

UNVEILING THE PHYTOCHEMISTRY OF PSIDIUM GUAJAVA: KEY COMPOUNDS AND THEIR THERAPEUTIC POTENTIAL

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ABSTRACT

Guava, or *Psidium guajava* Linn (Myrtaceae), is a notable medicinal plant with considerable pharmacological potential. The many components of the *Psidium guajava* plant, including its leaves, bark, roots, and fruit, have been used for their therapeutic capabilities to treat a variety of health concerns in India, especially in rural areas where access to conventional treatments can be limited. In addition to bioactive compounds like α -terpineol, β -caryophyllene (trans-caryophyllene), rutin, α -humulene, oleanolic acid, flavonoids, and quercetin, *Psidium guajava* Linn is a great source of important nutrients. These constituents demonstrate a range of therapeutic properties, including anti-inflammatory, anti-tumor, anti-cancer, anti-bronchitis, anti-proliferative, anti-bacterial, and anti-diabetic properties.

Keywords: Pharmacological, Anti-proliferative, Antioxidant

INTRODUCTION

There has been an association between plants, disease, and life since the dawn of humankind. Men in prehistoric times began researching illnesses and cures. There is no evidence to suggest that people in antiquity were interested in artificial medications for their food; instead, they tried to find value in the items they could carefully obtain. The surroundings, including the animals and saplings, contained the most common garments they could discover. When they started utilizing plants, they discovered that some plant were poisonous or had medical value, most plants could be eaten. Through their experiences, family medicine using herbal treatments was used from generation to generation. In other words, the history of herbal medicine predates human history. The majority of these plant-based medications were first discovered through research into indigenous peoples' folklore and traditional treatments; some of these couldn't be replaced despite the amazing advancements in synthetic chemistry^{1, 2}.

Consequently, it is possible to portray plants as a significant source of medicinal products, serving as both the general public's basic pharmaceuticals and separated active ingredients that must be administered in standardized dosage forms. Herbal and modern medications are employed in complementary ways in numerous developing nations, including India, as part of healthcare programs ³.

All societies have used herbs and medicinal plant throughout history, but India has among the most enduring, fruitful, and varied cultural life traditions pertaining to the use of medicinal plants. Currently, there is an exponential increase in the market for herbal goods worldwide, and large pharmaceutical corporations are actively researching plant materials for possible medical benefits. However, the traditional use of herbal remedies has frequently been empirical, based on observations from different clinical trials without experimental backing. It is imperative that comprehensive systematic research be conducted on indigenous medications. Historically, plants have played a significant role in treating illnesses in both humans and animals. Interest in using aromatic and therapeutic plants is growing globally. Despite the tremendous advancements in contemporary medicine over the past few decades, plants continue to play a vital ⁴⁻⁶.

The plant *Psidium guajava*

The fruit *Psidium guajava* (L.), a member of the Myrtaceae family, is widely consumed in tropical regions such as South America, Bangladesh, Pakistan, Indonesia, and India. Numerous phytochemicals, including guaijaverin, avicularin, apigenin, quercetin, kaempferol, hyperin, myricetin, epicatechin, gallic acid, chlorogenic acid, catechin, epigallocatechin gallate, and caffeic acid, have been associated with the health benefits of guava plant leaves. The biological properties of guava leaf (GL) extracts, such as their hepatoprotective, antibacterial, antidiabetic, anticancer, antioxidant, and antidiarrheal properties, have been investigated ⁷.



Figure 1.0- (Psidium guajava Leaves)

The guava, is a very special and traditional plant that is farmed for its many nutritional and therapeutic uses. In tropical regions such as South America, Bangladesh, Pakistan, Indonesia, India, and others, guavas are grown and used as a crop. Many nations have used various guava tree parts, such as the leaves roots, stem,, bark and fruits, to treat conditions like diarrhea, diabetes, and stomachaches. The dark green, oval, elliptical, guava leaves (*Psidium guajavae folium*; GL) are distinguished by their obtuse-style apex. Guava leaves, pulp, and seeds are used to treat stomach and respiratory issues and to increase platelets in dengue fever patients. The cough sedative, antispasmodic, antihypertensive, anti-inflammatory, antidiarrheic, anti-obesity, and antidiabetic qualities of GLs are also extensively utilized. Additionally, research utilizing animal models has demonstrated the efficacy of GL isolates as cytotoxic, antitumor, and anticancer drugs⁸.

GLs are frequently used to treat diarrhea and other digestive issues, while fruit pulp is utilized to increase platelet counts in the treatment of dengue fever. Moreover, studies have been conducted on the possibility of using guava leaf extracts to treat diarrhea. Guava leaf extract's antibacterial effectiveness is mostly determined by the flavonoids found in the leaves; its most abundant flavonoid, quercetin, has potent antidiarrheal properties. The relaxing impact of quercetin on the intestinal muscle lining, which stops bowel contractions, is thought to be responsible for its antidiarrheal properties. Guava leaf polysaccharides, or GLPs, can be added to meals as an antioxidant and used to treat diabetes. Guava leaves' distinctive array of bioactive polyphenolic compounds—including gallic, ferulic, and caffeic acids—as well as other flavonoids, such as quercetin, are primarily accountable for their bioactive and medicinal qualities. The phenolic compound are classified as secondary metabolites and have potent immunostimulant and antioxidant properties⁹.

Taxonomic classifications

Kingdom: plantae

Phylum: Tracheophyta

Class : Magnoliopsida

Subclass: Rosidae

Order:. Myrtales

Family :Myrtaceae

Subfamily: Myrtoideae

Genus: *Psidium*

Species : *guajava*

Geographical Distribution:

Subtropical and tropical area of Asia, tropical Africa, South and Southeast Asia, Oceania, and portions in the United States (from Tennessee and North Carolina southward, as well as the west and Hawaii) have adopted guava as a crop ¹⁰.

Morphology:

Guava leaves are typically 7–15 centimeters long and 3-5 cm wide, with an oblong to oval form. The leaves have small petioles, or stalks that connect the leaf to the stem, and grow in an opposing configuration, meaning that two leaves bud at the same location on either side of the stem. The broad, leathery surface of the deep green Guava leaf has some light brown areas and thin white veins. When crushed, guava leaves release a fragrant perfume that is reminiscent of the fruit. Guava leaves are found on a small tree with widely dispersed branches and flaking bark that flake away to reveal a green trunk ¹¹.

Phytochemicals

The tropical fruit tree known as guava (*Psidium guajava*) has long been valued for its possible health advantages; the substances you cited support this use. The main bioactive substances in guava are broken down here, along with some possible health advantages. One terpenoid alcohol that has been shown to have anti-inflammatory and antioxidant qualities is α -terpineol. It might be advantageous for relaxation and respiratory health. β -Caryophyllene, also known as trans-caryophyllene, is a sesquiterpene that modulates cannabinoid receptors. Its analgesic and anti-inflammatory qualities suggest that it could find use in pain relief and anxiety therapies. Rutin: Rutin is an antioxidant-containing flavonoid. Agent anti-cancer ¹².

Therapeutic Potential of Phytochemicals in *Psidium guajava*

These naturally occurring compounds have been extensively studied for their diverse biological activities, making guava an important subject in the field of medicinal research. This review highlights the significant therapeutic properties of guava phytochemicals, emphasizing their antioxidant, anti-inflammatory, antimicrobial, antidiabetic, cardiovascular, anticancer, and neuroprotective effects ¹³.

Antioxidant Properties

The antioxidant potential of *Psidium guajava* is one of its most well-documented attributes. Guava leaves, fruit, and bark are rich in polyphenols, flavonoids, and vitamins, particularly vitamin C, which contribute to its robust antioxidant capacity. These antioxidants play a crucial role in neutralizing free

Bhanja *et al.* Unveiling the Phytochemistry of *Psidium guajava*: Key Compounds and Their Therapeutic Potential radicals, thereby preventing cellular damage and reducing oxidative stress. Studies have shown that guava extract can significantly increase antioxidant enzyme activities and reduce lipid peroxidation, highlighting its potential in preventing diseases associated with oxidative stress, such as cardiovascular diseases and cancer ¹⁴.

Anti-inflammatory Effects

Inflammation is a fundamental biological response, yet chronic inflammation is implicated in numerous diseases, including arthritis, cardiovascular diseases, and cancer. Phytochemicals in *Psidium guajava*, particularly quercetin, kaempferol, and gallic acid, exhibit strong anti-inflammatory properties. These compounds inhibit the production of pro-inflammatory cytokines and enzymes, such as TNF- α , IL-6, and COX-2, thereby mitigating inflammatory responses. Research has demonstrated that guava leaf extract can reduce inflammation in various experimental models, suggesting its potential use in treating inflammatory conditions ¹⁵.

Antimicrobial Activity

The antimicrobial properties of guava are attributed to its diverse range of phytochemicals, including tannins, flavonoids, and essential oils. These compounds exhibit broad-spectrum antimicrobial activity against bacteria, viruses, and fungi. For instance, guava leaf extracts have shown effectiveness against common pathogens such as *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans*. The antimicrobial activity of guava is particularly significant in the context of rising antibiotic resistance, offering a natural alternative for managing infections ¹⁶.

Antidiabetic Potential

Diabetes mellitus is a major global health concern, and the search for effective natural remedies is ongoing. *Psidium guajava* has garnered attention for its antidiabetic properties, primarily due to its ability to modulate blood glucose levels and enhance insulin sensitivity. Phytochemicals such as quercetin and other flavonoids in guava have been shown to inhibit key enzymes involved in carbohydrate metabolism, like α -glucosidase and α -amylase. Additionally, guava leaf extract has demonstrated hypoglycemic effects in both animal and human studies, indicating its potential as a complementary therapy for diabetes management ¹⁷.

Cardiovascular Benefits

Cardiovascular diseases remain the leading cause of morbidity and mortality worldwide. The phytochemicals in guava contribute to cardiovascular health through various mechanisms. Antioxidants in guava help in reducing oxidative stress and preventing atherosclerosis. Moreover, the

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anti-inflammatory properties of guava phytochemicals play a role in reducing inflammation in the cardiovascular system. Studies have also shown that guava leaf extract can improve lipid profiles by lowering LDL cholesterol and triglycerides while increasing HDL cholesterol. These effects collectively reduce the risk of heart diseases, making guava a valuable component of a heart-healthy diet ¹⁸.

Anticancer Properties

Cancer is a complex disease characterized by uncontrolled cell growth and metastasis. The anticancer potential of *Psidium guajava* is attributed to its rich phytochemical content, including flavonoids, carotenoids, and terpenoids. These compounds exhibit multiple mechanisms of action, such as inducing apoptosis, inhibiting cell proliferation, and preventing metastasis. For instance, guava leaf extract has been shown to induce cell cycle arrest and apoptosis in various cancer cell lines, including breast, prostate, and colon cancers. The antioxidant properties of guava also play a role in protecting cells from DNA damage, further contributing to its anticancer potential ¹⁹.

Neuroprotective Effects

Neurodegenerative diseases, such as Alzheimer's and Parkinson's, are characterized by progressive neuronal loss and cognitive decline. The neuroprotective effects of *Psidium guajava* are primarily due to its antioxidant and anti-inflammatory properties. Phytochemicals in guava, such as quercetin and vitamin C, help in reducing oxidative stress and inflammation in the brain, which are key factors in neurodegeneration. Additionally, guava extract has been shown to enhance cognitive function and memory in animal models, suggesting its potential in preventing or slowing the progression of neurodegenerative diseases ²⁰.

Traditional Medicinal Applications

Guava has long been an integral part of traditional medicine systems in various cultures, particularly in tropical and subtropical regions where the plant is native. In traditional Ayurvedic medicine, guava is valued for its astringent properties and is often used to treat diarrhea and dysentery. The leaves, bark, and roots are commonly employed in decoctions and infusions to address gastrointestinal issues. In addition to its gastrointestinal benefits, guava leaves are traditionally used to alleviate toothaches, coughs, and throat infections due to their antimicrobial properties. Indigenous cultures in Central and South America have utilized guava leaves for wound healing and to reduce inflammation, leveraging the plant's natural antiseptic qualities ²¹.

The fruit of the guava is also traditionally consumed for its nutritional benefits, being rich in vitamins A and C, and dietary fiber. In traditional Chinese medicine, guava is used to regulate blood sugar levels and improve digestion. The leaves are brewed into a tea that is believed to aid in weight management and reduce blood lipid levels. The versatility of guava in traditional medicine highlights its role as a multipurpose remedy, addressing a wide range of ailments from infections and inflammatory conditions to metabolic disorders ²².

Modern Pharmacological Applications

The advent of modern pharmacological research has validated many of the traditional uses of *Psidium guajava* while uncovering new therapeutic potentials. Contemporary studies have focused on isolating and characterizing the bioactive compounds in guava, such as flavonoids, carotenoids, terpenoids, and polyphenols, which are responsible for its wide range of biological activities ²³.

One of the significant areas of modern research is the antioxidant properties of guava. High levels of vitamin C and other antioxidants in guava combat oxidative stress, a contributing factor in many chronic diseases including cancer and cardiovascular diseases. Research has demonstrated that guava leaf extracts can reduce oxidative damage in cells, thus supporting their traditional use in enhancing general health and longevity ²⁴.

Modern pharmacological studies have also corroborated the anti-inflammatory effects of guava. Compounds such as quercetin and other flavonoids inhibit inflammatory mediators, providing a scientific basis for the traditional use of guava in treating inflammatory conditions. These findings have led to the exploration of guava extracts as potential treatments for conditions such as arthritis, which are characterized by chronic inflammation ²⁵.

CONCLUSION

Psidium guajava is a remarkable plant that provides a wide range of therapeutic advantages, from boosting immunity to perhaps preventing cancer. Its delicious flavour and adaptability as a natural cure make it a special and appealing option for anyone looking to improve their health holistically. Drug resistance has quickly emerged globally as a result of the therapeutic and preventive usage of allopathic drugs for sickness. On the other hand, resistance to natural therapy or ayurveda therapy is highly unusual, which is why many patients switch from allopathic to ayurvedic medication. But getting the active ingredient out of the unrefined natural material is a big challenge for scientists, so they have to come up with a more efficient method.

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