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(REVIEW ARTICLE)

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A review: Nutritional and nutraceuticals properties of betel leaves (*Piper betle* L.)

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Abstract

Piper betel (locally known as *Paan*) belongs to the Piperaceae or pepper family and many health benefits bonded with it. Betel leaves are highly nutritive and contain considerable amount of vitamins and minerals, especially calcium, iron, potassium and β-carotene. The betel leaves possess therapeutic activities such as antioxidant activity, anti-microbial, anti-ulcerogenic, anti-haemolytic activity, anti-diabetic, immune-modulatory, anti-inflammatory, gastro protective, radio protective and cytotoxicity activity. Most of the therapeutic activities of betel leaves are due to presence of antioxidants. Scientific research on the betel leaves revealed that due to its beneficial bioactivities it has a great potential to be used in developing commercial products of enhanced medicinal and nutritional value. Many products were developed by incorporation of betel leaves such as *ladoo*, cutlets, *namkeen, khakhra* and *papad*. Therefore, we can use betel leaves in our day to day life to reduce the risk of many diseases. It has great potential to be incorporate in development of value added products.

Keywords: Betel leaf; Phytochemical; Biological activities; Antioxidant

1. Introduction

The betel leaf commonly known as '*Paan*' or '*Nagvalli*' (family-Piperaceae) is an evergreen and perennial creeper (Varier, 1995). Significance of leaves has been explained in relationship to every sphere of human life such as social, culture, religious and is very much relevant even in modern days. Betel leaf is an important commercial crop grown in India, Bangladesh, and Sri Lanka (Guha, 2006). From ancient time betel leaves are chewed along with areca nut, slaked lime, cardamom and clove in many Asian countries. (Walter and Sofia, 2007)

This plant originates from the central and eastern part of peninsular Malaysia and which is locally known as *Sirih* (Jaganath and Ng Teik ,2000). Due to the numerous benefits, betel vine is grown for its leaves. The best conditions for cultivation of betel vine are tropical rain forests, which provide cool shade, considerable humidity and an adequate supply of soil moisture like Indonesia, Malaysia, Philippines, Thailand, Cambodia, Vietnam and India (Balasubrahmanyamand Rawat, 1990). Betel leaf is well known for its various uses as masticatory or better known as betel quid, which consists of fresh betel leaf, betel nut, and slaked lime paste. This edible betel leaf is traditionally used for various medicinal purposes including improved appetite, tonic for brain, antiseptic for wounds, breath refresher, etc. Scientists found that this plant possesses many beneficial bioactivities including antimutagenic, anticarcinogenic, anti-inammatory, antimicrobial, antioxidant, and antidiabetic properties.[Amonkar *et al*., 1986)] Betel leaf is traditionally known to be useful for the treatment of various diseases like bad breath, boils and abscesses, conjunctivitis, constipation, headache, itches, mastitis, mastoiditis, leucorrhoea, otorrhoea, swelling of gum, rheumatism, cuts and injuries (Agarwal *et al*., 2012).

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2. Nutritive value of betel leaf

The leaves are very nutritive and also contain substantial amount of many vitamins and mineralsand therefore, six leaves with a little bit of slaked lime can be compare with 300 ml of cow milk particularly for the vitamin and mineral nutrition.

Table 1 Nutritive value of Betel leaves (fresh)

Nutrient	Quantity (Per 100g)
Moisture (g)	84.93
Protein (g)	3-3.5
Fat (g)	0.75-1.0
Dietary fiber (g)	1.97-2.3
Carbohydrate (g)	6.16-7.37
Energy (Kcal)	43.73-48.27
Calcium (mg)	207
Phosphorus (mg)	51.73-55.72
Iron (mg)	5.0-7.0
Potassium (mg)	649-678
Sodium (mg)	14.04-16.80
β-carotene (µg)	4186-4686
Vitamin C (mg)	18.40-24.51

(IFCT, 2017); (Agarwal, et al.2012); (Ghosh et al. 2014)

Table 2 Nutritive value of Betel leaves (dry)

Nutrient	Quantity (Per 100g)
Moisture (g)	12.66-13.53
Protein (g)	12.07- 13.47
Fat (g)	4.46-4.62
Crude fiber (g)	5.2-6.2
Carbohydrate (g)	48.62
Energy (Kcal)	285.14-288.54
Calcium (mg)	2018.8-2894.2
Phosphorus (mg)	213-242.3
Iron (mg)	23.15-40.98
Potassium (mg)	3822-4054
Sodium (mg)	24.3-32.83
β-carotene (µg)	5440-6693
Vitamin C (mg)	32.86-34.73

(Verneker et al., 2018)

3. Chemical Constituents

Phytochemical investigation on leaves revealed the presence of alkaloids, carbohydrate, amino acids, tannins and steroidal components (Sugumaran *et al*., 2011). The specific strong pungent aromatic flavour in leaves is due to phenol and terpene like bodies (Bajpai *et al*., 2010). The leaf contains water (85-90%), proteins (3-3.5%), carbohydrates (0.5-6.1%), minerals (2.3-3.3%), fat (0.4-1%), fibre (2.3%), essential oil (0.08-0.2%), tannin (0.1-1.3%) and alkaloid (arakene). It also contains different vitamins like vitamin-C (0.005-0.01%), nicotinic acid (0.63-0.89mg/100gms), vitamin-A (1.9-2.9mg/100gms), thiamine (10-70µg/100gms), riboflavin (1.9-30µg/100gms). Beside these it contains minerals such as calcium (0.2-0.5%), iron (0.005-0.007), iodine (3.4µg/100gms), phosphorus (0.05-0.6%), potassium (1.1- 4.6%) (Guha, 2006). The fresh new leaves contain much more amount of essential oil diastase enzyme and sugar as compare to old leaves. Betel leaf also contain 'Chavicol' that is four times potent as antiseptic agent as compare to carbolic acid (Kumar *et al*., 2010). It is a colorless liquid found together with terpenes in betel oil.

3.1. Therapeutic aspects

3.1.1. Traditional Use

Betel leaf known from ancient times as an aromatic, stimulo-carminative (CSIR, 1992) (katu), astringent and aphrodisiac [Sudrik*et al*., 2012; Chu, 2001]. According to Indian traditional system of medicine, the leaves identified with digestive and pancreatic lipase stimulant activities (Mula *et al*., 2008; Santhanam and Nagarajan,1990; Chatterjee and Pakrashi, 1995; Deshpande *et al.,* 1970; Rawat *et al.,*1989). The leaves were chewed by singers to improve their voice and also efficiency and stamina (Chandra *et al*., 1987). The fresh betel leaves possess antimicrobial, ringworm, antifungal, antiseptic and anti-helminthic effects (Vossen and Wessel, 2000). Leaves are also used in eye drops for eye injury/infection as a baby lotion for the new born, for coughs, asthma, constipation and to arrest milk secretion (Amalia *et al*., 2008). In folk medicine the roots were used as long lasting female oral contraceptive (Evans *et al*., 1984). Piper betel also showed many activities such as hypotensive, cardio tonic, smooth and skeletal muscles relaxant actions (Bangar *et al*., 1966; Ali and Mehta, 1970).

3.2. Biological Activities

3.2.1. Antimicrobial activity

The leaf has a significant antimicrobial activity against various micro-organisms (Jesonbabu *et al*., 2012). It also shows the antimicrobial activity against Streptococcus pyrogen, Staphylococcus aureus, Proteus vulgaris, E.coli, Pseudomonas aeruginosa etc., beside this the leaf extract also poses the bactericidal activity against the urinary tract pathogenic bacteria such as Enterococococcus faecalis, C.koseri, C.fruendi, Klebsiella pnemoniae etc. (Agarwal and Singh, 2012; Chakraborty and Shah, 2011). The bioactive molecules present in leaves thought to be responsible for anti-bacterial activity is sterol, which has been obtained in large quantities in betel leaf extracts.

3.2.2. Gastroprotective activity

The hot water extract of betel leaves significantly increased the mucus content adhering to the wall of the mucosa. The mucus layer is considered to be important in mucosal defences against gastric acids, and also as an agent in facilitate the repair process. Many researches proved that anti-oxidants might be effective mechanism not only in protecting against gastric mucosal injury, but also inhibiting progression of gastric ulceration. Ulceration progression is caused by free radical-induced chain process. Consequently, its arrest by radical scavengers helps in the faster healing (Majumdar *et al*., 2003; Arambewela *et al*., 2004).

3.2.3. Antioxidant activity

Oxidative damage is an important effect of ionizing radiation on biological membranes. It is a chain reaction (Verma *et al*., 2010). Free radicals generated from the radiolytic decomposition of water can attack fatty acid chains of membrane lipid. A free radical that has sufficient energy to abstract an allylic hydrogen from the methylene carbon of polyunsaturated fatty acids can initiate the peroxidative process. Here the presence polyphenols compounds like chatecol, allylpyrocatecol etc. in betel leaf extract inhibited the radiation induced lipid peroxidation process effectively. This could be attributed to its ability to scavenge free radicals involved in initiation and propagation steps. The extracts reduced most of the Fe3+ ions and possess strong reductive ability (Manigauha *et al*., 2009). The extract also showed strong hydroxyl radical and superoxide anion radical scavenging property when compared with different standards such as ascorbic acid and BHT (Dasgupta and De, 2004; Rathee *et al*., 2006; Pin *et al*., 2010; Arambewela *et al*., 2006).

3.2.4. Antidiabetic activity

The aqueous extract of betel leaves possess hypoglycaemic action when tested in fasted normoglycaemic rats (Chandra *et al*., 2011). The betel leaf suspension, significantly reduces the blood glucose level, glycosylated haemoglobin and decreased activities of liver glucose-6-phosphatase and fructose-1, 6- bisphosphatase, whereas liver hexokinase increased in Streptozocin (STZ) diabetic rats compared with untreated diabetic rats. The ability of lowering blood glucose level of Streptozocin (STZ) induced diabetic rat gives a suggestion that the betel leaf extract have the insulin-omimetic activity (Arambewela *et al*., 2005; Ramji *et al*., 2002).

3.2.5. Effect on the cardiovascular system

Betel leaf is considered to provide strength to the heart and regulates irregular heart beat and blood pressure (http://www.ejournalofdentistry.com/ebook/Is sue3/data/pages/8.swf, 2012). By chewing betel leaves for few minutes (Chu, 2001), which includes cardio-acceleration, sweating and salivation. It induces catecholamine secretion from the adrenal cortex contributing to increase in stamina, heart rate, blood pressure, blood glucose levels and sympathetic neural activity.

3.2.6. Platelet Inhibition activity

The pathogenesis has platelet hyperactivity due to cardiovascular diseases (intravascular thrombosis). Piperbetol, ethylpiperbetol, piperol A and piperol B isolated from leaves, selectively inhibited platelet aggregation in a concentration dependent manner which induced by platelet activating factor (PAF) (Pisar *et al*., 2007).

3.2.7. Immunomodulatory activity

The methanolic extract has lymphocyte proliferation, interferon-C receptors and the production of nitric oxide were measured in vitro. Further, the extract at different dose levels was studied in vivo for the humoral and cellular immune responses on mice immunized with sheep red blood cells. The result showed that it significantly suppressed haemaglutinin stimulated peripheral blood lymphocyte proliferation in a dose-dependent manner. The decrease in antibody titre and increased suppression of inflammation suggests possible immunosuppressive effect of extract on cellular and humoral response in mice (Sharma et al., 2007). From past findings we can conclude that betel leaf a novel candidate for immunosuppressive activity. The same could be further evaluated for its anticancer activity or as a potential candidate in the treatment of autoimmune disorders such as rheumatoid arthritis, systemic lupus erythomatous or emphysema (http://www.ejournalofdentistry.com/ebook/Is sue3/data/pages/8.swf, 2012).

3.3. Formulation of Food Products using Betel Leaves

Vernekar and Vijayalaxmi (2018) developed value added *papads* from the same in an order to increase the consumption of betel leaves to exploit their nutritional benefits. *Papads* were prepared by incorporating dehydrated betel leaves both *Kariyele* and *Ambadiyele* powder at 5, 7.5 and 10 per cent levels and evaluated organoleptically in comparison to control sample using 9- point hedonic scale. All the *papads* were found to be acceptable at 5 percent level of incorporation. *Kariyelepapad* found to have higher moisture 10.76 percent, fat 1.52 gm, vitamin-C 1.73 mg and iron 4.94 mg whereas *Ambadiyelepapad* had higher ash 3.75 gm, crude fiber 1.27 gm, β-carotene 413.41 µg and calcium 252.15 mg.

Bhargava and Tyagi (2011) developed value added *Laddu*, *Namkeen* and cutlet by using betel leaves and mint leaves as control and then evaluated their acceptability among the population by sensory evaluation. Results revealed that cutlets were equally accepted while betel leaves *Laddu* and *Namkeen* were more accepted than mint leaves *Laddu* and *Namkeen* by the population. Moreover, none of the product was rated poor or very poor on a five point scale.

Roy and Guha (2015) developed a novel cupcake by incorporating essential oil of betel leaf. The textural properties of the cakes were measured by texture analyzer instrument; whereas the organoleptic properties were adjudged by human preferences using sensory tables containing 9-point hedonic scale. Price estimation was done considering all costs and charges. Finally, all parameters of the developed cake were compared with different cupcakes available in the market for ascertaining consumer acceptability of the newly developed product in terms of quality and market price. Results revealed that the Novel cupcake developed with 0.005 % (v/w) essential oil of betel leaf occupied the 1st place among the four developed novel cupcakes. However, it occupied 4th place among the nine cupcakes in the overall preference list prepared based on the textural and organoleptic qualities, though its market price was calculated to be comparable to all the leading cupcakes available in the market. This indicates that manufacturing of novel cupcake with essential oil of betel leaf would be a profitable and self-sustaining entrepreneurship.

The product *khakhra* prepared with the incorporation of betel leaves powder both *Kariyele* and Ambadiyele at 5, 7.5 and 10% level. *Khakhra* were prepared by using wheat flour as base ingredient along with betel leaves powder. The developed *khakhra* were evaluated organoleptically using nine point scale. *Khakhra* prepared with 5% of *Kariyele* and *Ambadiyele* powder was best acceptable and used for their nutrient computation. Results revealed that khakhra prepared with *Kariyele* powder was found to be high in moisture (12.76 %), protein (12.87 gm) and vitamin-C (2.79 mg) whereas *Ambadiyelekhakhra* was found to be high in ash (2.23 gm), crude fiber (2.97 gm), carbohydrate (69.66 gm), β- carotene (378.68 µg), calcium (215.85 mg) and iron (7.30 mg) (Vernekar *et al.*, 2018).

4. Conclusion

From above literatures we can conclude that betel leavespossess therapeutic activities such as antioxidant activity, anti-microbial, anti-ulcerogenic, anti-haemolytic activity, anti-diabetic, immune-modulatory, anti-inflammatory, gastro protective etc.Betel leaves also contains numerous nutrients such as vitamins and minerals, especially calcium, iron, potassium and β-carotene. The plant leaves also used from ancient times in treatment of various diseases like bad breath, boils and abscesses, conjunctivitis, constipation, headache, itches, mastitis,leucorrhoea, cuts and injuries. As researches revealed that betel leaves are fit for treating various disease conditions further investigation on betel leaf may be execute to study the detailed mechanism of action for different diseases which will be beneficial for human begins.

Compliance with ethical standards

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There is no conflict about the review paper and publication between both the authors.

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