

## ***Psidium guajava* L. : A detailed overview on its nutritional value, health importance, therapeutic uses and different extraction methods**

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### **Abstract**

*Psidium guajava* L. is an ever green shrub belongs to the Myrtaceae family and is an essential fruit tree in tropical regions. Guava leaves reserved for the vast amount of phytochemicals which incorporates quercetin, avicularin, apigenin, epicatechin, kaempferol, guajaverine, catechin, gallic acid, hyperin, myricetin, chlorogenic acid, and epigallocatechin gallate and caffeic acid. Guava leaf extract has been considered for herbal activities, including anticancer, antidiabetic, antioxidant, antimicrobial, antidiarrheal, lipid-lowering, and hepatoprotective activities. Particular extraction strategies can be used for curing particular health problems. Consumption of guava leaves may be based mostly on the individuals. It may be taken orally, or taken as capsules, or as a liquid extract which helps in holding blood sugars, and moreover guava leaves tea are consumed mostly. Considering the phytochemical profile and useful results of guava leaves, they may doubtlessly be used as a component with the improvement of functional food and pharmaceuticals.

**Key words :** Guava leaves, Phytochemicals, antioxidant, extract, antimicrobial.

**P**lants are a primary plant based supply of many bioactive compounds<sup>15</sup>. Many diseases have been healed by the use of various plant preparations in human medicine, considering that in the past and now the nutraceutical, cosmetic, pharmaceutical industries are compensating great interest to natural phytochemicals and plant provisions.

The leaves are the main collectors of bioactive compounds from all plant organs involved in secondary metabolism.

Guava tree is a very unique and old-style plant, cultivated for its various medicinal and nutritional properties. Guava as a vital fruit has been grown in tropical regions like India,

Pakistan, Indonesia, South America and Bangladesh. Different parts of guava namely the leaves, stem, bark, roots, and fruits were being used to treat stomach ailments, diabetes, diarrhoea, and various diseases in many nations. The dark green leaves of guava are elliptical, oval and with blunt tips. Guava leaves, in the form of pulp and seeds, are used to treat gastrointestinal and respiratory diseases and increase platelets in people with dengue fever<sup>11</sup>. Guava leaves are widely used for anti-inflammatory, antispasmodic, antitussive, antidiarrheal, antihypertensive, anti-obesity and antidiabetic properties<sup>4</sup>.

The flavonoids of the guava leaf extract determine its antibacterial action although the well-known quercetin, the main flavonoid in guava leaf, suggests strong antidiarrheal activity. The antidiarrheal effect of quercetin is due to its stimulating effect on

intestinal muscles and helps prevent intestinal contractions. Guava leaf polysaccharides can be used as antioxidants improver in foodstuff and also help treat diabetes<sup>9</sup>.

The presence of bioactive polyphenolic compounds such as quercetin and other individual flavonoids, ferulic acid, gallic acid and caffeine in guava leaves is considered a phenolic compound identified as a secondary metabolite with potent antioxidant and immunostimulatory effects<sup>4</sup>.

*Scientific classification of Guava leaves :*

Guavas are plants in the genus *Psidium* of the family Myrtaceae. There are about 100 species of tropical shrubs and small trees in the genus. The scientific classification was denoted in (table-1).

Table-1. Scientific classification of guava leaves

<b>BOTANICAL CLASSIFICATION</b>		
S.No	Kingdom	Plantae
1	Sub Kingdom	Trachcobionta Vascular plants
2	Division	Magnoliophyta Flower plants
3	Super division	Spermatophyta Seed plants
4	Class	Magnoliopsida Dicotyledonous
5	Sub class	Rosidae
6	Order	Myrtales
7	Family	Myrtaceae
8	Sub family	Myrtoideae
9	Tribe	Myrteae
10	Genus	<i>Psidium</i>
11	Species	<i>Psidium guajava</i>

***Composition of Guava leaves :******Nutritional profile :***

Guava leaves (GL) are an amusing source of many healthy macro and micro nutrients, as well as bioactive components. Leaves encompass moisture 82.47%, carbohydrate 12.74%, protein 18.53%, fat 0.62%, ash 3.64%, ascorbic acid 103 mg and gallic acid 1717 mg equivalent GAE/g all phenolic compounds<sup>19</sup>.

***Protein :***

Leaves of guava contain 9.73% dried protein<sup>18</sup>. These proteins are huge biological molecules of amino acid compounds and act as building blocks of cells. Proteins involved in cell signalling, development and repairs, plays an important role in the regulation of enzymes and metabolism. In recent times, the total amount of nutrients from plant sources has increased due to the overwhelming demand for nutrient-dense foods, especially protein. A great effort is made to find nutrient-dense and incredibly sustainable food sources<sup>12</sup>. It is recommended that 16.8mg of protein and 8mg of amino acid/100g in guava leaves are respectively provided by using Lowry and ninhydrin techniques<sup>20</sup>. It is also recommended to use guava leaves as a completely unique and as a long-term sole dietary supplement as they are high in protein, starches and fibre<sup>7</sup>.

***Vitamins and minerals :***

Guava leaves are a wealthy supply of minerals, including potassium, calcium, sulphur, sodium, iron, magnesium, boron, manganese, and vitamins B and C. The highest content of

Magnesium, Sulphur, Sodium, Manganese and Vitamin B micronutrients in guava leaves lead to a particularly adequate nutrient requirement in the diet of humans and animals which helps in preventing micro nutrient deficiency<sup>1</sup>. The knowledge of the mineral is confirmed as 1660 of calcium, 360 mg of Phosphorous, 1602 mg of potassium, 13.50 mg of ferrous and 440 of magnesium of mg/100 g of guava leaf respectively as dry weight basis<sup>20</sup>. Vitamin B and C concentrations were 14.80 and 103 milligram per 100 g of dry weight respectively depicted in (table-2). Ingestion of calcium and phosphorus rich guava leaves helps in decreasing the risk of deficiency diseases such as hypocalcaemia, osteoporosis and hypophosphatemia. The concentrations of P, Ca, Fe Mg, and B vitamins in guava leaves were higher than those in guava fruit. The high content of vitamin C in guava leaves helps to improve the immune system and maintain healthy blood vessels, while the B vitamins play a vital function in improving circulation of blood, relaxing the nervous system and stimulating cognitive functions<sup>9</sup>.

***Polysaccharides :***

Polysaccharides are macromolecules that mainly occur in nature. They consist of elongated polymer chains composed of monosaccharide units. They also exhibit numerous physicochemical, biological and pharmacological properties, with antioxidant, antidiabetic, immunomodulatory, anti-inflammatory and antitumor actions<sup>13</sup>. Polysaccharides of guava leaf can be controlled remotely by usage of ultrasonic extraction (duration: 20 min, power: 404 W at temperature: 62°C). The guava leaf Polysaccharides

Table-2. Nutritive profile of guava leaves

S.No	Composites	Quantity( Per 100g)
1	Moisture	84.47 %
2	Ash	3.64%
3	Fat	0.62g
4	Carbohydrates	12.74 k.cal
5	Ascorbic acid	103mg
6	Gallic acid	1717mg
7	Calcium	1660mg
8	Phosphorous	360mg
9	Potassium	1602mg
10	Iron	13.50mg
11	Magnesium	440mg
12	Vitamin C	183.50mg
13	Vitamin B	14.80mg

(GLPs) contains approximately 9.13% of uronic acid and 64.42% of total sugars including 2.24% reducing sugars. GLPs are water soluble, although they are insoluble in natural solvents such as ethanol, chloroform, acetone, ethyl acetate and diethyl ether. The GLPs extracted at a concentration of 100 µg/ml shows excellent antioxidant power with 56.38% and 51.73% of 2,2-diphenyl-1-picrylhydrazil (DPPH) radical and 2.20 of azinobis cation scavenging capacity (3 ethylbenzothiazoline 6 Sulfonic acid (ABTS) of radical respectively. GLPs also appear to be useful in treating the symptoms of diabetes mellitus. Acarbose is an antidiabetic agent generally used as a remedy for type 2 diabetes<sup>12</sup>. One study suggested that GLP inhibits  $\pm$  glucosidase, which has a greater effect than acarbose without obstructive off  $\pm$ -amylase activity<sup>22</sup>. They can also be utilized as substitute for acarbose for dealing with diabetes mellitus and also as an antioxidant

additive in foods<sup>9</sup>.

#### **Health Benefits :**

##### *Helps in weight loss :*

Obesity is being an endemic which can cause many health issues which include diabetes and coronary heart disease. Guava leaf includes a flavonoid known as Quercetin that could inhibit fats cell formation. They try this aid by changing inhibiting complicated starches into sugars. Normally, the sugar is metabolized with the aid of using the liver wherein it receives fats after which it is secreted into the blood and leads to weight gain. The lively components in guava leaves have the unusual capacity to prevent the absorption of carbohydrates with the aid of using the frame, that could lower the quantity of sugar and energy the body absorbs, hence assisting in weight loss<sup>3</sup>.

*Helps in decreasing the chance of Heart Diseases :*

Guava leaf allows decreasing the extent of cholesterol and additionally allows in reducing blood pressure. Regular consumption of guava leaves for months which will help to reduce low-density lipoproteins (bad cholesterol) and triglycerides with none aspect results and increase “good” HDL cholesterol.

Quercetin, found in guava leaves, has a robust antioxidant impact at the body as it reduces oxidative pressure due to free radicals in the body. Therefore, quercetin blocks the formation of LDL. LDL is responsible for inflicting atherosclerosis and various cardiovascular diseases. Consumption of tea made from guava leaves for 3 months, helps in reducing low LDL levels, triglycerides and bad cholesterol with none terrible impact on the coolest cholesterol and for that reason lowering the threat of coronary heart diseases<sup>6</sup>.

*Helps in preventing Diabetes :*

A recent research observed that guava leaf extract progressed blood sugar ranges, long-time period blood sugar control, and insulin resistance. Guava leaf extract has a phytochemical known as Catechin which controls the blood glucose level or in different names; it has a hypo-glycaemic impact at the body. Tea made from guava leaf can reduce the alpha-glycosidase enzyme activity and helps in decreasing of blood glucose levels in diabetic patient through. Also, averts the absorption of maltose & sucrose through the body, for that reason reducing blood sugar ranges. A latest animal observe observed that

guava leaf extract has exceptional capability to reduce blood sugar ranges and oxidative strain in addition to enhance infection in diabetic subject.

*Helps in treatment of Diarrhoea and Dysentery :*

To deal with Diarrhoea and Dysentery, guava leaves had been frequently chewed and eaten. It consists of antimicrobial properties. Diarrhoea is a situation because of a bacterial contamination of *Staphylococcus aureus*. Observation suggested that guava leaf has robust antibacterial compounds which include tannins and essential oil which are very potent in fighting *S. aureus* contaminate and inhibit the growth of microorganisms. Guava leaves can also be boiled with water and the strained extract can be taken as medicinal drug 2-3 times a day until the issues of diarrhoea & dysentery disappear<sup>2</sup>.

*Helps in Fighting Dengue fever :*

Guava leaves are very useful in curing dengue fever. Drinking guava leaf extract increases the platelet count in blood and allows in preventing dengue. If, we boil 8-9 portions of guava leaves with five cups of water till it will become 1/2 of water and then it can consume. This combination may be very useful for dengue patients<sup>8</sup>.

*Therapeutic uses of Guava leaves :**Antioxidant Activity :*

Oxygen is an aerobic source because it acts as an ultimate acceptor of electrons during the respiratory process, an important

element in energy production. During metabolic strategies, the free radicals produced are responsible for various diseases of the human body such as inflammatory diseases, neurological disorders, ischemic diseases, acquired immunodeficiency syndrome, hemochromatosis and emphysema. The phenolic compounds, consisting of pyrocatechol, gallic acid, ellagic acid, taxifolin, ferulic acid and many others, are responsible for the antioxidant role of green leaf extracts<sup>4</sup>. An overall HPLC (high performance liquid chromatography) evaluation of guava leaf extract revealed the existence of 7 primary flavonoids: quercetin, kaempferol, hesperetin, rutin, apigenin and catchin even as different bioactive compounds such as isoquinoline, kaempferin, and corilaginoline alkaloids are identified and also known to have antioxidant properties.

Phenolic composites like gallic acid, pyro catechol, taxofolinin guava leaves are accountable for the antioxidant activity. Additionally, numerous flavonoids in guava leaves also are accountable for the antioxidant activity. By intake of guava leaves minimizes the dangerous outcomes of free radicals has been proved.

#### *Antibacterial Activity :*

Guava leaf extract show off antibacterial interest in case of both gram positive and gram negative bacteria. It has a capability for controlling cholera within side the remedy of affect. Majorly villagers avoid English medicinal drug and that they typically eat guava leaves chewed and swallowed orally. Guava leaves are generally effective towards E- Coli, intestinal microbes and vibrio cholera<sup>9</sup>.

#### *Antidiabetic Activity :*

Guava leaves facilitates to hold the blood sugar levels. Guava leaves inhibit intestinal glycosidase related to postprandial hyperglycaemia. Guava leaves are suggesting a breakthrough in treatment of diabetes type 2. The excessive fibre content material in guava leaves reduces the absorption of glucose from the intestine which there by it prevents the danger of growth in blood sugar levels after a meal<sup>9</sup>.

#### *Anticancer Activity :*

Guava leaves incorporate an antioxidant named Lycopene present excessively which plays a prime role in prevention of maximum cancers with the useful resource of the usage of performing on free radicals. The aqueous extract of guava leaves has anti-prostate maximum cancers interest in cell line model. In addition guava leaves consists of carotene as well which allows to prevent lung and oral cancer<sup>17</sup>.

Flavonoids like (apigenin) and  $\beta$ -caryophyllenein guava leaves showed strong anti-proliferative interest towards human colon cancer cell lines Caco-2, HT-29 and SW480. The anti-angiogenic properties of  $\beta$ -caryophyllene arise from its interaction with transcriptional details of HIF-1 $\alpha$  that regulate natural pathways associated with hypoxia, tumor-mediated angiogenesis and tumor metastasis. HIF-1 $\alpha$  is also involved in the transcription of vascular endothelial strengthening (VEGF) with the existence of  $\beta$ -caryophyllene in it, which explains the anti-angiogenic and anti- colorectal most cancer properties of guava leaf extract<sup>9</sup>.

*Antimicrobial activity :*

Plant bioactive compounds produce promising sources of antibacterial agents. Guava leaves are known for their antimicrobial properties, since they contain a variety of easy, natural, inorganic and anti-inflammatory compounds<sup>14</sup>. Guava leaf essential oils have antibacterial properties towards *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Streptococcus faecalis* and *Bacillus subtilis*.

The qualitative evaluation of the aqueous and natural extracts of guava leaves highlighted the presence of flavonoids, phenolic acids, glycosides, terpenoids and saponins whose occurrence is undoubtedly related to the antimicrobial activity. HPLC-TOF-ESI/MS evaluation of fermented GL showed the presence of, quercitrin, gallic acid, rutin, chlorogenic acid, kaempferol, isoquercitrin, avicularin, morin and quercetin. These compounds have ability to inhibit ergosterol, a component of the fungal cell membrane, and glucosamine, which is an indicator of fungal cell growth. Similarly, the water-soluble tannins present in GLs act as bacteriostatic agents, with locomotion mechanisms including substrate retention, inhibition of oxidative phosphorylation, and inhibition of extracellular enzymes. They have been shown to have an inhibitory impact on antibiotic resistant *Staphylococcus aureus* clinical isolates<sup>5</sup>.

*Hepatoprotective activity :*

Liver fat metabolism includes adenosine monophosphate (AMPK) and PPAR $\alpha$ -activated protein kinase activity, and mice treated with guava leaf extract improved the activity of each

parameter. Additionally, guava leaf extracts are believed to improve liver insulin resistance. Aspartate aminotransferase (AST) and alanine transaminase (ALT) are linked to liver function. Increased levels indicate fatty liver, which can be restrained by administration of leaf extracts<sup>21</sup>.

*Wound healing :*

Guava leaves are used as a medicine to heal wounds since time immemorial. Guava leaves are ground into a paste with some water and this is applied to the wounds. The presence of tannins, flavonoids in guava leaves show rapid recovery from wounds.

***Technologies used for Guava leaves extract:****Super critical fluid extraction :*

The extraction process consists mainly of separation from each other by solvent extraction. In Super critical fluid extraction (SFE) the supercritical fluid can use as an extraction solution by some a compromise to increase its potential. SFE contains a very important liquid containing pressure elements, pressure regulators, collection vessels, heating and cooling systems, pumps, etc. are considered as a solvent with many components such as CO<sub>2</sub>, ethanol and methanol. The first liquid is criticalized and then transported to the extraction vessel, where it is easily dispersed in the solid matrix of the sample and the required material. At low pressure, the solvent material is removed from the cell column and the resulting material precipitates. After the process CO<sub>2</sub> can be recycled. For this extraction method temperature and pressure parameters should be at 45-55°C and 200-300 bars<sup>16</sup>.

*Soxhlet extraction :*

Various components are used for Soxhlet extraction, including water cooling systems, electron tank, adapter tubes, electron siphon pipe, and capacitor. Take 10 mg of stable leaf material in a thimble loaded into a Soxhlet container with a vial containing the extraction solvent. The solvent vapour passes through the column and fills the chamber holding the fixed cartridge. Some non-volatile compounds are soluble in solvents. The process was repeated many times until the desired concentrated compound was obtained in the flask bottle and was executed at the boiling temperature of the solvent and the extraction was carried out in 100 ml of ethanol for 3.5 hours<sup>16</sup>.

*Steam distillation :*

This process is primarily intended for natural fragrances used in heat-sensitive compounds that decompose at high temperatures. 25 mg of dry lamellar material are purified in 300 ml of water. The process is carried out at the boiling point of the solvent and the distillation of water. Volatile compounds and methyl chloride are eliminated in 3-4 hours. The gray appearance indicates vapor and lowers the boiling point of compounds in the mixture, allowing cleaning before removing heat.

*Ultrasound extraction :*

Collect a 1.5 mg solid sample in an ultrasonic device. The ultrasonic device consists of a water tank, an ultrasonic generator, a digital timer, and a rotating mechanism. After this procedure, the material was filtered

through a vacuum evaporator.

*Guava leaves as functional food :*

Recent documents show that vegetable by-products, such as fruit or vegetable puree, seeds, pods/husk/tegument, pods and leaves are important sources of bioactive substances and can be used as a functional nutrient. Numerous reports proven the useful effects of guava extract in foods as a functional nutrient, due to the existence of a large number of compounds such as rutin, naringenin, gallic acid, catechin, epicatechin, kaempferol, isoflavonoids, vitamins, citric acid and flavonoids such as quercetin and guaiaverine, known for their antimicrobial properties, antioxidant and anti-inflammatory effect.

Addition of yellow Strawberry GL with an abundance of phenols and flavonoids in the laying feed chickens exhibited antimicrobial and antioxidant effects that could improve their quality of eggs by the inhibition mechanism of cyclooxygenase enzymatic pathways (COX), which plays a vital role as a mediator of inflammation. In this recent study, natural antioxidants which are found in Guava leaves are fortified in fresh pork sausage, which help in slowing down the lipid oxidation process in fresh pork sausage<sup>6</sup>. More recently, In jelly manufacturing industry guava leaf extract is used to make jelly in which gelatin and pectin were combined and confirmed by mass spectrometry. Presence of gallic acid, quercetin, esculin, 3-cinnamoylquinic acid, acids like gallic, ellagic and citric acids, responsible for its antioxidant and antibacterial properties<sup>3</sup>. Also, adding guava leaves does not change the textural changes of the jelly.



This review summarizes various aspects of guava leaves, including their nutritional aspects, health benefits, therapeutic uses, and different extraction methods. Guava leaves have been documented as a source of herbal compounds that can be readily available. Guava leaf extracts have been broadly researched for their antioxidant, hypoglycemic, anti-cancer and other effects. The rich presence of proteins and minerals and the presence of vitamins, in guava leave promote its uses as an immediate source of nutrients. The presence of various bioactive chemicals in guava leaves has been mentioned to improve and stabilize the unique physiological and metabolic properties of the human body. Guava leaf also high in secondary metabolites including triterpenoids, alkaloids, flavonoids, glycosides, saponins, sesquiterpenes, and various phenolic compounds. These complexes show a significant role as immunostimulant and modulators of chronic diseases, as well as diabetes, gastrointestinal and cancer, cardiovascular and neurodegenerative diseases. It is also recognized that various extraction methods can used for guava leaf extract, such as supercritical fluid extraction, Soxhlet extraction, steam distillation, ultrasonic extraction.

#### Conflicts of Interest :

Authors declare that there is no conflict of interests.

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