

## THERAPEUTIC ASPECTS OF *PSIDIUM GUAJAVA* IN THE MANAGEMENT OF VARIOUS DISORDERS: A COMPRESSIVE REVIEW

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### ABSTRACT

#### Introduction



Figure 1: Morphology of Guava leaves & fruits.

**Synonyms:** *Psidium pumilum* Vahl, *Psidium guajava* L.

#### Vernacular Names

Hindi: Amrood

Marathi: Jamba

English: Yellowguava

Gujrai: Jamruk, Jaamkal Urdu: Amrud

Bengali: Peraya.

#### Scientific classification

Kingdom: Plantae

Clade: Angiosperm

Order: Myrtales

Family: Myrtaceae

Genus: *Psidium*

Species: *P. guajava*.

**Botanical name:** *Psidium guajava*.

#### 4.2. Origin and Habitat

Guava, one of the most gregarious fruit, is popular throughout the world. The actual origin of the fruit is unknown. However, guavas are believed to be native to area ranging from tropical America (Mexico) to

Caribbean region where it is also known as “sand plum”. Guava has a documented history from around fifteenth century. Now a day, the commercial cultivation of guava is carried out in many countries such as India, Mexico, Hawaii and Egypt. Guava trees grow best in tropical and sub-tropical climate having dry summers and short winters.<sup>[86]</sup>

Guava trees do equally well in all types of soils ranging from heavy clay to gravel or even limestone. Nonetheless, well drained, fertile soil with pH 4.5–9.4 is ideal for cultivation of guava tree. Moreover, the soil should have high salt concentration and high-water table level.

Generally, propagation of guava trees is carried out via seed through cuttings, grafting, air layering and air budding. Air layering and marching were the common methods of plantation followed in India which has been replaced by budding and grafting methods as the trees planted in former fashion doesn't stand beyond 2–3 years. Plantation of guava tree cutting is done usually during the month of July and August. Guava cutting is hard and thus is planted under mist. Usually, 6–12.5 mm

thick half ripened cutting with roots is the propagating material. If plantation is practised through seeds, they germinate within 2–3 weeks of sowing. However, some varieties can even germinate in the 8th week of sowing. Guava tree cuttings are planted 5–6m away from each other. The trees are fast growers and bears fruit after 2–4 years of its plantation. They are long lived, produce fruits up to 40 years, however, the yield decline after 15th year.

#### 4.3. Morphological Characteristics

Guava tree is small tree or shrub with many branches and stand 2–7 m tall. The bark of the tree is smooth but thin and copper coloured that sheds off. Beneath the surface, is the greenish skin which gets exposed once the upper surface is removed. The trunk attains the diameter of 25 cm when the tree is fully mature. The twigs of the tree are quadrangular and bended downwards. The leaves are placed opposite to each other and are evergreen, leathery and short petioled. The shape of leaves is irregular ranging from oval to elliptical and are 7–15 cm long and 3–5 cm wide. The leaves consist of parallel lines (veins) which emerge from centre axis and move towards the periphery. Flowers, 2–5 cm in diameter, are borne as clusters on the leaf axils with 4–5 white petals and 250 stamens.<sup>[87]</sup>

Botanically, guava is a berry of the family myrtle and genus *Psidium*. The fruit, 5–10 cm across and 50–200 g in weight, is round, ovoid or pear shaped depending on the variety. The surface of the fruit known as exocarp is thin, light yellow in colour with a hint of pink. Right next to exocarp is mesocarp, the fleshy part of the fruit. The flesh is granular, thick white to yellowish or dark pink in colour and extends up to 3–12 mm. The mesocarp is juicy, acidic and flavourful. Beyond granular flesh is the central pulp (endocarp). The endocarp is juicy, slight darker in shade and a reservoir of stony yellowish seeds. The pulp is 6mm in diameter and contains 112–535 seeds. The pulpy endocarp of the berry comprises 2 types of

cell wall tissues—stone cells and parenchyma cells. Stone cells which are composed of lignified woody material are responsible for characteristic gritty texture of the fruit and are resistant to enzymatic digestion. Guava fruit has a shelf life of about 3–5 days at room temperature due to its high respiration rate and intense metabolism.<sup>[88]</sup>

#### 4.4. Nutrition and Chemical Composition

Guava fruit is often regarded as “Queen of fruits” due to the presence of higher amount of several nutrients. It is high protein, fibre rich and no cholesterol fruit. Like other fruits, guava are also a concentrated source of vitamins and minerals. The vitamin C content of fruit is 4 folds as compared to oranges and 6–7 times more than other citrus fruits<sup>[89]</sup>, protein 3 times higher and fibre 4 times more than pineapples. Furthermore, the lycopene content of fruit is twice that of tomato. Even potassium in the fruit is slightly higher than in bananas.<sup>[90]</sup>

#### 4.5. Chemical Constituents

The main constituents of guava are vitamins, tannins, phenolic compounds, flavonoids, essential oils, sesquiterpene alcohols and triterpenoid acids, glycosides. The main constituents of guava leaves are phenolic compounds, isoflavonoids, gallic acid, catechin, epicatechin, rutin, naringenin, kaempferol. The pulp is rich in ascorbic acid, carotenoids (lycopene,  $\beta$ -carotene and  $\beta$ -cryptoxanthin). Guavas provide both polyphenols and carotenoids. The polyphenolic content of guava is 2.62% which equates 126.40 mg/100 g of fresh weight of fruit. The bulk of the polyphenols (65%) is composed of condensed tannins. Over 150 different bioactive compounds have been identified in guava fruit. These are benzaldehyde,  $\alpha$ -copaene, myrcene, 2-methyl propyl acetate, hexyl acetate, ethyl decanoate,  $\beta$ -caryophyllene,  $\alpha$ -humulene,  $\alpha$ -selinene, leucocyanidin and gallic acid.

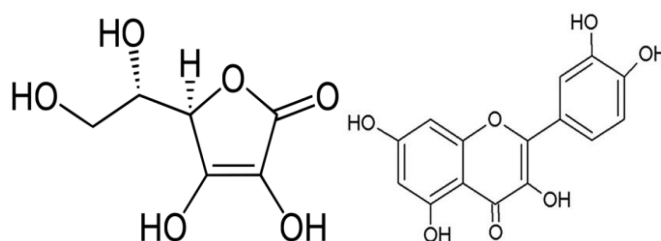


Figure 6: (a) Chemical structure of ascorbic acid; (b) Chemical structure of quercetin.

#### 4.6. Phytochemistry and functional components

The important constituents of guava are vitamins, tannins, phenolic compounds, flavonoids, essential oils, sesquiterpene alcohols and triterpenoid acids.<sup>[91]</sup> Leaves contain phenolic compounds, isoflavonoids, gallic acid, catechin, epicatechin, rutin, naringenin, kaempferol having hepatoprotective, antioxidant, anti-inflammatory, antispasmodic, anticancer, antimicrobial, anti-hyperglycemic, analgesic actions.<sup>[91]</sup> The leaf contain two important flavonoids quercetin known for its

spasmolytic, antioxidant, antimicrobial, anti-inflammatory actions<sup>[92,93]</sup> and quajaverin known for its antibacterial action.<sup>[94]</sup> Pulp contains ascorbic acid, carotenoids (lycopenes,  $\beta$ -carotene) possessing antioxidant, anti-hyperglycemic, antineoplastic.<sup>[93]</sup> The seed contains glycosides, carotenoids, phenolic compounds having antimicrobial actions.<sup>[94]</sup>

#### 4.7. Therapeutic role of Guava leaves

Guava leaves provide quick, short-term relief for

toothaches. Select a tender guava leaf and chew on it. The leaf's juice will work into the sore tooth region and relieve the pain. You can also boil guava leaves in water and add salt to the boiled solution to use it as a mouthwash.

The leaf extract of guava has traditionally been used for its health benefits. Toothpaste is a dentifrice used clean, maintain and improve the health of teeth. Toothpaste is mainly used to promote oral cleanliness and also acts as an abrasive that helps to prevent dental plaque and food particles from the teeth. The main aim of this investigation is to incorporate the herbal ingredient to that toothpaste that can effectively cleanse oral bacteria.

#### 4.7.1. Anticancer Activity

The aqueous extract of *Psidium guajava* leaves comprises high content of polyphenolic and isoflavonoids. Thus, can be used as an antitumour chemopreventive. Guava extract's antitumour properties are found to be tightly bound to induction of apoptosis and differentiation. *Psidium guajava* extracts are efficacious for the prevention of tumor development by depressing Tr cells and subsequently shifting to Th1 cells.<sup>[95]</sup>

#### 4.7.2. Improves Thyroid health

Thyroid is a small gland present at the base of the throat. The gland is important as it synthesis various hormones which regulates numerous metabolic processes of the body. One of the hormones, thyroid stimulating hormone (TSH) is significant in energy regulation of the body.<sup>[96]</sup>

Copper, one among the three most important elements, is essential for normal functioning of thyroid gland. Copper is not synthesized in body and is provided by diet. Copper is carried through blood in the form of ceruloplasmin. It catalyses the formation of TSH and deficiency of copper leads to hyperthyroidism.<sup>[97]</sup> Guava provides copper in sufficient amounts to elevate hyperthyroidism.

#### 4.7.3. Ophthalmic health

Guavas are good for vision. Consumption of guavas not only prevents degradation of eyesight and even improves it. Guava is beneficial in treating cataract and macular degeneration. Cataract implies presence of cloudy or opaque area in the otherwise normal clear lines which results in blurred vision. This effect of guava is due to its rich vitamin A content especially lycopene and  $\beta$ -carotene. Vitamin A decreases the risk of vision loss from macular degeneration and reverses cataract formation.<sup>[98]</sup>

#### 4.7.4. Cardioprotective effect

High blood pressure is one of the major risk factors associated with heart diseases. Blood pressure also has an effect on ophthalmic health and other vital organs of the body. About 1.15 billion people are under the influence of elevated BP levels globally. Furthermore,

elevated bp causes 7.5million deaths annually which account for 12.8% of the total deaths in a year. A person is said to be suffering from high BP when its systolic blood pressure is greater than 120 and diastolic exceeds. Guavas are also known to reduce LDL cholesterol level by causing its oxidation thereby preventing accumulation on artery wall, again elevating high blood pressure.<sup>[99]</sup>

Guavas being low sodium, high potassium food exert beneficial effects on heart by regulating blood pressure in subjects suffering from hypertension. Higher intake of sodium causes thickening of blood vessel walls leading to their stiffening and narrowing which exert pressure on flow of blood through them, thus, high blood pressure. Moreover, smooth flow of blood as well as oxygen to key organs is restricted. To overcome this, heart pumps harder which worsen the situation even more. Potassium is the best replacement for sodium. The higher the potassium intake, the more is sodium urinated. Potassium prevents the stiffening and narrowing of blood vessels and reduce the effects of pressure on blood vessels and is involved in various neural mechanisms that maintain the blood pressure. Potassium helps relax vascular as well as cardiac muscles and reduces the resistance to flow of blood through them.<sup>[100]</sup>

#### 4.7.5. Anti-glycemic activity

Due to low GI score and high fibre content, the guava is beneficial for diabetic patients. Low GI scores reduce the chances of sudden spike in sugar levels. Soluble dietary fibre invigorates the uptake of carbohydrate by body as dietary fibre causes increase in insulin sensitivity which leads to decrease in blood glucose levels. Moreover, dietary soluble fibre causes appreciable decrease in levels of low-density lipoprotein and total cholesterol. Dietary soluble fibre when comes in contact with aqueous solution forms viscous gels and delayed glucose absorption. The possible mechanisms of action are an effect of gastric emptying or hinder the diffusion of glucose towards the intestine. Nonetheless dietary soluble fibre also effect the rate of enzymatic action on food in intestine.<sup>[101]</sup>

#### 4.7.6. Anti-diarrhoeal Activity

Anti-diarrhoea effect is also contributed due to the quercetin. Among the major effect of the plant extract are antibacterial and trypanocidal activities which may be attributed mainly to the broad antimicrobial property of the flavonoids and iron chelating property of tannins.<sup>[102]</sup>

#### 4.7.7. Anti-Diabetic Activity

*Psidium guajava* has been reported to lower the blood glucose level. Guava fruit extract has been shown to significantly restore the loss of body weight and reduces the blood glucose level in the diabetic condition. In STZ induced diabetic's guava fruit extract, when administered at a dose of 125 and 250mg/kg. Fruit extract of guava protects the pancreatic tissues, including islet beta cells,

against lipid per oxidation and thus reduces the loss of insulin-positive beta cells and insulin secretion.<sup>[103]</sup>

Wu Ju-Wen et al. showed aqueous leaf extract of guava at 0.01–0.625 mg/ml showed significant inhibition on low density lipid (LDL) glycation in a dose dependent manner 31. Various investigations indicated that leaf extract of guava and its phenolic compounds inhibit the glycation process in an albumin/glucose model system. The guava leaf extracts also showed strong inhibitory effects on the production of Amadori products and advanced glycation end products (AGEs) from albumin in the presence of glucose.<sup>[104]</sup>

Quercetine, the major component of the guava leaf extract is responsible for the inhibition of the intestinal movement and reduce capillary permeability in the abdominal cavity and inhibition of increased watery secretion that occur in the acute diarrhoeal disease.<sup>[105]</sup>

#### 4.7.8. Antimicrobial Activity

Due to the presence of tannins the leaf extract of guava has been reported for antimicrobial activity against gram-positive and gram-negative organisms (*Sarcina lutea* and *Staphylococcus aureus*) and *Mycobacterium phlei*. Studies indicates that leaf extract of *psidium guajava* has potent anti-microbial activity against Propioni bacterium acnes and beneficial for the treatment of acne. The leaf extract of guava is effective against the agents which cause the infection in the human intestine like *Streptococcus mutatis*, *Pseudomonas aeruginosa*, *Salmonella enteritidis*, *Bacillus cereus*, *proteus* spp. *Shigella* spp.<sup>[106]</sup>

#### 4.7.9. Antioxidant Effect

Oxidative stress occurs when free radical production exceeds the antioxidant capacity of a cell which can damage crucial cellular compounds, such as lipids, carbohydrates, proteins, and DNA 51, 52. Many studies have reported significant alterations in plasma antioxidant enzyme systems, including superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx), and in lipid peroxidation 29. It has been well reported that *Psidium guajava* (PG) exhibit its antioxidant effect through the inhibition of Nuclear factor-kappa B (NF-kB) activation and restoration of enzymatic antioxidants.<sup>[107]</sup>

#### 4.7.10. Antitussive Activity

It has been reported that water infusion from *Psidium guajava* leaf extract decreases the frequency of coughing induced by capsaicin aerosol.<sup>[108]</sup> In senegal and Peru *Psidium guajava* leaves boiled together to make adecoction is very effective for cough and treatment of trachea bronchitis.<sup>[109]</sup>

#### 4.7.11. Anti-Inflammatory Activity

A decoction of *Psidium guajava* leaves is used for the treatment of various inflammatory ailments including rheumatism. Anti-inflammatory and analgesic effects of

the leaf extracts of *psidium guajava* was due to the presence of polyphenolics compound and triterpenoids. Aqueous extract of *Psidium guajava* at a dose of 50–800mg/kg, i.p. produced dose-dependent and significant inhibition of fresh egg albumin-induced acute inflammation (oedema) in rats. Further, leaf extract (50–800 mg/kg, i.p.) also produced dose-dependent and significant analgesic effects against thermally and chemically induced nociceptive pain in mice.<sup>[110]</sup>

#### 4.7.12. Guava as a wound healer

The gingival, periodontal ligament fibers are composed of collagen. Fibroblasts are the principal cell type present in the connective tissue of periodontium. Vitamin C is essential to maintain the overall integrity of the periodontium. Guava contains high levels of vitamin C (ascorbic acid). Ascorbic acid can modulate the expression of procollagen gene leading to collagen formation, altering the fibroblast differentiation through its effects on extracellular matrix. Vitamin C supports immune functions, maintains structural and functional integrity of epithelial tissues and physiological or metabolic parameters relevant to periodontal health.<sup>[111]</sup>

#### 4.7.13. Antimicrobial activity

Guava has a high antimicrobial activity. Guava leaf's extract doses can reduce the amount of cough due to its anti-cough activity. Aqueous, chloroform and methanol extract of leaves can reduce the growth of different bacteria. Due to its anti-cough activity it is recommended in the condition of cough.<sup>[112]</sup>

#### 4.7.14. Antibacterial Activity

The guava leaves were extracted in four different solvents of increasing polarities (hexane, methanol, ethanol, and water). The efficacy of these extracts was tested against those bacteria through a well-diffusion method employing 50  $\mu$ L leaf-extract solution per well. According to the findings of the antibacterial assay, the methanol and ethanol extracts of the guava leaves showed inhibitory activity against gram-positive bacteria, whereas the gram-negative bacteria were resistant to all the solvent extracts. The methanol extract had an antibacterial activity with mean zones of inhibition of 8.27 and 12.3 mm, and the ethanol extract had a mean zone of inhibition of 6.11 and 11.0 mm against *B. cereus* and *S. aureus*, respectively.<sup>[113]</sup>