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REVIEW ON *PIPER BETLE LEAF L.*

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ABSTRACT

Betel leaf (*Piper betle L.*), a member of the Piperaceae family, is a renowned medicinal plant native to Asia. It has diverse applications in medicine, industry, and pharmaceuticals due to its rich antioxidant and phytochemical content, along with its cooling and refreshing properties. Globally, there are 90 varieties of betel leaf, of which 45 are cultivated in India. This plant is cost-effective, safe, and available year-round. Betel leaf exhibits a wide range of therapeutic properties, including antifungal, antiseptic, antimicrobial, anticancer, antidiabetic, anti-allergic, anti-fertility, anti-filarial, wound-healing, and anti-dermatophytic effects. It also prevents gastrointestinal infections by modulating the immune system and may aid in diabetes management by regulating blood sugar levels. Traditionally, it is used in religious ceremonies and widely consumed after meals to promote digestion. Ayurveda recommends its consumption post-meal for benefits such as enhanced digestion, oral cleansing, cough reduction, and weight maintenance.Its medicinal applications extend to treating wounds, fungal infections, respiratory issues, joint pain, and oral health problems. Betel leaf extracts are also utilized in food preservation for their antifungal properties and in personal care products like toothpaste and perfumes. The review highlights the significance of betel leaf as a versatile botanical resource with immense potential to benefit humanity.

KEYWORDS: *Piper betel*, Pharmacological activity, Pan, medicinal plant, Nutritious leaf.

INTRODUCTION

Herbal medicine has been utilized globally for centuries to treat various infectious diseases. The use of medicinal plants as innovative antibiotics presents numerous advantages, including enhanced safety, greater availability, and a reduced risk of side effects and addiction.[1] One notable example is betel leaf, which is known by various names across different regions in India and other countries, reflecting its characteristics such as structure, color, aroma, taste, and size. Some of these names include Venmony, Magadhi, Salem, Kauri, Banarasi, Mysore, Bagerhati, Bangla, Kasi, Desavari, Meetha, Ghanagete, Sanchi, and Kapoori.[2]

Betel leaves are rich in antioxidants, including flavonoids, terpenoids, tannins, alkaloids, and saponins.[3] The Indian system of medicine has adopted the use of betel leaves for various applications. In traditional Indian medicine, they are well-known for their antiseptic properties and are frequently applied to wounds and lesions to promote healing. Additionally, the essential oil extracted from betel leaves serves as an industrial raw material for producing a variety of products such as medicines, perfumes, mouth fresheners, tonics, and food additives.[4]

In traditional practices, betel leaves are used as carminatives and stimulants and have antifungal and antibacterial properties.[5] *Piper betle L* is recognized as a potential nontoxic natural antioxidant. Chewing and consuming betel leaves stimulate salivary glands, promoting salivation—the initial phase of digestion. Extracts and purified compounds from *Piper betle L* exhibit various beneficial properties including anti-septic, anti-bacterial, anti-oxidant, anti-inflammatory, anti-cancer, and immunomodulatory effects. The plant contains various phytochemicals such as alkaloids, flavonoids, steroids, saponins, tannins, sugars, diastases, and essential oils.

Additionally, Ayurveda suggests that betel leaves and their components may function as regulators of heart rate by relaxing blood vessels, thereby helping to lower hypertension.[6]

Over 700 species of *Piper betle L* are distributed worldwide; 30 species are recorded in India alone. This plant is cultivated extensively in India as well as in Sri Lanka, Malaysia, Indonesia, the Philippines, and East Africa.[7].

The essential oil is the main biochemical component of betel leaves and contributes to their therapeutic effects. The plant contains a light yellow, aromatic essential oil with a sharp, burning taste. The important ingredient in betel pepper volatile oil is phenol's (Chavicol, Chavibetol, Eugenol,…) at the side of another phenoplast compound as well as betaCaryophylln , beta-Cadinen, 4-allyl-1,2diaxetoxybenzen (27.51%).[8].

The most important and effective asexually propagated crop, with an extensive range of cultivars, is betelvine. [9] It is a plant that likes sheds. It has a perennial creeper and has 2-4 inch large, 4-7-inch-long leaves. It has flowers that are both male and female.

The bulb stands alone at the end and facing the leaves. grain length about 5 - 15 cm and width 2 - 5 cm. The male ear is about 1.5 - 3 cm long, and there are two short stamens, while the female ear is about 2.5 - 6 cm long, where there are three to five white and yellowish green pistils.[10]

The betel vine (*Piper betle L*.) belongs to the genus Piper of the family of Piperaceae . The leaves of *Piper betle L* possess various bio-active properties and are utilized in traditional medicinal systems to treat conditions such as indigestion, stomach aches, diarrhea, flatulence, and to promote healing for wounds, scales, burns, and swelling.[11]

Different names for *Piper betle L* have been used in India: Pan (Hindi), Tambala (Sanskrit), Villayadele (Kannada), Vetulicolid (Malayalam), Vetali (Tamil), Tamalapaku (Telugu), Videch-pan (Marathi), Naggable (Gujarati), Pan (Bangladeshi), Tanbol (Arabic), and Burg-e-Tanbol (Persian). Betel leaves are primarily used as a natural mouthwash but also have a long history of managing a diverse range of infectious diseases such as viral infections and coughs as well as non-communicable diseases like bronchial asthma and rheumatism.[12]

Betel leaves are primarily used as a natural mouthwash, but they also have a long history of use in managing a diverse range of infectious and non-communicable diseases. These include viral infections, coughs, bronchial asthma, rheumatism, stomach pain, and various other conditions such as halitosis (bad breath), boils, abscesses, conjunctivitis, constipation, gum swelling, cuts, and injuries.[13]

History

The betel leaf is rich and deeply intertwined with cultural practices across Asia. This evergreen plant, often referred to as "paan" in Hindi, has been utilized for thousands of years, both for its culinary and medicinal properties.[14] Betel leaf traces back to prehistoric times, with archaeological findings indicating its use in the spirit caves of Northwest Thailand as early as 5500-7000 BC. Similar evidence has been found in Timor, Indonesia, from around 3000 BC, and in the blackened teeth of a skeleton in Palawan, Philippines, dating to 2600 BC. These discoveries suggest that betel leaves were chewed long before organized agriculture emerged.[15] Betel leaf has been a significant part of various cultures throughout history. In ancient texts such as the "Mahawamsa" of Sri Lanka and references from Vatsyayana's Kamasutra, betel is noted for its importance in social rituals and medicinal uses. It was traditionally offered during auspicious occasions.[16]

Ayurvedic Significance

Piper betle L, known in the Vedic texts as Saptasira, is referred to in Sanskrit as Tambool, Nagvelleri, and Nagani. This plant has been utilized for therapeutic purposes to address various health issues. References to Tambool can be traced from ancient texts, including Vatsyayana's Kamasutra and Panchatantra, extending to Kalhan's Rajatarngni, which is considered one of the last significant old Sanskrit writings. Thus, the term Tambool has been documented over a span of approximately 2000 years.. In Ayurveda medicine system, the properties of betel leaf described as given below:[17,18]

Guna (Quality): Laghu, Ruksha, Tikshan

Rasa (Taste): Tikt

Vipak (Metabolism): Katu

Virya (Potency): Ushan

Prabhav (Impact): Hridy

Betel leaf extract is extensively utilized in Ayurveda as an adjuvant, often combined with pharmaceuticals to enhance their effectiveness. The *Sushruta Samhita* describes tambool leaves as aromatic, sharp, hot, and acrid. They are recognized for their benefits in improving voice quality, acting as a laxative, and stimulating appetite. Furthermore, these leaves are known to pacify Vata and promote Pitta doshas.[19]

Vernacular Names

Sanskrit: Tamboolavalli, Tamboola, Tamboola vallika

English: Betel leaf plant.

Kannada: Villayadela

Hindi: Pan

Malayalam: Vetta, Vettila

Bengali: Pan,[20]

Synonyms

Betel pepper.

True pepper.

Pepper vine.

Piper.[21]

Taxonomical classification

Kingdom: Plantae

Division: Spermatophyta

Sub-division: Angiosperms

Class: Magnoliopsida

Sub-class: Magnolilidae

Order: Piperales

Familia: Piperaceae

Genus: Piper

Species*: Piper betle L.*[22]

Plant description

A perennial dioecious creeper. Stems semi woody, climbing by means of short adventitious roots. The leaves measure 10-20 cm in length and are broadly ovate, with a slightly cor-date shape that is often unequal at the base. They are shortly acuminate, glabrous, and glaucous on both sides, exhibiting bright green or yellowish hues. The petiole is stout, measuring 2.0-2.5 cm long. Male spikes are cylindrical and dense, while female spikes range from 2.5 to 5.0 cm in length and are pendulous. Fruits are rarely produced and are often embedded within the fleshy spike, resulting in nodule-like structures.[23]. The Betel (*Piper betle*) is a spice whose leaves have medicinal properties. This dioecious creeper features swollen branches at the nodes and has alternate, heart-shaped leaves that are smooth, shiny, and long-stalked, with a pointed apex. The leaves typically have five to seven ribs that originate from the base and bear minute flowers.[24]

Distribution

Southeast Asia, particularly Indochina (Vietnam, Cambodia, Laos, Thailand, and Myanmar), East Timor, the Lesser Sunda Islands, and Peninsular Malaysia is where the pipe beetle originally originated.[25] In addition to Southeast Asia, Papua New Guinea and Malaysia, Micronesia, South Asia, the Maldives, Mauritius, Reunion Island and Madagascar, its cultivation spread through Austrian migration and trade. The Caribbean also collected it during colonial rule.[26]

Cultivation of Betel Leaf

Betel vine is widely cultivated at altitudes ranging from 2 to 1400 meters in highland, moist tropical, and subtropical regions. This plant thrives in areas with annual rainfall between 2250 and 4750 mm, relative humidity levels of 40 to 80%, and temperatures between 15 and 40°C. It requires a tropical climate, abundant rainfall, and shaded environments for optimal growth. Betel vine can be grown either within forest ecosystems, where it can climb on supporting structures due to its weak stem, or in artificially created shaded conditions that provide high humidity, rich soil moisture and nutrients. Betel vine prefers light soils, specifically loamy or sandy loam types, that contain good organic matter and have excellent drainage condition. The ideal conditions for its growth are found in red loamy soil that is light, has sufficient depth, and maintains a pH range of 5.6 to 8.2. In contrast, saline and alkaline soils, as well as waterlogged areas, are unsuitable for betel vine cultivation and can be harmful to its growth.[27]

Methods of Extraction for *Piper betel*

Sl No	Method	Solvent	Time (hours)	Reference
01	Hydro distillation	Water	3.5 hours	28
02	Microwave Assisted extraction	Water	20-60 mins	28
03	Steam distillation	Water	6 hours	29
04	Soxhlet Extraction	Ethanol Deionized water Acetone	24 hours 24 hours 08 hours	30 30 31
05	Maceration Extraction	Ethanol Acetone	72 hours or 3 days 72 hours or 3 days	32 33
06	Super critical fluid Extraction	Super critical carbon dioxide Ethanol	210 min 3 hours	34 35
07	Ultrasound Assisted extraction Extraction	Ethanol Methanol Acetone	30 min 30 min 30 min	36 36 36

Composition of Betel Leaf

Betel leaves mainly contain chlorophyll, water, protein, fat, fibre, carbohydrate, minerals and vitamins. The percentages of all nutritional constituents are mentioned in Table.[37]

Nutritional composition of fresh betel leaves.[38]

Constituents	Percentage
Water	85–90%
Protein	3–3.5%
Minerals	2.3–3.3%
Fat	0.4–1.0%
Chlorophyll	0.01–0.25%
Carbohydrate	0.5–6.10%
Nicotinic acid	0.63–0.89 mg/100 g
Vitamin C	0.005–0.01%
Vitamin A	1.9–2.9 mg/100 g
Thiamine	10–70 µg/100 g
Riboflavin	1.9–30 µg/100 g
Tannin	0.1–1.3%
Nitrogen	2.0–7.0%
Phosphorus	0.05–0.6%
Potassium	1.1–4.6%
Calcium	0.2–0.5%
Iron	0.005–0.007%
Iodine	3.4 µg/100 g
Essential oil	0.08–0.2%
Energy	44 kcal/100 gm
Fibre	2.3%

Betel leaves are composed of various sugars, including glucose, fructose, maltose, and sucrose. The average concentration of free reducing sugars in different types of betel leaves typically ranges from 0.38% to 1.46%.[39] Betel leaves are rich in various vitamins, particularly nicotinic acid, ascorbic acid, and carotenoids, which play crucial roles in biochemical processes and have beneficial effects on the human body. These vitamins exhibit anticancer properties as well as antimicrobial and antioxidant effects. Carotenoids further enhance immune cell communication within the body. Additionally, betel leaves contain significant amounts of essential amino acids, although they are lacking in lysine, histidine, and arginine, which are important for fat metabolism and muscle development. The leaves are particularly high in asparagine, along with notable levels of glycine and proline. They also contain enzymes such as diastase and catalase.[40]

Chemical Composition

Piper betle L leaves are known to contain several important compounds, including piperol-A, piperol-B, and methyl piper betlol, which have been successfully isolated. The essential oil extracted from these leaves comprises various components such as terpinen-4-ol, safrole, allyl pyrocatechol monoacetate, eugenol, eugenyl acetate, hydroxyl chavicol, and piper betol. Additionally, the betel oil is characterized by major constituents like cadinene, carvacrol, allyl catechol, chavicol, pcymene, caryophyllene, chavibetol, cineole, and estragol.[41]

Phytochemicals Constituents

The primary component of betel leaves is the volatile oil known as betel oil, which contains two phenolic compounds: betelphenol (also referred to as chavibetol) and chavicol. The leaves are reported to yield an alkaloid called arakene, which exhibits properties similar to cocaine. The aroma of betel leaf is due to the presence of essential oils, consisting of phenols and terpenes.The active ingredient of *piper betle* oil (or) volatile oil content ranges from 0.8% to 1.8%, comprising chavicol, betelphenol, eugenol, allyl pyrocatechin, terpene, cineol, caryophyllene, cadinene, and menthone. polyphenol, alkaloids, saponin, tannin, steroids and other compounds are also found in *Piper betle*. The chemical composition of the essential oil varies; for instance, safrole is found in the leaves, stalks, stems, and roots, while β-phellandrene is present in the fruit. Younger leaves tend to produce a higher quantity of essential oil.[24] Leaf and other plant parts have yielded active compounds: hydroxychavicol, hydroxychavicol acetate, allypyrocatechol, chavibetol, piperbetol,methylpiperbetol, piperol A

and piperol B. Study of essential oil and ether soluble fraction of leaves yielded fourteen components including eight allypyrocatechol analogs. Major constituents show in table

Chemical constituents of *Piper betle L.* [42]

Component Percentage of Components	Percentage of Components
Chavibetol	53.1
Caryophyllene	3.71
Chavibetol acetate	15.5
Allylpyrocatechol Diacetate	0.71
Chavibetol methyl ether	0.48
Campene 0.48	0.48
f-Pinene 0.21	0.21
Eugenol	0.32
u-Limonene	0.14
a-Pinene	0.21
1,8-Cineol	0.04
Saprobe	0.11
Allylpyrocatechol Monoacetate	0.23

Ethno Botanical Uses of *Piper betle L*

Leaf

The juice extracted from betel leaves is administered systemically to address various health issues in children, including cough and indigestion. Additionally, it exhibits a range of beneficial activities such as anti-malarial, antibacterial, anti-fungal, insecticidal, antioxidant, anti-diabetic, gastro-protective, cyto-toxic, and anti-platelet effects.

Stem

The stems of *Piper betle L* are believed to be effective in treating conditions such as indigestion, bronchitis, constipation, coughs, and asthma.

Whole plant

Plants from the genus *Piper betle L* are utilized for a variety of purposes, including as food and spices, fish bait, and fish poison. They are also used as hallucinogens, insecticides, oils, ornaments, and perfumes, as well as for their anti-worm and anti-infectious properties due to their pungent taste. Additionally, these plants aid in normalizing the digestive tract, making them highly effective in maintaining digestive health thanks to their mild properties.[43]

Major Varieties of Betel Leaf

1. *Piper Betle L* (Common Betel Leaf)

This is the most recognized variety, commonly referred to as "paan" in India. It is characterized by its heart-shaped leaves and is used extensively in culinary and cultural practices across Asia.

2. *Piper Ornatum* (Red Betel Leaf)

Known for its striking appearance, this variety features glossy, heart-shaped leaves with olive green tops and a blood-red underside. It is often used as an ornamental plant due to its vibrant colors.

3. Variegated Betel Leaf

This type has deep green leaves with creamy white variegation, making it visually appealing. It is also a climbing vine and is prized for its ornamental value.

4. *Piper Magnificum* (Lacquered Pepper)

This variety has shiny, dark green leaves that can appear lacquered. It thrives in low-light conditions and adds aesthetic value to indoor spaces.[44].

5. Calcutta

A popular variety known for its robust flavor, often favored in culinary applications.

6. Banarasi

Renowned for its taste and thickness, this variety is commonly cultivated in the Banaras region of India.

7. Magahi

Another well-known variety, particularly appreciated for its unique flavor profile and is cultivated primarily in Bihar, India.[45]

8. Bagerhati

This variety includes subtypes like Bagerhati 4 and 6, known for their high yield and quality leaves.

9. Mysore

Grown mainly in Karnataka, this variety is recognized for its distinct taste and aroma .

10. Venmony

A traditional variety from Kerala, celebrated for its flavor and used in local chewing practices.[46]

11. Sirih Varieties (in Malaysia)

Malaysian farmers cultivate types such as sirih India, sirih Melayu, sirih Cina, and sirih Udang, each with specific characteristics suited to local preferences.[47]

List of varieties of betel leaf popular in different states in India.[48]

State	Varieties of betel leaf available
Andhra Pradesh	Karapaku, Chennor, Tellaku, Bangla, Kalli Patti
Assam	Assam Patti, Awani Pan, Bangla, Khasi Pan
Bihar	Desi Pan, Calcutta, Paton, Maghai,Bangla
Karnataka	Kariyale, Mysoreale, Ambadiale
Kerala	Nadan, Kalkodi, Puthukodi
Madhya Pradesh	Desi Bangla, Calcutta, Deswari
Maharashtra	Kallipatti, Kapoori, Bangla
Odisha	Godi Bangla, Nova Cuttak, Sanchi, Birkoli
Tamil Nadu	Pachai Kodi, Vellaikodi
Uttar Pradesh	Deswari, Kapoori, Maghai, Bangla
West Bengal	Bangla, Sanchi, Mitha, Kali Bangla, Simurali Bangla

Traditional uses of Betel leaves

The use of betel leaves can be traced back to over two millennia ago. These leaves have been traditionally used to treat various ailments and promote overall health. Such as

1. Headache

Betel leaves are a popular traditional remedy for treating headaches. These leaves possess analgesic (pain-relieving) and cooling properties that can provide relief when applied topically to the affected area during intense headaches. The leaves can be crushed or made into a paste and gently massaged onto the forehead or temples, offering soothing effects that help alleviate the discomfort associated with headaches.

2. Sore Throat

Betel leaves are an effective household remedy for treating coughs and sore throats. Applying the leaves locally can significantly alleviate the discomfort of a sore throat. Additionally, crushing fruit or berries of the plant and mixing them with honey can help soothe an irritating cough when consumed. This combination offers both relief and a soothing effect on the throat.

3. Weakness of Nerves

Betel leaves are essential in addressing issues related to nervous pain, exhaustion, and debility. The juice extracted from a few betel leaves, combined with a teaspoon of honey, acts as an effective tonic. Taking a teaspoon of this mixture twice daily can help strengthen the nervous system and alleviate symptoms of weakness.

4. Obstructed Urination

Betel leaf juice is known for its diuretic properties, which can aid in relieving obstructed urination. When mixed with diluted milk and lightly sweetened, this juice can help facilitate easier urination and promote overall urinary health.

5. Respiratory Disorders

Betel leaves have proven beneficial in treating pulmonary (lung) conditions, particularly in children and the elderly. To alleviate cough and breathing difficulties, the leaves can be soaked in mustard oil, warmed, and then applied to the chest. This method can provide relief for respiratory disorders.

6. Constipation

For children experiencing constipation, a simple yet effective remedy involves creating a suppository using the stalk of a betel leaf dipped in castor oil. When introduced into the rectum, this suppository can instantly relieve constipation, making it a convenient and natural solution for this common digestive issue.

7. Problem of Breast Milk Secretion

Applying betel leaves smeared with oil to the breasts is believed to enhance milk secretion during lactation. This traditional practice is thought to support breastfeeding mothers by promoting the production of breast milk.[49]

8. Inflammation

When applied locally, betel leaves are effective in treating inflammation, including conditions like arthritis and orchitis (inflammation of the testes). Their anti-inflammatory properties help reduce swelling and discomfort in affected areas.

9. Wounds

Betel leaves can also promote wound healing. To use them, extract the juice from a few leaves and apply it directly to the wound. Afterwards, wrap a betel leaf around the area and

secure it with a bandage. This method can facilitate healing, often resulting in recovery within just two days after a single application.

10. Boils

Betel leaves serve as an effective remedy for boils. To treat a boil, gently warm a leaf until it softens, then coat it with castor oil. Place the oiled leaf over the inflamed area and replace it every few hours. After several applications, the boil is likely to rupture, allowing the purulent matter to drain. This treatment can be applied overnight and removed in the morning for best results.[50]

Side Effects of Betel Leaf

Betel leaves may have side effects when consumed with tobacco, lime, and areca nuts, as follows

1. May cause substance dependence
2. May cause a feeling of euphoria
3. May cause sweating
4. May cause salivating.[51]

Betel leaves as described in ayurvedic texts.

In the textbook of Maatraashitiya adhaaya chapter 5 about Betel leaf is described like this Betel leaf Chewing.

It should be worn with the mouth by one who desires a pleasant taste and fragrance.

They also ate the fruits of jati, bitter gourd and clove. The fruit of the coconut tree and the leaf of the bean tree are auspicious Similarly the extract of camphor and the fruits of fine oil.

In the textbook of Bhavaprakash – Guduchyadivarg about Betel leaf is described like this
Betels are clear, tasty, sharp, hot, tuberous, juicy
Vasya is bitter, pungent, salty, red and bile-producing and light and
It is strong and relieves mucus, bad breath, dirt, wind and fatigue

In the textbook of Annapaanavidi adhaaya chapter 46 about Betel leaf is described like this
Betel leaf is a sharp hot bitter gallbladder
It is fragrant, clear, bitter, sweet, and relieves wind and phlegm
Sansana is bitter in cooking and pungent and inflammatory

Cleansing of the mouth, itching, dirt, mucus, bad breath, etc.

CONCLUSION

In summary, *Piper betle L* is a versatile medicinal plant with significant cultural importance in India and beyond. Its various applications in traditional medicine highlight its potential as a natural source for innovative antibiotics while also addressing numerous health conditions effectively.

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