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Biological activities of *Psidium Guajava* phytochemicals on human health

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ABSTRACT

Guava (*Psidium guajava* L.*)* contains various biologically active compounds, such as kaempferol and quercetin, which possess anti-cancer properties. Its leaf has high concentration of polyphenols, flavones and tannins, while exhibiting lower levels of alkaloids, flavonoids, saponins and triterpenes. Despite the potent antibacterial properties of polyphenols, it may be inferred that the antimicrobial efficacy of guava is primarily attributed to its elevated levels of phenols, tannins, and flavonoids. Numerous research has demonstrated that guava leaf extracts have antibacterial properties in rats and guinea pigs, indicating that guava leaves and their other components may be utilized to treat many ailments, including diarrhea, spasms, rheumatism and wounds. This review elucidates the several phytochemicals found in *Psidium guajava* that are responsible for diverse biological activities. This work concentrates on the investigation of several bioactives that may be examined in future research to provide more beneficial outcomes.

Key words: Antimicrobial, Bioactive, Flavonoids, Guava, Phytochemicals, Polyphenols, *Psidium guajava,* Tannins.

1. INTRODUCTION

Psidium guajava, commonly called guava, is a tropical tree extensively cultivated for its fruits (Figure 1). It is classified under the Magnoliophyte phylum, Magnoliopsida class and Myrtaceae family (15). In Malaya, it is typically known as guava or jambu batu (18). This plant is used not only for culinary purposes but also in traditional medicine, with many parts exhibiting medicinal properties, including antibacterial and anticancer activities (14). Guava farming is also reasonably easy because it blooms and modifies in

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different environments, the fruits also grow quickly (19). Guava trees are found all over India due to their numerous economic applications (17). Fruit is high in carbs, proteins, lipids, minerals and other nutrients, which reduces malnutrition (8). The nutritional values of different phytoconstituents are given in Table 1 and Figure 2 (20).

Figure 1. Donor Guava and Recipient plant *Vigna radiata*.

2. HARMACOLOGICAL ACTIONS

2.1. Safety Profile, *In-Vitro, In-Vivo* Studies

Comprehensive investigations on guava sections and their extracts revealed that its components have extensive applicability. The material provided below elucidates further examples that support its applications and safety (13). The aqueous extract of guava leaves suppressed the mutagenicity of the nitro derivative of ortho-phenylenediamine and the S9-dependent mutagen, 2-aminofluorene, in *Salmonella typhimurium* during the Ames experiment (3). The cytotoxicity and the mutagenicity of guava leaf extract (aqueous) were tested *in-vitro*. The increased concentration of *P. guajava* L. infusion significantly suppressed cellular division. These studies on the cytotoxicity and mutagenicity plant provide critical information on their safety as therapeutic agents (1).

Acute oral doses of the plant extract were administered to normoglycemic and STZ-induced diabetic rats (PGE; 50-800 mg/kg, P.O.), resulting in a dose-dependent, significant hypoglycaemic effect (P; 0.05-0.001). Additionally, acute intravenous injection of guava leaf extract (PGE, 50-800 mg/kg IV) produced substantial, dose-dependent reductions (P; 0.05-0.001) in systemic arterial blood pressure and heart rates in hypertensive Dahl salt-sensitive rats (16). Etuk and Francis determined that the oral administration of 10-50 mg/100 g of the extract to rats exhibited no significant deleterious effects after 72 h (5).

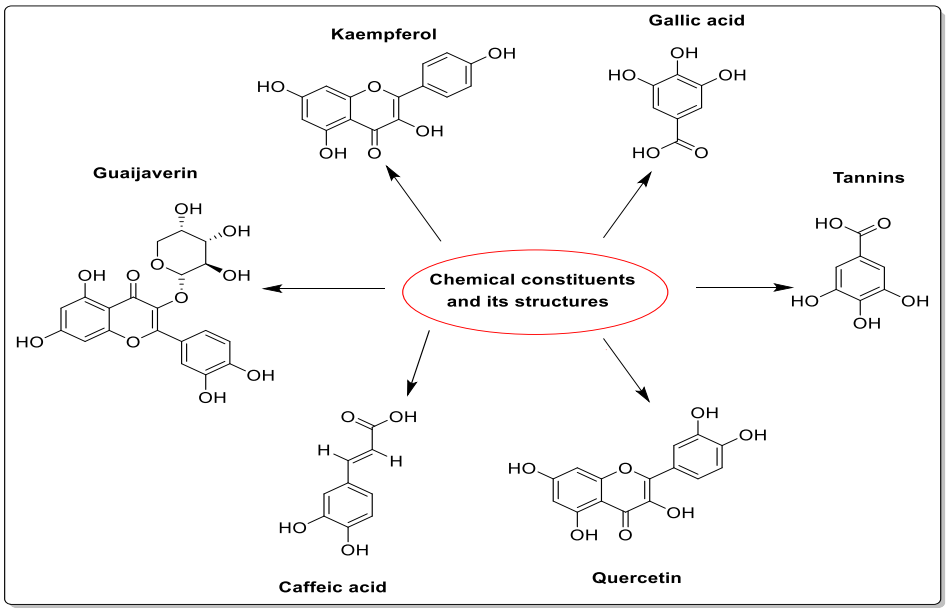

Figure 2. Chemical constituents and structures of bio actives present in *psidium guajava*

These findings revealed that the aqueous extract of *Psidium guajava* leaf was harmless at the levels studied and effective to treat *Salmonella* infection in Wistar rats (5). Furthermore, an acute toxicity investigation of guava leaf ethanolic extract revealed no evidence of lethal activity or induced mortality in the Albino Rats at dosages greater than 2000 mg/kg (4). PGE ethanolic extract has potent anti-inflammatory properties. In an antimicrobial efficacy study of guava leaves it was reported that chewing the leaf or use of the rootbark of the guava plant as a decoction has reported anti-microbial and anti-diarrheal activities (22). In another research, the 14 guava leaves decoction was found safe treatment for adults with acute non-complicated diarrhea of unknown etiology. The outcomes examined were a reduction in stool frequency and an improvement in consistency.

2.2. Antimicrobial Activities

A study of the antibacterial activity and anti-adherent effect of guava leaves was done and reported that the extract of guava leaves either in crude or liquid form inhibited *S. gordonii* biofilm development, adhesion and formation. In the study, it was also reported that guava leaves are polyphenolic and show bactericidal activity via binding proline-rich proteins that prevent protein production (12). Batubara e*t al.* (2) researched the best technique that can be used to extract the kaempferol or quercetin isolation from the leaf of *Psidium guajava*. They performed 12 different extraction and isolation techniques to separate the flavonoid kaempferol and the quercetin from guava leaves. They also studied toxicity test against *Artemia salina* larvae and found that all the extracts were lethal. It was also observed that Guaijaverin is present in guava leaves and possesses

antibacterial properties, whereas, Kaempferol is well known for its antibiotic properties. They concluded that the human cancer cell lines were shown to be less proliferative in culture when the extract is high in kaempferol and quercetin. Zahidah *et al.* (24) researched on antioxidant and microbicidal activities of pink guava and its leaves with seeds. They tested the antimicrobial test using the disc diffusion method against the bacteria *Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis* and *Pseudomonas aeruginosa* including the fungi *Aspergillus niger* and *Candida albicans* and analyzed that the leaves showed more phenolic and flavonoid content than its seeds. They used the Rancimat test to detect the delay in the development of oxidative destruction in margarine. They stated that the pink guava leaf extract exhibits strong antibacterial and antimicrobial properties in contrast with its seed extract.

Table 1. Nutritional Values of Phytoconstituents Present in *Psidium Guajava*

Phytochemicals	**Percentage (%)**
Carbohydrates/ Sulphates/ Phenols	
Arabinose	22.6
Xylose	7.71
Rhamnose	3.88
Fucose	1.44
Galactose	29.41
Glucose	33.79
Mannose	0.59
Phenol	15.28
Sulphate	18.58
Protein	
AOAC method	9.73 %
Lawry's method	16.8 mg/100g
Ninhydrin method	8.0 mg/100g
Ascorbic acid and other elements	
Potassium	1.11 %
Ascorbic acid	142.55 mg/100g
Phosphorus	0.23 %
Nitrogen	1.02 %

Jaiarj *et al.* (7) researched on anticough and antibacterial activity of guava leaf extract. They took rats and guinea pigs for their evaluation. Their results showed that the aqueous extraction with doses 2 g/kg and 5 g/kg reduced the cough frequency when administered through aerosol by 35 and 54 % respectively, vis-à-vis administration through injection as it shows the result within 10 min. When experimented on isolated rats the extract directly promoted muscular contraction in tracheal muscle and got synergized with the stimulatory effect of pilocarpine. Atropine counteracted the mentioned impact. Furthermore, water, methanol and chloroform extracts of dried leaves of guava suppressed the development of *Staphylococcus aureus,* in disc diffusion method. As a result, they claimed that the extract of guava leaf is a necessity for the duration of cough.

2.3. Antioxidant Activities

Melo *et al.* (11) researched on antioxidant capacity and microbicidal activity in the samples of guava leaf. They determine the antiviral, antioxidant, antibacterial and cytotoxicity activities of flavonoids and phenols present in the guava leaves by different assay methods such as TZM-bl, ABTS or DPPH, XTT, Reduction of Plaque, Spectrophotometric and Kirby Bauer respectively. They stated that numerous natural antioxidants are produced by plants including ascorbic acid, nitrogen compounds namely alkaloids, chlorophyll derivates, amino acids and amines, phenolic compounds namely phenolic acid and flavonoids, as well as carotenoids. In the research work, it was observed that the extracts have the potential to block gram-positive and gram-negative bacteria (11). Verma *et al.* reviewed thesis papers and concluded that reactive free radicals like hydroxyl, superoxide, peroxyl and alkoxyl as well as non-radicals like hydrogen peroxide and hypochlorous acid, can cause oxidative damage to lipids, proteins and nucleic acids. They also culminated that antioxidants are substances that can stop or delay this damage (21). Wu *et al.* researched the biological use of extracts of *Psidium guajava* and the effectual compounds present in its leaves on the protein's glycation process. They used an albumin/ glucose model system to compare the puissance of the extracts using a polyphenol compound coined as polyphenols (23).

2.4. Anti-Inflammatory Activities

Jang *et al*. (9) investigated the anti-inflammatory effects of guava leaf's ethanolic extract in vivo and *in-vitro*. They observed through their research that the guava leaf extract is successful in inhibiting the production of nitric oxide and prostaglandin E2 when administered. They also succeeded in exhibiting anti-inflammatory activity with the use of two different models. The models are (i). LPS-induced endotoxic shock in mice, (ii). Freund's complete adjuvant-induced hyperalgesia in rat. In their investigation, they assessed the restraint impact of GLE on the generation of inflammatory biomarkers including NO and PGE2 as well as iNOS and COX-2 expression in LPS-stimulated RAW264. 7 cells. Guintu *et al.* (6) researched the potency of guava leaves used as a mouthwash for patients suffering from an aphthous ulcer. They estimated that patients dealing with aphthous ulcers got relief from pain within three days of administration of guava leaves mouthwash. They also evaluated that the observed anti-inflammatory and analgesic benefits of the GLE are attributed to a variety of tannins, polyphenolic compounds, flavonoids, triterpenoids, quaijaverin and quercetin.

2.5. Other Activities

Zhu *et al.* (25) researched the hypoglycaemic potential of the contents present in guava leaves. They obtained flavonoids from guava leaves and used a diabetic mouse model to evaluate the anti-hyperglycaemic liver protective effects with a low-dose streptozotocin and a high-fat diet. They found that the fasting plasma glucose, glucose tolerance and resistance index were reduced in diabetic mice after the administration of flavonoids. There was also a reduction in the kidney and liver indexes and an improvement in the hepatocyte morphology in diabetic rice. Guaijaverin and avicularin were found to be the two main antidiabetic components of the 14 guava leaf chemicals identified in studies

that had established an *in-vitro* glucose-uptake boosting bioassay approach to examine the hypoglycaemic action of guava leaf active components. As a result, they concluded that flavonoids from guava leaves had consequential anti-diabetic and lipid protective activities when tested in diabetic rice.

Kim *et al.* (10) researched on FRSA (free radical scavenging activity) of guava leaves according to the harvest time with the use of a ^{1}H-NMR-based metabolic technique. They used PLS analysis, which demonstrated a connection between the metabolic profile and FRSA. By using the 1H-NMR-based metabolomic approach, guava leaves were categorized and the (FRSA) was assessed according to various harvest periods. They found that the guava leaf harvested in October and December possessed high levels of FRSA because of the presence of increased concentrations of 3-hydroxybutyric acid, acetic acid, glutamic acid, citric acid, malonic acid, trans-aconitic acid, ascorbic acid, maleic acid and xanthine.

3. CONCLUSIONS

Psidium guajava is widely used in traditional medicine and as a nutritional resource. Thorough investigations have shown an array of beneficial components in its leaves and fruits, including phenolics, flavonoids, carotenoids, terpenoids and triterpenes. These compounds demonstrate considerable pharmacological effects, including antispasmodic and antibacterial characteristics, which are especially efficacious in the treatment of diarrhoea and dysentery. The plant's abundant phytochemical composition underpins its conventional medical uses and indicates promise for the creation of therapeutic medicines. Plants produce a diverse spectrum of active chemicals with pharmacological effects. Nature has endowed Guava with numerous necessary nutrients as well as medical capabilities, with the pink variety having the most medicinal value. Guava and its leaves exhibit strong antimicrobial properties and rich in polyphenolic chemicals, which may be the source of guava leaves' antifungal and antibacterial properties. It can be concluded that they can be used as bio-preservatives in food products as well as in biologicals. The whole review paper information summarizes that further research on guava and its parts may prove to have fascinating medicinal properties soon.

DECLARATION

We declare that all authors of this Ms. have made substantial contributions. We did not exclude any author who substantially contributed to this Ms. We have followed the ethical norms established by our respective institutions.

AUTHORS CONTRIBUTION

RKM and PSM conceived of the present idea for the article. RKM and ANR performed the literature search and data analysis and wrote the manuscript. RM and AVM provided critical feedback and helped to shape the final draft.

CONFLICT OF INTEREST

The authors announce that they have no conflict of interest.

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ETHICAL APPROVAL

The authors declare that the study was carried out following scientific ethics and conduct. However, this study did not involve any use of animals, hence no ethical approval has been obtained from the concerned committee.

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