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A Review On 'Betel Leaf'

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ABSTRACT

Betel leaf (Piper betle Linn.) is a plant that holds cultural significance and is noted for its medicinal uses across Asia, where it serves various religious, social, and therapeutic functions. The plant contains a range of phytochemicals such as chavibetol, safrole, allylpyrocatechol, and eugenol, which contribute to its diverse pharmacological effects, including antimicrobial, antioxidant, antidiabetic, anticancer, antifungal, and gastroprotective properties. In traditional Ayurveda, betel leaf has been used to manage ailments such as headaches, constipation, respiratory problems, inflammation, and wound healing. The economic significance of the plant is evident in its roles within pharmaceuticals, cosmetics, nutraceuticals, and cultural practices. However, prolonged use, particularly in combinations like betel quid with tobacco and areca nut, can result in toxicity and negative health outcomes. This review covers the botanical characteristics, phytochemistry, cultivation, pharmacological effects, traditional applications, and economic importance of betel leaf, offering a thorough overview of its potential therapeutic benefits and limitations.

Keywords: Betel Leaf ,Piper betle Linn. (or P. betle), Paan, Piperaceae

INTRODUCTION

The betel leaf is an evergreen, perennial creeper characterized by glossy, heart-shaped leaves and white catkins. The genus Piper (Piperaceae) is found primarily in tropical and subtropical regions around the world. Piper betel is cultivated in countries such as India, Sri Lanka, Malaysia, Indonesia, the Philippines, the Islands, and East Africa. The plant produces light yellow aromatic essential oil with a sharp taste. There are over 90 varieties of betel vine globally, with around 45 found in India and approximately 30 varieties in West Bengal.[1] It is grown in tropical and subtropical areas for its evergreen leaves, which are used in religious ceremonies and as a chewing stimulant.[1]

Betel leaf (Piper betle L.) has been utilized since ancient times for its ceremonial, cultural, and medicinal properties in Southeast Asia. Various types of betel leaf can be found in this region. In India, it is commonly consumed in the form of 'Paan' or betel quid. A quid is prepared using fresh or dried betel leaf and includes several other ingredients such as slaked lime, areca nut chips, catechu, aniseed, clove, sweeteners, and tobacco.[2]

These leaves are highly nutritious and contain significant amounts of various nutrients and chemical compounds. [3,4] They also include molecules such as arginine, diastase, histidine, catalase, and lysine, along with other essential amino acids. Previous studies on betel leaves have concentrated on the components of their extracts.[5] Various methods have been explored to develop a feasible extraction technique that separates the phyto-components from the leaves. Solvents like methanol, ethanol, propanol, and derivatives of ethyl acetic acid have been commonly used for phenolic extraction from different varieties. [5,6,7]

Table 1. Name of Betel Leaf in Various Languagesa

Indian Languages	Names
Sanskrit	Nagavalli, Nagavallari, Nagini
Marathi	Vidyache pan
Hindi, Bengal, Gujraji, Urdu	Paan
Kannada	Vilya, Veeleya, Villayadel
Konkani	Phodi paan
Malayalam	Vettila, Vettilakkoti
Tamil	Vetrilai
Telugu	Tamalapaku
Other Asian Languages	
Vietnamese	Tråu
Arabic	Tanbol

Mon	Plu
Khmer	Maluu
Thai	Plue
Sinhalese	Bulath
Persian	Burg-e-Tanbol
Chamorro	Papulu
Malay	Daun sirih
Kapampangan	Bulung samat

PLANT PROFILE

Scientific classification

Synonyms: Chavica Beta, Artanthe Hixagona

Kingdom: Plantae

Order: Piperales

Family: Piperaceae

Genus: Piper

Species: P. betle

Taste: Pungent tasting and warming.

Division: Magnoliophyte [12]

FIG. 1: LEAVES OF BETEL PLANT

HISTORY

The piper betel plant is noted for being perennial and evergreen. Anthropologists have found traces of betel in the spirit caves of Northwest Thailand, dating back to between 5500 and 7000 BC, predating the establishment of organized agriculture.

Similar findings from around 3000 BC have been reported in Timor, Indonesia, as well as in the darkened teeth of a human skeleton found in Palawan, the Philippines, dating back to 2600 BC.

The earliest historical text on Sri Lanka, the Pali-written "Mahawamsa," includes information about this practice. In countries such as Thailand, Myanmar, and Indonesia, some long-term betel chewers have been found to have blackened teeth due to years of chewing. The exact time when these two stimulant ingredients were first combined is uncertain, but archaeological evidence suggests that betel leaves and areca nuts have been chewed together since ancient times. Consequently, determining the specific origins of the custom of chewing paan may be difficult.[8,9]

The references to this practice in both the Raghuvamsa and the Kamsutra of Vatsyayana indicate its historical significance. The importance of paan can be inferred from the fact that in ancient India, receiving paan bida—a pair of leaves filled with churna (lime), kattha (catechu), and supari (areca nut)—from kings and nobility was considered a considerable honor. Terms such as Tambuladhikara, Tambuladyaka, Tambuladayini, and Tambulika were used during this period (around 600 AD) in various texts. Kadamberi describes several common uses of paan. Additionally, in the Sakta-tantra, paan is identified as a means to attain siddhi, with the belief that no siddhi could be achieved without chewing betel and offering paan to the Guru.[10]

AYURVEDIC OF BETEL LEAF

Ayurvedic Significance

Piper betel is a plant referenced in Vedic texts, where it is known as Saptasira. In Sanskrit, it is referred to by several names, including Tambool, Nagvelleri, and Nagani, and has been used as a remedy for various ailments. Mentions of Tambool can be found in works ranging from Vatsyayana's Kamasutra and Panchatantra to Kalhan's Rajatarngni, which may be among the last recognized historical Sanskrit writings.

Tambool has been referenced over a period of approximately 2000 years. In the Ayurvedic medicine system, the properties of betel leaf are described as follows:

Guna (Quality) : Laghu, Ruksha, Tikshan

Rasa (Taste) : Tikt

Vipak (Metabolism) : Katu

Virya (Potency) : Ushan

Prabhav (Impact) : Hridya

In Ayurveda, betel leaf extract is often utilized as an adjunct and combined with various medications to potentially enhance their effects, in addition to its standalone medicinal purposes. The Sushruta Samhita describes tambool leaves as aromatic, sharp, hot, and acrid, noting their benefits for voice, acting as a laxative and appetizer. Furthermore, they are said to pacify Vata while aggravating Pitta.[13]

AYURVEDIC AND TRADITIONAL USES

Swelling

Betel pepper is commonly used in certain regions for therapeutic purposes, such as treating joint pain and wounds. The oil extracted from its leaves can be applied to injuries. After applying the oil, a betel leaf should be folded around the affected area. After two or three applications, any pus will be expelled.[14]

Bubbles

Piper betel is an effective treatment for blisters. The leaves are initially warmed gently until they become soothing, then they are coated with Chinese wound oil. The oiled leaf is applied to the affected area. This leaf should be changed at regular intervals. After a few applications, the blister will drain its fluid.[15]

Headache

Piper betel is recognized for its potential benefits in alleviating headaches. The leaf of the betel plant is known for its soothing and calming properties. It is commonly applied to the affected area to help manage migraines.[14]

Sparse or Hindered Urination

The oil obtained from the leaves of the medicinal plant has a quality that aids in regulating fluid balance and is mixed with weakened milk.[14]

Inadequacy of Nerve fibre

Piper betel plays a significant role in the treatment of individuals experiencing anxious fatigue and weakness. The oil extracted from a few leaves, combined with a teaspoon of honey, serves as an effective stimulant. [14]

Pulmonary disease

Betel pepper leaf supports the respiratory relationship between adolescents and older individuals. It absorbs Chinese wood oil and is heated, which may be applied to the rib cage to help alleviate discomfort and promote relaxation. [14]

Constipation

This is an example of obstruction in young individuals, involving a medication made from a leaflet's tail soaked in Chinese wood oil, which can be administered rectally to provide immediate relief from obstruction. [14,15,16].

Boils

The herb is a remedy for boils. A leaf is warmed until it softens and then coated with a layer of castor oil. The oiled leaf is placed over the affected area. This leaf should be replaced every few hours. After several applications, the boil may rupture, allowing the pus to drain. The application can be done at night and removed in the morning.

Weakness of Nerves

Betel leaves are helpful in addressing nervous disorders. The juice from several betel leaves, combined with a teaspoon of honey, acts as an effective tonic. This mixture can be consumed in a teaspoon dosage twice daily.

PHARMACOLOGICAL ACTIONS

Antimicrobial Activity

The aqueous and methanol extracts from the leaves of Terminalia catappa L. and Manilkara zapota L. were examined (Nair and Chanda et al 2008). Piper betel L. exhibited antibacterial activity against 10 Gram-positive bacteria, 12 Gram-negative bacteria, and the fungal strain Candida tropicalis. The three plants showed different levels of effectiveness against the microorganisms studied. Among the aqueous and methanolic extracts, the methanolic extract was found to be significantly more effective in inhibiting the microbial strains than the aqueous extract. Piper betel leaf is noted as the most active antimicrobial herb. [17]

Anti-diabetic activity

The antidiabetic effects of Piper betel leaves were evaluated in normoglycemic and streptozotocin (STZ)-induced diabetic rats through the oral administration of hot water extract (HWE) and cold ethanol extract (CEE) (Arambewela et al., 2005). Both HWE and CEE were found to moderately lower blood glucose levels in a dose-dependent manner in normoglycemic rats. Additionally, both extracts significantly reduced the external glucose load during the glucose tolerance test. The antidiabetic efficacy of HWE was similar to that of CEE. Following chronic oral administration, both extracts were determined to be non-toxic and well tolerated, showing no evident signs of toxicity, hepatotoxicity, or renal toxicity. However, in the treated groups, an increase in spleen weight was observed, suggesting a potential lympho-proliferative effect. [17,18]

Anti-malaria activity

Essential oils from Piper betle offer more effective protection against Anopheles stephensi and Culex fatigans mosquitoes than the commonly known mosquito repellent citronella oil. When applied at a dosage of 20 µl/cm2, Piper betle oil provided over 4 hours of protection from Anopheles stephensi and Culex fatigans, whereas citronella oil only offered protection for 2.2 and 2.6 hours, respectively. Thus, the repellent properties of Piper betle have been demonstrated. [17,19]

Antifungal activity

Hydroxychavicol, derived from the chloroform extraction of Piper betel L. aqueous leaf extract (Piperaceae), was studied for its antifungal properties against 124 strains of various fungi (Ali et al., 2010). This compound shows a significant inhibitory effect on fungal species, with minimal inhibitory concentrations (MICs) ranging from 15.62 to 500 µg/ml for yeasts, 125 to 500 µg/ml for Aspergillus species, and 7.81 to 62.5 µg/ml for dermatophytes, while the minimal fungicidal concentrations (MFCs) are equal to or double the MICs. There is a concentration-dependent killing effect observed for Candida albicans and Candida glabrata up to 8 × MIC. Hydroxychavicol also demonstrates an extended post-antifungal effect lasting 6.25 to 8.70 hours at 4 × MIC for Candida species and reduces the emergence of resistant mutants of the tested fungal species at 2 × to 8 × MIC concentrations. The study concluded that the antifungal activity of this compound could potentially be employed experimentally as an antifungal agent for treating topical infections and as a gargle mouthwash for oral infections caused by Candida. [17,20]

Anticancer Activity

Research indicates that different plants contain combinations of bioactive compounds that can function as anticancer agents and suppress the proliferation of cancer cells, supporting the development of anti-cancer drugs. Additionally, the antioxidant properties found in these plants are linked to their ability to inhibit cancer cell growth.

Azahar et al. (2020) conducted a study on human breast cancer cells, specifically using MCF-7, to investigate antiproliferation effects. The cells were cultured in 96-well plates and allowed to adhere for 24 hours before treatment with Piper Betle extracts, which were obtained using four different solvents: ethyl acetate, hexane, methanol, and water. The results indicated that ethyl acetate had the highest antioxidant and antiproliferative effects, while the hexane extract demonstrated dose-dependent inhibitory effects on MCF-7 cells, with IC50 values of 56.00 ± 0.00 µg/mL and 163.30 ± 2.89 µg/mL, respectively. The study also evaluated the cytotoxicity and migratory effects of Piper Betle extract on MCF-7 cells by incorporating the extract into transdermal patches. The findings revealed that Piper Betle extract exhibited both cytotoxic and anti-migratory properties. Specifically, increasing the dose of Piper Betle extract resulted in decreased viability of MCF-7 cells, and cell migration was significantly suppressed at a dose of 25 µg/mL, showing a reduction of 30% compared to the control group. [21]

Gastroprotective Activity

Majumdar B et al. (2003) examined the healing effects of ethanol extract from P. betel at a dosage of 150 mg/kg body weight administered daily for 10 days, following the induction of peptic ulcers using NSAIDs in albino rats. The treatment with the piper betel extract resulted in an increase in antioxidant factors, such as superoxide dismutase and catalase activity, as well as mucus and total gastric tissue sulphahydryl groups. It can be inferred that the healing properties of the plant extract may be attributed to its antioxidant or free radical scavenging activity.[31]

CHEMICAL CONSTITUENT

Betel vines are widely studied plants, and their phytochemical analyses reveal that Piper betel contains a variety of biologically active compounds whose presence depends on the type of plant, season, and environmental conditions. The chemical composition of essential oil includes safrole in the leaves, stalk, stem, and root, along with β-phellandrene in the fruit. The characteristic aroma of betel leaves is attributed to the presence of essential oils, such as phenols and terpenes. [23] Younger leaves are noted to produce higher amounts of essential oil. The primary component of the leaves is a volatile oil, commonly referred to as betel oil, and its chemical makeup varies based on the geographic location. The leaves and other parts of the plant have been shown to yield active compounds like hydroxychavicol acetate, allylpyrocatechol, chavibetol, piperbetol, methylpiperbetol, piperol A, and piperol B. Additionally, the leaves of Piper betel are reported to contain an alkaloid known as arakene, which has properties similar to those of cocaine.[23]

The synthetic component present in the medicinal plant known as betel leaves comprises essential oil found in its stalks, stems, leaves, roots, and fruits. This plant is classified under the normal piper betel variety, which can be observed in the agriculture of Nagawalli, Ratadalu, Galdalu, Kudamaneru, and Mahamaneru. [24] The essential oil of normal piper betel leaves contains chavibitol, acetic derivation (12.5%), and safrole (48.7%).

In contrast, malbulath lacks these two constituents. Notably, malabulath oil contains allylpyrocatechol diacetate (34.4%), which is one of the three significant components, whereas the typical piper betel oil has 11.3% of this compound. [25] Additionally, eugenol, 4-terpineol, beta-caryophyllene, chavibitol acetate, α-cymene, and safrole are found in the normal leaves' oil, but malabulath lacks all these major constituents. [26] The composition of various parts of natural piper betel was analyzed using Gas Chromatography-Mass Spectroscopy, revealing that the structure of the tail oil differed when compared to other parts that did not contain significant amounts of allyl pyrocatechol diacetate. The essential oil extracted from the stalk, leaf, and stem was identified as safrole, whereas the fruit oil was different, displaying α-phellandrene. The compound composition in Ethylene oxide (EO) of betel leaves appears to be similar to that of the Deshwari variety cultivated in India. [27]

Table No. 2: Chemical Constituents of Betel Leaf [22]

SR NO.	Chemical Constituents	% of Chemical Constituents
1	Chavibetol	53.1
2	Chavibetol acetate	15.5
3	Caryophyllene	3.71
4	Allyl pyrocatechol diacetate	0.71
5	Chavibetol methyl ether	0.48
6	Eugenol *(assuming "Eugene" = Eugenol)*	0.32
7	α-Pinene	0.21
8	β-Pinene *(f-Pinene corrected)*	0.21
9	Safrole	48.7
10	1,8-Cineole	0.04

FIG. 2: STRUCTURE OF EUGENOL AND CHAVIBETOL

CULTIVATION AND COLLECTION

PROPAGATION

Propagation is simple using root division or cuttings. Betel prefers well-drained, fertile soil in a semi-shaded position. Waterlogged, saline, and alkaline soils are unsuitable for its cultivation.

CULTIVATION

First, create a lawn known as a barouj for cultivating betel. The barouj is enclosed with bamboo sticks and coconut leaves. The soil is prepared into furrows measuring 10 to 15 meters in length, 75 cm in width, and 75 cm in depth. Oil cakes, manure, and leaves are thoroughly mixed with the topsoil of the furrows along with wooden ash. The cuttings are planted at the beginning of the monsoon season. Proper watering and monitoring of soil moisture are essential for successful cultivation of this crop. Betel requires consistently moist soil, but excess moisture must be avoided. Irrigation should be moderate, and standing water should not remain for more than half an hour.[11]

Development occurs in a dark, crumbly topsoil that resembles tank earth and contains a significant amount of natural organic matter. In Bengal, fertile land is prevalent in low-density soils with variations in color. This plant variety thrives from sea level to 1000 meters, requiring more precipitation than 179 cm. It grows best in high-quality conditions close to tropical forests, which offer high humidity and ample soil moisture. Under typical circumstances and managed conditions, there are two main cultivation systems. The open cultivation system is found in areas where soil moisture and direct sunlight are abundant. This plant variety is primarily a climber that relies on supporting trees like coconut (Cocos nucifera) and areca nut (Areca catechu), reaching heights of 10 to 15 meters with dense foliage at the top. The second type of cultivation is semi-pressurized growth, common in regions with high humidity and low sunlight throughout the year, where plant life is sheltered from excessive sun exposure. [15,28]

Based on this development, bajera may have existed as early as 600-400 BC. The management of water supply and light conditions that cannot be maintained leads to minimal negative effects on the shape, taste, size, and variety of its leaves. Some effects are listed here:

1. Sufficient light, but excessive soil moisture can lead to dying plants, rotting roots, less flavorful produce, uneven leaf surfaces, and stunted leaf growth.[29,30]

2. Excessive light, combined with adequate soil moisture, results in leaves developing a harsh taste and becoming tougher, with a darker green color.

3. Sufficient light and lower soil moisture lead to smaller leaf size, increased harshness in taste, premature leaf drop, tougher leaves, fewer leaves per plant, uneven edges, yellowing of leaves, and weak stems.

4. Insufficient light, along with adequate soil moisture, causes leaves to turn light green, leads to smaller leaf sizes, shorter lifespan resembling damage, and a milder, thinner leaf taste.

FIG. 3: CULTIVATION OF BETEL LEAF

COLLECTION

In three to six months, the vine reaches a height of 150 to 180 cm and begins to branch. The harvesting process starts as the farmer removes the leaf and its petiole together using their thumb. This harvest period lasts for approximately 15 days to at least one month.

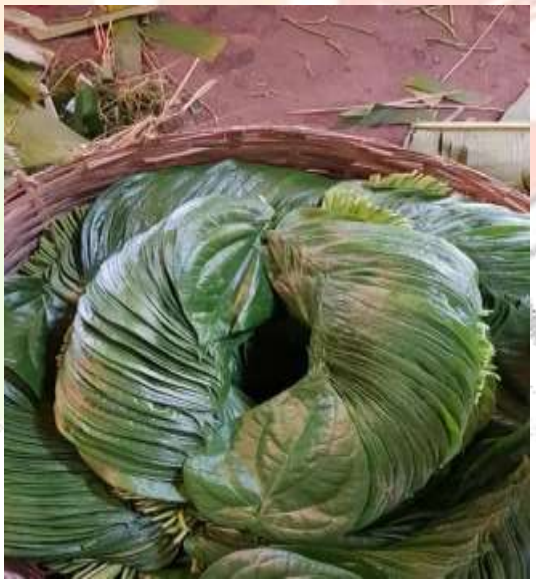

FIG. 4: COLLECTION OF BETEL LEAF

ECONOMIC STATUS

Betel leaves hold significant economic value in the market, significantly influenced by the final outcomes in India. These leaves and their derivatives are available in various forms, including liquids, powders, and capsules. They are recognized for their multiple therapeutic uses and benefits. Certain forms of the leaves are noteworthy additives found in a wide range of products, including food and beverages, cosmetics, dietary

supplements, oral care items, and pharmaceuticals. In contemporary manufacturing, betel leaves are incorporated into products such as betel toothpaste and powders, fragrances, betel leaf oil, mouthwash, pan masala, face creams, instant betel quid and pellets, betel treatments, shampoos, antiseptic ointments, and other cosmetic items and remedies.

The previously mentioned betel items have established a viable market and facilitated some international trade through exports. In India, the trade of betel leaves extends to several countries, including Malaysia, Pakistan, Burma, Bangladesh, Thailand, and Indonesia. The price of betel leaves depends on packaging and transportation costs. The annual turnover of betel leaves is estimated at Rs. 10,000 million. According to the Food and Agriculture Organization, the yield of betel leaf cultivation varies based on factors such as region, plant health, and seasonal conditions. It is estimated that the overall profit may reach Rs. 735 for every 150 feet (approximately 14 meters) of betel farm every six months. The financial stability of farmers is affected by fluctuations in betel leaf prices. To address these challenges, a well-structured marketing system should be developed.[32]

TOXICITY

Limited information exists regarding the short-term safety of oral betel nut. However, betel nut is not regarded as safe for long-term use or when consumed in high doses. Certain chemicals present in betel nut have been associated with cancer, while others are considered toxic. Consuming between 8 to 30 grams of betel nut can be fatal. Chewing betel nut may lead to symptoms such as redness in the mouth, lips, and stool. It can produce side effects similar to those of caffeine and tobacco use. Additionally, it may result in serious adverse effects, which can include nausea, diarrhea, gum disease, drooling, chest pain, irregular heartbeat, low blood pressure, shortness of breath, heart attack, excessive thirst, and potentially death. [33]

FUTURE PREFERENCES

There is a lack of comprehensive reviews on the neuropharmacological profile of Piper betel leaf and its relation to neurological disorders, indicating a need for further investigation in this area. Additionally, research into the anti-anxiety effects of Piper betel leaf is limited, as there is insufficient evidence regarding its anti-anxiety activity. Thus, there is an opportunity to conduct in vitro and in silico studies on Piper betel leaf concerning its neuropharmacological profile and associated disorders.

CONCLUSION

Betel leaf (Piper betle Linn.) is a plant of medicinal and cultural significance that has been valued in traditional systems like Ayurveda for its therapeutic properties, including digestive stimulation, wound healing, antimicrobial effects, and respiratory benefits. The phytochemical composition of betel leaf contains bioactive compounds such as chavibetol, safrole, eugenol, and allylpyrocatechol, which contribute to its various

pharmacological activities. Research has demonstrated its antimicrobial, antioxidant, antidiabetic, antifungal, anticancer, and gastroprotective properties, which support its traditional applications and suggest potential for use in modern pharmaceuticals. However, the misuse of betel quid, particularly with tobacco and areca nut, is linked to negative health effects, including toxicity and carcinogenic risks, highlighting the necessity for safe and regulated usage. Overall, Piper betle shows therapeutic promise that necessitates further investigation, standardization, and development for safe medicinal and commercial applications. [34.35,36,37,38]

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