Psidium Guajava (Guava): A Plant of Multipurpose Medicinal Applications

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Abstract

Chronic degenerative diseases have reached epidemic proportions in industrialized and developing countries. Many studies have shown that plants can be helpful to prevent or treat diseases. Psidium guajava is a small medicinal tree that is native to South America and Brazil is among the world’s top producers and most of the country’s production is destined for the food industry. It is popularly known as guava and has been used traditionally as a medicinal plant throughout the world for a number of ailments. This review is to present some chemical compounds in P. guajava and their pharmacological effects. The main constituents of guava leaves are phenolic compounds, isoflavonoids, gallic acid, catechin, epicatechin, rutin, naringenin, kaempferol. The pulp is rich in ascorbic acid, carotenoids (lycopene, β-carotene and β-cryptoxanthin). The seeds, skin and barks possess glycosids, carotenoids and phenolic compounds. All parts of the plant have been used for different purposes: hepatoprotection, antioxidant, anti-inflammatory, anti-spasmodic, anti-cancer, antimicrobial, anti-hyperglycemic, analgesic, endothelial progenitor cells, anti-stomachache and anti-diarrhea. P. guajava has many effects on health and that it should be researched more extensively in clinical trials. Furthermore leaves, seeds and peel are treated as wastes by the food processing industry and are discarded, so their use may reduce the disposal of these parts of guava as pollutants.

Keywords: Psidium guajava; Anti-inflammatory; Antioxidant; Cancer; Diabetes; Dyslipidemia

Introduction

Industrialization has led to many modifications in the lifestyle of the world’s populations, giving rise to increase the indices of several diseases, including chronic degenerative diseases such as insulin resistance, diabetes mellitus, dyslipidemia, metabolic syndrome and cardiovascular diseases, reducing the quality of life and increasing costs on hospitalizations, medications and other public health interventions [1,2].

Studies have demonstrated that the consumption of fruits, vegetables and seeds can be helpful to prevent the risk factors of many diseases due to the bioactive compounds. Many plants have been used for the purpose of reducing risk factors associated with the occurrence of chronic disorders and for many other purposes [3-8].

Psidium guajava L. is a small medicinal tree that is native to South America. It is popularly known as guava (family Myrtaceae) and has been used traditionally as a medicinal plant throughout the world for a number of ailments. There are two most common varieties of guava: the red (P. guajava var. pomifera) and the white (P. guajava var. pyrifera) [9,10].

All parts of this tree, including fruits, leaves, bark, and roots, have been used for treating stomachache and diarrhea in many countries. Leaves, pulp and seeds are used to treat respiratory and gastrointestinal disorders, and as an antispasmodic, anti-inflammatory, as a cough sedative, anti-diarrheic, in the management of hypertension, obesity and in the control of diabetes mellitus. It also possesses antineoplastic properties [11]. The seeds are used as antimicrobial, gastrointestinal, anti-allergic and anticarcinogenic activity [12-15].

Brazil is among the world’s top producers of guava and most of the country’s production is destined for the food industry to produce candies, juices, jams and frozen pulp. As result of the fruit process there is a discard of the leaves, seeds, part of the peel and pulp fraction not separated in the physical depulping process [9,10,16,17].

The high cost of pharmaceutical medications conduces to the search for alternative medicines to treat many ailments. In view of this, studies are necessary to confirm the effects of medicinal plants. The aim of this review is to show that several studies have demonstrated the presence of different chemical compounds in P. guajava and their pharmacological effects.

Medical Properties and Composition of Guava Pulp

The main constituents of guava are vitamins, tanins, phenolic compounds, flavonoids, essential oils, sesquiterpene alcohols and triterpenoid acids. These and other compounds are related to many health effects of guava [10].

Some authors have found high concentrations of carotenoids (beta-carotene, lycopene, and beta-cryptoxanthin), vitamin C and polyphenols in guava pulp [18-20]. Lycopene has been correlated with the prevention of cardiovascular damage because of its positive effects on dyslipidemia [21,22]. Ascorbic acid is recognized for its important antioxidant effects [23-25].

Shu et al. [26] isolated nine triterpenoids from guava fruit: ursolic acid; 1beta, 3beta-dihydroxyurs-12-en-28-oic acid; 3beta,19alpha-dihydroxyurs-12-en-28-oic acid; 1beta, 3beta-dihydroxyurs-12-en-28-oic acid; 2alpha,3beta-dihydroxyurs-12-en-28-oic acid; 2beta,3alpha-dihydroxyurs-12-en-28-oic acid; 1beta,3alpha-dihydroxyurs-12-en-28-oic acid; 3beta,19alpha-dihydroxyurs-12-en-28-oic acid; 19a-hydroxyurs-12-en-28-oic acid-3-O-alpha-L-arabinopyranoside [27-30].
side; 3beta, 23-dihydroxy urs-12-en-28-oic acid; 3beta, 19alpha, 23beta-
tri-hydroxylurs-12-en-28-oic acid; 2alpha, 3beta, 19alpha, 23beta-
tetraydroxylurs-12-en-28-oic acid and 3alpha, 19alpha, 23,24-tetrahy-
droxyurs -12-en-28-oic acid. Ursolic acid and other triterpenoids are
associated with anti-cancer properties [27].

Shu et al. [28] found three benzophenone glycosides in ripe edible
fruits of P. guajava L: 2, 6-dihydroxy-3, 5-dimethyl-4-O-beta-D-
glucopyranosyl-benzophenone; 2, 6-dihydroxy-3-methyl-4-O-(6''-O-
galloyl-beta-D-glucopyranosyl)-benzophenone and 2, 6-dihydroxy-3,
5-dimethyl-4-O-(6''-O-galloyl-beta-D-glucopyranosyl)-
benzophenone. Benzenophene glycosides have inhibitory effect on
triglycerides accumulation [29].

Thuatong and Anprung [30] found antioxidative activity in guava
and the major constituents identified in white and red guavas were
ascorbic acid, gallic acid, catechin equivalents, cinnamyl alcohol, ethyl
benzoate, β-caryophyllene, (E)-3-hexenyl acetate and α-bisabolene.
The antioxidative properties of the guava pulp can be related to anti-
cancer effects [15].

Studies with humans have found that the consumption of guava for
a period of 12 weeks reduced blood pressure by 8%, total cholesterol
levels by 9%, triacylglycerides by almost 8%, and induced an 8%
increase in the levels of HDL-c [31,32].

Farinazzi et al. [33] showed that animals treated with guava pulp
juice had significantly lower body weight, glycemia, cholesterol and
triglycerides levels and significantly augmented the levels of HDL-c
when compared to the animals from the control group.

Lyophilized pulp of P. guajava in diabetic rats induces to significant
hypoglycemic effects probably due to its antioxidative activity of
compounds present in the pulp [14].

Medical Properties and Composition of Guava Leaves

Guava leaf extract has analgesic, anti-inflammatory, antimicrobial,
hepatoprotective and antioxidative activities. These effects are probably
due to the presence of phenolic compounds [11,34-39].

Jiménez-Escrig et al. [40], Wang et al. [41] and Haida et al. [10]
reported the presence of higher amounts of phenolic compounds with
antioxidant activity in the leaves of white (Psidium guajava var. pyrifera
L.) and red guava (Psidium guajava var. pomifera L.) when compared
with other vegetable species. Wu et al [42], Melo et al. [43] and Chen et
al. [27] found gallic acid, catechins, epicatechins, rutin, naringenin and
kaempferol in the leaves.

Studies have shown that gallic acid, catechin, and epicatechin inhibit
pancreatic cholesterol esterase, which decreases cholesterol levels.
Catechins are important as a preventive treatment for diabetes type 2
and obesity. Quercetin has been associated with decreased mortality from
cancer effects [15].

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Rahim et al. [61] evaluated the effects of aqueous mixture and water
soluble methanol extract from guava leaves and bark against multi-
drug-resistant Vibrio cholera and found strong antibacterial activity.
They concluded that this plant offers potential for controlling epidemics
of cholera.

Birdi et al. [62] and Birdi et al. [63] related that P. guajava leaves
have a broad spectrum of antimicrobial action (as anti diarrheal and
antirotaviral activity) that could be effective in controlling diarrhea due
to a wide range of pathogens. The antimicrobial activity can be linked
to the presence of flavonoids extracted from guava leaves [64,65].

Deguchi and Miyazaki [66] reported that guava leaves infusion not
only reduced postprandial glycemia and improved hyperinsulinemia in
murine models but also contributed to reduce hypercholesterolemia,
hyperfibrinogemia and hyperapoproteinemia in the animals of their
study.

Rutin and kaempferol found in guava leaves are compounds related
to the decrease of HMG-CoA reductase activity in hepatic tissue and
improve lipid profiles [67]. Akinmoladun et al. [68] studied methanol
extracts of some fruits, including P. guajava, and demonstrated that
there is a good correlation between total phenolic contents and reductive
potential and a fair correlation between total phenolic contents and
lipid peroxidation inhibitory activity.

Several studies have found that aqueous extract of Psidium guajava
contains components with LDL-c antilipolysis action, suggesting its
contribution to the prevention of neurodegenerative and cardiovascular

Ojewole [72] identified the presence of phenolic compounds in the leaves demonstrating their hypoglycemic and hypotensive effects on diabetic rats treated with aqueous leaf extract. Soman et al. [73] reported a decline in the levels of glycated hemoglobin and fructosamines, as well as a significant reduction in the glycemic levels of diabetic rats treated with guava leaf extract. Singh and Marar [74] studied the effects of *Psidium guajava* leaves on the inhibition of the activity intestinal glycosidases related with postprandial hyperglycemia, suggesting its use for the treatment of individuals with type 2 diabetes. Other studies have demonstrated that guava leaf and peel extracts also had hypoglycemic effects on experimental models drug-induced to severe conditions of diabetes [17,75,76].

Wu et al. [42] found that the phenolic compounds, gallic acid, catechins and quercetins in guava leaves inhibited the glycation of proteins suggesting its use for the prevention of diabetes complications. The Psigualdias A, B and guajadial isolated by Shao et al. [55] exhibited potent inhibitory effects on the growth of human hepatoma cells. Kim et al. [52] related that the guava leaves contain compounds that promote free radical scavenging activity showing promising antioxidant properties.

Dutta and Das [77] identified significant anti-inflammatory activity of the ethanol extract of guava leaves in experimental models, while Kawakami et al. [78] observed the antiproliferative activity of the leaves through inhibition of the catalytic activity of prostaglandin endoperoxide H synthases involved in the inflammatory process. Guava budding leaves aqueous extract possesses an extremely high content of polyphenolic and isoflavonoids and suppresses the cell migration and the angiogenesis. In view of this, clinically it has the potential to be used as an adjuvant anti-cancer chemopreventive [79,80]. Matsuzak et al. [51] isolated phenolic glycosides from guava leaves and showed significant inhibitory activity against histamine release from rat peritoneal mast cells, and nitric oxide production from a murine macrophage-like cell line.

Roy and Das [81] studied the hepatoprotective activity of different extracts of *P. guajava* (petroleum ether, chloroform, ethyl acetate, methanol and aqueous) in acute experimental liver injury induced by carbon tetrachloride and paracetamol. The effects were compared with a known hepatoprotective agent and observed that the best effects came from guava methanolic leaf extract that significantly reduced the elevated serum levels of enzymes (aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase) and bilirubin.

*P. guajava* leaves exhibit high capacity to reduced polymerization and aggregation of sickle cell hemoglobin molecule. This molecule is a product of a defective genetic code of hemoglobin molecule and is prone to deoxygenation-induced polymerization and has low insolubility. The development of chemical modification agents that reduce the tendency of sickle cell hemoglobin molecule to aggregate represents an important chemotherapeutic goal [82].

Guava extract leaves can be responsible for membrane stabilizing effect on sickle erythrocytes that are susceptible to endogenous free radical-mediated oxidative damage. This effect can be attributed to the flavonoids, triterpenoids and host of other secondary plant metabolites [83].

Chen et al. [80] found that aqueous extract of guava budding leaves possess anti-prostate cancer activity in a cell line model and concluded they are promising anti-androgen-sensitive prostate cancer agent.

Han et al. [84] studied the effects of *P. guajava* ethyl acetate extract on apoptotic dermatitis and found that it inhibits chemokine expression in keratinocytes what suggests this extract can have possible therapeutic application in atopic dermatitis and other inflammatory skin diseases.

Methanol extracts of the leaves can also be useful in the treatment of gastric ulcer disorders possibly due to the presence of volatile oil, flavonoids and saponins [85].

Methanolic extract of guava leaves can exhibit wound healing effects and this property can be explained by the presence of tannins and flavonoids [86,87].

Guava leaves extract also can show anti cough effects as shown by Jaiarj et al [88].

**Medical Properties and Composition of Guava Discarded Products**

As told before, the fruit process results in the discard of the leaves, seeds, part of the peel and pulp. Some studies showed the presence of total phenolic compounds in the agroindustrial wastes (seeds, skin and pulp) of guava, confirming its antioxidant activity [16,32,72].

Leaves, seeds and peels of fruits have significant proportions of bioactive compounds with beneficial physiological and metabolic properties. Its antioxidants can control body weight and biochemical variables like glycemia, dyslipidemia, hypertension and other risks of cardiovascular diseases. The antioxidant properties of the guava seeds extracts can be associated to anti-cancer effects on both hematological and solid neoplasms and the antioxidant properties of the guava peel can be related to anti-cancer effects. [5,15,89-91]

Castro-Vargas et al. [92] and Ojewole [72] extracted and identified significant levels of carotenoids and total phenolic compounds from guava seeds. Seeds exhibit antimicrobial, gastrointestinal and anti-diabetic properties [69,70]. Other studies have found cardioprotective effects of aqueous extract of *P. guajava* in myocardial ischemia-reperfusion injury in isolated rat hearts, primarily through their radical-scavenging actions [71].

<table>
<thead>
<tr>
<th>Compound</th>
<th>Effects</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Leaves</strong></td>
<td>Phenolic compounds, isoflavonoids, gallic acid, catechin, epicatechin, rutin, naringenin, kaempferol</td>
<td>Hepatoprotection, antioxidant, anti-inflammatory, anti-spasmodic, anti-cancer, antimicrobial, anti-hyperglycemic, analgesic</td>
</tr>
<tr>
<td><strong>Pulp</strong></td>
<td>Ascorbic acid, carotecoids (lycopene, ß-carotene, ß-cryptoxanthin</td>
<td>Antioxidant, anti-hyperglycemic, Anti-neoplastic</td>
</tr>
<tr>
<td><strong>Seed</strong></td>
<td>Glycosids, Carotenoids, phenolic compounds</td>
<td>Antimicrobial</td>
</tr>
<tr>
<td><strong>Skin</strong></td>
<td>Phenolic compounds</td>
<td>Endothelial progenitor cells and improvement of their intestinal absorption</td>
</tr>
<tr>
<td><strong>Bark</strong></td>
<td>Phenolic compounds</td>
<td>Strong antibacterial activity (against multi-drug-resistant Vibrio cholera); stomachache and diarrhea</td>
</tr>
</tbody>
</table>

*Table 1: Some compounds in guava leaves, pulp, seed, skin and bark and their pharmacological effects.*
anticarcinogenic activities probably due to the presence of phenolic
glycosides in the composition [12,93].

Farinazzi et al. [33] showed that Wistar rats treated with guava seed
had significantly lower glycermia, cholesterol and triglycerides levels
and body weight. These animals significantly increased HDL-c levels.

Rai et al. [94] reported hypolipidemic and hepatoprotective effects
in diabetic rats treated with aqueous extract of lyophilized guava peel.

Psidium guajava stem-bark extract can be used to treat malaria
because it presents antiplasmodial activities possibly due to the presence
of anthraquinones, flavonoids, secoiridoids and terpenoids. [95]

Table 1 presents some compounds in guava leaves, pulp, seed, skin
and bark and their pharmacological effects.

Conclusion

Many researchers have been demonstrating the presence of a wide
variety of bioactive compounds in the leaf, seed and bark of Psidium
guajava that are capable of showing beneficial effects on human health.
If we consider that chronic degenerative diseases have reached epidemic
proportions in many countries and increase the socio-economic burden
for the public health system, it is necessary to find non-allopathic
alternatives that minimize risk factors of these diseases and help in
the treatment. Furthermore, population consumes medicinal plants
also to treat other kind or diseases because of high costs of allopathic
medications.

The studies using P. guajava bring information that may provide
validation for its medicinal uses but it should be researched more
extensively in clinical trials so it could be used for prevention and as a
adjvant in the treatment of numerous disorders.

Nevertheless we should emphasize the importance of experimental
and clinical studies involving more specific factors related to the
bioavailability of the compounds, as well as the effective and safe doses
to be used by individuals for the prevention and treatment of various

Author Disclosure Statement

All the authors report no conflicts of interest.

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