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A REVIEW ON PHARMACOLOGICAL ACTIVITIES OF GUAVA LEAVES

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ABSTRACT

Psidium guajava Linn., widely known as guava, is a tropical fruit-producing plant belonging to the Myrtaceae family, renowned for its nutritional value and medicinal benefits. It is packed with a variety of bioactive compounds, including flavonoids, carotenoids, polyphenols, and antioxidants, which contribute to its health-enhancing properties. Traditionally, guava leaves and fruits have been used in the treatment of various ailments such as diarrhea, diabetes, infections, and inflammation. Recent scientific studies have validated many of these traditional applications, revealing that guava possesses antidiabetic, antidiarrheal, antimicrobial, anticancer, and hepatoprotective activities. Phytochemicals like quercetin, catechin, guaijaverin, and gallic acid are considered key contributors to these pharmacological effects. Evidence from both *in vitro* and *in vivo* studies supports its therapeutic potential. As a result, guava extracts are being explored for use in functional foods and pharmaceutical formulations; however, more extensive clinical research is needed to confirm their efficacy in humans.

KEYWORDS: Psidium guajav, Allahabad Safeda, Sardar, Lalit, Shweta and Allahabad Surkha.

INTRODUCTION

Guava (*Psidium guajava*) is a nutrient-rich plant endowed by nature with numerous essential compounds. Historically, it is believed to have been commercially cultivated in South Africa and introduced to India by the Portuguese.[1] Plants have long served as a primary source of bioactive compounds, with various plant-based remedies used in traditional medicine for centuries. Today, industries such as pharmaceuticals, cosmetics, and nutraceuticals are

increasingly turning their focus to plant-derived ingredients and pure phytochemicals. Although plant leaves are often regarded as agricultural waste, they are actually valuable sources of high-quality nutraceutical and pharmaceutical compounds.[2] Among all plant organs, leaves tend to accumulate the highest levels of bioactive secondary metabolites and are widely utilized in products ranging from medicines to cosmetics, beverages, and food.

Guava is widely grown across tropical and subtropical regions, showing adaptability to various climates, though it thrives best in dry conditions. Major guava-producing countries include India, China, Thailand, Pakistan, Mexico, Indonesia, Brazil, Bangladesh, the Philippines, and Nigeria. India, Pakistan, and Brazil are the leading commercial producers, while Bangladesh ranks 8th globally, with a production volume of 1,048,850 metric tons recorded in 2017–2018.[3] Traditionally, different parts of the guava plant—including its roots, bark, leaves, and unripe fruits—have been used to treat ailments such as diarrhea, dysentery, and gastroenteritis. The leaves are also applied to wounds and ulcers, used to ease rheumatic pain, and chewed to relieve toothaches.[4]

Guava (*Psidium guajava*) leaf extracts, particularly in aqueous form, have long been used in traditional medicine to address a range of gastrointestinal issues. These include vomiting, diarrhea, gastroenteritis, dysentery, abdominal bloating, flatulence, gastric discomfort, and inhibition of peristaltic movement, along with spasmolytic effects. Beyond digestive health, guava leaf preparations have also been traditionally used to manage neurological symptoms such as insomnia, convulsions, and epilepsy. Herbal teas made from guava leaves are believed to help treat respiratory conditions including bronchitis, asthma, coughs, and other pulmonary disorders. Additionally, guava extracts exhibit anti-inflammatory and hemostatic properties.[5] Due to their antibacterial and pain-relieving effects, they have also been used in the treatment of conditions like diabetes, hypertension, obesity, rheumatism, and various gastrointestinal ailments. The therapeutic benefits of guava leaves and fruits are largely attributed to their rich composition of carotenoids, essential oils, flavonoids, phenolic compounds, and vitamins.[6]

BIOLOGICAL SOURCE

Guavas belong to the genus Psidium, which includes several trees and shrubs.[5] An evergreen plant in the Myrtaceae family is *Psidium guajava*.[7]

TAXONOMICAL CLASSIFICATION

Kingdom: It belongs to the kingdom Plantae.

Subkingdom: It belongs to the subkingdom Tracheobionta (vascular plants).

Division: magnoliophyta

Class: magnoliopsida dicotyledonous

Subclass: Rosidae

Order: myrtales

Family: It belongs to the family Myrtaceae.

Genus: Psidium

Subfamily: Myrtoideae

Species: psidium guajava.[3]

SYNONYMS

Arabic: guwafah

Bengali: piara

Brazil: araca

Cambodia: trapaeksruk

Chinese: fan shiliu

English: apple guava

French: gouyave

Germany: guavenbaum

India: amarood; jamba

Portuguese: goiaba

Spanish: guayaba

Thailand: farang

Philippines: bayabas.[4]

Fig. 01: Guava Fruit.

Fig. 02: Guava Leaf.

GEOGRAPHICAL SOURCE

In tropical regions such as South America, Bangladesh, Pakistan, Indonesia, and India, guava has been cultivated and used as a significant fruit.[2] Guavas are said to have come from Central America or Mexico. In addition to becoming more widely accessible in American nations, it is currently quite popular in Asian countries. India, China, Thailand, Mexico, Brazil, the Philippines, and Nigeria are the top producers of guavas. Commercial guava cultivars were mostly produced in Brazil and other countries. Bangladesh ranks 8th among nations that produce guavas. In 2017–18, Bangladesh produced 1,048,850 MT annually.[3]

CHEMICAL CONSTITUENTS

Leaves: Guava leaves are a great source of nutrients, including vitamins C and B, calcium, potassium, sulfur, sodium, iron, boron, magnesium, and manganese. In order to combat micronutrient deficiencies, the increased amounts of magnesium, sodium, sulfur, and manganese make it an excellent choice for both human nutrition and animal feed. On a dry weight basis, 9.73% of guava leaves have protein. Large macromolecules made up of amino acids, proteins serve as the building blocks of cells.[2] The primary constituents of the essential oil found in leaves are copanene, farnesene, humulene, selinene, cardinene, curcumene, menthol, terpenyl acetate, isopropyl alcohol, longicyclene, caryophyllene, bisabolene, cineol, caryophyllene oxide, and limonene. The leaves were used to extract flavonoids, saponins, and oleanolic acid. Other acids that have been discovered include ursolic, crategolic, guayavolic, nerolidiol, and sitosterol. The leaves are also rich in triterpenic acids and flavonoids, including avicularin and its potent antibacterial 3-l-4-pyranoside, fixed oil (6%), resin (3.15%), and tannin (8.5%), along with a variety of other fixed compounds, fat, cellulose, tannin, chlorophyll, and mineral salts. From Psidium guajava fresh leaves, guajavolide and guavenoic acid were extracted.[4] The leaves are rich in caryophyllene (about 21.3%) and limonene (42.1%). Guava leaves contain a variety of volatile substances.[7]

Flesh: 16 carotenoids were identified in Brazilian red guava flesh. Their structures were determined using mass spectra, circular dichroism spectra, UV-visible, 400 and 500 MHz ^{1}H NMR, and 120 and 125 MHz ^{13}C NMR. This is the first report of 13 of the recognized carotenoids as guava carotenoids.[5]

Fruit: Along with phosphoric, oxalic, and malic acids, manganese is also found in the plant.[4] Iron, calcium, manganese, phosphorous, oxalic and malic acids, vitamin C, vitamin A, and saponin mixed with oleanolic acid are the four elements. apigenin, myricetin,

guaijavarin, quercetin, flavonoids, and morin-3-O-α-L-lyxopyranoside and morin-3-O-α-L-arabopyranoside. However, β-caryophyllene, nerolidol, 3-phenylpropyl acetate, caryophyllene oxide, pentane-2-thiol, 3-penten-2-ol, 2-butenylacetate, 3-hydroxy-2-butano, and phenol are also present in essential oil. Limonene, octanol, ethyl octanoate (pink guava fruit), fiber, fatty acid, 3-methyl-1-butanol, 2,3-butanediol, 3-methylbutanoic acid, (Z)-3-hexen-1-ol, and 6-methyl-5-hepten-2-one.[8] Based on the knowledge that is currently available, guava leaves and fruits both contain alkaloids. Guava leaf extracts' phytochemical tests have verified the presence of alkaloids.[9]

Bark: It has 12–30% tannin, calcium oxalate crystals, and resin. Tannins, leukocyanidins, sterols, gallic acid, sugars, and salts are all found in roots. Tannic acid is present in significant amounts in all leaves, stem bark, and roots.[4]

Seed: Among the phenolic and flavonoid components they contain include quercetin-3-O-d-(2″-O-galloyl-glucoside)-4′-O-vinylpropionate, 14% oil by dry weight, 15% proteins, and 13% starch. Certain isolated substances have cytotoxic properties.[4] Glycosides, phenolic chemicals, and carotenoids.[10]

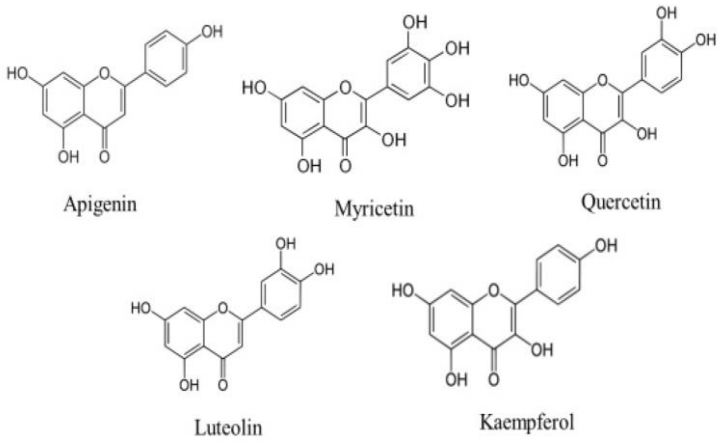

Fig. 3: Chemical Structure.

PHARMACOLOGICAL ACTION

Laxatives

The foundation for treating constipation is the adequate quantity of dietary fiber found in guava fruits and leaves. The fiber and roughage content of younger tender leaves is very high, which is essential for the prevention and management of hemorrhoids and constipation. According to some reports, there are up to 36 grams of dietary fiber in 100 grams of guava fruit. In addition, guava seeds have strong laxative properties that aid in colon cleaning and

persistent constipation. Compared to other fruits, guavas are one of the highest sources of dietary fiber and vitamin C. A single guava provides around 12% of the daily required intake of fiber, making it a highly helpful fruit for maintaining digestive health.[1]

Cold and Cough

It has been shown that guava leaves may effectively treat coughs and colds. Guava is a great source of iron and ascorbic acid, which helps to keep the respiratory system clear of harmful pathogens while also reducing lung congestion and mucus production. According to reports, these guava-derived ingredients work like a miracle to treat influenza.[1] Within 10 minutes of the extract injection, cough frequency decreased by 35% and 54%, respectively, in comparison to the control.[3] Within 10 minutes following injection, the plant's water extract at dosages of 2 and 5 g/kg reduced the frequency of coughing brought on by capsaicin aerosol by 35 and 54%, respectively, in comparison to the control.[5] Guava leaves are a good way to cure colds and coughs because they are high in iron and ascorbic acid, two nutrients that are important for respiratory health. These nutrients benefit the respiratory system by lowering excessive mucus production and easing lung congestion. Guava leaves' astringent qualities reduce inflammation and eliminate pathogenic infections by tightening the mucous membranes in the lungs and throat.[10]

Antibacterial activity

Both Gram-positive and Gram-negative bacteria are susceptible to the antibacterial properties of guava extracts. Guava leaves and bark water-soluble methanol extract and aqueous combination were evaluated *in vitro* for their ability to inhibit multidrug-resistant Vibrio cholera, and they were shown to have potent antibacterial activity. They came to the conclusion that this plant has the ability to contain cholera outbreaks. Villagers typically avoid using store-bought medications to treat children's illnesses and instead choose traditional cures like chewing and swallowing young, sensitive guava leaves. It has been demonstrated that guava extract works very well against E. coli, which is resistant to the majority of the current antibiotics available on the market. The extract from guava leaves has excellent efficacy against the intestinal bacteria that causes cholera, Vibrio cholera.[1] Guava leaf extracts have proven to be highly effective in inhibiting the development of several bacterial strains, and they also show excellent antifungal and antibacterial activity against S. suis, P. multocida, E. coli, and S. typhimurium.[3] Numerous studies have highlighted the

antibacterial capabilities of guava, especially its flavonoid components, which are responsible for the antibacterial qualities of Psidium guajava leaves.[9]

Antidiabetic Activity

To prevent diabetes, guava leaves are peeled and consumed empty-handed in China. The Medicinal Research Laboratory in Allahabad did a study on mice that demonstrated the ability of guava leaves and fruits to reduce blood sugar levels when the fruit was consumed without its peel. Numerous writers have investigated how *Psidium guajava* leaves affect postprandial hyperglycemia by inhibiting intestinal glycosidases, which may represent a breakthrough in the treatment of type II diabetes.[1] Guava leaves have been utilized extensively in ethnomedicine to treat diabetes. Numerous research studies have documented the antidiabetic potential of guava leaf flavonoids and polysaccharides.[2] Through a number of studies, several researchers have investigated Psidium guajava's ability to treat diabetes. In particular, studies have shown that extracts from guava leaves and bark efficiently increase muscle cells' absorption of glucose and reduce α-amylase activity. Furthermore, it has been demonstrated that guava leaf extract lowers fasting glucose plasma levels.[9] Antilipid and antidiabetic properties guava leaves antidiabetic properties were initially documented in 2005. They found that the extract reduced lipid droplets in the mice's liver and blood glucose at a dosage of 10 mg/kg. When palatable alcohol-soluble extracts of wild guava leaves were given to Kunming mice, a reduction in blood glucose levels was seen.[11]

Anticancer activity

Lycopene, an antioxidant found in large quantities in guavas, is essential for both preventing and treating cancer. Prostate and breast cancer react the best out of all of them. Compared to the other types, red flesh guavas have a higher lycopene content.[1] The growth of cell proliferation or a reduction that results in apoptosis is a hallmark of cancer, a complicated medical condition. Numerous endogenous and exogenous variables that contribute to the overproduction of reactive oxygen species (ROS) might cause it. Single- or double-strand breaks in DNA or RNA, base mutations, chromosome disruption and rearrangement, DNA cross-linking, nucleic acid breakdown, lipid peroxidation-induced damage to cell membrane integrity, and tumor development are all possible outcomes of this.[2] It has been demonstrated that a Psidium guajava leaf possesses anti-prostate cancer properties. In a xenograft mouse tumor model, it reduced the tumor growth and blood levels of the prostate-specific antigen (PSA).[3] The cancer cell line DU-145 was dose-dependently suppressed (its

viability) by an aqueous extract of Psidium guajava leaves. After 48 and 72 hours of incubation, the extract decreased the viability of PCa DU-145 (androgen-independent PCa cells) to 36.1% and 3.6%, respectively, at 1.0 mg/ml. The essential oil derived from Psidium guajava leaves proved very successful in slowing the growth of murine leukemia and human oral epidermal cancer.[4]

Wound healing activity

Throughout human history, guava leaves have been used extensively to treat wounds. Ancient Chinese and Indians ground guava leaves into a paste with a little water or oil, which they then applied to the surface of wounds. When a methanolic extract of guava leaves is given topically twice a day, tannins and flavonoids show quicker healing of the experimental lesion.[1] The excision wound model was used to assess the wound healing capabilities of a methanolic Psidium guajava leaf extract. After 14 days following surgery, almost 90% of the wounds had healed, whereas the group that received distilled water only saw 72%.[4]

Antihypertensive and hypolipidemic activity

Heart disease, hypertension, and hyperlipidemia can all be effectively treated with guava. Additionally, it has a little quantity of potassium, which relaxes blood vessels and lowers blood pressure. Because guava fruit contains more potassium and fiber, it has been shown that eating it every day significantly lowers blood pressure and blood lipids. Additionally, guava has a high pectin content, which lowers blood lipids significantly by postponing meal absorption and lowering the risk of cardiovascular diseases.[1]

Hepatoprotective properties

Adenosine monophosphate-activated protein kinase (AMPK) and PPAR activity are necessary for liver lipid metabolism, and rats given guava leaf extract showed increased activity of both enzymes. Furthermore, the extracts from guava leaves may help reduce insulin resistance in the liver. Aspartate aminotransferase (AST) and alanine transaminase (ALT) are linked to liver function. The use of guava leaf extract may limit the increase in their levels, which is a sign of fatty liver. Due to the liver's fundamental role of stabilizing blood glucose levels, diabetes has also been discovered to be closely associated with liver dysfunction, including steatosis, fibrosis, and liver enlargement. One of the hallmarks of type 2 diabetes mellitus is any imbalance in the metabolism of insulin, lipids, and glucose. The bioactive substances guaijaverin and avicularin, which are found in guava leaves, are strong inhibitors of the glucose transporter 4 (GLUT4)-mediated glucose uptake and dipeptidyl-

peptidase IV-mediated glucose uptake, respectively, which raise blood glucose levels. In rats with type 2 diabetes mellitus, treatment with guava leaf extract that had higher flavonoid contents increased insulin resistance and inhibited the rise in glucose and lipid levels.[2] Aqueous leaf extracts of Psidium guajava (250 and 500 mg/kg) exhibit strong hepatoprotective properties.[5] Numerous scientific studies have demonstrated that the extract from guava leaves has antioxidant properties, mainly due to its high phenolic content. This characteristic plays a crucial role in reducing or avoiding liver damage brought on by free radicals, especially in diabetic rats that have been given alloxan. As a result, guava leaf extract has both hepatoprotective and antidiabetic properties. According to these results, Psidium guajava fruit purée is safe even at larger dosages, successfully overcomes hyperglycemia, and protects the liver in alloxan-induced diabetic rats by lowering lipid peroxidation and improving antioxidant status. These findings provide scientific evidence in favor of using Psidium guajava fruit purée as a nutraceutical treatment for hepatotoxicity and diabetes.[9]

Gastrointestinal problems

Guava leaves' quercetin and flavonoid content has been shown to combat a number of gastrointestinal-related illnesses. One plant that is frequently used as a popular remedy for a variety of gastrointestinal disorders is the leaf of Psidium guajava. The development of harmful bacteria that cause gastroenteritis is inhibited by the alkalinity of fruits and leaves. Guava helps cure diarrhea because it stops bacteria from growing and helps to bind loose stools by releasing too much mucus from the colon. Carotenoids, vitamin C, and potassium are just a few of the vital vitamins and minerals found in guavas that help prevent GIT issues. Guava leaves can effectively reduce the development of extra mucus in the large intestine when they are chewed on an empty stomach. Stool consistency is maintained when modest amounts of guava leaf tea are consumed. Guava leaf extract's quercetin and flavonoid levels make it useful for treating gastrointestinal issues.[1]

Antidiarrheal activity

Diarrhea can be effectively controlled by boiling 6–10 fresh, tender guava leaves in a saucepan with warm water and then drinking the mixture on an empty stomach while still warm. Psidium guajava leaves, according to researchers, exhibit a broad spectrum of antimicrobial activity (such as antigiardial and antirotaviral activity) that may be useful in managing diarrhea with pathogenic origin. Guava leaves' high flavonoid content is

responsible for their antidiarrheal properties. Because of its astringent qualities, guava bark is often used to cure diarrhea in children.[1] One of the leading causes of death for children between the ages of 0 and 5 at the moment is diarrhea. New medications with little adverse effect on the body's other organs have been sought after. In order to create new medications with little adverse effects, focus has been placed on finding novel phytochemicals derived from medicinal plants in impoverished countries.[2] Rats and mice were significantly protected against delayed stomach emptying, intestinal transit inhibition, and diarrhea caused by castor oil. Significant antimotility impact that inhibited the animals' enteropooling produced by castor oil in a dose-dependent manner. The beginning of castor oil-induced diarrhea was significantly postponed.[3]

Spermatoprotective activity

Psidium guajava Linn. leaf extracts have positive effects on sperm production and quality, which may help infertile guys and those with nonobstructive oligospermia or azoospermia enhance their sperm parameters.[5]

Anti-allergy activity

Psidium guajava leaf methanol and aqueous extracts were studied; the results demonstrated strong suppression of mast cell histamine release and prevented IL-10-mediated in vitro activation of T regulatory (Tr) cells from CD4+ splenocytes of C57BL/6 in mice. By directly reducing Tr cell activity, the extracts also caused a change in the Th1/Th2 balance toward a Th1-dominant position.[1] In mice, guava leaf extracts reduced the allergic response mediated by T cells.[1] One of the processes behind the medicinal benefits of herbal medicine is polarization. Leaf extracts from Psidium guajava have shown anti-allergic effects on mice's T cell immunity.[4]

Antimalarial effects

The antiplasmodial actions of the aqueous leaf, stem bark, and fruit extracts of Psidium guajava were investigated using the parasite lactate dehydrogenase (pLDH) test technique, a recently established in vitro enzymatic method for assessing antimalarial drugs. Plasmodium falciparum D10, a chloroquine-sensitive strain of the malarial parasite, demonstrated antigiardiasic action with trophozoite mortality (87% 1.0) in an in vitro antiplasmodial test; guava stem bark extract had IC50 values of 10–20 g/ml. Different research examined the development of Psidium guajava leaves and stem bark in MAC-habituated Entamoeba histolytica.[4] When making fever "teas," the leaves are a necessary element. They are also a

component of the pot plant that is used to cure malaria with steam. The extract from the stem bark, which included terpenoids, flavonoids, secoiridoids, and anthraquinones, was shown to be useful in the prevention and/or treatment of malaria.[5]

CONCLUSION

Guava is a rich in nutrient fruit with significant medicinal properties. Its leaves and extracts contain antioxidants, vitamins, and bioactive compounds and these compounds offer anticancer, antidiabetic, antimicrobial and anti-inflamatory effect. Guava leaves support immune function and help to manage chronic diseases like diabetes and cancer. Essential oils from guava show antiproliferative against various human cancers. Both fruit and leaves are valuable in modern and traditional medicine. The intricate chemical pro file of guava leaves, including phenols, flavonoids, and terpenoids, contributes to their hypoglycemic, antioxi dant, anticancer, antidiabetic, antimicrobial, anitlipid and antidiarrheal effects. The compounds in guava leaves, such as gallic acid and water-soluble tannins, prevent bacterial and fungal growth.

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