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An overview of betel leaf: Green gold of India

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Abstract
Betel leaf is a traditional nutritional and medicinal food plant known as Paan. Paan is the name given to the vivid green fresh leaves of the betel vine. *Piper betle* L. belonging to *Piperaceae* family, known as a traditional herbal medicinal plant and used for several health benefits in Asian countries. The scientific information of betel leaf nutrition values and health benefits are crucial for raising betel leaf consumption in daily life. *Piper betle* L. is also known as a Neglected Green Gold of India with a higher nutritional and dietary value such as fiber, vitamins, and minerals. Regarding the nutritional and therapeutic properties of betel leaf, around 15-20 million people in India take it regularly. Furthermore, several phytochemicals and nutritional components are found in the betel leaf, which is recognized as a bioactive compound (BAC). These compounds have several significant pharmacological properties, in which antimicrobial, antidiabetic, antiulcer, anti-inflammatory, anticancer, antimutagenic, and antioxidant properties are crucial once. The present review provides information on betel plant including colour categories, varieties, phytochemistry, extraction techniques, health benefits and their biological activities.

Keywords: *Piper betle*, phytochemistry, bioactive compound

Introduction
The scientific name of betel vine is *Piper betle* L. belongs to the family Piperaceae, i.e. the Black Pepper family. In spite of its alienness, the plant is much more popular in India than in any other country of the world since the antiquity. This would be evident from the numerous citations laid down in the ancient literature, particularly the Indian scriptures [1].
Medicinal plants are of proven value as potential therapeutics with the increase of resistant pathogens to commonly used antibiotics and the emergence of new infectious diseases. Traditionally ethno-medicines were used everywhere in India due to their low cost, easy accessibility and less side effects [2].
Extracts of the *Piper betle* leaves are seen to be effective against several human pathogens. *Piper betle* is a medicinal plant that has long been used by Indonesian people as an anti vaginal or oral candidiasis. Utilization of bacterial endophytes from medicinal plants had a new way to get the antibacterial compounds without having to directly extract from the medicinal plants [3]. Many research investigations have given a lot of valuable information about *Piper betle* and its activities like anticancer, anti-allergic, antimalaria, anti-filarial, antibacterial, antifungal study, insecticidal, antioxidant, anti-diabetic, gastro-protective, cyto-toxic, anti-platelet, wound healing activity, chlorophyllase activity, oral hygiene, anti-asthmatic effect etc. [4, 5]. Scientific Classification of betel leaf Shown in following table 1 [6].

Table 1: Scientific classification of betel leaf

Synonyms	Chavica Beta. Artanthe Hixagona
Kingdom	Plantae
Order	Piperales
Family	Piperaceae
Genus	Piper
Species	Betle
Division	Magnoliphyta

A perennial dioecious creeper. Stems semi woody, climbing by means of short adventitious roots. Leaves 10-20 cm long, broadly ovate, slightly cordate and often unequal at the base, shortly acuminate, glabrous, glaucous on both sides, bright green or yellowish, petiole stout 2.0-2.5 cm long. Male spikes cylindrical dense. Female spikes 2.5-5.0cm long, pendulous. Fruits rarely produced, often sunk in the fleshy spike, forming nodule-like structures.

Betel leaf is the most valuable home remedy for common illness. The Betel (*Piper betle*) is a spice whose leaves have medicinal properties. The branches of the plant are swollen at the nodes. The plant has alternate, heart-shaped, smooth, shining and long stalked leaves, with pointed apex. It has five to seven ribs arising from the base; minute flowers. Betel is a native of central and eastern Malaysia. It spread at a very early date throughout tropical Asia and later to Madagascar and East Africa. In India, it is widely cultivated in Tamil Nadu, Madhya Pradesh, West Bengal, Orissa, Maharashtra and Uttar Pradesh. Offering betel morsel (pan-supari) to guests in Indian subcontinent is a common courtesy [7].

Betel (*Piper betle Linn*) is a well-known species in the genus Piper since it is not only utilized as herb but also has important cultural or cultural value in the community. Betel plants are classified according to the color of their leaves; some are green, red, black, and yellow, while others are silver. Betel is classified into following categories based on leaf color (Table 2) [8].

Table 2: Categories of betel plant according to the color of their leaves

Red betel	**Red betel (*Piper crocatum* Ruiz & Pav.) is in high demand due to its medicinal and ornamental characteristics. This plant has a high selling price since its attractive look, particularly its leaves. The red betel plant is a climbing plant that grows on fences and trees. When illuminated, the surface of the red betel leaf is silvery red and reflective**
Wulung betel	Wulung betel is sometimes referred to as purple betel because it generates a purple glow when lit from below at night.
Green betel	Green betel is typically utilized for traditional rituals and medicinal purposes.
Golden betel	Golden betel, also known as betel jalu, features batik-like or pale-yellow patches.
Black betel	Black betel is sometimes associated with the supernatural.

Fig 1: Red betel

Fig 2: Green betel

Fig 3: Black betel

Fig 4: Golden betel

Betel vine (*Piper betle*) can be classified based on various morphological features and essential oil content [9]

Leaf Morphology

1. **Broad Leaf Varieties:** These varieties have broad leaves, often characterized by their large size. Examples include Calcutta and Kallimadugu varieties.
2. **Slender Leaf Varieties:** These varieties have slender leaves, which may be smaller in size compared to broad leaf varieties. Examples include Sanchi and Bangla varieties.

Stem Characteristics

1. **Robust Stem Varieties:** Some betel vine varieties have robust, vigorous stems, contributing to their strong growth habit. Examples include Bangla, Kallimadugu and Calcutta varieties.
2. **Slender Stem Varieties:** Other varieties may have slender stems, which may affect their overall growth and canopy density. Examples include Sanchi and Bangla.

Essential Oil Content

1. **High Oil Content Varieties:** These varieties have a high concentration of essential oils in their leaves, resulting in strong aroma and flavor. Examples include Calcutta and Kallimadugu varieties.
2. **Moderate Oil Content Varieties:** Varieties with moderate essential oil content offer a balanced aroma and flavor profile. Examples include Sanchi and Bangla varieties
3. **Low Oil Content Varieties:** Some varieties may have lower levels of essential oils, resulting in milder aroma and flavor characteristics. Examples include Desi (Local) variety.

Flavor Profile

1. **Strong Flavor Varieties:** Certain varieties are known for their intense flavor, often preferred for their bold taste in paan preparation. Examples include Bangla and Magahi varieties.
2. **Mild Flavor Varieties:** Other varieties may offer a milder flavor profile, suitable for consumers who prefer a gentler taste. Examples include Desi and Sanchi varieties.

Regional Varieties

Local Varieties: Each region may have its own indigenous betel vine varieties adapted to local climatic conditions and cultural preferences. These varieties may exhibit unique morphological features and essential oil content based on their geographic origin. Examples include Magahi (Cultivated in Bihar and neighboring regions) and Bangarpet (Found in Karnataka and Tamil Nadu).

Hybrids and Cultivars

Improved Varieties: Breeders may develop hybrid varieties or improved cultivars with specific traits such as disease resistance, yield potential, or enhanced flavor profile. These varieties may combine desirable characteristics from different parent lines. Examples could include hybrids developed by agricultural research institutions.

This classification system helps categorize betel vine varieties based on their morphological features, essential oil content, flavor profile, and regional variations. It provides insight into the diversity and characteristics of different cultivars, aiding growers and consumers in selecting varieties suitable for their specific needs and preferences. Betel vine Cultivars of India Based on the morphological characters and essential oil content, betel vine varieties are grouped into six main groups *viz*, Bangla, Desawari, Kapoori, Sanchi, Meetha and Kasi (Table 3). The important morphological characters of betel vine include plant leaves, leaf area and weight etc. All these characters influence yield and consumer acceptability [10].

Table 3: Betel vine varieties

Bangla	**This variety is popular for its robust growth and consistent leaf quality. Bangla had large thin leaves with nine main nerves and ovate lamina with cordate base. Leaf apex was pointed and short, not curved. Petiolar sinus of Bangla was more prominent than other varieties. Bangla was common in North India**
Desawari	Desawari had large thin leaves and cordate lamina with seven to nine nerves. Leaf of Desawari was pinkish in color and leaf apex was short, acuminate and curved. Deswari was common in North India.
Kapoori	Kapoori leaves were more elliptical and lamina was thin with undulated margin. Leaf apex of Kapoori was acuminate and petiolar sinus was inconspicuous. Kapoori was the principal cultivars in the peninsular India.
Sanchi	Sanchi had cordate leaf base with more elliptical lamina and long tapering apex. Normally seven nerves were seen in Sanchi. Sanchi betel vine is characterized by its slender stems and medium-sized leaves. It is known for its balanced aroma and flavor profile. Sanchi was the principal cultivars in the peninsular India.
Meetha	Leaves of Meetha were large and lamina was cordate to broadly ovate and thick. Meetha leaf was waxy in texture with yellowish dots and three to five main nerves. Leaf apex of Meetha was short and pointed. It had prominent joint in the petiole. Meetha Paan varieties are specifically cultivated for their sweetness. They are often used in the preparation of sweet paan, a popular after-meal snack in India. Meetha was grown on commercial scale in West Bengal only.
Kasi	"Kasi" betel leaves refer to a specific variety of betel leaves that are grown in the Kasi region, which is another name for Varanasi. Kasi betel leaves are characterized by their large size, dark green color, and strong aroma. They are favored for their robustness and distinct flavor.

Extraction methods for the crude drugs from betel leaves

Extracting crude drugs from betel leaves involves various methods to obtain the active constituents, including essential oils, alkaloids, phenols, and flavonoids. Here are some standard extraction methods commonly used for betel leaves [11, 12].

Steam Distillation

Steam distillation is commonly employed to extract essential oils from betel leaves, which contain aromatic compounds like eugenol, chavicol, and cineole. Betel leaves are subjected to steam, which helps in releasing the volatile oils. The steam containing the essential oils is then condensed and collected.

Solvent Extraction

Solvent extraction involves using organic solvents like ethanol, methanol, or hexane to dissolve the desired compounds from the betel leaves. Betel leaves are usually dried and ground into a powder. The powder is then mixed with the solvent, and the mixture is allowed to stand for a period to facilitate extraction. After extraction, the solvent is evaporated under reduced pressure to obtain the crude extract, which may further be concentrated or purified.

Soxhlet Extraction

Soxhlet extraction is particularly useful for extracting lipophilic compounds from betel leaves.

The powdered betel leaves are placed in a thimble and loaded into a Soxhlet extractor. A suitable solvent (e.g., ethanol) continuously cycles through the sample, extracting the desired compounds. The solvent is then evaporated, leaving behind the concentrated crude extract.

Maceration: Maceration involves soaking the powdered betel leaves in a solvent for a specified period to allow the extraction of active constituents. The mixture is periodically agitated to enhance extraction efficiency. After a suitable extraction time, the solvent is separated from the marc (solid residue). The resulting crude extract can be further concentrated or processed as needed.

Percolation

Percolation involves passing a solvent through a bed of powdered betel leaves to extract the desired compounds. The solvent gradually percolates through the bed, picking up the active constituents as it passes through. The extract is collected at the outlet. Percolation is often used for large-scale extraction and allows for precise control over the extraction process.

Supercritical Fluid Extraction (SFE)

SFE utilizes supercritical fluids such as carbon dioxide (CO2) to extract compounds from betel leaves. Under specific conditions of temperature and pressure, CO2 becomes a supercritical fluid with properties intermediate between a gas and a liquid, making it an efficient solvent. The supercritical CO2 selectively extracts desired compounds from the betel leaves, and upon depressurization, the CO2 evaporates, leaving behind the crude extract.

These extraction methods are commonly used to obtain crude drugs from betel leaves, each offering advantages depending on the desired compounds, scale of production, and available equipment. It's important to optimize extraction parameters to ensure high yield and quality of the extracted compounds. Additionally, proper safety measures should be observed,

especially when working with organic solvents or high-pressure systems.

Suryasnata Das *et al*. had disused extraction method in their article. Fresh *Piper betle* leaves were washed properly in distilled water, air dried for 10 days at room temperature and powdered. Then, the dried leaf powder was extracted by three different extraction methods, namely Soxhlet extraction, sonication and maceration using acetone as solvent. All the extractions were carried out from 100 g of the powdered leaf sample in 500 mL of acetone (99.7%, v/v). Soxhlet extraction was conducted using acetone as solvent (56 °C) for 8 h; maceration was carried out at the room temperature for 72 h with occasional stirring. Sonication was carried out at room temperature for 1 h using Sonics Vibra cell sonicator with a power level at 135 W and sonication frequency at 40 kHz. All the extracts obtained from different methods were stored in an air tight container at 4 °C for analysis [13].

Phytochemistry of betel leaves

The aroma of betel leaf is due to the presence of essential oils, consisting of phenols and terpenes. The fresh new leaves contain much more amount of essential oil, diastase enzyme and sugar as compare to old leaves. The 'Chavicol' present in betel leaf is a potent antiseptic agent as compared to carbolic acid. Betel leaf is a second most popular daily consumption item in Asia, which contribute the best oral hygiene to oral cavity. The chewing of paan develops red colour in the mouth due to oxidation of lime, and the mild stimulant activity is owed with the presence of betel quid, however the betel leaf gives mouth a fresh feel after chewing paan. Betel leaves chewing increases the salivation in turn increases the amount of peroxidase, lysozyme and antibodies to combat against bacterial growth in the oral cavity. It also enhances the gastric juice, pancreatic lipase secretion which helps in digestion process. The betel leaves contain a wide variety of biologically active compounds whose concentration depends on the genotype, season and climatic conditions. Betel leaves (*Piper betle*) contain a variety of phytochemicals, including alkaloids, phenolics, flavonoids, essential oils, tannins, and steroids (Table 4.) [14].

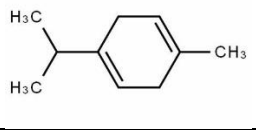
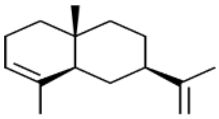
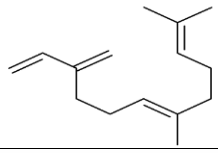
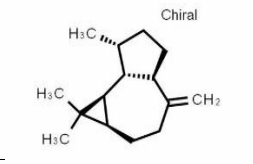
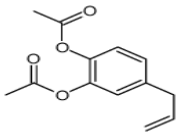
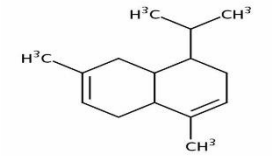
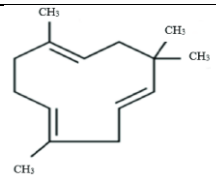
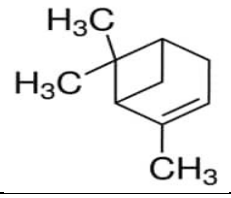
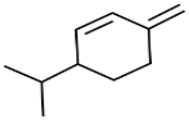
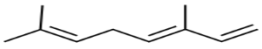
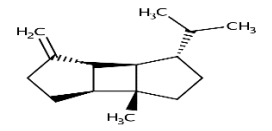
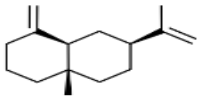
Table 4: Phytochemistry of betel leaves

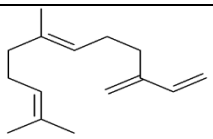
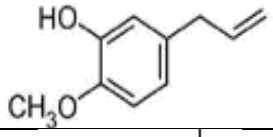
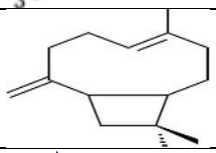
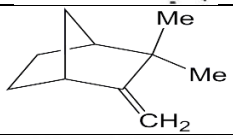
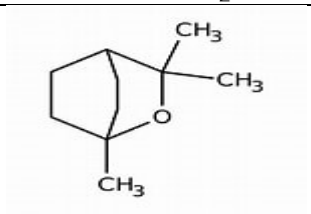
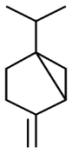
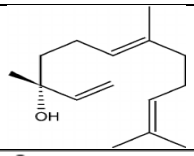
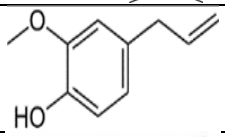
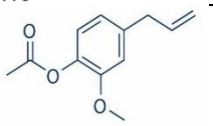
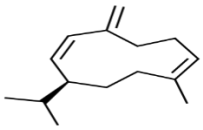
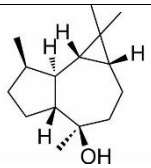
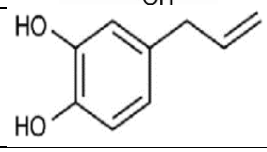
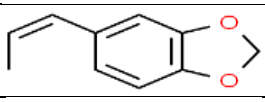
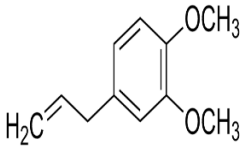
Alkaloids	**Betel leaves contain several alkaloids, with the most notable being arecoline, which is primarily responsible for the stimulating effects of betel chewing. Arecoline acts as a central nervous system stimulant and has been associated with various pharmacological effects**
Phenolics	Betel leaves contain phenolic compounds such as phenolic acids (e.g., caffeic acid, ferulic acid) and their derivatives. Phenolic compounds possess antioxidant properties and contribute to the overall medicinal properties of betel leaves.
Flavonoids	Flavonoids are abundant in betel leaves and include compounds such as quercetin, kaempferol, and myricetin derivatives. These flavonoids exhibit antioxidant, anti-inflammatory, and antimicrobial activities, contributing to the medicinal value of betel leaves.
Essential Oils	Betel leaves contain essential oils rich in aromatic compounds such as eugenol, chavicol, cineole, and various terpenes. These essential oils contribute to the characteristic aroma and flavor of betel leaves and possess antimicrobial and anti-inflammatory properties.
Tannins	Tannins are polyphenolic compounds found in betel leaves, contributing to their astringent taste. Tannins have antioxidant and antimicrobial properties and may also play a role in the traditional medicinal uses of betel leaves.
Steroids	Betel leaves contain steroidal compounds, including phytosterols such as β-sitosterol. Phytosterols have been associated with various health benefits, including cholesterol-lowering effects and anti-inflammatory properties.
Vitamins and Minerals	Betel leaves also contain vitamins (such as vitamin C) and minerals (such as calcium, iron, and phosphorus), which contribute to their nutritional value.

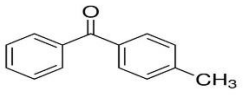
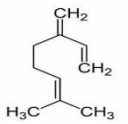
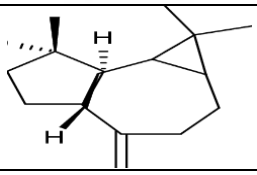
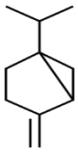
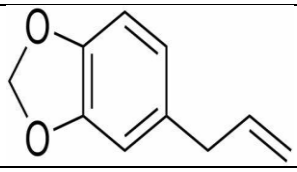
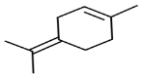
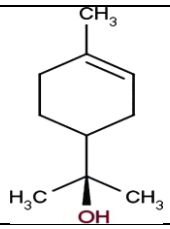
Younger leaves reported to yield more essential oil. Leaf and other plant parts have yielded active compounds: hydroxychavicol, hydroxychavicol acetate, chavibetol, piperbetol, methylpiperbetol, piperol A and piperol B. Study of essential oil and ether soluble fraction of leaves yielded fourteen components including eight allypyrocatechol analogs. The various phytochemicals found in the betel plants are chavibetol, chavicol, hydroxychavicol, estragole, eugenol, methyl eugenol, hydroxycatechol, caryophyllene, eugenol methyl ether, cadinene, γ-lactone, allyl catechol, p-cymene, cepharadione A, dotriacontanoic acid, tritriacontane, p-cymene, terpinene, eucalyptol, carvacrol, sesquiterpenes, cadinene, caryophyllene, dotriacontanoic acid, hentriacontane, pentatriacontane, stearic acid, n-triacontanol, triotnacontane, piperlonguminine, allylpyrocatechol diacetate, isoeugenol, 1, 8-cineol, a-pinene, ß-pinene, sitosterol, ß-sitosteryl palmitate, γ-sitosterol, stigmasterol, ursolic acid, ursolic acid 3ß-acetate. The phytochemial analysis of leaves also revealed the presence of alkaloids, carbohydrates, tannins, amino acids and steroidal components. The essential oil extracted from stalk, leaf, stem and root constitutes safrole, and the fruit essential oil constitute ß-phellandrene [15].

Betel Leaf is also known as 'The Green Gold' for its medicinal properties. It was reported that fresh leaves contain moisture 85.4, protein 3.1, fat 0.8, carbohydrate 6.1, fibre 2.3, calcium 230mg, phosphorous 40mg, iron 7mg, insoluble iron 3.5mg, iodine 3.4µg, carotene (vitamin A)9600IU, Thiamine 70µg, riboflavin 30µg, nicotinic acid 0.7mg & vitamin C 5mg/100g. They have a high content of potassium nitrate (0.26-0.42%). The sugar identified in betel leaf include glucose, fructose, maltose & sucrose. The average content of free reducing sugars in different types of betel leaves varies from 0.38%-1.46%. It also contains the enzyme like diastase and catalase. The oil consists of phenols and terpenes. Based on some research literature, it has been reported that red betel leaf has the potential to be used as a natural antibacterial agent in treating dental and oral health problems [16] (Table 5).

Table 5: Chemical compounds present in betel leaf and its uses [31]

Betel leaf bioactives	Structure	Uses
A-Terpinene		Cosmetics and food
A-Selinene		Aroma
A-Farnesene		Plant defence
Aromadendrene		Antioxidants and anti-ageing
Allylpyrocatechol Diacetate		Antimicrobial activity
A-Cadinene		Anticancer activity
A-humulene		Anti-inflammatory, effective in reducing platelet activating factor
a-Pinene		Anti-inflammatory and antibiotic
B-Phellandrene		Cosmetics and personal care
B-Ocimene		Perfume
B-Bourbonene		Flavour and fragrance agents
B-Selinene		Antibacterial characteristics

B-Farnesene		Natural insect repellent
Chavibetol		Aromatic compound with a spicy odour
Caryophyllene		Antioxidant, anti-inflammatory, anti-cancerous
Camphene		Fragrances and food additive for flavouring use
1,8-Cineol		Treatment of inflammatory diseases
Cis-sabinene		Anti-Infective Agents
E-Nerolidol		Flavouring property
Eugenol		Antiseptic and anaesthetic
Eugenyl acetate		Anti-virulence significance
Germacerene-D		Analgesic and anti-inflammatory properties
Globulol		Antimicrobial activity
Hydroxychavicol		Antimutagenic effect
Iso-safrole		Fragrance
Methyl Eugenol		Fragrance ingredient

Methyl isoeugenol		Flavour and fragrance agents
Myrcene		Fragrances and food additive
Spathulenol		Antibacterial activity
Sabinene		Antimicrobial properties
Safrole		Beverages and candy preparation
Terpinolene		Perfumes and food additive
Terpineol		Disinfectants

About 15 to 20 million individuals in India frequently use betel leaf due to its therapeutic and nutritional benefits. The betel leaf, which is regarded as a bioactive compound, also contains a number of phytochemicals and nutritional components. The antimicrobial, antioxidants, antifungal, anticancer, anti-inflammatory, anti-diabetic and digestive and gastro protective characteristics of these substances are among their important pharmacological qualities which are mentioned below [17].

Antimicrobial properties

Betel leaf has various types of bioactive properties among which antimicrobial activity is the most important property of Betel leaf. The antimicrobial property of betel leaf also acts as a food preservative due to containing many bioactive compounds like Chavicol, Chavibetol, ally pyrocatechol, chavibetol acetate, and ally pyrocatechol diacetate, etc. It is providing protection of food material from unwanted or harmful microorganisms. The antimicrobial activity of betel leaf works against E. coli, streptococcus pyrogen, pseudomonas aeruginosa, staphylococcus aureus proteus vulgaris, etc. Sterol bioactive molecules are responsible for antimicrobial activity. A huge amount of sterol molecules is present in the extract of betel leaf [18].

Antioxidant properties

Antioxidants are another important property of betel leaf. This property of betel leaf is due to the presence of polyphenol compounds such as allyl pyrocatechol and chavicol etc. The presence of these compounds in the extract of betel leaf shows control against the radiation-activated lipid peroxidation process. The presence of polyphenol compounds in the extract of betel leaf is more dominant than in polyphenol compounds of tea, it is reported by Subramani[19]. Nouri *et al.* have reported a good source of natural antioxidants is ethanolic betel leaf extracts. In the ethanolic and methanolic extracts of betel leaf, there are a lot of phenolic compounds [20].

Anti-fungal properties

Betel leaf (*Piper betle*) is known for its traditional use in various medicinal practices. It has been reported to have antifungal properties, which makes it effective against fungal infections. Studies have shown that the essential oil extracted from betel leaf has significant antifungal activity against several fungal species, including Candida albicans, Aspergillus Niger, and Trichophyton mentagrophytes [21]. The antifungal activity of betel leaf is attributed to the presence of various active compounds, such as eugenol, chavicol, and terpenes. Betel leaf extract has also been found to inhibit the growth of dermatophytes, which are fungi that cause skin infections such as athlete's foot and ringworm. In addition, betel leaf extract has been shown to have synergistic effects with other antifungal agents, such as fluconazole, which can improve their effectiveness. Overall, the antifungal properties of betel leaf make it a promising natural remedy for fungal infections. However, more research is needed to determine its efficacy and safety as a treatment for fungal infections [22].

Anti-cancer properties

The betel leaf also shows another most important anti-carcinogenic property due to having polyphenol compounds. The presence of bioactive components such as chlorogenic

and hydroxychavicol bioactive are ruin carcinogenic of tobacco[23]. Due to phenolic compounds, betel leaf is known as herbal medicine. Luteolin and apigenin are phenolic compounds of red betel leaf. Derivatives of apigenin and luteolin are cytotoxic to cancer cells. Red betel leaf extracts methanolic are used to evaluate the anti-migration and cytotoxic effects on metastatic breast cancer [24].

Antidiabetic

It is well known that betel leaf extract has potent anti-diabetic properties and can regulate blood glucose levels [25]. In a glucose tolerance test, the extract showed antihyperglycemic activity in the external glucose level [26]. The aqueous extract of betel leaves significantly reduced blood sugar levels in rats with low blood sugar after being tested on an overnight schedule. When compared to untreated diabetic rats, Streptozocin (STZ) diabetic rats exhibit significantly lower blood glucose levels, glycosylated hemoglobin, and decreased liver glucose-6-phosphatase and fructose-1, 6-bisphosphatase activity, although liver hexokinase levels are higher [27].

Anti- Inflammation

Anti-inflammation is part of the complex biological response of vascular tissue to harmful substances, such as pathogens, damaged cells, and irritants. It is a natural defense mechanism and is characterized by pain, fever, redness, swelling, and loss of function [28]. The main active compounds in betel leaf responsible for its anti-inflammatory properties are phenolic compounds, flavonoids, and terpenoids. These compounds have been shown to have antioxidants and anti-inflammatory effects, which can help reduce inflammation in the body [29]. In addition to being anti-inflammatory, flavonoids also have anti-allergic, antioxidant, anti-microbial, anti-cancer, and antidiarrheal properties. Various cancers, including hepatic, pancreatic, breast, esophageal, and colon cancers, have been linked to flavonoids that increase apoptotic activity. Studies have found that betel leaf extract can help reduce inflammation in various conditions such as arthritis, asthma, and skin allergies [30].

Future scope: The leaves are frequently used as remedies because they contain important bioactive components. Due to their inexpensive cost and ease of usage, they are widely utilized in India and abroad. To cure alcoholism, bronchitis, asthma, leprosy, and dyspepsia, it can be taken as a dietary additive or taken separately. There are only a limited number of studies on the use of leaf isolates and EO. Because there is a dearth of study in this field, we should concentrate on its possible technologies in a variety of procedures such as food applications, pharmaceutical industries, cosmetic industries, and so on. A Research and Development Board should also be established by the government. This could help keep the price of betel leaves stable. If farmers, scientists, technicians, and researchers work together to resolve the limits, the economy and job prospects will grow. In addition, future studies are also needed to discover nutraceutical foodstuffs or products and their use in cancer therapy.

Conclusion

It was concluded that betel leaf (*Piper betle*) is an excellent herb used in various fields and has potential benefits and applications. India has wide range of cultivation of betel leaves. Therapeutic applications of betel leaves are due to its antioxidant, anti-fungal, anti-microbial and anti-septic properties. Not only therapeutic applications of betel leaf have been popularised but it has wide range of application in the field of ancient science as well as modern science. The betel leaf is a rich source of phenolic compounds, which are advantageous to many different areas of health and have a wide range of therapeutic uses. The use of betel leaf extract in a variety of commercial applications, including food supplements, the cosmetics, and pharmaceutical industries, among others, is gaining in popularity as a result. The extremely powerful bioactive chemicals found in betel leaves and their derivative products are in high demand worldwide. Therefore, the same with lots of biological activities and has a tremendous strength to come out as a future herb medicinal and nutrients uses.

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