WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.453
Volume 13, Issue 23, 148-161. Review Article ISSN 2277–7105

AN OVERVIEW OF BETEL LEAF: GREEN GOLD OF INDIA

Chavan Navnath S.*, Sabafarin H. Shaikh*, Chavan Satyapal B., Kawade Prachee, Ambilwade Pranali and Rathod Neha

Valmik Naik College of Pharmcy Telwadi, Tq. Kannad, Dist. Chh. Sambhjinagar (M.S)-431103.

Article Received on
07 October 2024,

Revised on 27 October 2024,
Accepted on 17 Nov. 2024

DOI: 10.20959/wjpr202423-34644

***Corresponding Author**
Sabafarin H. Shaikh
Valmik Naik College of Pharmcy Telwadi, Tq. Kannad, Dist. Chh. Sambhjinagar (M.S)-431103.

ABSTRACT

Paan, a traditional nutritive and therapeutic food plant, is betel leaf. The betel vine's bright green, young leaves are known as pandan. *Piper betle* L., a member of the *Piperaceae* family, is a traditional herbal medicinal plant used for a variety of health advantages in Asian countries. Raising betel leaf use in daily life requires scientific knowledge about the nutrition values and health benefits of betel leaf. With a greater nutritional and dietary value, including fiber, vitamins, and minerals, *Piper Bettle* is also referred to as India's Neglected Green Gold. About 15-20 million people in India frequently use betel leaf due to its nutritional and medicinal qualities. Moreover, the betel leaf, which is known as a bioactive compound (BAC), contains a number of phytochemicals and essential elements. These substances exhibit a number of important pharmacological characteristics, among which are antibacterial, antidiabetic, antiulcer, anti-inflammatory, anticancer, antimutagenic, and antioxidant qualities. Information on the betel plant, including color classifications, variations, phytochemistry, extraction methods, biological activities, and health advantages, is provided in this review.

KEYWORD: *Piper betle*, Phytochemistry, Bioactive compound.

INTRODUCTION

Betel vine, or *Piper betle L.*, is known by its scientific name and is a member of the *Piperaceae* family, which includes the family of black pepper. Ever since antiquity, India has been the country where the plant is most popular worldwide, despite its foreign appearance. The ancient literature, especially the Indian scriptures, contains a plethora of citations that

demonstrate this Given the rise in pathogens that are resistant to widely used antibiotics and the introduction of new infectious illnesses, medicinal plants have demonstrated utility as possible treatments. In the past, ethno-medicines were widely utilized in India because they were inexpensive, easily accessible, and had few adverse effects. It has been shown that piper betel leaf extracts are efficient against a number of human diseases. Indonesians have historically utilized piper betel, a medicinal herb, to treat oral or vaginal Candida infection Utilization of bacterial entomophores from medicinal plants had a new way to get the antibacterial compounds without having to directly extract from the medicinal plants.[1]

A reddish-brown salivary inducer and stimulant, arecoline is an alkaloid in areca nuts. Since ancient times, people have utilized this mixture known as a "betel quid" for many purposes. The genus Piper contains plants used for various products, including spices and food, pesticides, fish bait, fish poison, hallucinogens, oils, decorations, and perfumes.[2,3]

Table 1: Betel leaf categorization.

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

An evergreen dioecious vine. Semi-woody stems that cling to objects with short adventitious roots. Broadly oval, slightly cordate, and frequently uneven at the base, leaves are 10–20 cm long, glabrous, glowing green or golden on both sides, glaucous and have a sturdy, 2.0–2.5 cm long petiole. thick, cylindrical male spikes. Female spikes, pendulous, 2.5–5.0 cm long. Fruits are infrequently developed and Within the genus Piper, betel (Piper betle Linn) is a well-known species because it is valued in the community for cultural purposes in addition to being used as a herb. The color of the leaves on betel plants is used to categorize them; some have silver leaves, while others have green, red, black, and yellow leaves. The color of the leaves determines which groups betel falls within.[4]

Table 2: Plant classifications for betel based on leaf color.

Red betel	Due to its decorative and therapeutic qualities, red betel (Piper crocatum Ruiz & Pav.) is much sought for. Due to the attractiveness of its leaves in particular, this plant sells for a premium price. Growing on trees and fences, the red

	betel plant is a climbing plant. The red betel leaf has a silvery crimson, shiny surface when lit.
Wulung betel	Because it produces a purple glow when lit from below at night, Wulung betel is frequently referred to as purple betel.
Green betel	Usually used in ceremonial and therapeutic contexts, green betel
Golden betel	The pale yellow or batik-like patches on golden betel, also called betel jalu,
Black betel	There are occasions when black betel is connected to the paranormal.

Fig. 1: Red betel.

Betel vine (Piper betel) can be classified on various morphological features and essential oil content

Leaf morphology

1) **Broadleaf varieties:** These types have broad leaves frequently distinguished by size. Calcutta and Kallimadugu variants were two examples
2) **Slender stem varieties:** In comparison to broad leaf variants, these types have narrower leaves that could be lower in size. Sanchi and Bangala types are two examples.

Fig. 2: Green betel.

Features of the stem

1. **Sturdy stem varieties:** Beetel vines can have strong growth habits because certain of their stems are sturdy and vigorous. Kallimadugu, Calcutta, and Bangla are a few examples.
2. **Thin stem types:** The overall growth and canopy density of some types may be impacted by their thin stems. Sanchi and Bangla are two instances.

Fig. 3: Black betel.

Content of essential oils

1. **High oil content varieties:** These cultivators have leaves with a high concentration of essential oils, giving them a potent flavor and scent. Calcutta and Kallimadugu variants are two examples.
2. **Modest oil concentration varieties:** These types have a well-balanced flavor and aroma profile due to their modest essential oil concentration. Bangla and Sanchi variants are two examples.

Fig. 4: Golden betel.

Profile of flavour

1. **Kinds with strong flavours:** Some types are renowned for having strong flavors, which are frequently chosen for their robust taste when preparing paan. Bengali and Magahi versions are two examples.
2. **Moderate flavour types:** For customers who like a softer taste, alternative types may have a milder flavor profile. Desi and Sanchi variants are two such instances.

Regional varieties local varieties

There may be native betel vine kinds in every area that have been suited to the particular climate and cultural tastes. Depending on where they originated, these cultivars could have distinct physical traits and essential oil contents. Two such are Bangarpet, which is located in Karnataka and Tamil Nadu, and Magahi, which is grown in Bihar and its surrounding areas.

Hybrids and Cultivars improved varieties

Breeders can create enhanced cultivars or hybrid varieties with certain qualities like increased flavor profile, disease resistance, or yield potential. Certain kinds might blend desired traits from various parent lines. Hybrids created by agricultural research organizations can be among the examples. Based on its morphological characteristics, flavor profile, essential oil concentration, and regional variances, betel vine varieties are categorized using this approach. It helps producers and consumers choose cultivars that are appropriate for their unique needs and tastes by shedding light on the diversity and traits of various cultivars. Indian Betel Vegetable Cultivars Six primary groupings of betel vine varieties are identified based on their morphological characteristics and essential oil content: Bangla, Desawari, Kapoori, Sanchi, Meetha, and Kasi . Plant leaves, leaf area, weight, and other morphological characteristics are significant for betel vines. Each of these features affects consumer acceptability and yield.[5]

Table 3: types of betel vines.

Bangla	This kind is well-liked for its steady leaf quality and strong growth. Bangla has broad, thin leaves with an oval lamina and a cordate base, along with nine major nerves. The tip of the leaf was short and pointed rather than curled. The Bangla variety has a more pronounced petiolar sinus than the other kinds. In North India, Bangla was widely spoken.
Desawari	Large, slender leaves with seven to nine nerves per cordate lamina characterized desawari. The Desawari leaf had a pinkish hue, with a short, acuminate, and curled leaf tip. In North India, deswari was a common dish.
Kapoori	The lamina of kapoori leaves had an undulating edge and was thinner than the leaf shape. Kapoori leaves have acuminate leaf apex and a

	hardly noticeable petiolar sinus. The main cultivars in the Indian peninsula were kapoori.
Sanchi	Sanchi's leaf base was cordate and its lamina was more oval, with a long tapering apex. In Sanchi, seven nerves were often visible. The medium-sized leaves and thin stems of the Sanchi betel vine are its defining features. It is renowned for having a well-balanced flavor profile and scent. The primary cultivars in the Indian peninsula were Sanchi.
Meetha	Meetha had huge, thick, cordate to broadly ovate leaves with a lamina. The leaf of the metha plant had three to five major nerves and a waxy texture with yellowish spots. The tips of Meetha's leaves were sharp and short. Its petiole included a noticeable junction. Varieties of Meetha Paan are grown especially to be sweet. In India, sweet paan is a common after-meal snack that is made using them. Only in West Bengal was meetha grown commercially.
Kasi	Varanasi, also known as the Kasi area, is home to a particular variety of betel leaves known as "Kasi" betel leaves. Large size, deep green hue, and potent scent are characteristics of Kasi betel leaves. Their particular flavor and toughness make them popular.

Techniques used to get the raw medications from betel leaves

To extract the active ingredients, such as flavonoids, phenols, alkaloids, and essential oils, from betel leaves, a variety of extraction techniques are used. These are a few typical extraction techniques that are frequently applied to betel leaves.[6]

Maceration

In order to allow the active ingredients to be extracted, powdered betel leaves are soaked in a solvent for a predetermined amount of time. To improve extraction efficiency, the mixture is periodically stirred. The solvent and marc are separated after the extraction time is appropriate (Solid residue). As required, the resulting crude extract can undergo additional processing or concentration.[6]

Steam distillation

The process of steam distillation is widely used to extract essential oils from betel leaves, which include chemicals with aromatic properties such as cineole, chavicol, and eugenol. Steaming betel leaves facilitates the release of their volatile oils. After that, the essential oil-infused steam is condensed and gathered.[6]

Percolation

In percolation, the required chemicals are extracted by passing the solvent through a bed of powdered betel leaves. As the solvent moves through the bed, it eventually seeps through and collects the active ingredients. The output is where the extract is collected. Percolation gives

exact control over the extraction process and is frequently employed for large-scale extraction.[6]

Extraction of solvent

Utilizing organic solvents such as ethanol, methanol, or hexane to dissolve the target chemicals from the betel leaves is known as solvent extraction. Typically, betel leaves are powdered after being dried and pulverized. To aid in extraction, the powder and solvent are combined and left to stand for a while. The solvent is removed under low pressure after extraction to produce the crude extract, which can then be refined or concentrated.

Soxhlet extractive

Extracting lipophilic chemicals from betel leaves is a particularly good use for soxhlet extraction. A thimble filled with powdered betel leaf is placed inside a Soxhlet extractor. To extract the required chemicals, a suitable solvent (Such as ethanol) is continually cycled through the sample. After that, the solvent evaporates, revealing the concentrated crude extract.[7]

Fluid extraction (Supercritical)

Carbon dioxide (CO2) and other supercritical fluids are used by SFE to extract chemicals from betel leaves. CO2 is an effective solvent because, at certain pressure and temperature levels, it transforms into a supercritical fluid with characteristics halfway between those of a gas and a liquid. Desired chemicals are selectively extracted from the betel leaves by the supercritical CO2, which then evaporates upon depressurization, leaving the crude extract behind.

These extraction techniques are frequently used to extract crude medications from betel leaves; the benefits of each technique vary based on the desired components, production volume, and equipment accessibility. To guarantee a high yield and good quality of the extracted chemicals, it is crucial to adjust the extraction parameters. Following that, three distinct extraction techniques were used to extract the dried leaf powder: Soxhlet extraction, sonication, and maceration with acetone as the solvent. 500 mL of acetone (99.7%, v/v) was used for each extraction, which started with 100 g of powdered leaf material. Acetone was used as the solvent in the soxhlet extraction process, and it was done for 8 hours at 56 °C. The maceration process was done for 72 hours at room temperature with periodic stirring. One hour of room temperature sonication was carried out using a Sonics Vibra cell sonicator,

which has a power output of 135 W and a sonication frequency of 40 kHz. Every extract made with a different method was stored at 4°C in an airtight container for analysis.[8]

Betel leaf phytochemistry

It is the essential oils, which include phenols and terpenes, that give betel leaf its scent. Compared to older leaves, the fresh new leaves have significantly higher concentrations of sugar, diastase enzyme, and essential oil. Compared to carbolic acid, betel leaf's "Chavicol" is a stronger antiseptic. Betel leaf, which provides the finest oral hygiene for the oral cavity, is the second most popular daily consumable in Asia. Due to the oxidation of lime, chewing paan causes the mouth to turn red. The presence of betel quid is responsible for the modest stimulant activity, but chewing paan also leaves the mouth feeling fresh because of the betel leaf. Chewing betel leaves stimulates salivation, which in turn boosts the levels of antibodies, lysozyme, and peroxidase to fight oral bacterial growth. Additionally, it improves pancreatic lipase and gastric juice output, both of which aid in digestion. Biologically active chemicals found in betel leaves vary widely in concentration, depending on factors such as season, climate, and genotype. Betel leaves (*Piper betle*) contain a variety of phytochemicals, including alkaloids, phenolics, flavonoids, essential oils, tannins, and steroids.

Table 4: Phytochemistry of betel leaves.

Alkaloids	The stimulating effects of chewing betel are mainly caused by arecoline, one of the many alkaloid found in betel leaves. Known to have several pharmacological effects, arecoline functions as a stimulant of the central nervous system.
Phenolics	Phenolic substances such as phenolic acids (Ferulic acid, caffeic acid, and so on) and their derivatives are found in betel leaves. The antioxidant qualities of phenolic compounds add to the betel leaf's overall therapeutic qualities.
Flavonoids	Flavonoids, which include compounds like myricetin, kaempferol, and quercetin variations, are abundant in betel leaves. The therapeutic advantages of betel leaf are further enhanced by the antibacterial, anti-inflammatory, and antioxidant characteristics of these flavonoids.[9]
Essential Oils	Rich in aromatic components including cineole, eugenol, chavicol, and other terpenes, betel leaves are a source of essential oils. These antibacterial and anti-inflammatory essential oils give betel leaves their distinctive flavor and scent.[10]
Tannins	The astringent flavor of betel leaves is attributed to tannins, which are polyphenolic chemicals. The traditional medical uses of betel leaves may involve the utilization of tannins, which possess antibacterial and antioxidant qualities.
Steroids	Steroid chemicals, such as β-sitosterol and phytosterols, are found in betel leaves. Numerous health advantages, such as the ability to reduce

	cholesterol and have anti-inflammatory qualities, have been linked to phytosterols.
Vitamins and Minerals	Additionally, betel leaves have vitamins (such as vitamin C) and minerals (such as calcium, iron, and phosphorus), which contribute to their nutritional value.

Due to its numerous medical uses, betel leaf is frequently referred to as "green gold." The moisture content of fresh leaves was observed to be 85.4, protein content 3.1, mg fat content 0.8, mg carbohydrate content 6.1mg, fiber content 2.3mg, calcium content 230 mg, phosphorous content 40 mg, iron content 7 mg, insoluble iron content 3.5 mg, iodine content 3.4µg, carotene (vitamin A) 9600 IU, thiamine content 70µg, riboflavin content 30µg, nicotinic acid 0.7 mg, and vitamin C content 5 mg/100g. Potassium nitrate is present at high concentrations in them (0.26-0.42%). The sugars found in betel leaves are sucrose, fructose, glucose, and maltose. Among the many varieties of betel leaves, the average amount of free-reducing sugars ranges from 0.38% to 1.46%. It also includes enzymes such as catalase and diastase. Terpenes and phenols are the components of the oil. According to reports based on several academic research, red betel leaf can be used as a natural antibacterial agent to treat oral and dental health conditions.[11]

Betel leaf: A treasure trove of bioactive compounds

Betel leaf (Piper betle) is celebrated for its diverse bioactive compounds, making it valuable in food, cosmetics, and traditional medicine.

Key bioactives include

- A-Terpinene: Acts as a natural preservative in foods and cosmetics.
- A-Selinene: Known for its pleasant aroma, it's often used in fragrances.
- A-Farnesene: Helps plants defend against pests and diseases.
- Acetone Allylpyrocatechol: Demonstrates strong antimicrobial properties, ideal for food preservation.
- A-Cadinene: Exhibits potential antitumor effects.
- Caryophyllene: Recognized for its anti-inflammatory, anti-cancer, and antioxidant benefits.
- Eugenol: Functions as an antiseptic and sedative, aiding in pain relief.
- Methyl Eugenol: A popular ingredient in perfumery.
- Spathulenol and Sabinene: Both display significant antibacterial and antimicrobial qualities.

These compounds not only enhance flavor and fragrance in various products but also offer therapeutic benefits, such as anti-inflammatory and antimicrobial effects. The versatility of betel leaf makes it an essential component in diverse applications, from culinary delights to personal care products.

Antibacterial attributes

The leaf of betel has avariety of bioactive qualities, the most significant of which is its antibacterial activity. Because betel leaf contains numerous bioactive chemicals, including ally pyrocatechol, pyrocatechol, ally chavicol, chavicol, diacetate, and acetate, it also has antibacterial properties and serves as a food preservative. It shields food materials from undesirable or dangerous microbes. Betel leaf's antibacterial properties against a variety of microorganisms, including E. Coli, streptococcus pyrogen, pseudomonas aeruginosa, staphylococcus aureus, proteus vulgaris, and others. The antibacterial action is caused by bioactive sterol molecules. The betel leaf extract contains an enormous number of sterol molecules.[12]

Qualities of an antioxidant

Another significant characteristic of betel leaf is its antioxidant content. This characteristic of the betel leaf is caused by the presence of polyphenolic substances as chavicol and allyl pyrocatechol, among others. In the betel leaf extract, these chemicals show regulation of the radiation-induced lipid peroxidation process. According to Subramani, betel leaf extract contains a higher concentration of polyphenol components than tea does.[13] Natural antioxidants can be discovered in good amounts in ethanolic betel leaf extracts, according to research by Nouri et al. The ethanolic and methanolic extracts made from betel leaf include a variety of phenolic compounds.[14]

Antifungal qualities

Traditional medicinal uses for betel leaf, often referred to as piper betle, date back many years. It is useful against fungal infections since it has been reported to have antifungal properties. Research has indicated that the essential oil derived from betel leaf exhibits noteworthy antifungal properties against multiple fungal species, such as Aspergillus Niger, Trichophyton mentagrophytes, and Candida albicans.[15] Several active substances, including eugenol, chavicol, and terpenes, are thought to be responsible for the antifungal action of betel leaf. The growth of dermatophytes, or fungi that cause skin illnesses like ringworm and athlete's foot, is suppressed by betel leaf extract, according to research.[16]

Anti-tumortraits

Tobacco products are highly carcinogenic due to the inclusion of bioactive ingredients like hydroxychavicol and chlorogenic acids.[17,18] Tellicher leaf is regarded as a natural remedy because of its phenolic contents. The phenolic chemicals found in red betel leaf are luteolin and apigenin. Apigenin and luteolin derivatives have cytotoxic effects on cancer cells. Red betel leaf extracts' cytotoxic and anti-migration properties on metastatic breast cancer are evaluated.[19]

Antidiabetic

Betel leaf extract is well known for its strong anti-diabetic effects and ability to control blood sugar levels. Using an external glucose level as a test for glucose tolerance, the extract demonstrated antihyperglycemic action. The liquid extract of betel leaves dramatically lowered the rats' blood sugar levels. Having low blood sugar following an overnight test timetable. As opposed to diabetic rats who were not treated, Rats with diabetes treated with streptozocin (STZ) show noticeably reduced levels of blood glucose, glycosylated hemoglobin, and Fructose-1, 6-bisphosphatase and liver glucose-6-phosphatase activity, despite increased liver hexokinase levels.[20]

Anti-Inflammatory

One of the many intricate biological responses in the vascular tissue to infections, injured cells, and irritants is anti-inflammation.[21] It manifests as pain, fever, redness, swelling, and loss of function and is a natural defense response. Phenolic chemicals, flavonoids, and terpenoids are the key active ingredients in betel leaf that give it its anti-inflammatory qualities. The body's inflammatory response can be mitigated by these chemicals because of their demonstrated anti-inflammatory and antioxidant properties.[22] Flavonoids' anti-inflammatory qualities are complemented by their anti-allergic, antioxidant, anti-microbial, anti-cancer, and antidiarrheal qualities. Flavonoids that raise apoptotic activity have been connected to a number of malignancies, including those of the liver, pancreas, breast, esophagus, and colon Research has demonstrated that betel leaf extract can reduce inflammation in a variety of conditions, such as skin allergies, asthma, and arthritis.[23]

Future potential

The leaves are frequently used as treatments because of their high bioactive content. They are frequently used both in India and beyond because of their low cost and simplicity of use. It

can be taken separately or as a dietary supplement to treat diarrheal alcoholism, bronchitis, asthma, leprosy, and dyspepsia. Studies on the application of leaf isolates and EO are scarce.

Due to the paucity of research in this area, weshould concentrate on the technological tools that can be employed in various operations., including those in the food, pharmaceutical, and cosmetic industries, among others. The government should also set up a Research and Development Board. This may contribute to the stability of betel leaf prices. The economy and job opportunities will expand if farmers, scientists, technicians, and researchers collaborate to overcome the limitations.

CONCLUSION

Piper betle, or betel leaf, is a great herb with potential uses and benefits across a range of industries.India produces a wide range of betel leaf varieties.. Because of its anti-inflammatory, anti-fungal, anti-microbial, and antiseptic properties, betel leaves have several therapeutic uses. characteristics. In addition to its widespread use in medicine, betel leaves has a variety of other uses in both ancient and contemporary science. Betel leaves are abundant in phenolic chemicals, which have numerous medicinal applications and positive effects on various aspects of health. The utilisation of betel leaves extract in many commercial domains such as food supplements, cosmetics, and pharmaceuticals is experiencing a surge in demand due to this. The highly potentbioactive compounds included in betel leavesandproducts derived from them are in great demand around the world. Consequently, it possesses a multitude of biological activities and immense potential for usage as a therapeutic plant and source of nutrients in the future.

Conflict of interest

No conflict of interest is declared.

ACKNOWLEDGEMENTS

The authors are thankful to the HOD & Assistant Professor Waghamare S.U for their support.

REFERENCE

1. Gogtay, N. J.; Bhatt, H. A.; Dalvi, S. S.; Kshirsagar, N. A. The Use and Safety of Non-Allopathic Indian Medicines: *Drug Safety*, 2002; *25*(14): 1005–1019.

2. (Biswasroy, P.; Pradhan, D.; Pradhan, D. K.; Ghosh, G.; Rath, G. Development of Betulin-Loaded Nanostructured Lipid Carriers for the Management of Imiquimod-Induced Psoriasis, 2023.
3. Mr. Prashant M. Damle; Prof. Waghmare S. U; Miss. Rohini H. Mishra; Mr. Vivek Shinde; Mr. Prasad Shelke. Formulation, Evaluation and Comparison of Lab Made Toothpaste with Marketed Brand of Toothpaste. *IJARSCT*, 2024; 603–613.
4. Puspitasari, N.; Septiarini, A.; Hairah, U.; Tejawati, A.; Sulastri, H. Betel Leaf Classification Using Color-Texture Features and Machine Learning Approach. *Bulletin EEI*, 2023; *12*(5): 2939–2947.
5. Callaham, R. Z. Pinus Ponderosa*: Geographic Races and Subspecies Based on Morphological Variation*; PSW-RP-265; U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: Albany, CA, 2013; PSW-RP-265.
6. Dasgupta, N.; De, B. Antioxidant Activity of Piper Betle L. Leaf Extract in Vitro. *Food Chemistry*, 2004; *88*(2): 219–224.
7. Khudekar A.R, Kodag B.Poonam, Sayyad J.H, Shaikh Nadera. T, Jadhav Sagar V, Done J.E, Drwade A.P, Sonawane K.B. Kadu A.K, Waghamare S.U*. "Cultivation & Isolation of T. Brevifolia." *International Journal of Research in Engineering and Science (IJRES)*, 2023; *11*(4): 601–605.
8. Das, S.; Ray, A.; Nasim, N.; Nayak, S.; Mohanty, S. Effect of Different Extraction Techniques on Total Phenolic and Flavonoid Contents, and Antioxidant Activity of Betelvine and Quantification of Its Phenolic Constituents by Validated HPTLC Method, 2019; *3*, *9*(1): 37.
9. Mr. Tushar Balu Pawar; Prof. Waghmare S. U; Prof. Suryawanshi R. K; Mr. Prasad S. Shelke; Miss Pooja R. Thengade; Harshal R. Bhingare. A Review Article on Formulation And Evaluation of Herbal Cough Syrup. *IJARSCT*, 2024; 12–25.
10. (Kadu Ashish, W. S. U. Review on: Formulation Development and Evaluation of Transdermal Patch for Inflammation Using Vintex Nirgudi Linn Leaf Extract. *IRJMETS*, 2024.
11. Chakraborthy, G. S. Pharmacognostical and phytochemical evaluation of leaf of abutilon indicum (linn.). *Int. J. Pharm. Sci. Drug Res*, 2009; 28–31.
12. Roy, A.; Guha, P. Development of a Novel Cup Cake with Unique Properties of Essential Oil of Betel Leaf (Piper Betle L.) for Sustainable Entrepreneurship. *J Food Sci Technol*, 2015; *52*(8): 4885–4894.

13. Subramani, K.; Shanmugam, B. K.; Rangaraj, S.; Murugan, V.; Srinivasan, S.; Awitor, O. K.; Massard, C.; Venkatachalam, R. Functional and Antimicrobial Properties of Herbal Nanocomposites from Piper Betle Plant Leaves for Enhanced Cotton Fabrics. *J Coat Technol Res*, 2020; *17*(5): 1363–1375.
14. (Nouri, L.; Nafchi, A. M.; Karim, A. A. Mechanical and Sensory Evaluation of Noodles Incorporated with Betel Leaf Extract. *International Journal of Food Engineering*, 2015; *11*(2): 221–227.
15. Nayaka, N. M. D. M. W.; Sasadara, M. M. V.; Sanjaya, D. A.; Yuda, P. E. S. K.; Dewi, N. L. K. A. A.; Cahyaningsih, E.; Hartati, R. Piper Betle (L): Recent Review of Antibacterial and Antifungal Properties, Safety Profiles, and Commercial Applications. *Molecules*, 2021; *26*(8): 2321.
16. Sivareddy, B.; Reginald, B.; Sireesha, D.; Samatha, M.; Reddy, Kh.; Subrahamanyam, G. Antifungal Activity of Solvent Extracts of Piper Betle and Ocimum Sanctum Linn on Candida Albicans: An in Vitro Comparative Study. *J Oral Maxillofac Pathol*, 2019; *23*(3): 333.
17. Chowdhury, U.; Baruah, P. K. Betelvine (Piper Betle L.): A Potential Source for Oral Care. *CB*, 2020; 87–92.
18. Hiwarde Dipali B, Miss. G. R. J. Review: Revolutionizing Drug Delivery And Cancer Therapeutics Through Niosome Innovation. *nternational Journal Of Novel Research And Development (www.ijnrd.org)*, 2024; *9*(6): 162–208.
19. Zulharini, M.; Sutejo, I. R.; Fadliyah, H.; Jenie, R. I. Methanolic Extract of Red Betel Leaves (Piper Crocatum Ruiz & Pav) Perform Cytotoxic Effect and Antimigration Activity toward Metastatic Breast Cancer. *Indones J Cancer Chemoprevent*, 2018; *8*(3): 94.
20. Farid Hossain, Md. Uses Impact of Betel Leaf (& lt; I & gt; Piper Betle & lt; /I & gt; L.) on Public Health. *SJPH*, 2017; *5*(6): 408.
21. Kale, D. R.; Ingle, R. B.; Narode, P. A.; Lodwal, P. B.; Borhade, V. N. Research On Preparation, Evaluation And Comparison Of Herbal Toothpaste With Marketed Herbal Toothpaste.
22. Borhade, V. N. Review on Nature's Remedies for Diabetes: Evaluating the Efficacy of a Herbal Powder. *Insulin*, 2024; *5*: 33.
23. Aara, A.; Chappidi, V.; Ramadas, M. Antioxidant Activity of Eugenol in Piper Betel Leaf Extract. *J Family Med Prim Care*, 2020; *9*(1): 327.