



Socio, Economic and Cultural Importance of Betel Vine (*Piper betle* L.) Cultivation: Its Present Status and Future Perspectives

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The present study aims to investigate the Socio, Economic and Cultural importance of Betel Vine Cultivation. Betel vine is the most important and useful asexually propagated cash crop having various cultivars. The betel leaf has many chemical constituents that have many important industrial applications. The leaves are found to contain a terpinene, P-cymene, carvacrol, chavicol and its derivatives, allyl catechol, eugenol, estragole, oxalic acid, malic acid and amino acids. The economic status of betel leaves in the worldwide market depends on the physical nature of the end products. Betel leaf and its products in different forms such as powder, liquid, capsules, etc., are highly remarkable due to its various medicinal applications. The properties like antimicrobial activity, antioxidant activity, antidiabetic, anticancer activity, etc. justify its bioprospecting for future green medicine.

Keywords: Betel vine; antimicrobial activity; green medicine; cultivation.

1. INTRODUCTION

A Betel leaf is a heart-shaped deep green leaf which grows on a climbing vine. The most

significant and practical asexually propagated cash crop, with a variety of cultivars, is betel vine. It is a plant that enjoys sheds and is a member of the Piperaceae family. It is popularly

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known as “*Pan*” in the local vernaculars mostly in the north-east region and eastern parts of India. Despite being foreign, the plant is significantly more well-liked in India than in any other nation since antiquity. Numerous allusions to it may be found in early Sanskrit literature from 3000 BC, including the Vedas, Ramayana, Mahabharata, and other works. These references show how closely it was related to ancient Indian history, religion, and culture. Typically, this crop is grown in Southeast Asian nations including Taiwan, Malaysia, Thailand, Sri Lanka, and India. Odisha, Tamil Nadu, Madhya Pradesh, West Bengal, Maharashtra, and Uttar Pradesh are among the Indian states where it is intensively grown [1-3].

2. PLANT DESCRIPTION

Semi-woody stems that climb via short adventitious roots. The plant has long-stalked, alternating, smooth, shiny, heart-shaped leaves with pointy apexes. It has little flowers and five to seven ribs that rise from the base. Bright green or yellowish, broadly oval, glabrous, glaucous on both sides, short acuminate, and petiole stout 2.0-2.5 cm long are all characteristics of the leaves, which are 10–20 cm long. In East India's humid climate, female plants frequently produce blossoms or fruit [4].

3. CHEMICAL CONSTITUENTS

The betel leaf has many chemical constituents that have many important industrial applications. The leaves are found to contain a terpinene, Carvacrol, p-cymene, chavicol and its derivatives, allyl catechol, eugenol, estragole, oxalic acid, malic acid, and amino acids. Additionally, leaves contain significant levels of vitamins, including nicotinic acid, ascorbic acid, and carotene. Aside from lysine, histidine, and arginine, they also contain sizeable amounts of all other important amino acids. Asparagine is present in high concentrations, and glycine and proline are also present in respectable levels. The leaf's essential oil is what gives the food its aromatic flavour. The essential oil has a strong, scorching taste and an aromatic light-yellow liquid appearance. It contains chavicol, a phenol with potent antibacterial effects. It contains the alkaloid arakene, which shares some characteristics with cocaine. These oils are a potential and enticing flavouring component for the food and beverage industries due to their antibacterial and antioxidant qualities [5]. They also have a bright future in the new food packaging industry. Betel leaves are incredibly nourishing and rich in essential oil (EO), proteins, enzymes, and minerals [6]. Additionally, betel



Fig. 1. Betel leaf

Table 1. The detail components of fresh betel leaf

| Sl. No. | Component | Amount in fresh green leaf |
|---------|----------------|----------------------------|
| 1 | Water | 85-90 % |
| 2 | Protein | 3-3.5 % |
| 3 | Fat | 0.4-1.0 % |
| 4 | Minerals | 2.3-3.3 % |
| 5 | Fiber | 2-2.3 % |
| 6 | Chlorophyll | 0.01-0.25 % |
| 7 | Carbohydrate | 0.5-6.10 % |
| 8 | Nicotinic Acid | 0.63-0.89 mg/ 100 g |
| 9 | Vitamin C | 0.005-0.01 % |
| 10 | Vitamin A | 1.9-2.9 mg/ 100g |
| 11 | Thiamine | 10-70 µg/100g |
| 12 | Riboflavin | 1.9-30µg/ 100g |
| 13 | Tannin | 0.1-1.3 % |
| 14 | Nitrogen | 2.0-7.0 % |
| 15 | Phosphorus | 0.05-0.6 % |
| 16 | Potassium | 1.1-4.6 % |
| 17 | Calcium | 0.2-0.5 % |
| 18 | Iron | 0.005-0.007 % |
| 19 | Iodine | 3.2-3.4µg/ 100g |
| 20 | Essential Oil | 0.08-0.2 % |

Source: CSIR, 1969 and Gopalan et al. 1984

leaves contain diastases, sugar, and tannins. Table 1 lists the specific elements of a fresh betel leaf.

4. AGRONOMIC CONDITION FOR BETEL VINE CULTIVATION

4.1 Climate

A favourable environment for the commercial growth of betel vines includes artificial shade, a high level of humidity, sufficient soil moisture, and consistent, moderate temperatures all year round. Its cultivation is therefore best carried out in controlled or shaded settings. For the plant to develop well and thrive in the shadow, it needs warm temperatures, or approximately 10°C in the winter and 40°C in the summer. For this crop, a yearly average rainfall of about 170 cm and high humidity (60 to 80%) are suitable. Temperatures below 10°C and above 40°C make plants wilt. The vines thrive in high humidity conditions and develop quickly during the vegetative stage. The rate of evaporation is consequently influenced by the amount of air movement and hence, one of the vital factors for controlling the growth.

4.2 Soil

The best constituents of soil with adequate moisture-holding ability are loamy or sandy soil

with good organic matter that is rich in humus. The optimum soil for growing betel vines is one that is exceptionally well drained. The crop cannot thrive in clay soil because it encourages illness during the rainy season. Ideal soil is thought to have a high organic matter content and good water retention capacity. The best soil is loamy soil with a permeable substratum underneath.

Pan is grown in two separate ecosystems: naturally in forests, and artificially, in conditions of shade. India uses both open and closed ways to grow the betel vine. Baraja is the name given to the closed cultivation system. Barajas typically have a rectangular shape and range in size from 50 to 30 square metres. Barajas are often tiny since they should be simple to maintain and have affordable erection costs. Bamboo, khar, straw, jute, sticks, arhar stalks, munj, and various grasses are just a few of the materials used to build a baraja. "Barajas" are typically constructed on gently sloped land that is higher than the surrounding region and closer to an irrigation supply for quick drainage of surplus water. The shape of known as "Baraja" resembles a mandap. It stands three to five metres tall. A roof made of thatch surrounds it. Bamboo poles that are set at a distance of roughly 2.0 metres apart from each other strengthen the walls. Inside the "Baraja," the top roof is made of thick straw and supported by bamboo pillars with bamboo poles

that are longitudinally separated. A horizontal pole is spaced apart from another by roughly 2 to 2.5 metres. Instead of built poles, supporting poles in a crisscross pattern are employed. To shield the plants and soil surface from the sun's direct rays, the wall and top are covered with bamboo sticks and straw. When a new "Baraja" is being built, the roof is thatched twice a year: first, at the time of construction of new "Baraja" and second, just after the rainy season. Severe construction was used to build the "Baraja" in order to endure strong winds and storms. In terms of controlling humidity and temperature, this shape makes sense.

4.3 Features of 'Baraja'

High humidity and mild temperatures are necessary for the growth of betel vine plants. Therefore, only by partially controlling the two crucial elements, its cultivation possible. The "Baraja" design makes sure that the interior is kept at the right humidity levels. Within the "Baraja," water evaporation increases humidity while also lowering temperature. During hot summers, when low humidity combined with high temperatures can cause the plants to wither and become damaged by photo inhibition, and it is extremely important for plant survival. Solar radiation's ability to heat surfaces can be successfully reduced by obstructing the intensity of light that reaches the surface. By placing dry leaves or straw on top, the top of the "Baraja" should be constructed to block check light. In the

summer, the thatching is thick enough to screen more than 75% of incident solar radiation. In order to properly control the rise in air and soil temperature inside the "Baraja," this lessens the intensity of light that strikes the delicate leaves and soil. The thatching on the top is reduced during the wet season, when the climate is most conducive to vine growth, so that roughly 50% of incident solar radiation reaches the leaves and soil. The grass cover at the top is somewhat enhanced when winter approaches and the temperature begins to drop in order to prevent frost and cold damage. During this period, the incident of light in the 'Baraja' is more than in summer.

4.4 Planting Method

The dibbling technique is typically applied to planting. Khurpi is used to assist with planting (a hand operated implement). A hole is dug for planting using khurpi such that the internodes below the bud point are dipped in soil, but they must touch surface soil. With the aid of the thumb finger, the hole is entirely filled. The planted stuff is then covered with straw or khar. With the aid of a watering cane or sprinkler, this betel vine plant has to be watered twice daily. While irrigating, extra care must be taken to ensure that the plants' covers are removed after twenty days of nonstop watering. The newly planted Baraja is properly maintained. Overwatering is prevented.



Fig. 2. 'Baraja': The artificial betel vineyard constructed for pan cultivation

4.5 Irrigation

The betel vine is very particular about how much water it needs. It requires a moist, but not swampy, soil. That is to say, it needs seasonal, light irrigation that is regular. The plantation must be situated close to the irrigation source, which could be a well, pond, or tank. The amount of sunshine and the air's humidity affect how often plants are watered. In the summer, irrigation is applied to the new plant almost daily and to the older plant once a week. Irrigation is only done every two weeks throughout the winter. Except in rare cases of unfavourable weather, irrigation is typically not done during the rainy season. Excessive irrigation results in leaf shedding and root rot. Irrigation of betel vine crop was done through a sprinkler or pot.

4.6 Weeding / Interculturing

Its rapid eradication is required to keep the plantation free of weeds. Growing betel vine in a covered conservatory or in shade has the benefit of keeping out weeds in most cases. Vine lowering is only carried out twice a year, in June and November. Giving earthing to the vines that are laying on the soil's surface is the primary goal of this method. Staking is then carried out with the use of supporting materials. Each vine is held up with sharkanda or bamboo sticks (like wooden sticks). Each piece of support is fastened to the roof and buried in the ground. The vine begins falling as soon as it reaches the ceiling of Baraja. The main vine's auxiliary branches are routinely pruned throughout monsoon season. During the time of monsoon, leaves upto 2 ft height from the soil are removed to reduce the infection from soil borne diseases and pathogens.

4.7 Insect Borne Disease Control Measures

Numerous bacterial and fungal pathogens prey on the betel vine crop, causing a wide range of illnesses in the plant. Additionally, a number of unknown diseases and insects make it difficult to cultivate betel vines, which costs cultivators a lot of money [7]. Marginal blight, anthracnose, and leaf spot, which harm both leaves and vines, are the most prevalent. Pathogens also significantly impact the root, stem, and leaf. The harmed plant passes away suddenly. Leaf spot is one of the bacterial diseases that affects newly planted crops and Baraja the most frequently. Fusarium semitectum was shown to cause the leaf spot

disease, according to Patra and Pradhan [8]. Red spider mite damage to the crop is also quite detrimental. The most damaging disease that reduces the production of betel leaf is sclerotium rolfsii's foot and root rot [9]. Different pesticides and insecticides are frequently used by farmers in the Baraja to manage pests, illnesses, and insects. However, some forward-thinking farmers manage diseases and pests in their farms using integrated methods. They employ natural means to prevent illness, such as providing proper drainage facilities in the Baraja and removing and burying vines and leaves that are susceptible to disease outside the Baraja. For stem and leaves that are not affected, they frequently employ Bordeaux combination as well. Chemical insecticides are also used to control white flies. Farmers frequently employ herbicides and insecticides throughout the harvesting process to keep the soil sterile. Under soil protection measures, sunlight exposure is the only option.

4.8 Cultivation, Yield, Processing and Preservation

The planting season varies from state to state in India depending on the cultivation of betel vine, however the beginning of monsoon season and October are the ideal times for planting. The period from May to January is when harvesting is at its busiest. A betel vine typically has a productive lifespan of 12 to 15 years. Five times a year, a betel leaf can be plucked from a vine.

5. ECONOMIC STATUS

The physical characteristics of the finished goods determine the betel leaf's economic standing on the global market. Due to its many medical uses, betel leaf and its products in many forms, such as powder, liquid, capsules, etc., are extremely outstanding. There are many different sorts of value-added items on the market, such as dietary supplements, food and beverage products, medications, oral care products, and cosmetics. The aforementioned goods have a strong export potential and have generated some foreign currency from exports. Betel leaf exports from India go to a lot of nations, including Bangladesh, Pakistan, Indonesia, Myanmar, and Thailand. The majority of the expense of packaging and shipping goes into the marketing cost of betel leaves. Betel leaf exports from India to the UK, USA, Canada, and Sri Lanka have increased recently. Betel leaf exports from India to the United Kingdom, the United States, Canada, Sri

Lanka, Malaysia, Pakistan, Bangladesh, Singapore, Myanmar, Thailand, and other Arab nations now generate an annual income of Rupees 198 lakh through foreign exchange. In the coastal Odisha regions of Balasore, Jagatsinghpur, Puri, Khordha, and Ganjam, this plant is raised as a cash crop [10]. The fluctuation in the price of betel leaves, however, hindered the farmers' capacity to maintain their economic stability. Damage to seedlings during shipping is another problem (Sahu et al. 2022). Low betel leaf output is primarily caused by conventionally managed businesses, unskilled personnel, and subpar planting supplies (Sahu et al. 2022).

6. TRADITIONAL USES OF BETEL LEAVES

One of the grandmother's cures is betel leaf, which is recommended by knowledgeable, senior family members. The following ailments can be cured using betel leaves. For instance:

6.1 Headache

A well-liked home treatment for headache is betel leaf. The betel leaf has cooling and analgesic qualities.

6.2 Difficulty Urinating or Obstruction

Betel leaf juice is thought to have diuretic effects. Its juice, when combined with diluted milk and moderately sweetened, aids in making urination easier.

6.3 Weakness of Nerves

Betel leaves are essential in the treatment of nervous aches, nervous weariness, and nervous debility. A teaspoon of honey and the juice from a few betel leaves will make a wonderful tonic. This can be consumed twice daily with a teaspoon.

6.4 Sore Throat

Betel leaf is a great home remedy for treating sore throat and cough. The leaves can effectively heal sore throats when applied locally. The fruit juice or the crushed fruit or berry should be mixed with honey and taken to relieve irritating cough.

6.5 Respiratory Conditions

Betel leaves can help with pulmonary conditions in children and the elderly. The leaves can be

applied to the chest to ease coughing and breathing difficulties after being warmed and soaked in mustard oil.

6.6 Constipation

A betel leaf stem coated in castor oil can be used as a suppository to treat constipation in young children. Constipation is immediately relieved by this.

6.7 Wounds

Anatomical structure and function that are disrupted by a wound are referred to as wounds [8]. The process of healing a wound is an extremely intricate one that involves numerous cellular and molecular processes [8]. It is best to take the juice from a few leaves and apply it to the wound. After that, a betel leaf should be placed on the top. Then a betel leaf should be wrapped over and bandaged. The wound will heal up with a single application within 2 days.

6.8 Boils

Betel leaf also works well as a boil treatment. Castor oil is applied after a leaf has been gently warmed until it becomes soft. Over the inflamed area, the oiled leaf is applied. Every couple of hours, this leaf needs to be changed. The boil will explode after a few applications, emptying all the noxious material. It is possible to apply at night and remove it in the morning.

7. OTHER THERAPEUTIC VALUES OF BETEL LEAF

7.1 Antimicrobial Activity

The process of eliminating or suppressing disease-causing bacteria is referred to as antimicrobial activity. Antibacterial, antifungal, and antiviral antimicrobials are all possible. Along with EO, the betel leaf's methanolic and aqueous extracts exhibit potent anti-yeast action.

7.2 Antioxidants Effects

Antioxidants are cellular defences against free radicals. Free radicals are substances that can injure our bodies if their concentrations rise too high. They have been connected to numerous diseases, including as diabetes, heart disease, and cancer. Both pulmonary and neurological illnesses are linked to internal free radical reactions in the body. These free radicals have a significant impact on how quickly we age. As a powerful antioxidant, ascorbic acid is particularly helpful in lowering levels of free radicals in the

body and preventing cancer. Betel leaf extracts displayed free radical scavenging action, according to Shah et al. [11].

7.3 Antiulcer Activity

Many people experience ulcers, a common gastrointestinal condition. An open sore on the skin or mucous membrane known as an ulcer is characterised by the shedding of inflammatory dead tissue. There are numerous different forms of ulcers, including vaginal, esophageal, peptic, and oral ulcers. Peptic ulcers (also known as stomach ulcers) are the most common of them. The antioxidant phytochemicals polyphenols, particularly tannins, found in betel leaves can prevent stomach ulcers brought on by indomethacin [12].

7.4 Anti-diabetic Activity

Diabetes disorder in people is on the rise today. Due to an absolute lack of insulin, it is a heterogeneous metabolic disorder of protein, lipid, and carbohydrate metabolism that is characterised by elevated blood glucose levels. Body cells don't react to insulin adequately as a result of this deficit. In order to control the elevated blood glucose level in the body, some anti-diabetic medications are used as medicine. Some studies found that streptozotocin-induced diabetic rats received oral betel leaf suspension at 75 and 150 mg/kg of body weight for 30 consecutive days, and this resulted in a significant drop in blood glucose and glycosylated haemoglobin levels.

7.5 Anti-malaria Activity

As compared to the well-known insect deterrent citronella oil, EO of betel leaf provides greater resistance against mosquito bites from *Anopheles Stephensi* and *Culexfatigans* [13]. The oil provides greater than 4% of resistance from *Anopheles stephensi* and *Culex fatigans* when sprinkled at a rate of 20l/cm², whereas citronella oil provided only 2.2 and 2.6h of protection, correspondingly.

7.6 Cultural Importance of Betel Leaf

In the Indian subcontinent, it is customary to offer guests pan quid or betel mersel (Pan-supari). In Odisha's traditional culture, a sheaf of betel leaves is traditionally given as a sign of respect and good fortune. In India, holy water is also sprinkled during all religious events using a betel leaf. Even the different parts of a betel leaf have

different lords linked with them (Gods). It is claimed that the goddess Laxmi, the Hindu deity of wealth and prosperity, resides in the front. Parvati On the left, Yama, the Lord of Death, lives in the stalk; Vishnu lives within; the moon lives outside; Shiva lives all around. Only the blade of the betel leaf is used for mastication; the stalk and leaf tip are associated with illness and sin, respectively. Every sacred ceremony in Hinduism includes the tying of betel and mango leaves around the neck of a "kalasa" that is filled with water. Also in Hindu marriages, "pan" plays a significant role. For priests, "Pan" is an essential component of "dakshina." Betel leaf is similarly significant in funeral-related grief rituals.

8. PROBLEMS ASSOCIATED WITH BETEL VINE CULTIVATION AND TRADE

Due to a lack of scientific study and development for its optimum growth, the crop is often grown by small farmers using traditional methods generation after generation. Due to agro-climatic variables, transportation infrastructure, farm location, and demand-supply ratios that discourage growing and disrupt the economic situation of plant producers, the market price of betel vine fluctuates often [14-16]. To increase the export potential and revenue creation, regular commercialization of betelvine with an effective marketing structure is required. If agronomic techniques are well researched, export revenue from betel vines can easily be surpassed. The nature of betel leaves is one of great perishability. Because to microbial infections, pest invasions, and discolouration, these might readily spoil during storage and transportation periods. Harvested betel leaves cannot be kept for an extended period of time, sometimes a significant amount of the leaves go unsold. Betel leaf spoilage may result from illnesses, pest assaults, dehydration, and leaf discoloration. As a result of poor marketing, a constantly fluctuating price, and a lack of storage space, enormous quantities of betel vine leaves are also wasted [17-19]. Therefore, it is crucial to use a variety of cutting-edge ways for betel leaf preservation and transportation in order to preserve the quality of betel leaves throughout the seasons. By obtaining essential oils from the plant's leaves, such wastes can be minimised.

9. BETEL VINE CULTIVARS

Due to the presence of its synonyms, betel vine farming has been plagued with numerous issues. The taste and shape of the leaves, as well as the

place in which it is grown, were always used by betel vine growers to name their plants. In some locations, distinct betel plants are grown in the same region under the same names, while in other locations, different betel plants are grown under the same names. As a result, there is a great deal of uncertainty among farmers. There are still few reports on accurate characterization or identification. The majority of the varieties of betel vine have not yet been subject to chemical or molecular fingerprinting reports. As a result, it is never easy to tell apart the varieties that the local farmers give names to.

10. CONCLUSIONS

The aforementioned discussion makes it abundantly clear that betel vine is a significant herbal cash crop from a botanical, export potential, economic, pharmacological, chemical, and industrial point of view. The betel leaf is a rich source of phenolic chemicals, which have a wide range of therapeutic applications and are beneficial to many aspects of health. As a result, there is growing interest in the use of betel leaf extract and essential oil in a variety of industrial applications, including food supplements, the cosmetics and pharmaceutical industries, among others. The medicinal chemicals found in betel leaves and the products generated from them are in high demand globally. Its bioprospecting for future green medicine is justified by its features such as antibacterial activity, antioxidant activity, antidiabetic, anticancer activity, etc. It might be said that the betel vine continues to show promise as a natural reservoir for its medicinal, dietary, and economical aspects for the rapidly growing human population.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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