *Plectranthus zeylanicus* using tissue culture techniques and essential oil content of tissue cultured plantlets with maturity by using recommended protocols. These results on chemical analysis are in agreement with previous studies

(Chauhan & Pillai, 2007). Therefore, results of the present study either singularly or as a whole could be incorporated for commercial scale production, standardization and quality control of *Plectranthus zeylanicus*.

4. Conclusion

Although the genus *Plectranthus* comprises many plants of medicinal and economic interest, the chemistry of Sri Lankan species, *P. zeylanicus* of this genus remains poorly known. *P. amboinicus* and *P. zeylanicus* are two common species used in the traditional Sri Lankan and Indian Ayurvedic medicine since ancient times. Thus, both *Plectranthus amboinicus* and *Plectranthus zeylanicus* are promising medicinal plants with aromatic importance in many industrial aspects.

This review provides an insight to these valuable medicinal plants and highlights the fact that not enough is known about the chemistry of these two species of *Plectranthus* to exploit their available phytochemicals in diverse array of pharmaceuticals and other natural products.

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