

## A Review on Phytochemical and Pharmacological Profiling of Parts of *Psidium guajava*

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### ABSTRACT

The guava (*Psidium guajava* L.) tree, belonging to the Myrtaceae family, is a very unique and traditional plant which is grown due to its diverse medicinal and nutritive properties. Guava has been grown and utilized as an important fruit in tropical areas like India, Indonesia, Pakistan, Bangladesh, and South America. Different parts of the guava tree, i.e., roots, leaves, bark, stem, and fruits, have been employed for treating stomachache, diabetes, diarrhea, and other health ailments in many countries. As an excellent antiplaque, antimicrobial, anti-inflammatory, antioxidant agent guava hopefully will be considered in the future for more clinical evaluations and possible applications as an adjunct to conventional periodontal therapy. Nevertheless, we should emphasize the importance of experimental and clinical studies with emphasis on bioavailability of compounds, effective and safe doses to be used.

### INTRODUCTION

Plants are a predominant natural source of numerous bioactive compounds [Newman et al, 2003,]. Several diseases have been cured using a variety of plant preparations in folk medicine since ancient times [3] and, presently, cosmetic, pharmaceutical, and nutraceutical industries are paying more attention to plant preparations and pure phytochemicals. The projected growth of the plant preparation market is around USD 86.74 billion by 2022, with the largest market share belonging to the pharmaceutical sector, followed by the nutraceutical industry. Interestingly, the utilization of plant preparations for cosmetics, beverages, food, and medicine is mainly dependent on plant leaves. Among all plant organs, leaves are the largest accumulators of bioactive compounds, such as secondary metabolites. Several recent studies reported phytochemical profiles and biological activities of leaf extracts of various cultivated plants [2,4,5,6]. Hence, although plant leaves are considered as agricultural waste, they are a rich source of high-value nutra-pharmaceutical compounds.

The guava (*Psidium guajava* L.) tree (Figure 1), belonging to the Myrtaceae family, is a very unique and traditional plant which is grown due to its diverse medicinal and nutritive properties. Guava has been grown and utilized as an important fruit in tropical areas like India, Indonesia, Pakistan, Bangladesh, and South America. Different parts of the guava tree, i.e., roots, leaves, bark, stem, and fruits, have been employed for treating stomachache, diabetes, diarrhea, and other health ailments in many countries. Guava leaves (*Psidiiguajavae folium*; GL) are dark green, elliptical, oval, and characterized by their obtuse-type apex. Guava leaves, along with the pulp and seeds, are used to treat certain respiratory and gastrointestinal disorders, and to increase platelets in patients suffering from dengue fever [7]. GLs are also widely used for their antispasmodic, cough sedative, anti-inflammatory, antidiarrheic, antihypertension, antiobesity, and antidiabetic properties [8]. Studies on animal models have also established the role of GL isolates as potent antitumor, anticancer, and cytotoxic agents [9,10].



***Psidium guajava* (fig.1)**

## Traditional medicinal value of *Psidium guajava*

*Psidium guajava* L. is consumed not only as food but also as folk medicine in subtropical areas all over the world due to its pharmacologic activities [11]. Medicinal plants find a very important place in medical systems almost in the entire world. These observations are reflected from traditional knowledge. It is well known that guava is frequently employed in numerous parts of the world for the cure of a lot of sickness like diarrhoea reducing fever, dysentery, gastroenteritis, hypertension, diabetes, caries, pain relief and wounds. The countries which have a long history of using medicinal plants are also using guava at big level like Mexico, Africa, Asia and Central America. With its medicinal uses it is also used as food and in the preparation of food products. It is also used in house construction and toys making. Guava contains high content of organic and inorganic compounds like secondary metabolites e.g. antioxidant, polyphenols, antiviral compounds and anti-inflammatory compounds. Guava has a lot of compounds which have anti cancerous activities. It has a higher number of vitamins and minerals. Phenolic compounds like flavonoids also find an important place in the guava. Lycopene and flavonoids are important antioxidants. They help in the cure of cancerous cells and help to prevent skin aging before time [12]. Guava can affect the myocardium inotropism [13]. Guava skin extract can control level of diabetes after 21 days treatment [14].

## Pharmacological actions of *Psidium guajava*

### Anti-microbial activity

Guava has a high antimicrobial activity. Guava leaf's extract doses can reduce the amount of cough due to its anti-cough activity. Aqueous, chloroform and methanol extract of leaves can reduce the growth of different bacteria. Due to its anti-cough activity it is recommended in the condition of cough [15].

Guava leaves have high antibacterial activity in extracts that can inhibit the growth of *S. aureus*. Plant leaf and bark methanolic extracts of *P. guajava* have high antimicrobial activity. These extracts can inhibit the *Bacillus* and *Salmonella* bacteria [16]. Methanolic extract of guava contains a remarkable antimicrobial activity. Species of *Bacillus* and *Salmonella* bacteria can be controlled by these extracts. It also has anti-plaque activity due to the presence of active flavonoids compounds [17].

The flavonoid compounds and their derivatives can be isolated from the guava. These compounds can inhibit the growth of different bacteria in different dilutions. Terpinene and pinene are present into the aqueous extract of plant's leaves which shows antimicrobial activity. Due to bacteriostatic effects on pathogenic bacteria it is also used as medicine in cough, diarrhoea, oral ulcers and in some swollen gums wound [1, 18].

Aqueous and ethanol extracts show low antimicrobial activity or minimum inhibitory concentration (MIC) whenever methanol extract shows high MIC. Due to its high activity methanolic extract is most effective. This extract also displays anti haemolytic potential as it shows activity against haemolysis [19]. The antibacterial activity of guava is high against gram positive bacteria and moderate against the gram-negative bacterial strains [20]. In 2012 it was reported that guava leaves have many compounds which act as fungistatic and bacteriostatic agents. They can stop the growth of a lot of bacteria and act as anti-viral agents. They can control the viral infections like influenza virus. They can hold and occupy the viral resistance. The actual reason of guava anti-viral activity is protein degradation ability of the guava extract [21]. Essential oil of guava also has activity against the *Salmonella* and *S. aureus* [22]. Guava also possesses anticancer and antioxidant activities. There are a lot of compounds like Gallic acid, galangin, kaempferol, homogentisic acid and cyanidin 3-glucoside which are found in peels, seeds and pulp of guava. But it is surprising that the amount of these compounds is high in seeds and skin as compared to the pulp. Due to the presence of these compounds guava's food importance becomes high [23]. It is very clear that aqueous and methanol extract of the guava leaves inhibit the growth of bacteria and can produce a remarkable zone of inhibition. The extracts in methanol and water show maximum MIC whenever ethanol extract shows minimum anti-fungal activity. Conclusively leaves, seeds, skin and pulp of guava have a remarkable anti-microbial activity [24].

The antimicrobial activities of alcohol fruit extracts from guava (*Psidium guajava*) were compared to those of pineapple (*Ananas comosus*) and apple (*Malus pumila*). Eight bacterial strains including *Pseudomonas aeruginosa*, *Klebsiella*, *Enterococcus faecalis*, *Shigella flexneri*, *Enterobacter cloacae*, *Enterotoxigenic E.coli (ETEC)*, *Enterococcal Aggregative E.coli (EAEC)* and *Staphylococcus aureus* were used for antimicrobial evaluations. The fresh fruits of the above mentioned plants were purchased from the market; then they were cut into small cubes and finally dried over 4–5 days in sun to a crisp. The pieces were blended to the fine powder; finally methanol extracts were obtained by passing 75 g of each powder through a Soxhlet apparatus having 250 ml of 99% methanol. The same process was performed with 250 ml of ethanol to produce a methanolic crude extract. The sample extracts were evaluated using agar well diffusion method. Norfloxacin and water were used as positive and as negative controls, respectively. The extracts caused the inhibition of microbes; the zones of inhibition were measured and an activity index was calculated from the mean zone sizes. It was concluded that all the fruits possess some antimicrobial potential; the highest activity index (2.6) was observed from pineapple extracts against EAEC. The pineapple fruit displayed strong potential against all the bacteria. The guava extracts possessed the antimicrobial potential against all the microbes with the exception of ETEC. The methanolic and ethanolic extracts of apple were found active only against EAEC and *Staph. Aureus*. The methanolic extracts of



guava and apple were found active as compared to the ethanolic extracts while the ethanolic extracts of pineapple showed slightly larger inhibition zones. The results of this investigation show great promise for potential antimicrobial drugs [25].

The antimicrobial potential of guava can be compared to that of similar commonly used fruit like pomegranate which have been found to possess high antimicrobial properties [26]. The antimicrobial activity of various extracts prepared from pomegranate fruit peels were evaluated using both in-vitro agar diffusion and in-situ methods against some food-borne pathogens. It was found that 80% methanolic extract of peels was a potent inhibitor for *Yersinia enterocolitica*, *Listeria monocytogenes*, *Staphylococcus aureus* and *Escherichia coli*. And the presence of active inhibitors in peels including phenolics and flavonoids were revealed by phytochemical analysis as potent constituents. The study suggested that the various extract of pomegranate can successfully control various kinds of human pathogenic bacteria [27].

### Anti-diarrheal action

Diarrhoea is one of most common and well recognized health problem and a global issue. It is very common even in developed countries. It is estimated that about 2.2 million people die annually by diarrhoea; most of them, are children or infants [29].

Guava leaves have quercetin-3-arabinoside and quercetin which can be isolated from leaves. Its leaves contain a compound which has morphine like action. It controls the muscular tone. Quercetin repressed intestinal contraction encouraged by enhanced absorption of calcium. Quercetin has a strong effect on ileum. It is thought that quercetin in guava leaf are responsible for its spasmolytic activity. Guava has high cytotoxicity [30]. Guava can be used to treat the diarrhoea caused by the *E. coli* or *S. aureus* toxins [31]. Ethanolic and aqueous extracts of *Psidium guajava* at a concentration of 80 g/ml in an organ bath, display more than 70% embarrassment of acetylcholine and/or KCl solution-induced reduction of isolated guinea-pig ileum. The rates of impulsion in the small intestine into male Sprague Dawley rats as it means of evaluate anti-diarrhoeal activity of the aqueous extracts of leaf of *Psidium guajava* using morphine like the standard drug for reference was measured [32]. Locomotor coordination can be improved by the ethyl acetate extract of guava fruit [33].

Ojewole 2008 examined anti-diarrheal activity of guava leaves extract in water provoked diarrhoea in the rodents. This extract produces important protection to rats and the mice in opposition to castor oiled induced diarrhoea. It inhibits the intestinal transit in rats. The activity of this extract is dose dependent. Atropine dose have significant anti motility effect due to which castor oil-induced diarrhoea is inhibited. Loperamide dose significantly delays the onset of the castor oil-induced diarrhoea. By comparison of animals it was noticed that intestinal fluid secretion is reduced significantly. Guava extract have anti diarrhoeal activity and it can be used for the treatment and prevention of diarrhoea [34]. Guava have significant antidiabetic and anti-diarrhoeal activities in ethanolic extracts [35, 36].

### Anti-inflammatory activity

Extract of guava in ethyl acetate can stop the germ infection and thymus production. It can act as anti-viral agent. It can enhance the mRNA expression. Guava can alter the heme oxygenase-1 protein's work. And due to this reason, it can be used as anti-inflammatory agent for skin. Extract of guava in ethanol inhibit the lipopolysaccharide from manufacturing of nitric oxide. It suppresses the expression of E2. In this way it works as anti-inflammatory agent [53].

Extract in ethyl acetate has the ability to minimize the antigen. It can stop the release of the  $\beta$ -hexosaminidase with histamine into RBL-2H3 cells. Due to this reason the appearance of TNF- $\alpha$  and IL-4 mRNA stops. In this way the antigen inhibits and I $\kappa$ B- $\alpha$  become spoil. Benzophenone and flavonoids are important compounds found in guava. These compounds are responsible for the histamine inhibition and nitric acid production [54].

Guava extract also show anti-nociceptive activity. It happened by acetic acid production. Phenol is an important compound which is present in guava and dependable for the anti-allergic and anti-inflammatory activity [55]. The dose of guava extracts are effective in liver damage inflammation and serum production [56]

### Anti-oxidant activity

Antioxidants are molecules which retard the oxidation process. The oxidation reactions may produce free radicals which damage the cells by starting various chain reactions. Free radicals which damage the cells cause cancer and many other diseases. Antioxidants terminate the free radicals and stop the chain reactions. Examples of antioxidants include beta-carotene, lycopene, vitamins C, E, and A and other substances. Oxidative reaction is one of most important destructive reaction. Free radical's damage is responsible for a lot of disorders in human like nervous disorders, inflammation, debates and viral infections. When drugs are metabolized in body the free radicals are produced. Sometimes the environmental changes and hormones become the reason of free radical production. These free radicals are responsible for all the oxidation reactions [57].

Guava contains high amount of antioxidants and anti-providing nutrients which are essential not only for life but also help to control the free radical activities. It also have a variety of phytochemicals which are beneficial for human health like diabetes,

obesity and high blood pressure. There are two common methods by which antioxidants neutralize free radicals that is DPPH and FRAP assay. Extracts of guava in water and organic solvents have a large quantity of antioxidants which can stop the oxidation reaction. The concentration of these compounds become high with the increase in concentration [58]. Pink guava also has a high antioxidant activity [59].

### **Anticancer activity**

*P. guajava* plant contains bioactive phytochemicals in various parts, and these compounds have demonstrated anticancer properties. Multiple studies have highlighted the ability of *P. guajava* and its bioactive molecules, particularly those derived from its leaves, to selectively inhibit the growth of cancerous cells without harming normal cells. Researchers researched the potential anti-cancer properties of guava seed polysaccharides against Michigan Cancer Foundation-7 cells (MCF-7). Their findings indicated a significant dose-dependent inhibition of MCF-7 cell viability<sup>(43)</sup>. Other researchers explored the anticancer potential of red *P. guajava* extract and reported the anticancer activity of a lycopene extract of *P. guajava*, with an IC<sub>50</sub> value of 29850 at 5964 ng/mL. A recent study recognized compounds with anticancer activity versus a human colorectal carcinoma cell line initiated from an adult male (HCT116) and a human colorectal adenocarcinoma cell line with epithelial morphology cells (HT29). another study demonstrated the maximum inhibitory activity of *P. guajava* versus cancerous cells, with an IC<sub>50</sub> value of less than 0.03 µg/mL<sup>(44)</sup>.

The anticancer effects of *P. guajava* are thought to be attributed to the presence of chemical components such as vitamin E,  $\beta$ -sitosterol, and tetracosane. Guava extracts have demonstrated their effectiveness in combating various types of cancer, including (lung cancer, colorectal carcinoma, breast cancer, cervical cancer, and prostate cancer). The bioactive phytochemicals found in different parts of the guava plant have exhibited medicinal properties encompassing antimicrobial, antioxidant, anti-inflammatory, and antidiabetic activities, these results suggest that guava extracts and their bioactive constituents have the potential to serve as viable alternatives or supplementary treatments for human cancers<sup>(43,44)</sup>.

### **Antidiabetic activity**

Diabetes is a major chronic disease and about 10% of the world's population suffer from blood glucose metabolic disorder, mainly characterized by a hyperglycemic condition. This situation is either characterized by insufficient secretion of insulin from  $\beta$ -cells of pancreatic islets (type 1 diabetes) or the inability of cells to react in response to the secreted insulin (type 2 diabetes) [45,49]. The International Diabetes Federation (IDF) stated that 451 million people were affected by diabetes mellitus, resulting in 5 million deaths, in 2017 and the global prevalence of diabetes is projected to hit 693 million cases by 2045[50]. The prolonged condition of hyperglycemia leads to increased production of ROS and dyslipidemia, causing severe cellular damage and complications [51].

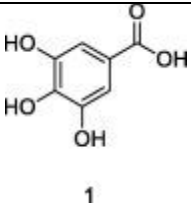
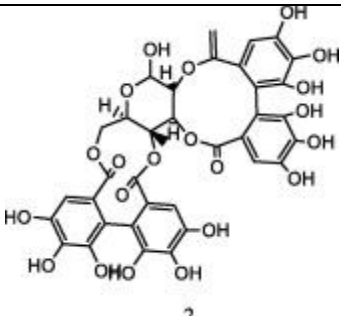
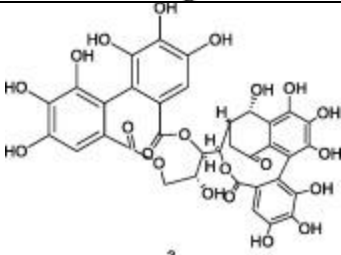
GLs have been widely used as ethnomedicine for diabetes management [47]. Flavonoids and polysaccharides of GLs have been reported for their antidiabetic potential in several studies. Guaijaverin and avicularin flavonoids of GL extract were associated with significant improvement in the function of  $\beta$ -cells of pancreatic islets and hepatocyte morphology in diabetic mice [52]. Guaijaverin suppressed the activity of the blood glucose homeostasis enzyme dipeptidyl-peptidase IV [53], while avicularin inhibited intracellular lipid aggregation by impeding glucose uptake through GLUT-4 in vitro and revealed no distinct toxicity for 3T3-L1 adipose cells [54]. Luo et al. [46] extracted GL polysaccharides (GLPs) and further tested the antidiabetic effects on streptozotocin-induced diabetic mice in combination with a high-fat diet. The authors revealed that GLP was associated with a significant reduction in total cholesterol, triglycerides, glycated serum protein, creatinine, fasting blood glucose, and malonaldehyde content, and increased total superoxide dismutase and total antioxidant capacity enzyme activity in vivo. Suboptimal glycemic regulation may lead to elevated postprandial glucose concentrations. Nair et al. [55] suggested that the inhibitors of  $\alpha$ -amylase and  $\alpha$ -glucosidase enzyme can decline postprandial glucose absorption, and are therefore possible targets for diabetes management. The polysaccharides were isolated from GLs by ultrasound-assisted extraction and the antiglycation activity of extracted polysaccharides was studied [48]. The authors found that GLP showed strong inhibition of  $\alpha$ -glucosidase, with a 99.54% inhibition rate at a 100 µg/mL concentration, and less inhibition of  $\alpha$ -amylase, with a 14.06% inhibition rate at a 1mg/mL dose concentration. The findings suggests that bioactive compounds from GLs can be effective in reducing the risk of diabetes.

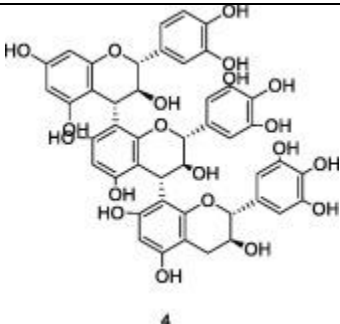
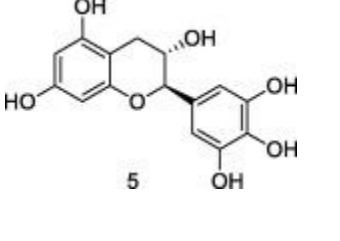
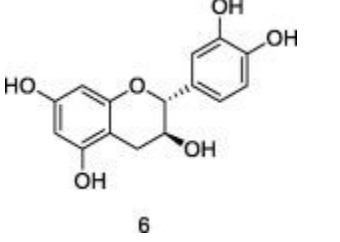
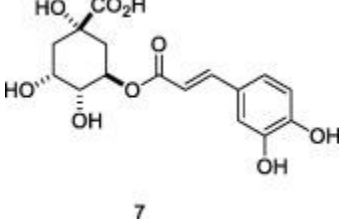
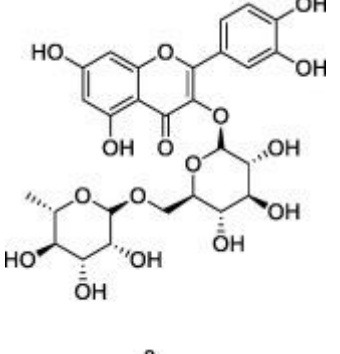
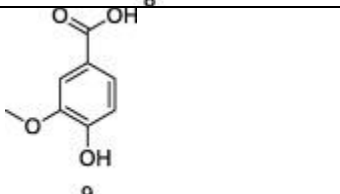
### **Phytochemistry**

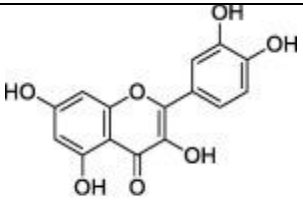
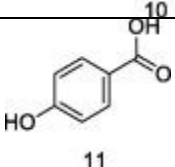
The study of Díaz-de-cerio et al. (2016) reported the presence of 72 phenolic constituents in guava leaves using high-performance liquid chromatography coupled to electrospray ionization and quadrupole time-of-flight mass spectrometry (HPLC-ESI-QTOF-MS). De Araújo et al., (2014) quantified the polyphenolic content (gallic acid and catechin) of *P. guajava* leaves using high-performance liquid chromatography (HPLC). Results of the study showed the presence of condensed tannins (catechins) and hydrolysable tannins (gallic acid) in *P. guajava* leaves (Table 1). Phytochemical studies of *P. guajava* leaves by Bhagavathy et al. (2018) using gas chromatography and mass spectrometry (GC-MS) confirmed the presence of carotenoids, flavonoids, alkaloids,

polyphenols, saponins, tannins, glycosides and sterols. Babatola and Oboh (2021) characterized and quantified the phenolic constituent of guava leaves using HPLC-DAD, the major compounds identified include: chlorogenic acid, rutin, vanillic acid, quercetin, and p-hydroxyl benzoic acid, syringic acid, kaempferol, myricetin, isoquercetin, and apigenin. Bezerra et al., 2018, Bezerra et al., 2020) analyzed the chemical constituents of two fractions, viz. flavonoid and tannic fractions extracted from *P. guajava* leaves using UPLC-ESI-QTOF-MS. In the flavonoids fraction, reynoutrina (quercetin-3-O- $\beta$ -D-xylopyranoside), guajaverina (quercetin-3-O- $\alpha$ -L-arabinopyranoside) and Morin, a condensed tannin (Catechin), and two hydrolysable tannins (ellagic acid and guavinoside B), an acetophenone (myrciaphenone B) were identified, whereas in the tannic fraction two flavonoids (quercetin and 2,6-dihydroxy-3-methyl-4-O-(6"-O-galloyl- $\beta$ -D-glucopyranosyl)-benzophenone), a condensed tannin (catechin), a hydrolysable tannin (guayinoside C), and an elagotonine (vescalagin/Castalagin isomer, (1S\*,5S\*)-2,2-bis(biphenyl-4-yl)-5-indian-1-yltetrahydrofuran (IV-81)). Hseih et al. (2007) reported the presence of the following phenolic compounds; gallic acid, ferulic acid, and quercetin, in *P. guajava* leaves. Eidenberger et al. (2013) demonstrated that ethanolic extract of guava leaves contain seven main flavonol-glycosides through semipreparative HPLC analysis. They include; peltatoside quercetin-3-O-arabinoglucoside, hyperoside, quercetin-3- $\beta$ -O-arabinoglucoside, isoquercetrin, quercetin-3-O- $\beta$ -glucoside, guajaverin, and quercetin-3-O- $\alpha$ -L-arabinopyranoside (Table 1). Flores et al. (2015) identified the following chemical compounds; delphinidin-3-O-glucoside and cyanidin-3-O-glucoside, myricetin-3-O-arabinoside, myricetin-3-O-xyloside, isorhamnetin-3-O-galactopyranoside, myricetin-3-O-glucoside, gallocatechin-(4 $\alpha$ -8)-gallocatechol, gallocatechin-(4 $\alpha$ -8)-catechin, abscisic acid, turpinionoside A, pinfaensin, pedunculoside, guavenoic acid, madecassiac acid and asiastic acid from guava cultivars (Table 1).

### Bioactive phytochemicals present in various parts of *Psidium guajava* plant.

Name of compound	Chemical structure	Method of identification	Pharmacological activity	References
Gallic acid	 1	High-Performance Liquid Chromatography with diode-array detection coupled to electrospray ionization quadrupole time-of-flight mass spectrometry (HPLC-DAD-ESI-QTOF-MS) analysis of phenolic fraction of <i>P. guajava</i> leaves using an ultrasound bath and a mixture of ethanol:water 80/20 (v/v) (Díaz-de-cerio et al., 2016)	Anti-inflammatory, Antifungal activities	Alves et al., 2014, de Araújo et al., 2014
Pedunculagin	 2	HPLC-DAD-ESI-QTOF-MS analysis of phenolic fraction of <i>P. guajava</i> leaves using an ultrasound bath and a mixture of ethanol:water 80/20 (v/v) (Díaz-de-cerio et al., 2016)	Anti-diabetic activity	Eidenberger et al. (2013)
Casuariin	 3	HPLC-DAD-ESI-QTOF-MS analysis of phenolic fraction of <i>P. guajava</i> leaves using an ultrasound bath and a mixture of ethanol:water 80/20 (v/v) (Díaz-de-cerio et al., 2016)	Anticoagulant, Anti-hypertensive activities	Dong et al., 1998, Xie et al., 2007

Prodelphinidin dimer isomer		HPLC-DAD-ESI-QTOF-MS analysis of phenolic fraction of <i>P. guajava</i> leaves using an ultrasound bath and a mixture of ethanol:water 80/20 (v/v) (Díaz-de-cerio et al., 2016)	Antioxidant activity	Ma et al. (2019)
Gallocatechin		HPLC-DAD-ESI-QTOF-MS analysis of phenolic fraction of <i>P. guajava</i> leaves using an ultrasound bath and a mixture of ethanol:water 80/20 (v/v) (Díaz-de-cerio et al., 2016)	Anti-aggregation activity	Sohail et al. (2018)
Catechin		HPLC-DAD-ESI-QTOF-MS analysis of phenolic fraction of <i>P. guajava</i> leaves using an ultrasound bath and a mixture of ethanol:water 80/20 (v/v) (Díaz-de-cerio et al., 2016)	Anti-inflammatory, Antifungal activities	de Araújo et al., 2014, Bezerra et al., 2018
Chlorogenic acid		HPLC-DAD analysis using phenolic fraction of guava leaves (Babatola and Oboh, 2021)	Potential anti-inflammatory activity	Bhandarkar et al. (2019)
Rutin		HPLC-DAD analysis using phenolic fraction of guava leaves (Babatola and Oboh, 2021)	Antitumor, Antimicrobial, Antidiabetic activities	Budzynska et al. (2019); Ghorbani (2017)
Vanillic acid		HPLC-DAD analysis using phenolic fraction of guava leaves (Babatola and Oboh, 2021)	Antioxidative activity	Yao et al. (2020)

Quercetin		HPLC-DAD analysis using phenolic fraction of guava leaves (Babatola and Oboh, 2021)	Anti-hypertensive, Antimicrobial, Antioxidant, Antidiarrhea activities	Alves et al., 2014, Hirudkar et al., 2020, Marunaka et al., 2017
p-hydroxyl benzoic acid		HPLC-DAD analysis using phenolic fraction of guava leaves (Babatola and Oboh, 2021)	Anti-inflammatory activity	Banti et al. (2021)

## Conclusion

This review attempts to shed light on the therapeutic potential of guava as an adjunct in treating periodontal disease. As an excellent antiplaque, antimicrobial, anti-inflammatory, antioxidant agent guava hopefully will be considered in the future for more clinical evaluations and possible applications as an adjunct to conventional periodontal therapy. Nevertheless, we should emphasize the importance of experimental and clinical studies with emphasis on bioavailability of compounds, effective and safe doses to be used. Our efforts in exploring and valuing newer phytotherapeutics in the treatment of periodontal disease should be maintained.

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