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Review Article

A Review Medicinal Benefits of Betel Leaf

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ABSTRACT

Betel leaf (Piper betel L.), an evergreen perennial climber that belongs to the Piperaceae family, is valued for its medicinal, cultural, and economic use in South and Southeast Asia. In Ayurvedic and traditional medicine, its leaves have long been chewed in a number of ways due to their stimulatory and restorative qualities. Among its many pharmacological properties are antibacterial, antioxidant, anticancer, anti-inflammatory, and gastroprotective actions. Despite its historic significance, cultivation has decreased because of financial limitations and contemporary consumption patterns. Betel leaf is grown in many tropical and subtropical nations, such as Bangladesh, Malaysia, Sri Lanka, and India. It is a fragrant shrub with heart-shaped leaves that is dioecious. It is especially important from a religious, cultural, and therapeutic perspective in traditional Indian systems like Ayurveda. It has been utilized for over two millennia and continues to be an essential part of traditional healing systems and rituals. Literature research and an evaluation of the pharmacological and phytochemical properties of Piper betel leaves were part of the study. The leaves were harvested from Bangladesh's Jahangirnagar University, examined by the National Herbarium, and extracted in a number of ways. A number of procedures, such as disc diffusion, DPPH radical scavenging, and GC-MS analysis, were used to examine the makeup of essential oils, antioxidants, an antimicrobial. The antibacterial, antioxidant, gastroprotective, anti-inflammatory, and anticancer properties of betel leaf (pyres betel) are just a few of its many therapeutic benefits. It may take into account both traditional formulations and drug development. Abuse of betel quid, however, can have detrimental health implications, especially when mixed with tobacco. To guarantee sustainable use, it is important to keep it economically relevant, promote its health benefits, and discourage harmful consumption habits.

INTRODUCTION

The betel leaf is a fascinating evergreen climber, known for its glossy, heart-shaped leaves and unique white catkins. This plant belongs to the Piper genus and the Piperaceae family, thriving

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mainly in tropical and subtropical areas around the globe. You can find the cultivation of Piper betel in countries like India, Sri Lanka, Malaysia, Indonesia, the Philippines, various island regions, and parts of East Africa. The essential oil derived from betel leaves is a vibrant yellow, aromatic, and carries a sharp, pungent taste. Interestingly, over 90 different varieties of betel vine have been recognized worldwide, with nearly 45 of them found in India, and about 30 of those specifically in West Bengal. (1). Betel leaf is a popular plant found in tropical and subtropical areas, cherished not just for its lush green leaves but also for its deep cultural, religious, and medicinal importance. In Bangladesh, a staggering 60–70% of people enjoy betel leaves as part of their daily lives. Throughout Southeast Asia, traditional medicine has long recognized this plant as a vital source of healing. Betel leaves are a crucial component of betel quid, which usually includes areca nut (Areca catechu L.), tobacco (Nicotiana tabacum L.), and slaked lime. Historically, these leaves have been used to treat a variety of health issues, such as rheumatism, wounds, skin infections, abscesses, eye inflammations, headaches, itching, mastitis, mastoiditis, leucorrhea, ear discharge, gum swelling, and joint pain. Beyond their medicinal and cultural significance, betel leaves are also essential for the livelihoods of many communities, making their cultivation incredibly important for the economies of South Asia.(2).Countries like India, Pakistan, Bangladesh, China, Sri Lanka, Burma, the Philippines, Nepal, Indonesia, and Malaysia have all accorded the betel vine a distinguished position. Its raw leaves are chewed with a variety of other items, including coconut, sliced areca nut, anise, coriander, cardamom, etc., especially in these nations. Betel leaves come in a wide variety depending on their size, color, flavor, and aroma. Among these types are Venmony, Mysore, Kauri, Magadhi, and Banarasi(3).The vine is a perennial root climber that prefers shade and is dioecious (male and female plants differ). Of the approximately 100 betel vine kinds identified worldwide, about 40 are found in India and 30 in West Bengal. Malaysia is the most likely area where the betel vine originated. Despite their similarity, the plant has been more well-liked in India than any other nation since the distant past(4).The Piper betel, which is a member of the Piperaceae family and contains over 2000 species, has been used for centuries to treat a variety of illnesses because to its important qualities as an antioxidant, anticancer, and anti-allergic. It is an indigenous plant in India. One(5).Although betel vines are most likely native to Malaysia, they are currently grown in India, Sri Lanka, Bangladesh, Burma, and Nepal (Kumar et al., 2010; Guha et al., 2006).(6).The health department's national postpartum program policy requires women to have at least four postpartum appointments in order to guarantee their basic health. The case of "Permits and Implementation of Midwife Practices" is 1464/MENKES/PER/X/2010. The provision of maternal health services, including postpartum care, by midwives is covered under Article 10.According to Republic of Indonesia Health Minister Decree No. 381/MENKES/SK/III/2007 creating a national policy for traditional medicine (Kotranas) that aims to advance the sustainable use of traditional herbs and natural resources to improve healthcare(7)The most significant Ayurvedic remedies made from the Piper Betel plant are Brhat Sarwajwarahara, Lanha, Laghusutaseknara Rasa, Brhat Visamajwarantaka Rasa, Lokantha Rasa, and Puspadhava Rasa. In Ayurveda, betel leaf juice is frequently taken as a supplement and in combination with other drugs that may have positive side effects. Tambol leaves are described in the Susruta Samhita as being astringent, exhausting, heated, smelly, and sound- valuable, as well as reducing vata and raising pitta (8).

Fig no: 1 Betel Leaf [9]

1.1 MORPHOLOGY (9)

Colour:	A rich, deep green
Shape	Heart- Shaped
Length	Approximately 15 to 18 cm
Width	Roughly 10 cm
Odor	Has a distinctly aromatic scent
Apex	Pointed, featuring A symmetrical base

1.2 Ayurvedic significance

The Sanskrit names Tambool, Nagvelleri, and Nagani, as well as the Vedic term Saptasira, refer to piper betel. It was used to treat a variety of illnesses. There are references to Tamil from the Kamasutra and Panchatantra of Vasyayana to Kalhan's Rajatarngni, which is arguably the last extant ancient Sanskrit text of historical significance. Thus, tambool has been used to refer to a time span of around 2000 years (10).

1.3 Betel leaf's bioactive qualities:

Betel leaf is widely used by 15 to 20 million people in India because of its nutritional and medicinal properties (Fig. 1). In addition to being a bioactive substance, the betel leaf has several phytochemicals and nutritional elements. These compounds' significant pharmacological properties, which are listed below, include their antibacterial, antioxidant antifungal, anticancer, anti-inflammatory, anti-diabetic, and digestive and gastroprotective properties.(11) 1.4 Material and methods plant material In February 2011, we collected leaves from the Piper betel Linn. plant on the Jahangirnagar University campus in Bangladesh. The plant material was carefully verified by the Bangladesh National Herbarium, and we've preserved a voucher specimen (No. JU/33334) in our lab for future reference.((12).

2. SCIENTIFIC CLASSIFICATION (13,14,15)

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Piperales
Family	Piperaceae
Genus	Piper
Species	Piper betel

2.1 Health Effects: In India, epidemiological studies have demonstrated a substantial correlation between the incidence of cancer and chewing betel quid that contains tobacco, areca nuts, limewater, and betel leaf. A strong correlation has been found between chewing paan (betel quid) and an increased risk of head development.(16)

2.2.Adverse reactions to betel leaf.(17)

The following adverse consequences can occur when betel leaves are taken with tobacco, lime, and areca nuts

1. Could lead to substance abuse
2. Could result in euphoria
3. Could make you perspire
4. Can result in salivation

2.3.Synonyms(18)

- Latin: Piperis folium;
- Sanskrit: Nagavallari, Nagini;
- Hindi: Paan;
- Marathi: VidyachePan;
- Tamil: Vetrilai;
- Telugu: Tamalapaku;
- Arabic: Tanbol;
- Malayalam: Vettilakkoti .

2.4. Moisture content determination

An oven set between 100 and 105 degrees Celsius was used to dry the powdered material (1 g) in a moisture dish to a consistent weight. The weight loss of the air-dried material was determined in milligrams per gram.(19)

3. PHYSIOCHEMICAL PROPERTIES

The concentration of bioactive compounds in Piper betel can vary quite a bit depending on the plant variety, the season, and the environmental conditions. The fruit is known to contain β-phellandrene, while the leaves, stems, stalks, and roots are packed with safrole, both of which play a significant role in its essential oil profile. Additionally, Piper betel is recognized for having hydroxychavicol acetate, allyl pyrocatechol, piperbetol, isoeugenol, anethole, stearic acid, methyl eugenol, carvacrol, polyphenols, alkaloids, saponins, tannins, and a host of other metabolites. The distinctive aroma of betel leaf mainly comes from its essential oil, which is rich in phenolic and terpenoid compounds. The leaf oil extracted from Piper betel primarily consists of hydroxy catechol, eugenol, methyl eugenol, estragole, chavibetol, chavicol, and various allylbenzene derivatives. When solvents like ether (at 40–60 °C), chloroform, ethanol, and water are used for extraction, the plant produces different phytochemicals: phytosterols are present in all extracts except for water, petroleum ether extracts are devoid of alkaloids, while ethanol and aqueous extracts reveal phenols, carbohydrates, and tannins. Flavonoids are only found in the water extract, whereas essential oils are most concentrated in the ethanol extracts. Gas chromatography (GC) and gas chromatography–mass spectrometry (GC–MS) analyses were performed using a BP-1 (polydimethylsiloxane, 50 m × 0.25 mm) column on a Perkin Elmer GC 8500 with flame ionization detection. The findings showed 25 and 35 individual components, respectively. In the Bangladeshi variety of Piper betel, the leaf oil was primarily composed of eugenol (50.29%), followed by α-selinene (11.39%), β-selinene (10.14%), germacrene-D (2.82%), α-farnesene (2.48%), hydroxyl chloride (1.20%), and methyl eugenol (1.17%), which together accounted for 79.4% of the oil. On the other hand, the Deswari variety displayed a different composition, with eugenol .(20).

3.1 Measurement of the physicochemical

We assessed the spray-dried powder of Piper betel following the guidelines set by the WHO. We looked into various physicochemical properties, including moisture content, total ash, acid-insoluble ash, water-soluble ash, and the values for ethanol-soluble extracts in the formulation.(21)

3.2 The characteristics of betel leaves Betel leaves could have the following characteristic(22)

1. It could offer cancer prevention.
2. It could have antioxidant properties.
3. It might inhibit the development of fungus.
4. It might prevent allergic responses.
5. It might help wounds heal
6. Constipation may be treated with it.

4. ECONOMIC GROWTH

According to a study from 2006, betel was cultivated on about 55,000 hectares of farmland in India, bringing in an annual production value of around Rs. 9 billion (which averages out to about $1,455 per acre). This industry supports around 400,000 to 500,000 farming households. However, a research report from March 2011 indicates that betel cultivation in India is on the decline. Even under the best conditions, some farms struggle to make a gross annual income after expenses that exceeds Rs. IN. The income from betel farming can be quite unpredictable, ranging from $26,000 per farm to about $5,780 per acre, largely due to fluctuations in temperature and rainfall, along with a staggering 35-70% loss during transit caused by poor infrastructure. At the same time, the demand for betel leaves has dropped as more people have turned to gutkha, or chewing tobacco, instead of the traditional betel leaf preparation known as "paan." A report noted that the betel leaf trade plummeted by 65% between 2000 and 2010, leading to an oversupply. As a result, the paper concludes that growing betel is no longer a profitable venture for Indian farmers. (23).

Fig No:2 A Women Is Selling Green Betel Leaf [23]

4.1 Distribution

The story of Piper betel begins in Indochina, which includes modern-day countries like Vietnam, Cambodia, Laos, Thailand, and Myanmar. It also stretches to Peninsular Malaysia, East Timor, and the Lesser Sunda Islands in Southeast Asia. As people migrated and traded, the plant found its way to new places, reaching Papua New Guinea, Malaysia, Micronesia, South Asia, the Maldives, Mauritius, Réunion Island, and even Madagascar. Interestingly, during the colonial era, it made its way to the Caribbean as well.(24).

4.2 AYURVEDIC USE

1. Scanty or Obstructed Urination: Diuretic qualities are attributed to betel leaf juice. Urine transit is made easier by its juice, which is mildly sweetened and combined with diluted milk.
2. Respiratory disorder: Betel leaves are beneficial. In lung diseases that occur in both youth and elderly life. When the leaves are warmed and soaked in mustard oil, they can be applied to the chest to ease coughing or breathing difficulties.(25,26)

4.3 Dental Health and Beetle Nuts

In the Indian subcontinent, betel quid—often referred to as paan—is a traditional chew made by wrapping various ingredients in a betel leaf. Typically, it includes areca nut, slaked lime, and the nut from the Areca catechu palm, with some variations adding tobacco. The areca nut is derived from the endosperm of the fruit of the Areca catechu palm. People usually place the quid in their mouth, chewing it for about 10 to 15 minutes before either swallowing or spitting it out. This practice can happen several times a day, sometimes as many as six times. The main

attraction of chewing betel nut is its euphoric effects. (27)

5. PHARMACOLOGICAL ACTIVITY

Numerous natural products are used in traditional medicine in a number of nations to treat a wide range of illnesses. Piper betel is a member of the Piperaceae family, which includes more than 2000 species. This plant is native to India. Although the exact processes underlying the effectiveness of piper betel leaves against several human infections remain unclear, they have been demonstrated to be effective. Because of its vital qualities, which include anti-oxidant, anti-cancer, and anti-allergic capabilities, extracts of piper betel have been used for centuries to cure a variety of illnesses.(28)

5.1 Platelet Inhibition Activity

We conducted experiments to see how hydroxychavicol (HC) affects platelet aggregation. The findings showed that HC is a strong inhibitor of cyclooxygenase activity, helps reduce reactive oxygen species, disrupts platelet calcium signaling, and lowers thromboxane B2 production, which in turn limits platelet aggregation. These characteristics indicate that HC could be a promising option for treating and preventing cardiovascular issues, including conditions like osteoarthritis. Notably, it provides antiplatelet and anti-inflammatory benefits without interfering with normal blood clotting functions.(29)

5.2 Antioxidant Activity

A Research has revealed that aqueous extracts from three different types of Piper betel leaves show impressive antioxidant properties when tested through various in vitro methods, including DPPH radical scavenging, superoxide radical neutralization, hydroxyl radical inhibition, and protection against lipid peroxidation [51]. Additionally, the ethanolic extract of betel leaves has been studied in experimental animals, particularly rabbits, using concentrations of 5%, 10%, and 15%. In this experiment, burns were created by applying heated metal plates to the shaved backs of the rabbits, which caused damage to the dermis and subcutaneous tissues, leading to blister formation. The rabbits received topical treatment with the betel leaf extract once a day for a week. The healing process was monitored visually and compared to Bioplacenton, which acted as a positive control. The findings indicated that the ethanolic extracts of Piper betel at all tested concentrations effectively promoted the healing of burn wounds in the rabbits (Oryctolagus cuniculus).

The phytochemical composition of betel leaves is notably abundant in flavonoids, phenolic compounds, and essential minerals, all of which enhance their antioxidant capabilities. These bioactive elements play a crucial role in shielding body cells from oxidative stress and damage caused by free radicals. Consequently, regular consumption of betel leaves has been associated with the prevention of various chronic diseases and the promotion of overall health and well-being.(30)

5.3 Radio Protective Activity

When exposed to radiation, mammalian systems can suffer negative consequences that include cell death and a higher risk of degenerative disorders. P. betel leaf ethanolic extract's radioprotective qualities have recently been investigated as a low-cost substitute for synthetic radioprotectants, which are said to be harmful. To determine how the extract works as a radioprotector, its ability to stop g-ray-induced lipid-peroxidation and DNA damage in rat liver mitochondria was measured and analyzed.(31)

5.4 Antibacterial Activity

The antibacterial properties of dried Piper betel leaves were evaluated using the disc diffusion method. To prepare the leaves, they were blended, extracted in water, and then heated to 90 °C for 15 minutes before testing. The study focused on bacterial strains like Staphylococcus aureus, Staphylococcus epidermidis, and Escherichia coli, with ampicillin–sulbactam used as the positive control. The findings showed that extracts from betel leaves effectively inhibited both Gram-positive and Gram-negative bacteria, as evidenced by the inhibition zones observed. Phytochemical analysis indicated that betel leaves are rich in terpenoids, glycosides, alkaloids, phenolics, flavonoids, tannins, saponins, and essential oils. The essential oil's major components included 5-(2-propenyl)-1,3-benzodioxole (25.67%), eugenol (18.27%), and 2-methoxy-4-(2-propenyl) acetate-phenol (8.00%). The antibacterial effects are primarily linked to the oxygenated terpenoids found in these oils. These bioactive compounds are recognized for their ability to combat oral pathogens that lead to dental caries, plaque accumulation, tooth decay, and bad breath. Traditionally, betel leaves have also been used to alleviate toothaches, gum inflammation, swelling, and oral infections. Eating a small amount of betel leaf paste after meals is thought to aid digestion, enhance gut health, and help reduce bad breath.(32,33)

5.5 Antimicrobial Activity

The antibacterial properties of betel leaf (Piper betel) ethanol extract were evaluated using the disc diffusion method. Previous studies on betel leaf powder have confirmed the presence of various compounds, including carbohydrates, flavonoids, alkaloids, and a significant amount of antioxidants. The antioxidant activity of the ethanol extract was assessed through the DPPH assay, which revealed impressive free radical scavenging abilities. These results indicate that the extract has considerable antimicrobial effects against several bacterial strains, such as Pseudomonas aeruginosa, Klebsiella pneumoniae, Proteus vulgaris, and Staphylococcus aureus. Further research has shown that different solvent extracts of Piper betel leaves—like water, methanol, ethyl acetate, and petroleum ether—also displayed antibacterial activity against a range of pathogenic bacteria, including Streptococcus pyogenes, Staphylococcus aureus, Proteus vulgaris, and Escherichia coli. Additionally, the essential oils derived from betel leaves exhibited inhibitory effects on Pseudomonas aeruginosa, Staphylococcus aureus, and Escherichia coli. The antibacterial effectiveness of betel leaf is linked to its rich array of phytochemicals and phenolic compounds, which help combat both Gram-positive and Gram- negative bacteria. (34,35).

5.6 Gastro Protective Activity

It has long been known that piper betel linn can cure stomach ulcers. It also possesses gastroprotective properties. Hot aqueous extracts (HAE) and cold ethanolic extracts (CEE) from its leaves can offer significant protection against ethanol-induced stomach injury when taken orally. Both extracts exhibit stronger efficacy against gastrointestinal injury at the greatest dosages. HAE prevents the volume of stomach acid from increasing as well. It is also believed to make the stomach mucosa more mucus-rich. HAE and CEE hence have strong gastroprotective properties.(36)

5.7 Anti Allergic Activity

Researchers have been looking into how Piper betel might help reduce the production of allergy-related substances in lung cells and mast cells derived from bone marrow. They tested an ethanolic extract of Piper betel in the lab, focusing

on its effects on the human lung epithelial cell line BEAS- 2B, particularly regarding the release of exotoxins and interleukin-8 (IL-8). Additionally, they examined how it influenced histamine release and the production of granulocyte–macrophage colony-stimulating factor (GM-CSF) in mouse bone marrow mast cells (BMMCs). The findings showed that the extract effectively inhibited the release of exotoxins and IL-8 during allergic reactions triggered by TNF-α and IL-4. Moreover, it significantly lowered histamine and GM-CSF levels in responses related to IgE-mediated hypersensitivity. These results indicate that Piper betel may have the potential to help manage allergic conditions by limiting the production of crucial mediators involved in allergies.(37).

5.8 Anticancer Activity

Anti-cancer drugs that contain antioxidants may work by balancing reactive oxygen species (ROS), which prevents cancer cells from proliferating when apoptosis is prevented (Abrahim et al., 2012). Experimental and clinical studies have shown that chronic inflammation is the primary cause of many human diseases, including cancer and tumors (Kangralkar and Kulkarni,2013). Traditionally, the betel leaf was used as a folk remedy to treat oral irritation. In Southeast Asia, where smoking and cigarette use are prevalent, 90% of cases of mouth cancer occur, making it one of the top ten most common cancers (Jiang et al., 2019). One of the first research (Toprani and Patel, 2013) found that hamsters' oral cancer caused by pinene was prevented by topical therapy with leaf extracts.(38)

5.9 Antimalarial Activity

More protection against Anopheles stephensi and Culex fatgans mosquito bites was offered by EO in comparison to the well-known insect repellent citronella oil. Citronella oil only offered 2.2 and 2.6 hours of protection against Anopheles stephensi and Culex fatgans, respectively, but the oil offered almost 4 hours when sprayed at a rate of 20 liters per centimeter 2. Paan's ability to fend against mosquitoes has thus been demonstrated (Pal and Chandrashekar, 2010; Ibrahim et al., 2017; Cang et al., 2020). (39)

5.10 Anti Nociceptive Activity

Piper betel contains anti-nociceptive properties, according to a 2011 study by Arambewela LS et al. The licking time in the early and late stages of the formalin test was significantly decreased by dosages of Piper betel extract of around 200 and 300 mg/kg, as shown by a bell- shaped dose-response curve. Histamine and bradykinin are examples of inflammatory mediators that cause pain in the late phase of the formalin test, whereas formalin directly stimulates sensory nerve fibers, causing pain in the early phase. According to reports, NSAIDs decrease the formalin test's two phases. The betel extracts also caused disruptions in both test phases, which may indicate that sensory transmission and the release of inflammatory mediators are impaired.(40)

5.11 Anti Diabetes Activity

According to numerous studies, betel leaf powder helps lower blood sugar levels in people with type 2 diabetes who have just received a diagnosis. A potent antioxidant, betel leaf aids in the treatment of diabetes by lowering inflammation brought on by uncontrolled blood sugar and combating oxidative stress. (41)

6. TRADITIONAL USE

Secondary metabolites found in the plant betel (Piper betel) can be used as a foundation for conventional medicine. Originating in central and eastern Malesia, this betel plant was first cultivated

some 2,500 years ago throughout tropical Asia, Madagascar, and East Africa. In the fifteenth century, Europeans introduced this variety of betel to South China and India, where it now grows and spreads. (42)

7. DISEASE

Collar rot," "foot rot," "leaf spot," (and powdery mildew are the main diseases that have an impact on betel vines.

1. Foot Root

Phytophthora species are responsible for the most prevalent fungal disease. Foot rot affects the plantaton (Meszka and Michalecka, 2016; Haider et al., 2013). Phytophthora species was identified as P. nicotanae var. parasitca when it was discovered in 1927 (Meng et al., 2014). According to Haider et al. (2013), foot rot caused by P. parasitca and Phythium vexans de Bery(Phythium piper-inum Dastur) was documented. The petiole of the leaves stays upright, but the lamina gradually starts to drop. This illness is referred to in the region as "Khada Kala," "Khada Pacha," or "Madua." Tegron and Blitox are being sprayed by nearby growers to stop the disease from spreading (Haider et al., 2013).

2. Leaf Spot

Leaf spot disease affecting betel vine, caused by Fusarium semitectum, was first reported by Patra and Pradhan in 2018. Prior to that, Singh and Shanker documented other pathogenic infections, such as Cladosporium pipericola, Drechslera rostrata, Corynespora cassicola, and Cercospora piperis-betel, in Madhya Pradesh and Uttar Pradesh, India, back in 1971. Mait and Sen also made additional observations in 1979. Locally, this disease is often referred to as "Champa Tipa" or "Champa Fulia." It manifests as small, curling leaf tips, and if the affected leaves aren't removed quickly, the infection can spread swiftly to the main stem of the vine. Ants and other insects help in transmitting the pathogens from one plant to another, making the situation even worse.

3. Powdery Mildew.

Narasimhan identified the condition in Mysore, India, in 1933. The primary cause of powdery mildew illness is Oidium piperis Uppal (Park et al., 2012). In local parlance, this condition is called "Jhalma." The infection shows up on the bottom of the leaves as powdery white to light brown patches. At this stage, the upper and bottom parts of the leaves have little white and black particles. This is a highly contagious illness. There is no cure or prevention for this disease. Farmers dust betel vine leaves with a mixture of dried fruit dust and water-diluted Neem tree (Azadirachta indica A. Juss.) leaf juice (Patra and Pradhan 2018).Histopathological and macroscopic analyses. The stomach was quickly taken from both the normal and treated groups, opened along the larger curvature, and then thoroughly cleaned with normal saline. A lengthy piece of gastric tissue was removed from the front of the stomach and preserved in a 10% formalin solution after the stomach ulcers were noted. It was cut into 5-micron slices on a glass slide after being fixed for 24 hours and then embedded in a paraffin block. Hematoxylin-eosin was then used to stain the sections for a histological evaluation of the stomach mucosa. The stomach's larger curvature was opened, and the gastric antral section was used for biochemical investigations. The portion's moist weight was also noted.(43).

8. FUTURE STUDIES

Betel leaves are popular for their medicinal benefits; thanks to a range of bioactive compounds they contain. Their low cost and easy availability

have made them a favorite not just in India, but around the world (Peddapalli et al., 2020). Traditionally, people have used them as dietary supplements or natural remedies for various ailments, including leprosy, alcoholism, bronchitis, asthma, and indigestion. However, one significant hurdle is their short shelf life, which complicates long-term storage. Consequently, many excess leaves end up being thrown away or fed to cattle. To tackle this problem, it's crucial for researchers to focus on developing effective methods for preserving and storing betel leaves, aiming to extend their freshness and reduce postharvest waste. Given that the production, processing, packaging, handling, transportation, and marketing of betel leaves impact a large segment of the population, both directly and indirectly, collaboration is key. There's a pressing need for stronger partnerships between federal and state governments to back research efforts and create a dedicated Research and Development Board. These steps would not only help stabilize prices but also boost the economic viability of betel leaf farming.44.

CONCLUSION

Overall, it offers a methodical perspective on Piper betel Linn's medicinal potential and is most helpful for investigating and developing fundamental pharmaceuticals. People of all ages eat the addictive drug areca nut in many places of the world. It has numerous, varied impacts on practically every organ in the human body, in addition to being carcinogenic to the throat, esophagus, liver, uterine, and oral cavity. Betel vine bioactive compounds should be separated, extracted utilizing both conventional and cutting-edge technologies, and evaluated for further bioactive properties including antibacterial, antioxidant, antidiabetic, anticancer, and so on. The pharmacological activities of piper betel make it one of the most significant plants in human life, with numerous applications, benefits, and medicinal value. People have been using piper betel as a mouth refresher since ancient times.(45,46,47,48,49,50)

REFERENCES

1. Rai, K. K. R., Trivedi, R. V., C Umekar, M. J. (2019). Review on betel leaf used in various ailments. Int J Pharmacognosy, 6(8), 259-267.
2. Hossain, M. F., Anwar, M., Akhtar, S., C Numan, S. M. (2017). Uses impact of betel leaf (Piper betel L.) on public health. Science Journal of Public Health, 5(6), 408-410.
3. Afridi, M., Muhammad, I. M. R., Ahmad, T., Hussain, A., Akram, M., Ghotekar, S., … C Marasini, B. P. (2021). Ethno-medicinal uses of Piper betel— A review. Adv. J. Chem.-Sect. B, 3, 199-208.
4. Chauhan, E. S., Aishwarya, J., Singh, A., C Tiwari, A. (2016). A review: Nutraceuticals properties of Piper betel (Paan). Am J Phytomed Clin Ther, 4(2), 28-41.
5. Rekha, V. P. B., Kollipara, M., Gupta, B. R. S. S., Bharath, Y., C Pulicherla, K. K. (2014)
6. A review on Piper betel L.: nature's promising medicinal reservoir. American Journal of Ethnomedicine, 1(5), 276-289.
7. Rai, M. P., Thilakchand, K. R., Palatty, P. L., Rao, P., Rao, S., Bhat, H. P., C Baliga, M. S. (2011). Piper betel Linn (betel vine), the maligned Southeast Asian medicinal plant possesses cancer preventive effects: Time to reconsider the wronged opinion. Asian Pac J Cancer Prev, 12(9), 2149-2156.
8. Vikash, C., Shalini, T., Verma, N. K., Singh, D. P., Chaudhary, S. K., C Asha, R. (2012). Piper betel Phytochemistry, traditional use C pharmacological activity a review. International Journal of Pharmaceutical

Research and Development (IJPRD), 4(4), 216-223.

9. Destiana, I., Nurhasanah, N., C Triwahyuningsih, R. Y. (2024). Benefits of Betel Leaves as a Medicine for Postpartum Perineal Wounds. Jurnal Medisci, 2(2), 117-129.
10. Bubera, N., Lamkhade, A., Sonawane, S., Raut, A., Waghmare, O., C Patil, S. The Wondersof Piper Betel Linn: A Systematic Review.
11. Jadeja, J., Khanpara, P., Chauhan, J., C Faldu, S. (2023). A REVIEW ON NUTRITIOUS LEAF:PIPER BETEL. World Journal of Pharmaceutical and Medical Research, 9(12).
12. Jadeja, J., Khanpara, P., Chauhan, J., C Faldu, S. (2023). A REVIEW ON NUTRITIOUS LEAF:PIPER BETEL. World Journal of Pharmaceutical and Medical Research, 9(12).
13. Singh, T., Singh, P., Pandey, V. K., Singh, R., C Dar, A. H. (2023). A literature review onbioactive properties of betel leaf (Piper betel L.) and its applications in food industry. Foodchemistry advances, 3, 100536.
14. Alam, B., Akter, F., Parvin, N., Sharmin Pia, R., Akter, S., Chowdhury, J., Sifath-E-Jahan, K.,C Haque, E. (2013). Antioxidant, analgesic and anti-inflammatory activities of the methanolic extract of Piper betel leaves. Avicenna journal ofphytomedicine, 3(2), 112–125.
15. Rai, K. K. R., Trivedi, R. V., C Umekar, M. J. (2019). Review on betel leaf used in variousailments. Int J Pharmacognosy, 6(8), 259-267.
16. Depi, S. (2020). Review of traditional use, phytochemical and pharmacological activity of Piper betel L. Galore International Journal of Health Sciences and Research, 5(3), 59-66.
17. Depi, S. (2020). Review of traditional use, phytochemical and pharmacological activity of Piper betel L. Galore International Journal of Health Sciences and Research, 5(3) 59-66.
18. Jadeja, J., Khanpara, P., Chauhan, J., C Faldu, S. (2023). A REVIEW ON NUTRITIOUS LEAF:PIPER BETEL. World Journal of Pharmaceutical and Medical Research, 9(12).
19. Jadeja, J., Khanpara, P., Chauhan, J., C Faldu, S. (2023). A REVIEW ON NUTRITIOUS LEAF:PIPER BETEL. World Journal of Pharmaceutical and Medical Research, 9(12).
20. Bubera, N., Lamkhade, A., Sonawane, S., Raut, A., Waghmare, O., & Patil, S. The Wonders of Piper Betel Linn: A Systematic Review.
21. Arawwawala, L. D., Hewageegana, H. G., Arambewela, L. S., & Ariyawansa, H. S. (2011).Standardization of spray-dried extract. Pharmacognosy magazine, 7(26), 157–160.
22. Chauhan, E. S., Aishwarya, J., Singh, A., & Tiwari, A. (2016). A review: Nutraceuticalsproperties of Piper betel (Paan). Am J Phytomed Clin Ther, 4(2), 28-41.
23. Arawwawala, L. D., Hewageegana, H. G., Arambewela, L. S., & Ariyawansa, H. S. (2011).Standardization of spray-dried extract. Pharmacognosy magazine, 7(26), 157–160.
24. Jadeja, J., Khanpara, P., Chauhan, J., & Faldu, S. (2023). A REVIEW ON NUTRITIOUS LEAF:PIPER BETEL. World Journal of Pharmaceutical and Medical Research, 9(12).
25. Jadeja, J., Khanpara, P., Chauhan, J., & Faldu, S. (2023). A REVIEW ON NUTRITIOUS LEAF: PIPER BETEL. World Journal of Pharmaceutical and Medical Research, 9(12).
26. Jadeja, J., Khanpara, P., Chauhan, J., & Faldu, S. (2023). A REVIEW ON NUTRITIOUS LEAF: PIPER BETEL. World Journal of Pharmaceutical and Medical Research, 9(12).
27. Rai, K. K. R., Trivedi, R. V., & Umekar, M. J. (2019). Review on betel leaf used in various ailments. Int J Pharmacognosy, 6(8), 259-267.

28. Rai, K. K. R., Trivedi, R. V., & Umekar, M. J. (2019). Review on betel leaf used in various ailments. Int J Pharmacognosy, 6(8), 259-267.
29. Aziz, S. R. (2010). Coming to America: betel nut and oral submucous fibrosis. The Journalof the American Dental Association, 141(4), 423-428.
30. Rai, K. K. R., Trivedi, R. V., & Umekar, M. J. (2019). Review on betel leaf used in various ailments. Int J Pharmacognosy, 6(8), 259-267.
31. Vikash, C., Shalini, T., Verma, N. K., Singh, D. P., Chaudhary, S. K., & Asha, R. (2012). Piperbetel Phytochemistry, traditional use & pharmacological activity a review. International Journal of Pharmaceutical Research and Development (IJPRD), 4(4), 216-223.
32. Vikash, C., Shalini, T., Verma, N. K., Singh, D. P., Chaudhary, S. K., & Asha, R. (2012). Piperbetel Phytochemistry, traditional use & pharmacological activity a review. International Journal of Pharmaceutical Research and Development (IJPRD), 4(4), 216-223.
33. Vikash, C., Shalini, T., Verma, N. K., Singh, D. P., Chaudhary, S. K., & Asha, R. (2012). Piperbetel Phytochemistry, traditional use & pharmacological activity a review. International Journal of Pharmaceutical Research and Development (IJPRD), 4(4), 216-223.
34. Depi, S. (2020). Review of traditional use, phytochemical and pharmacological activity of Piper betel L. Galore International Journal of Health Sciences and Research, 5(3), 59-66.
35. Jadeja, J., Khanpara, P., Chauhan, J., & Faldu, S. (2023). A REVIEW ON NUTRITIOUS LEAF:PIPER BETEL. World Journal of Pharmaceutical and Medical Research, 9(12).
36. Depi, S. (2020). Review of traditional use, phytochemical and pharmacological activity of Piper betel L. Galore International Journal of Health Sciences and Research, 5(3), 59-66.
37. Jadeja, J., Khanpara, P., Chauhan, J., & Faldu, S. (2023). A REVIEW ON NUTRITIOUS LEAF:PIPER BETEL. World Journal of Pharmaceutical and Medical Research, 9(12).
38. Afridi, M., Muhammad, I. M. R., Ahmad, T., Hussain, A., Akram, M., Ghotekar, S., ... &Marasini, B. P. (2021). Ethno-medicinal uses of Piper betel—A review. Adv. J. Chem.-Sect. B,3, 199-208.
39. Chauhan, E. S., Aishwarya, J., Singh, A., & Tiwari, A. (2016). A review: Nutraceuticals properties of Piper betel (Paan). Am J Phytomed Clin Ther, 4(2), 28-41.
40. Tutu, A. K. S., Guddun, S. S. K., Kumari, P., & Dey, S. K. D. (2022). An overview of Betel vine (Piper betel L.): Nutritional, pharmacological and economical promising natural reservoir. Advances in Horticultural Science, 36(1), 63-80.
41. Tutu, A. K. S., Guddun, S. S. K., Kumari, P., & Dey, S. K. D. (2022). An overview of Betelvine (Piper betel L.): Nutritional, pharmacological and economical promising naturalreservoir. Advances in Horticultural Science, 36(1), 63-80.
42. Rai, K. K. R., Trivedi, R. V., & Umekar, M. J. (2019). Review on betel leaf used in various ailments. Int J Pharmacognosy, 6(8), 259-267.
43. Jadeja, J., Khanpara, P., Chauhan, J., & Faldu, S. (2023). A REVIEW ON NUTRITIOUS LEAF:PIPER BETEL. World Journal of Pharmaceutical and Medical Research, 9(12).
44. Depi, S. (2020). Review of traditional use, phytochemical and pharmacological activity of Piper betel L. Galore International Journal of Health Sciences and Research, 5(3), 59-66.
45. Tutu, A. K. S., Guddun, S. S. K., Kumari, P., & Dey, S. K. D. (2022). An overview of Betel vine (Piper betel L.): Nutritional, pharmacological and economical promising

natural reservoir. Advances in Horticultural Science, 36(1), 63-80.

46. Bhattacharya, S., Banerjee, D., Bauri, A. K., Chattopadhyay, S., & Bandyopadhyay, S. K.(2007). Healing property of the Piper betel phenol, allylpyrocatechol against indomethacin-induced stomach ulce journal of gastroenterology,13(27), 3705–3713.
47. Tutu, A. K. S., Guddun, S. S. K., Kumari, P., & Dey, S. K. D. (2022). An overview of Betelvine (Piper betel L.): Nutritional, pharmacological and economical promising natural reservoir. Advances in Horticultural Science, 36(1), 63-80.
48. Bubera, N., Lamkhade, A., Sonawane, S., Raut, A., Waghmare, O., & Patil, S. The Wonders of Piper Betel Linn: A Systematic Review.
49. Garg, A., Chaturvedi, P., & Gupta, P. C. (2014). A review of the systemic adverse effects of areca nut or betel nut. Indian journal of medical and paediatric oncology, 35(01), 3-9.
50. Tutu, A. K. S., Guddun, S. S. K., Kumari, P., & Dey, S. K. D. (2022). An overview of Betelvine (Piper betel L.): Nutritional, pharmacological and economical promising natural reservoir. Advances in Horticultural Science, 36(1), 63-80.
51. Vikash, C., Shalini, T., Verma, N. K., Singh, D. P., Chaudhary, S. K., & Asha, R. (2012). Piperbetel Phytochemistry, traditional use & pharmacological activity a review. International Journal of Pharmaceutical Research and Development (IJPRD), 4(4), 216-223.
52. Rai, K. K. R., Trivedi, R. V., & Umekar, M. J. (2019). Review on betel leaf used in various ailments. Int J Pharmacognosy, 6(8), 259-267.
53. Mazumder, S., Roychowdhury, A., & Banerjee, S. (2016). AN OVERVIEW OF BETEL LEAF (PIPER BETEL L.): A REVIEW. Annals: Food Science & Technology, 17(2).
54. Fazal, F., Mane, P. P., Rai, M. P., Thilakchand, K. R., Bhat, H. P., Kamble, P. S., ... & Baliga, M. S. (2014). The phytochemistry, traditional uses and pharmacology of Piper Betel. linn (Betel Leaf): A pan-asiatic medicinal plant. Chinese journal of integrative medicine, 1-11.
55. Suri, M. A., Azizah, Z., & Asra, R. (2021). A review: Traditional use, phytochemical and pharmacological review of red betel leaves (Piper crocatum Ruiz & Pav). Asian Journal of Pharmaceutical Research and Development, 9(1), 159-163.
56. Roy, A., & Guha, P. (2021). Traditional and functional uses of betel leaf (Piper betel L.) pertaining to food sector: a review. J Postharvest Technol, 9(1), 72-85.
57. Balasubramanian, N., & Govindarasu, R. (2025). Medicinal Leaves and its Health Benefits-A Critical Review. GREEN PROCESS DESIGN AND SUSTAINABLE CHEMICAL MANUFACTURING, 112.
58. Rani, P., Shivaprasad, & Mishra, M. (2025). Emerging insights into supari (areca nut) toxicity: a review of current evidence on oral and general health. Toxin Reviews, 1-14.
59. Liu, Z., Wang, X., & Wen, L. (2025). Exploring the potential benefits of areca nut extract in animal production: a review. Frontiers in Animal Science, 6, 1495886.
60. You, S., Wu, J., Lai, S., Tu, H., Cui, X., Yi, Q., & Guo, Q. (2025). Global Insights of Oral Submucous Fibrosis: Concerns About Betel Nut and Oral Cancer. Journal of Oral Pathology & Medicine, 54(5), 380-391.
61. Singh, D. A., & Kolap, M. B. (2025). Antibacterial Efficacy of Betel Leaf Ethanol Extract Cream against Propionibacterium acne: A Natural Acne Solution. Research

Journal of Pharmacology and Pharmacodynamics, 17(3), 193-198.

62. Anil Kumar, K., Kumar, S., & Gupta, A. (2025). Prevalence and determinants of areca nut use among pregnant women in India. Journal of Substance Use, 30(3), 393-400.
63. Nagata, M., Merifield, L. E., Cruz-Mattos, G., Oamil, A., Heidelberg, X., Maskarinec, G., ... & Hernandez, B. Y. (2025). Association Between Betel Nut Chewing and Body Mass Index: A Cross-Sectional Study in Guam. International Journal of Environmental Research and Public Health, 22(7), 1006.
64. Pascawati, R., Hidayanti, D., & Fadilah, L. N. (2025). Efficacy of red betel (Piper ornatum) in accelerating perineal wound healing in postpartum women. Healthcare in Low-resource Settings, 13(s1).
65. Khonglah, D., Tariang, B. L., & Gogoi, G. (2025). INFORMATION LITERACY LITERATURE. International Journal of Economics, Business and Social Science Research, 3(4), 59-77.
66. Mane, G., Bhise, R., Kadam, R., Kaur, G., Verma, D., Chopade, R., ... & Mousavirad, S. J. (2025). PriBeL: A primary betel leaf dataset from field and controlled environment. Data in Brief, 111674.
67. Zubair, M. A., Marfani, S., Mahmood, J., Hameed, F., Haque, S. U., & Zafar, A. (2025). ANGIOGENESIS ACCELERATION IN WOUND HEALING: ZINC OXIDE VERSUS BETEL LEAF EXTRACT. Pakistan Journal of Physiology, 21(1), 21-24.
68. Thilakarathne, B. K. G., Schensul, J. J., & DeMarsilis, A. (2025). Use of betel quid with and without tobacco and challenges to quitting among women attending a rural hospital in Sri Lanka. BMC Oral Health, 25(1), 966.
69. CHAVHAN, M., SHARMA, S., & TIWARI, H. UNLOCKING THE THERAPEUTIC POTENTIAL OF PIPER BETEL: AN IN-DEPTH EXPLORATION OF ITS HEALTH BENEFITS.
70. Chavda, V. R., Bhatt, S. B., Umaretiya, V. R., Gajera, H. P., Padhiyar, S. M., Kandoliya, U. K., & Parakhia, M. V. (2025). Characterization and metabolomic profiling of endophytic bacteria isolated from Moringa oleifera and Piper betel leaves. Scientific Reports, 15(1), 632.
71. Kumar, H., Kulkarni, P. K., Tanuja, A. J., Venkatesh, K., & Joshi, H. REVIEW ON PIPER BETEL LEAF L.
72. Azzahra, Z., Nurbaiti, N., Syahfitri, T., Yolandari, A., Larasati, H., Habibah, A., & Sarina, G. (2025). A Scoping Review: traditional uses and pharmacology study of Piper crocatum. Journal of Ethnoscience and Educational Studies, 1(1), 8-19.
73. Bali, S. (2025). Paan–A Mouthful of Betel Leaf Packaged Ambrosia for Good Health. Sch Acad J Biosci, 1, 104-129.
74. Kuang, S., Xiao, S., Zhou, J., Liu, L., Li, N., Ding, Y., ... & Xue, P. (2025). Combined effect of areca nut, cigarettes, alcohol and SNPs in glycosyltransferase family genes on lung cancer development in Hainan, China. BMC cancer, 25(1), 814.
75. Moss, W. J., Hermiston, M., & Warnakulasuriya, S. (2025). Betel nut sweets present growing health threat to children. bmj, 389.
76. Noveriza, R., & Syahid, S. F. (2025). Identification and evaluation of bioactive compound from selected medicinal plants: potential antibacterial agent. Vegetos, 1-11.
77. Patil, P. H., & Shaikh, A. Z. (2025). The Formulation and Evaluation of a Herbal Gel contains powdered extracts of Tulsi leaves (Ocimum sanctum Linn) and Betel leaves (Piper betel) for the treatment of Fungal Infections. Asian Journal of Pharmacy and Technology, 15(3), 256-260.

78. Candra, K. P., Hardi, E. H., Ahmad, I., Panggabean, A. S., Kuncoro, H., & Nugroho, R. A. (2025). Effectiveness of combined bangle rhizome (Zingiber montanum) and black betel leaf (Piper betel var. nigra) water extract in combatting caries-causing oral pathogens using response surface methodology. Agriculture and Natural Resources, 59(2).
79. Xu, J., Li, M., Li, R., Zhang, Z., Ma, Y., Tao, R., ... & Li, R. (2025). Effect of areca nut extracts on growth performance, slaughtering performance, and meat quality of broiler chickens. Frontiers in Veterinary Science, 12, 1579415.
80. Khadim, M., Afzal, H., Siddique, A., & Fatima, S. Full Paper Development and Optimization of Advanced Fluorometric and Elisa Based Protocols for Comprehensive Aflatoxin Profiling in Areca (Betel) Nut. Available at SSRN 5277108.
81. Ahmad, M., Arif, A. M., Sartini, S., Usman, A. N., & Stang, S. Comparison of the Effectiveness of Red Betel Leaf (Piper Crocatum) and Green Betel Leaf (Piper Betel L) Decoction Water Against Candida Albicans Fungi that Cause Vaginal Discharge (Flour Albus) in Vitro. Available at SSRN 5269388.
82. Sajjad, A., Patel, R. S., Amer, R., Sajjad, M., Patel, J., Butt, M. D., & Mandayam, S. A. (2025). A rare case of betel nut-associated oral squamous cell carcinoma in the United States: a case study. Discover Medicine, 2(1), 142.
83. Padilla, J. T., & Paglinawan, J. L. (2025). Discovering the Cultural Symbolism and Beliefs Associated with Betel Nut (Areca Catechu) Among Manobo Tribes.
84. Chistie, S. M., Naik, S. U., Rajendra, P., Apeksha, Mishra, R. K., Albasher, G., ... & Hameed, J. (2025). Production and characterization of magnetic Biochar derived from pyrolysis of waste areca nut husk for removal of methylene blue dye from wastewater. Scientific Reports, 15(1), 23209.
85. Sharma, P., Rani, R., Singh, A. P., & Singh, A. P. (2025). Restoration of Memory Potential by Piper betel Leaves Extract in High-Fat Diet (HFD)-Induced Dementia in Mice. Journal of Drug Delivery & Therapeutics, 15(1).
86. Singh, T., Shafi, Z., Singh, R., Bisht, B., Yadav, K. K., Algethami, J. S., ... & Alreshidi, M. A. (2025). Microwave-assisted extraction of phytochemicals from Piper betel L.: Optimization, characterization, and bioactivity evaluation. Food Chemistry: X, 102672.
87. Siddique, M. R. (2025). The Impact of Betel Nut Chewing on Oral Health in Rural Bangladesh. Saudi J Oral Dent Res, 10(4), 210-215.
88. Xu, J., Li, R., Ma, Y., Zhong, D., Zhang, Z., Wang, J., ... & Li, R. Dietary Areca Nut Extract Supplementation Improves the Growth Performance and Intestinal Health of Aa Broilers. Available at SSRN 5229670
89. Trivedi, S., Azeem, M., Diwakar, S., Sahu, V. K., & Mishra, A. (2025). A REVIEW OF TRADITIONAL INDIAN MEDICINAL PLANTS WITH POTENTIAL WOUND HEALING ACTIVITY.
90. Mithurendran, B., & Abdulla Jamaludeen, D. R. Piper betel and Piper nigrum: Siddha, Traditional and Modern Perspectives on their Role as Antidotes Against Toxic Effects.
91. Alagumalai, V., Rajamanickam, V., Mohamed, H. G., Badruddin, I. A., Bashir, M. N., & Mensah, R. A. (2025). Optimisation of areca nut husk-derived cellulose nanofibers for enhancing the mechanical properties of epoxy composites using response surface methodology. Scientific Reports, 15(1), 26211.

92. Creeden, J. F., Machiraju, S. M., Amin, J. B., & Stahl, S. M. From Betel Nuts to Cobenfy: How an Ancient Recreational Drug Gave Rise to a New Class of Schizophrenia Medications. CNS spectrums, 1-18.
93. Suyasa, I. B. O., Dewi, N. N. A., Apriliapatni, M. D. B., & Bryan, S. N. (2025). IRRITATION TEST OF LIQUID ANTIBACTERIAL SOAP COMBINING LEGUNDI norvegicus). Meditory: The Journal of Medical Laboratory, 13(1), 95-103.
94. Koidis, A., Rawson, A., & Lei, H. (2025). Traditional and ethnic foods in the context of'one health': Bridging heritage and innovation for a sustainable future. Food Chemistry Advances, 7, 100974.
95. Yuniarti, R., Nasution, H. M., Dachban, S. M. B., Putri, N. I., Luthfianida, A., & Wahdaniati, T. (2025). Formulation, Characteristics of Physical Quality, and Evaluation of Sun Protection Factor Value of Transparent Soap with Red Betel Leaf Extract. Journal of Pharmaceutical and Sciences, 634-641.
96. Rathore, T., Upadhyay, E., & Jain, A. K. (2025). Therapeutic Role of Medicinal Plants in Combating Air Pollution-Induced Inflammation and Anxiety. International Journal of Environmental Sciences, 11(10s), 636-649.
97. Gaur, J., & Kaushal, S. (2025). Role of Piper betel extract in the Precipitation of ZnO Nanoparticles for improved Photocatalytic Efficiency. ICCK Transactions on Advanced Functional Materials and Processing, 1(1), 11-17.
98. ABD RAZAK, N. A. (2025). Silver Nanoparticles Synthesised with Red Betel Leaf (Piper crocatum) Extract as a Photosensitiser for Inactivation of Escherichia coli and Staphylococcus aureus. Sains Malaysiana, 54(7), 1701-1711.
99. Balli, S., Rachana, B. N. V., Vanitha, K., Kumar, M. L., & Kavya, N. PHYTOCHEMICAL INVESTIGATION, ANTHELMINTIC AND ANTI-MICROBIAL ACTIVITIES OF BETEL LEAF.
100. Nubuwwah, A. N., Rompegading, A. B., Fitriani, F., & Irfan, N. S. (2024). Literature Review: Benefits of the essential oil content in green betel leaves (Piper Betel L) as anti-bacterial. Hayyan Journal, 1(3), 1-6.
101. Vaghela, H., Mehta, F. T., & Patani, P. (2024). A Comprehensive Review On Anti- Microbial And Antioxidant Properties Of Betel Leaf. Journal of Advanced Zoology, 45(1).
102. Siddique, M. R. (2025). The Impact of Betel Nut Chewing on Oral Health in Rural Bangladesh. Saudi J Oral Dent Res, 10(4), 210-215.
103. Tsai, J. S., Chang, C. H., Huang, P., Ko, J. C. J., & Hsu, F. H. (2025). Avian communities of betel nut agroforestry and secondary forest in Taiwan. Biodiversity Data Journal, 13, e147871.
104. Sajjad, A., Patel, R. S., Amer, R., Sajjad, M., Patel, J., Butt, M. D., & Mandayam, S. A. (2025). A rare case of betel nut-associated oral squamous cell carcinoma in the United States: a case study. Discover Medicine, 2(1),142.
105. Shanmuganathan, R., Nguyen, N. D., & Al-Ansari, M. M. (2024). Synthesis of zero valent copper/iron nanoparticles using Piper betel leaves for the removal of pharmaceutical contaminant atorvastatin. Environmental Research, 257, 119334.
106. Karunanithi, S., Guha, P., & Srivastav, P. P. (2024). Valorization of betel leaves byproducts: A novel ingredient for sustainable cookie development. Food Chemistry Advances, 5, 100799.
107. Padilla, J. T., & Paglinawan, J. L. (2025). Discovering the Cultural Symbolism and

Beliefs Associated with Betel Nut (Areca Catechu) Among Manobo Tribes.]

108. Dafriani, P., Sartiwi, W., & Monita, G. A. (2024). The Potential of Red Betel Leaf and Mangosteen Peel in Lowering Blood Sugar Levels in Patients with Diabetes Mellitus. Jurnal Penelitian Pendidikan IPA, 10(4), 1668-1673.
109. Yuniarti, R., Nasution, H. M., Dachban, S. M. B., Putri, N. I., Luthfianida, A., & Wahdaniati, T. (2025). Formulation, Characteristics of Physical Quality, and Evaluation of Sun Protection Factor Value of Transparent Soap with Red Betel Leaf Extract. Journal of Pharmaceutical and Sciences, 634-641.
110. Dewi, N. P. D. C. (2025). Combination Of Betel Leaf Extract and Collagen as Liquid Anti-Inflammatory for Dental and Oral Tissue Treatment. Interdental Jurnal Kedokteran Gigi (IJKG), 21(1), 154-159.
111. Kurnia, D., Lestari, S., Mayanti, T., Gartika, M., & Nurdin, D. (2024). Anti- Infection of Oral Microorganisms from Herbal Medicine of Piper crocatum Ruiz & Pav. Drug Design, Development and Therapy, 2531-2553.

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