

PHYTOCHEMISTRY AND PHARMACOLOGICAL ACTIVITY OF *PSIDIUM GUAJAVA* (LINNAEUS 1753) AN OVERVIEW

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Abstract

This review aims to provide the information regarding the phytochemistry and pharmacological activity of *Psidium guajava* (guava) belonging to Myrtaceae family of phylum Magnoliophyta and class Magnoliopsida. This multibeneficial tree found in almost all regions, but dry climatic regions are most preferable for the cultivation. Flavonoids, polyphenolic compounds, pentacyclic triterpenoids, carotenoids, essential oils, ester and aldehyde are the important active constituents found in guava. The leaves, fruits, bark, stem, roots of this plant are the most commonly used parts and these parts carry different pharmacological activities ranging from antimicrobial to anti-cancer properties. Guava fruit contains carbohydrates, proteins, fats and high-water content. Bark contains tannin, resins, while roots contain sterol, gallic acid, carbohydrate and salt. According to a research, guava leaf extract is found to be beneficial in the treatment of diarrhea. Guajava leaf extract was examined for its efficacy in treating intestinal colonization caused by *Citrobacter rodentium* using a mouse model. The mice were divided into two groups- control and test group, which were given normal saline and *P. guajava* leaf extract respectively. This was found that the mouse that were given 250µl of guava leaf extract for 3 consecutive days (twice a day) showed clearance of infection by the removal of bacteria through feces on the 4th day and showed complete removal of infection on 24th day, while the mouse in the control group continued to show infection till 29th day. Thus, we found that the guava leaf extract has the potential to treat bacterial diarrhea.

KEYWORDS: Pharmacological properties, phytochemistry, plant profile, *Psidium guajava*.

INTRODUCTION

Since ancient times, guava has been widely utilised and appreciated for its health benefits. Due to its climate adaptation, it can be grown in all tropical and subtropical locations. But it favours predominantly arid environments. The parts of the guava plant that are most frequently used include the leaves, roots, bark, and fruits[1]. The major producers of this plant in India are Assam, Uttar Pradesh, Bihar, Maharashtra, Andhra Pradesh, and West Bengal. It has been utilised as food and as a vital component of human health since the dawn of time[2]. Essential oil, flavonoids, carotenoids, polyphenolic substances, pentacyclic triterpenoids, esters, aldehydes, and other substances are among the active components found in guava. The treatment of diarrhea, dysentery, vomiting, gastroenteritis, and flatulence involves the use of guava leaf extract [3]. Guavas come in a variety of types, and depending on the species, the fruits range in size from 1.6 to 4.7 inches and are either round or oval in shape. Guava fruit has a high concentration of vitamins A and C, calcium, potassium, phosphorus, and dietary fibers, all of which help lower blood pressure, cholesterol, and triglycerides [4]. Various portions of this

plant contain a variety of medical qualities, from antibacterial activity to anticancer property, and are utilised not just as food but also as folk medicine [5]. Studies shows that Aqueous extracts of *psidium guajava* are effective at reducing the development of harmful microorganisms [6]. Guava can withstand droughts but need full sunlight, mild temperatures, and well spaced rainfall throughout the year to grow. This review may serve as a guide for future research on the domestication and development of the guava [7]. The guava leaf's active ingredients are also thought to have immunostimulatory properties [8]. Numerous studies have shown that the leaf, seed, and bark of *Psidium guajava* contain a wide range of bioactive substances that can have positive benefits on human health[9].

PLANT PROFILE

Habit:

A dwarf tree with its bark white, 4-angled branches that are thin peeling off young.

Roots:

Shallow root system. It has low drooping branches from bottom and suckers through the roots

Stem:

It has hairy younger stems which are generally four-angled in cross-section (quadrangular) and relatively large yellow fruit (2.5-10 cm long). The dominant compounds in the essential oil of the stem of *Psidium guajava* were α -pinene, 1,8-cineole, and β -bisabolol [10].

Leaves:

Leaves are Opposite, elliptic and acute in arrangement. *Psidium guajava*'s leaves have been used to isolate five chemicals, including one new pentacyclic triterpenoid called guajanoic acid and four previously identified ones *ie* sitosterol, ursolic acid, oleanolic acid, and ursolic acid uvaol [11].

Inflorescences:

Cymes or solitary flowers (1 to 3 flowers) generally comes from the leaf axils.

Flower:

The flowers originate singly in the upper leaf forks (axils).

Calyx:

Splitting irregularly into 2- 4 lobes, whitish and hairy

Corolla:

Cream coloured with 5–7 petals and 150–185 stamens

Seed:

Guava contains 100 to 500 seeds in it

Branches:

Fruit is a berry, which consists of a chubby pericarp and fleshy pulp of seed cavity

BOTANICAL DESCRIPTION

The root system of *Psidium guajava* is typically superficial and very extensive, frequently extending well

beyond the canopy. There are some deep roots, but there is no clear taproot. It is a large dicotyledonous shrub or small evergreen tree, typically 3–10 m high, with many branches, crooked stems, and bark that is light to reddish brown and thin, smooth, and constantly flaking. The fruit's surface is fleshy, while its interior is made of a seedy pulp [12].

Scientific classification

Kingdom	Plantae - Plants
Subkingdom	Tracheobionta Vascular plants
Superdivision	Spermatophyta Seed plants
Division	Magnoliophyta Flower plants
Class	Magnoliopsida Dicotyledonous
Subclass	Rosidae
Order	Myrtales
Family	Myrtaceae
Subfamily	Myrtoideae
Tribe	Myrteae
Gender	Psidium
Species	Psidium guajava

ORIGIN

Psidium guajava belongs to the Myrtaceae family, is the most important fruit of genus in spite including about 150 species. It is originated from Central and South America. Today, guavas are grown in Florida, southern California and different parts of the world [13].

CHEMICAL COMPOSITION

Guava leaves are a great source of several macro and micronutrients that are good for health, as well as bioactive substances. They have 1717 mg of gallic acid equivalents (GAE)/g of total phenolic compounds, 103 mg of ascorbic acid, 3.64% ash, 0.62% fat, 18.53% protein, and a moisture content of 82.47% [14].

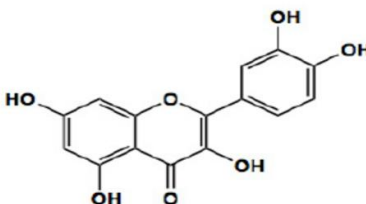
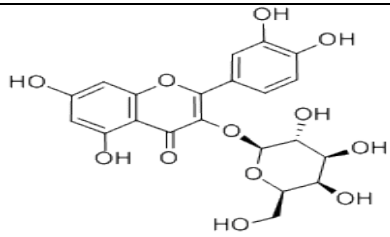
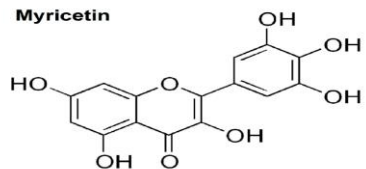
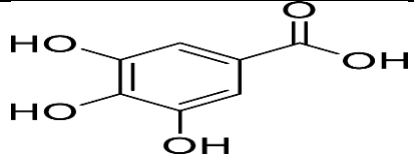
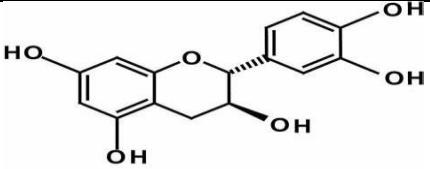
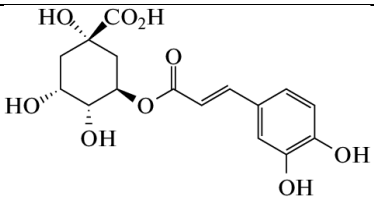
PHYTOCHEMICALS

There are various phytochemicals in leaves and fruits of *psidium guajava* such as tannins, essential oils, saponins, carotenoids phenols, triterpenes, β flavonoids, lectins, and fatty acids.

Ascorbic acid for anticarcinogenic and antioxidative effect [15], Phenolic compounds for anti – oxidant activit [16], Flavonoids such as morin-3-O-arabinoside, quercetin and quercetin-3-Oarabinoside are responsible for antimicrobial effect [17], Lecitins for antibacterial effect (Prevents the adherence between erythrocytes and bacteria) [18] and Linolitic acid a raw material in food and paint industry [19].

Secondary plant metabolites containing specific polyphenols that may have inherent antioxidant, anti-inflammatory and antiviral effects can be found in guava. Apigenin, flavonoids, and lycopene are the three most

often reported guava components that have been proposed to have anticancer effects in vitro [20].

PHYTOCHEMICALS	STRUCTURE	USES
Quercetin	 <p style="text-align: center;">Quercetin</p>	Reduces swelling, kill cancer cells, control blood sugar, and help prevent heart disease.
Hyperin		Efficient agent for cleaning, used as preservative, also used as disinfecting agent.
Myricetin	 <p style="text-align: center;">Myricetin</p>	Anti-Cancer properties, in brain protection, in heart disease, in diabetes, in skin protection.
Gallic acid		In cancer treatment, in inflammation, as anti-oxidant, in diabetes.
Catechin	 <p style="text-align: center;">(+)-catechin</p>	Reduction in atherosclerotic plaque, reduction in carcinogenesis, they also possess antibiotic activities.
Chlorogenic acid		Reduces the number of blood sugar spikes, boost metabolism, used to treat obesity.

BIOLOGICAL ACTIVITY

Anti-diarrhoeal – *P. guajava* leaf extracts are effective for treating acute diarrhea in traditional remedies [21]. The anti-diarrheal properties of *P. guajava* leaf decoction are extensive, and not all of them are attributable to quercetin alone [22].

As well equally being as effective as tetracycline in the treatment of acute infectious diarrhoea, antibacterial testing of the ethanolic extract (70%, v/v) of the leaves of *P. guajava* revealed a concentration dependent growth inhibition for both *E. coli* and *S. aureus* [23].

Antimicrobial activity - Extracts from the bark of *P. guajava* shown a notable antibacterial activity [24].

In the aqueous extracts of *P. guajava* stems, tannins, reducing sugar, and saponins were all present. *P. guajava* ethanolic stem extracts revealed the presence of saponins, reducing sugar, and tannins. *P. guajava* stems have phytoconstituents that serve as an anti-microbial by preventing the growth of *E. coli* and *S. mutans* [25].

According to research, peel water extracts of *P. guajava* had an antibacterial effect [26].

Acne lesions - Extracts from *P. guajava* leaves are efficient against organisms that cause acne. This result was better than TTO, which was recently thought to be a very effective topical acne treatment [27]. Numerous studies have also demonstrated the value of herbal-based cleaning products that remove excess oil; in light of this, the current effort was aimed to develop a face wash gel utilizing *P. guajava* seed extract, which has antibacterial and antioxidant qualities [28].

Dental Effects - Sanguinis, *S. mitis*, and *Actinomyces sp.* were susceptible to the aqueous extracts of *P. guajava*, which had a bacteriostatic effect on the early dental plaque bacteria. However, in the stressed growth environment, the bacteria appeared unable to carry out their normal biological functions and eventually stopped growing [29]. *P. guajava* mouthwash shown superior antibacterial properties. As a result, it makes a good dental care product [30].

Antimalarial effects - Leaf extracts from *P. guajava* showed good antimalarial efficacy. The presence of bioactive secondary metabolites in the plant material has been linked to the antimalarial activity of ethanolic and methanolic extract [31]. Extract from guava leaves has the potential to permanently suppress the malaria vector. According to reports, *P. guajava*'s aqueous extract at high concentrations shown positive larvicidal action [32].

Guava leaves extract containing flavonoids and flavonoid glycosides showed promising antimalarial activity compared to chloroquine and amodiaquine positive controls in vitro. In comparison to chloroquine and amodiaquine positive controls, guava leaves extract including flavonoids and flavonoids glycosides shown potential antimalarial efficacy [33].

Antitussive effects - Guava leaf extract including flavonoids and flavonoids glycosides shown potential antimalarial activity when compared to chloroquine and amodiaquine positive controls [34]. Due to its anti-cough properties, guava leaf extract doses might lesser the coughing. Leaf extracts in aqueous, chloroform, and methanol can inhibit the growth of certain bacteria. It is advised for use in cough conditions because of its anti-coughing properties [35]. It is also used to produce a cough remedy decoction by boiling it with lemon grass [36].

Hepatoprotective effects - Bark and fruits are the portions that are most frequently employed for the hepatoprotective properties [37]. Many research revealed, *P. guajava* leaf aqueous extract can be used as a liver tonic and does not significantly cause hepatotoxicity [38]. Studies have also shown that the leaf's ethanolic extract can change certain biochemical markers [39].

Anti-Cancer effects - Both haematological and solid neoplasias were controlled by *P. guajava* extract. The anti-tumor effects of *P. guajava* extract were discovered to be closely linked to the induction of apoptosis and differentiation [40]. Nearly half of the studies remarked that the strong antioxidant content of guava may have contributed to its anti-cancer properties [41].

Anti-Diabetic effect - According to research, *P. guajava* leaf extract has antidiabetic effects in type 2 diabetic mouse models, and these effects are at least partially mediated by inhibiting PTP1B [42].

In rats that had been given alloxan to create diabetes, the leaf decoction was tested for its ability to lower blood sugar levels. A statistically significant difference was seen in the extract in both acute and subacute testing [43].

Biswas *et.al.* (2013) studied that antimicrobial potential of *P. guajava* leaf extracts against two gram-negative bacteria (*E. coli* and *S. enteritidis*) and two gram-positive bacteria (*S. aureus* and *B. cereus*) which are some of food borne and spoilage bacteria. 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 μ 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. On the basis of the present finding, guava leaf-extract might be a good alternate in the search for a natural antimicrobial agent. This study provides scientific understanding to further determine the antimicrobial values and investigate other pharmacological properties [44].

Díaz-de-Cerio *et.al.* (2017) Studied that ethnomedicine applications of *P. guajava* leaves have been verified by several researches over the last decade against many disorders, demonstrating its potential in the treatment of the most common worldwide diseases. In addition, the effects of the leaves have been related to individual compounds such as quercetin, catechin, vescalagin, gallic acid, peltatoside, hyperoside, isoquercitrin, and guaijaverin [45].

Jimenez *et.al.* (2001) concluded the peel and pulp of *P. guajava* fruit presented high levels of dietary fiber, indigestible fraction and phenolic compounds. There was a statistically significant correlation between estimated extractable phenol content and radical scavenging activity/ferric reducing power (r) -0.928, $p < 0.01$; and r) 0.818, $p < 0.01$, respectively). These bioactive compounds contributed significantly to the high antioxidant capacity of guava fruit [46].

Singh *et.al.* (1985) studied volatile constituents from guava fruit where concentrates of fresh guava fruit pulp were obtained by standard controlled high-vacuum distillation with subsequent solvent extraction (pentane-dichloromethane 2:1) and silica gel LC pre-separation using a pentane-diethyl ether gradient. The concentrates were analyzed by capillary gas chromatography and coupled capillary gas chromatography techniques, *i.e.* on-line mass spectrometry and FTIR spectroscopy. A total of 154 substances were identified, from which 116 compounds could be described for the first time as guava fruit constituents. Quantitatively, lipid peroxidation products such as C6 aldehydes and alcohols were predominant [47].

Misra *et.al.* (1968) investigation demonstrated the fruits of guava were examined at three different stages of growth to follow the chemical changes. From the unripe fruits an ester of hexahydroxydiphenic acid with L-arabinose has been obtained and its constitution established. It disappears in the ripe fruits, which contain mainly free ellagic acid. Leucocyanidin and oxalates are present at their maximum in the unripe fruits and diminish with ripening [48].

Grover *et al.* (1993) investigation indicated that the water and chloroform extracts of guava were tested for their antimutagenicity. The water extract was effective in inactivating the mutagenicity of direct-acting mutagens, e.g. 4-nitro-o-phenylenediamine, sodium azide, and the S9-dependent mutagen, 2-aminofluorene, in the tester strains of *S. typhimurium*. The chloroform extract was inactive. Autoclaving of the water extract for 15 rains did not reduce its activity appreciably. The enhanced inhibitory activity of the extracts on pre-incubation suggests the possibility of desmutagens in the extracts [49].

Zahin.M *et al.* (2017) carried out investigation in which *P. guajava* leaf extract was fractionated in various organic solvents *viz.* petroleum ether, benzene, ethyl acetate, ethanol and methanol and tested for their antioxidant and antimutagenic properties. Methanolic fraction showed maximum antioxidant activity comparable to ascorbic acid and butylated hydroxyl toluene (BHT) as tested by DPPH free radical scavenging, phosphomolybdenum, FRAP (Fe³⁺ + reducing power) and CUPRAC (cupric ions (Cu²⁺) reducing ability) assays. The fraction was analyzed for antimutagenic activities against sodium azide (NaN₃), methyl methane sulfonate (MMS), 2-aminofluorene (2AF) and benzo(a)pyrene (BP) in Ames Salmonella tester strains. The methanol extracted fraction at 80 mg/ml concentration inhibited above 70% mutagenicity. Further, phytochemical analysis of methanol fraction that was found to be most active revealed the presence of nine

major compounds by gas chromatography–mass spectrometry (GC–MS). This data suggests that guava contains high amount of phenolics responsible for broad-spectrum antimutagenic and antioxidant properties in vitro and could be potential candidates to be explored as modern phytomedicine [50].

Manekeng *et al.* (2019) conclusion states the toxicological profile of the methanol extract of the *P. guajava* bark; the results obtained demonstrate that the single dose of 5000 mg/kg b.w. of this plant extract administered orally is not toxic. After long-term treatment (28 days) at high doses (1000 mg/kg b.w.), the toxic effects observed were sex specific and the plant may have some hematological potency and hepatoprotective activity with mild organ toxicity [51].

CONCLUSION

Our study of papers reveals the anti-microbial, anti-cancer, anti-diabetic, hepatoprotective, anti-tussive and other characteristics of *P. guajava*. Various phytochemicals of *P. guajava* like ascorbic acid, flavonoids, lecithins, linolitic acid and other phenolic compounds were also studied during the research. Due to its amazing features it can be used in variety of aspects and further research on this subject can be revolutionary for human health.

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