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Plectranthus amboinicus and its Various Biological Activities - A Review

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ABSTRACT

Present review focuses the pharmacological activities and bioactive compounds of *Plectranthus amboinicus*. *P. amboinicus* has been used in herbal therapy to treat a variety of ailments, including asthma, flu, eczema, and cardiovascular problems. The presence of various Phytoconstituents such as Phenol, tannins, squalene, glycosides, and flavonoids, the plant has medicinal properties such as Wound healing, Diuretic, skincare, Anti-inflammatory, antimalarial, anxiolytic, antiplatelet, antifungal, analgesic, antimicrobial, antibiofilm efficacy, antineoplastic, anti-diabetic, and respiratory disorder. Medicines have been made from various parts of the plant. This plant can be utilized to make medicines with no side effects because it contains a variety of vital ingredients.

Key words: *P. amboinicus*, Antibacterial, Phytochemical, Antofungal, Antidiabetic

Plectranthus amboinicus comes under the *lamiaceae* family. It may be found practically everywhere in India. It is a medicinal herb that has been employed in folklore medicine for therapy (syrup). Other conditions that it can help with include the flu, pneumonia, and epilepsy. It contains flavonoids such as apigenin, luteolin, and salvigenin, according to a photochemical analysis. *Lamiaceae* is a plant family with approximately 200 genera and species in the 3200 species that have a history of being used to treat illnesses and as food. *P. amboinicus*, aids in taxonomic identification. *C. aromaticus* belong to the *Lamiaceae* (Labiatae) family and genus *Coleus* (now called *Plectranthus*). It's a huge, juicy perennial aromatic herb with thick, fleshy leaves and stem that grows 30–90 cm tall. This is a succulent, heavily branched herb with aromatic leaves that have a distinct scent. This plant can be found all over India, and it is also grown in gardens for its flavour and perfume; the *P. amboinicus* leaves are perfect for seasoning fish and meat, as they enhance the taste of the foods while also masking odours. Its applications in the food industry have a lot of potential for research [1-6].

Botanical description

Taxonomy

Plectranthus amboinicus is a type of *Plectranthus* Sprengel that belongs to the *Lamiaceae* family of plants and the *Nepetoideae* subfamily. There are approximately 300 species of

subshrubs in this plant, which can be annual or perennial. Succulents make up the majority of these. *P. amboinicus* is a significant member of the genus since it is a fragrant and medicinal succulent. This plant is known for the unusual odor emanating from its leaves, which have very minute, soft hairs that rise to the surface [8].

Plant classification

Division	: Magnoliophyta
Kingdom	: Plantae
Clade	: Angiosperms
Class	: Magnoliopsida
Order	: Lamiales
Family	: Lamiaceae
Genus	: Plectranthus
Species	: <i>Coleus aromaticus</i>
Synonyms	: <i>Coleus amboinicus</i> Lour [7]

Morphological features

The succulent shrub *Plectranthus amboinicus* is described as having a climbing or creeping habit. Its wild variations are said to grow to a height of more than 1 m and a width of more than 1 m. These have a strong scent and are quite meaty. The stem can grow up to 30-90 cm in length and is covered in stiff hairs. Leaves' morphology is described as "simple and thick." The leaf has a blunt tip and is oblong to suborbicular in shape. The lower surface of the leaves has a large quantity of glandular hairs. The presence of these hairs gives the appearance of being fostered. The leaf has a wonderful aroma and flavor, as well as a pleasant and refreshing odor. The flower is a drab purplish tint. They are found on a short stem with a thick whorl and a short pedicel. The calyx is bell-shaped, and the throat has two smooth lips. The upper lip is slender and elliptical, with four

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tiny teeth on the bottom lip. There is an all purple-colored corolla that is more than four times the size of the calyx and has a tubular form with a short lip. Fruit nutlets are light brown in color and measure 0.7 mm in length and 0.5 mm in breadth. Collecting the seeds and colors of these plants is quite tough.



Fig 1 Picture of *P. amboinicus* plant

Wild relatives and geographical distribution

The name *Plectranthus* comes from the Greek terms “plectron,” which means spur, and “Anthos,” which means flower. The presence of spur-shaped flower in most of the plants belonging to this genus is associated with this name. Because there is no deep and accurate understanding of external features to distinguish between species of the genus *Plectranthus*, several difficulties with taxonomic names lead to improper placement of species of closely related genera like *Englerastrum*, *Coleus* and *Solenostemon*. *P. amboinicus* was first divided in the *Coleus* genus, and then in the *Plectranthus* genus; nonetheless, both names are used in literature, and there are numerous synonyms for this species. The taxonomy of *plectranthus* has been revised, albeit only at a regional level, resulting in major confusion about the same species. *P. amboinicus* is a fast-growing plant that propagates by stem cuttings. Because the plant rarely sets seeds, vegetative propagation is also used. When planted in a pot, the plant adapts well to a variety of climates. The plant should only be watered infrequently. Organic-rich soil, high humidity, and a neutral pH are essential for *P. amboinicus* to flourish well. As a result, this plant grows easily inside and is consequently a common houseplant in northern Europe [9].

Pharmacological uses

This herb has been used in folklore medicine for many years. This plant heals wounds effectively and with few adverse effects, so it's a really outstanding herb in this regard. The lethal poisonous dose of this plant was tested in laboratory mice, revealing that *P. amboinicus* is an herb without adverse effects, or to put it another way, this magnificent herb has no negative effects. The *Plectranthus amboinicus* is used to treat diseases such as asthma, cough, diarrhea, cholera, anorexia, fever, hepatopathy, malaria, etc. In Japan, this plant is used to treat mouth corner cracks. *P. amboinicus* has been shown to have anthelmintic activity, and as a result, it is widely farmed. Constant study and analysis revealed that undertaken to verify that *P. amboinicus* has antioxidant properties to meet the increased demand for herbal medications. *Coleus* species are significant because they provide food, medicinal, and decorative value. *Coleus* variants have been utilized by Ayurvedic practitioners for a variety of ailments, including fever piles, dyspepsia, gonorrhoea, heart illness, and calculus. The plant has been extensively researched for activities such as

prior biochemical antimutagenic and cancer, these compounds have antigen harmful properties, and are also useful for illness therapy [10-13].

Antimicrobial activity

The chloroform and Methanol extracts of *Plectranthus amboinicus* were tested against nine bacteria and four fungi, including *S. aureus*, *P. aeruginosa*, *E. coli*, *S. typhi*, *P. vulgaris*, *B. cereus*, *E. faecalis*, *S. flexneri*, *K. pneumoniae* and *C. albicans*, *A. niger*, *A. flavus*, *A. fumigatus*. *Plectranthus amboinicus* methanol extract had the best antibacterial activity against the bacteria *K. pneumoniae* and the fungus *Candida albicans*. *Plectranthus amboinicus* has higher antibacterial activity at 100 mg/ml concentration than at 50 mg/ml concentration. The Methanol extract of *P. amboinicus* demonstrated the strongest antibacterial activity when compared to the Chloroform extract. Except for *C. albicans*, a fungal yeast, *P. amboinicus* has shown good antibacterial activity against most bacteria. Other fungi, such as *A. niger*, *A. flavus*, *A. fumigatus*, and the Negative DMSO control, revealed no inhibitory zone [14].

Antioxidant activity

DPPH test, reducing power assay, and nitric acid screening procedures were used to assess the antioxidant potential of aqueous and ethanolic extracts of leaves of *Plectranthus amboinicus* (Lour) Spr. The total phenolic content is assessed because it contributes to the anti-oxidant properties of the product. With increasing concentrations of extract (50 µg – 250 µg), the anti-oxidant potential and reducing the power of both extracts. The phenolic content of ethanolic and aqueous extracts was determined to be 11.6 µg gallic acid equivalent per mg of extracts and 9.4 µg gallic acid equivalent per mg of extracts, respectively [15].

Anti-cancer activity

The currently studied the anticancer activity of *Plectranthus amboinicus* (Lour) essential oil on B16F-10 melanoma cell line injected C57BL/6 mice, which were then treated with the essential oil of *P. amboinicus* (50 µg/dose) via i.p. for 21 days. The essential oil of *P. amboinicus* have a potent chemotherapeutic/chemopreventive impact on lung metastasis in the current study. This is the first study to look at the effects of *P. amboinicus* (Lour) essential oil on lung cancer [11]. WiDr, HeLa, T47D, and WMCF-7 cell lines were studied in vitro using the 2,5-diphenyl tetrazolium bromide technique. Docking in silico with the PLANTS tool and visualization with the Yasara programme. EGFR, PI3K, ER, and human EGFR 2 were employed as models of three-dimensional enzyme architectures in this study (HER-2). The Marvin Sketch programme was used to create two and three dimensions of tamoxifen, sitosterol, and ZSTK474 as the standard. According to the findings, -sitosterol has inhibitory concentrations of 50 percent of 0.55, 0.87, 0.76, and 0.99 mM. EGFR and PI3K were suppressed by -sitosterol and ZSTK474 with docking scores of 92.8195; 91.7920 and 91.7470; 94.7491. ER-, ER-, and HER-2 were suppressed by -sitosterol and tamoxifen, with docking scores of 78.5570; 89.535, 68.7717; 52.008 and 90.4908; 50.5576, respectively [16].

Antibacterial activity

50 g/ml of ethanol extracts of *P. amboinicus* have antibacterial activity against *Streptococcus mutans*. For a variety of reasons, *P. amboinicus* leaves were chosen for the study of microorganisms. This plant is capable of combating *S. mutans* [17-18].

Antifungal activity

An agar well diffusion experiment was used to test *P. amboinicus* antifungal activity. In yeast extract sucrose medium, the effective concentration of Indian borage oil (IBO) on *A. ochraceus* growth was determined. IBO inhibited the radial growth of mycelia and exhibited broad fungitoxic properties against *A. oryzae*, *S. cerevisiae*, *Penicillium sp.*, *A. niger*, *A. ochraceus* CFR 221, *C. versatilis*, *Fusarium sp.* GF-1019, and *A. flavus*. At 500ppm, IBO completely inhibited the toxigenic strain *A. ochraceus* from producing ochratoxin (OTA). Furthermore, using IBO at 100 mg/g in food samples inhibited *A. ochraceus* growth in food systems like poultry, feed, and groundnut, maize, and no detectable quantity of OTA was present even after seven days at a 30% of high moisture level. Indian Borage Oil potentially have fungitoxicant that is used to protect stored foods against fungus attacks [19].

Anti-inflammatory activity

Anti-inflammatory potential of *P. amboinicus* leaves were carried out in vivo and in vitro. In mice, formalin-induced nociception and paw edema were studied in vivo, as well as lipopolysaccharide-induced inflammability using IC-21 macrophage in vitro. The phytochemical contents of *P. amboinicus* leaf extracts in aqueous and ethyl acetate were investigated. The carvacrol-containing ethyl acetate extract had better antinociception, with shorter paw licking times in the later phase of nociception and a 35 percent reduction in hind paw edema volume. The biochemical analysis revealed that pretreatment with both extracts modulated oxidative stress markers such as malondialdehyde and antioxidant enzymes, as well as the expression of inducible nuclear kappa B protein, nitric oxide synthase, IL-1, histamine 1 receptor genes, and cyclooxygenase. In addition, *P. amboinicus*-treated IC-21 macrophages showed a nitric oxide inhibitory action. As a result, that carvacrol in ethyl acetate extract has anti-inflammatory efficacy [20].

Anxiolytic activity

In mice, the elevated plus-maze, light-dark model, and hole-board test were used to analyze the alcoholic extract of *P. amboinicus*. In comparison to control mice, the extract was given orally at three different doses of 250, 500, and 750 mg/kg enhanced the time spent and several arm entries on the open arms of the elevated plus-maze, as well as the time spent in the lighted side of the light-dark test. In the hole-board test, doses of 500 and 750 mg/kg revealed in a greater increase in nose poking and decreased motility [21].

Diuretic activity

The diuretic effects of ethanolic and aqueous extracts were tested in male albino rats by measuring urine volume and electrolyte concentration. The benchmark was furosemide (10 mg/kg), while the control was normal saline (0.9 percent). The amount of urine and urinary concentrations of sodium, Potassium, and Chloride ions were significantly increased in both Aqueous and ethanolic extracts. As a result of this research, *P. amboinicus* have Diuretic properties [22].

Wound healing activity

Five distinct varieties of rats were used in the experiment. While under ketamine anaesthesia, each rat experienced partial-thickness burns. The wounds in the five groups of rats were treated topically with a petroleum base, silver sulfadiazine, 1 percent, 2 percent, and 3 percent ethanolic extract of *P. amboinicus* ointment, respectively, once daily for 21 days or until complete healing, whichever occurred first. The duration of epithelization and the rate of wound contraction

were also measured. According to the finding's, wound constriction was significantly higher in the *P. amboinicus*-treated groups than the control groups. The mean period of epithelization in the *P. amboinicus* treated group was significantly shorter than the control and silver sulfadiazine treated groups [23].

Antiurolithiatic activity

Water extract of *P. amboinicus* leaves were used to test antiurolithiatic activity on calcium stones in male rats. The extract of *P. amboinicus* made from the water was found to be effective in reducing calcium oxalate buildup. These findings show that *C. aromaticus* is effective in the treatment of calcium oxalate urinary and kidney tract stones. The research reveals that the kidneys have a more quantity of calcium oxalate crystals, as well as excessive fat levels in the blood serum. This reveals that giving a hydroalcoholic extract of *P. amboinicus* leaves to urolithiasis rats helps to lower cholesterol levels as well as other lipids like triglycerides [24-25].

Analgesic activity

Plectranthus amboinicus was tested as an analgesic in two animal models using intraperitoneal injections of acetic acid, which causes an increase in abdominal fluid prostaglandins like PGE2, and PGF2, serotonin, and histamine. The researchers discovered that *Plectranthus amboinicus* reduces the cramps and pain response caused by acetic acid in rats, but not the neurogenic pain caused by acetic acid. *P. amboinicus* has significant analgesic effects, according to these data [26].

Respiratory disorder

Cough treatment using *Coleus aromaticus* leaf infusion or aromatic syrup has been shown to be quite beneficial. The specifics of this are not given, and its use is only mentioned in Zulu medicine. The plant's leaves are used to flavour cuisine. This species is also used in cattle to treat sore throats, stuffy noses, congestion, aching sinuses, and other ailments. After chewing, the leaves provide relief because they contain chemical components that serve as expectorants, removing phlegm and mucus and clearing the sinuses. It also helps to boost immunity by preventing the growth of germs and other pathogens [19], [27-28].

Antiplatelet aggregation activity

Plectranthus amboinicus stem extract was tested for activity against platelet aggregation at various concentrations (50–250 g/ml, platelet-rich plasma), with adenosine triphosphate as the agonist; the results showed that platelet capacity to aggregate is dose-dependent, meaning that the higher the concentration, the greater the ability. Platelets play a crucial function in blood and in cardiovascular diseases, as we all know. Platelet activity can influence disease progression and atherosclerotic stability, thus natural antithrombotic medicines that can improve platelet function and also assist prevent cardiovascular disease are of increasing interest these days [29-30].

Antibiofilm efficiency

Plectranthus amboinicus extracts in methanol and ethyl acetate inhibited film formation in a dose-dependent manner. Inflammatory disorders such as pharyngitis are caused by pyrogens. Methanolic extract outperforms both extracts against the test pathogen at low concentrations. Methanol extract contains a variety of phytochemicals that have an influence on the pathogen's biofilm formation [31].

Antimalarial activity

An acute oral toxicity dose of 5000 mg/kg was used to assess the extract's safety. Twenty mice were divided into two groups: experimental and control. All of the mice showed toxicity, mortality, weight changes, and histological changes. In vivo antimalarial efficacy of different extract dosages (50, 200, 400, and 1000 mg/kg) during early, established, and residual *Plasmodium berghei* infections were examined in mice (five mice per group) [32].

Anti-diabetic activity

Anti-diabetic activity was analyzed in *P. amboinicus* by et al. Ethanol extract of leaf at the dose of 400 mg/kg body weight for 14 days exhibited significant anti hyperglycemic activity by Decreasing gluconeogenesis and improved utilization of glucose by peripheral tissues. *P. amboinicus* have anti-diabetic property due to presence of flavonoids [33].

Table 1 Phytochemical Analysis of extract of the leaf of *P. amboinicus*

Constituents	Ethanol extract	Aqueous extract
Alkaloids	+	+
Sugar and carbohydrates	+	+
Glucosides	+	+
Protein	+	+
Amino acids	+	+
Steroids	-	-
Saponin	-	-
Flavonoids	+	+
Quinone	+	+
Tanins	+	+
Anthocyanin	-	-
Phenolic compounds	+	+
Terpenoid	+	+
Fixed oil and fats	-	-
Gum and mucilage	-	-
Resins	-	-

+presence
-absence

Phytoconstituents of P. amboinicus

Plectranthus amboinicus' chemical composition and pharmacological effects have been examined in a large and growing body of literature. The presence of diverse kinds of phytochemical compounds was emphasized in this paper. Phytochemists and biologists have recently been interested in identifying and understanding the pharmacological significance of various bioactive compounds isolated from *P. amboinicus*. Differences in isolation and detection processes can also create variations in phytochemical concentration. As a result, accurate phytochemical identification, separation, and quantification are critical for understanding their pharmacological and biological relevance. *P. amboinicus* is said to include monoterpenoids, diterpenoids, triterpenoids, sesquiterpenoids, phenolics, flavonoids, and esters, among other phytochemicals. This section delves into the specifics of these bioactive components [34].

To extract the shade dried powder of leaves of *P. amboinicus*, various organic solvents (distilled water, chloroform, alcohol, and petroleum ether) were utilized in increasing order of polarity. Thin Layer Chromatography and preliminary phytochemical analyses have been done to identified 10 bioactive components in the leaves (Table 1). The findings will aid in the development of pharmacognostic criteria for plant identification, purity, quality, and monograph preparation [35].

Size exclusion chromatography techniques were used to make extraction from *P. amboinicus*. After *P. amboinicus* was divided into ten fractions by using Size exclusion chromatography with chloroform, methanol, and Methanol: chloroform as mobile phases. The DPPH reagent was used to analyze the antioxidant activity for each fraction and extract. Then, Thin Layer Chromatography was used to filter all of the fractions and extracts (TLC). The antioxidant activity of various fractions was found to be higher than that of the extract. They were discovered to be seven chemicals using thin layer chromatography and HPLC. They are three in the extremely polar area, two in the intermediate polar area, and two in the low polar area (Table 2) [36].

Table 2 Phytochemical analysis of *P. amboinicus* crude extract [36]

Constituents	Methanol extract	Acetone extract
Saponins	+	+
Pholabatanins	+	+
Resins	+	+
Lipids or fat	+	+
Steroids	-	-
Glycosides	+	+
Acidic compounds	-	-
Terpenoids	+	+
Reducing sugar	+	+
Phenols	+	+
Carbohydrates	+	+
Anthraquinone	+	+
Catachol	+	+
Sterols	+	+
Flavonoids	+	+

+presence, -absence

The powered air dried of *P. amboinicus* leaves, stem, and roots was subjected to analysis the phytochemical components. The results of this analysis, volatile compounds, Terpenes and/sterols, carbohydrates, green glycones and/or Catechol tannins, and volatile Flavonoids were identified in the *P. amboinicus* parts (leaves, stems, and roots) (Table 3) [37].

Bhatt *et al.* [38] investigated the phytochemical analysis in *P. amboinicus* stem extract by HPLC technique. After phytochemical examination, total flavonoids, tannins, phenolic content were identified in the extract. The most abundant of phenolic was caffeic acid, P- coumatinic acid, gallic acid, rutin and rosmarinic acid. The methanolic extract of stem contains biomolecules and has significant biological activity, suggesting that it could be used as functional food additives and nutraceuticals [38].

*Ayurvedic effect**Coleus amboinicus* is used in ayurvedic remedies

Syrup de Byekof: Byekof Syrup is an Ayurvedic medicine that can be used to treat coughs, asthma, and other respiratory problems. Grahanimihira Taila is an Ayurvedic oil used to cure diarrhea, fever, cough, and other ailments. External and internal administration are both handled using this oil.

Koorkkila, an Ayurvedic herb, has medicinal uses

Although Koorkkila is most commonly used to cure common colds and coughs in infants and toddlers, Ayurveda advises it for a variety of other diseases.

Koorkkila is a finnish cold remedy

Pick a few fresh koorkkila leaves, warm them over a hot

tava, squeeze off the aromatic juice, and apply it to the top of the head and chest as a quick remedy for a runny nose. Internally, the juice can ease chest and nasal congestion, loosen

phlegm, calm throat infections, and relieve coughs. Steam inhalation with leaves added to the water clears nasal passageways and congested noses [39].

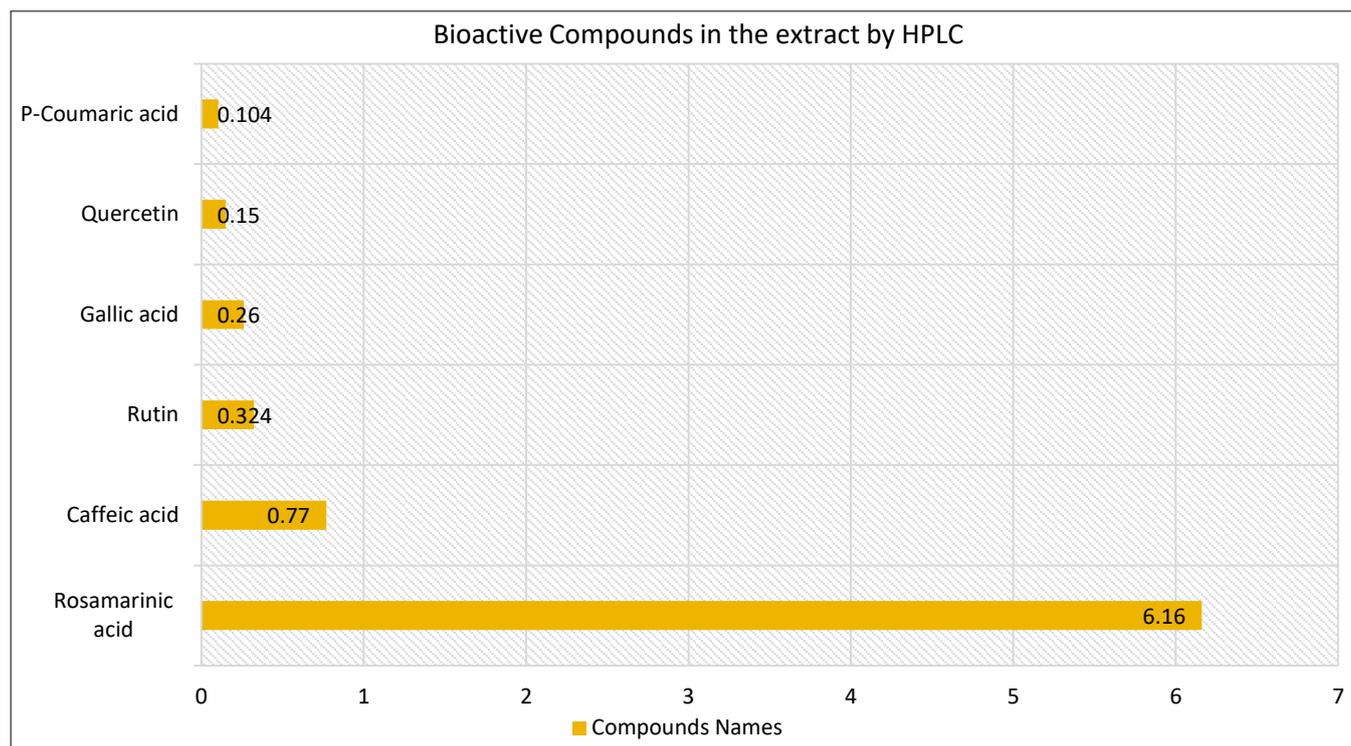


Fig 2 Graphics representation of total phenolic content in stem extract [38]

Table 3 Phytochemical screening of the different parts of *P. amboinicus* [37]

Constituents	Leaf	Stem	Root
Stem volatile substance	++	+	±
Sterols and/or triterpenes	++	+	+
Free glycones	++	+	+
Flavonoids	+	+	+
Crystalline sublimate	-	-	-
Carbohydrates	+	+	+
Glycosides			
Catechol tannins	+	+	++
Saponins	-	-	-
Alkaloids/ nitrogenous	-	-	-
Free anthraquinone	-	-	-
Combined anthraquinone	-	-	-
Cardiac glycosides	-	-	-
Bases			
Oxidases	-	-	-

+Presence, ++Strongly positive, ±Traces

Koorkkila as an anti-pyretic

When taken internally, the juice of koorkkila works as a fever reliever. Koorkkila is a Finnish word that means “first aid.” The juice of koorkkila leaves is used to treat bug bites. It relieves irritation and protects the skin from infection. It can also be used to treat small wounds and scrapes.

Lactating mothers' Koorkkila

Lactation is improved with Koorkkila. Furthermore, the health benefits of the mother's milk are passed on to the offspring [40].

Gastric troubles: Koorkkila

Koorkkila juice is a good remedy for both diarrhoea and flatulence.

Koorkkila in the kitchen

The aromatic and flavorful leaves are turned into tasty bajjis that are more than just a snack. These bajjis might also help with fever and throat problems. The leaves, which have a scent similar to oregano, are used to flavour soups and other foods in some culinary cultures.

This is why you should cultivate koorkkila in your Ayurvedic herbs garden so you can squeeze out the juice as soon as your child snuffles. These easy-to-grow herbs can be found here [41]

Table 4 Ayurvedic treatment of *P. amboinicus* [40]

Product name	Composition	Treatment
Punarnava panchang	Pure juice boerhavia, Diffusa sodium benzoate	Weight management, enlarged prostrate and liver, spleen problem
Punarnava powder	Anhydrous lactose, magnesium stearate, collidal silicon dioxide	Efficient kidney function, urinary tract infection, edema decreases inflammation and swelling, support liver function
Punarnava makoyaras	Embilica officinalis, boerhaaria, Diffusa picrohizakurrooa royalex, solanum nigrum, achillea	Help to cure jaundice, dissolve kidney stone, decreases acidity

CONCLUSION

According to the conclusions of this study, this plant can be used to treat a number of diseases. Because the plant has been used successfully in traditional medicine since ancient times,

more research is needed to discover its therapeutic applications. One of the most important characteristics of this plant is that it has a stronger effect when combined with other medicinal plants. The present review is all about pharmacological activities and the bioactive compounds.

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