Medicinal & Aromatic Plants
ISSN: 2167-0412

Barbalho et al., Med Aromat Plants 2012, 1:4
DOI: 10.4172/2167-0412.1000104

Review Article Open Access

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

Sandra M. Barbalho[1,2]*, Flávia M. V. Farinazzi-Machado[2], Ricardo de Alvares Goulart[3], Anna Cláudia Saad Brunnati[2], Alda Maria Machado Bueno Ottoboni[4] and Cláudia Cristina Teixeira Nicolau[4]

[1]*Department of Biochemistry and Pharmacology, School of Medicine, University of Marília (UNIMAR), Av. Higino Muzzi Filho 1001, Marília 15525-902, SP, Brazil.*
[2]*Department of Biochemistry and Nutrition, Faculty of Food Technology of Marília, Av. Castro Alves, 62, Marília 17506-000, SP, Brazil.*
[3]*School of Medicine - FAMEMA, Av. Monte Carmelo, 800 – Marília, SP CEP 17519-030, SP, Brazil.*
[4]*Department of Chemistry, Faculty of Food Technology of Marília (FATEC), Av. Castro Alves, 62, Marília 17506-000, SP, Brazil.*

Abstract

Chronic degenerative diseases have reached epidemic proportions in industrialized and developing countries. Many studies have shown that plant 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. The aim of 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, epicathechin, 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 anticancer 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 many 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; 2alpha,3beta-dihydroxyurs-12-en-28-oic acid; 3beta,19alpha-dihydroxyurs-12en-28-oic acid; 19a-hydroxylurs-12-en-28-oic acid-3-O-alpha-L-arabinopyrano-

***Corresponding author:** Dr Sandra Maria Barbalho, Av. Sampio Vidal, 300 Bairro Barbosa, Marília, São Paulo, Brazil, Tel: 0055 14 9655-3190 or 0055 14 34133487; E-mail: smbarbalho@terra.com.br

Received April 20, 2012; **Accepted** May 15, 2012; **Published** May 28, 2012

Citation: SM Barbalho, Farinazzi-Machado FMV, de Alvares Goulart R, Brunnati ACS, Otoboni AM, et al (2012) *Psidium Guajava (Guava)*: A Plant of Multipurpose Medicinal Applications. Med Aromat Plants 1:104. doi:10.4172/2167-0412.1000104

side; 3beta, 23-dihydroxy urs-12-en-28-oic acid; 3beta, 19alpha, 23beta-tri-hydroxylurs-12-en-28-oic acid; 2alpha, 3beta,19alpha, 23beta-tetrahydroxyurs-12-en-28-oic acid and 3alpha,19alpha,23,24-tetrahydroxyurs -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. Benzophenone glycosides have inhibitory effect on triglycerides accumulation [29].

Thuaytong and Anprung [30] found antioxidant activity in guava and the major constituents identified in white and red guavas were ascorbic acid, gallic acid, catechin equivalents, cinnamyl alcohol, ethyl benzoate, ß-caryophyllene, (E)-3-hexenyl acetate and α-bisabolene. The antioxidant 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 antioxidant 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 antioxidant 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 to decreased mortality from heart disease and decreased incidence of stroke. Quercetin presents hypocholesterolemic and antioxidant activity. Rutin is effective in the inhibition of triglyceride accumulation in adipocytes. Naringenin and kaempferol can promote moderate cytostatic activity against all cell lines and kaempferol can be useful as anti cancer [44-49].

Fu et al. [50] elucidated the structure of three novel sesquiterpenoid-based meroterpenoids of psidials A-C found in guava leaves. Matsuzak et al. [51] isolated two new benzophenone galloyl glycosides, guavinosides A and B, and a quercetin galloyl glycoside, guavinoside C as well as five known quercetin glycosides from guava leaves. The structures of the novel glycosides were elucidated to be 2,4,6-trihydroxybenzophenone 4-O-(6”-O-galloyl)-beta-D: -glucopyranoside (1, guavinoside A); 2,4,6-trihydroxy-3,5-dimethylbenzophenone 4-O-(6”-O-galloyl)-beta-D: -glucopyranoside (2, guavinoside B), and quercetin 3-O-(5”-O-galloyl)-alpha-L: -arabinofuranoside (3, guavinoside C).

Kim et al. [52] related that the guava leaves contain ascorbic acid, citric acid, acetic acid, epicatechin, xanthine, protocatechuic acid, glutamic acid, asparagine, malonic acid, trans-aconitic acid, maleic acid and cis-aconitic acid.

Ghosh et al. [53] isolated two terpenoids from the leaf extract of *P. guajava* (betulinic acid and lupeol) and reported their potential antimicrobial and phytotoxic activities. Betulinic acid and lupeol can be used in the treatment of diabetes, cardiovascular desease, obesity and atherosclerosis [54].

Shao et al. [55] isolated two terpenoids from guava leaves: Psiguadials A and B, two novel sesquiterpenoid-diphenylmethane meroterpenoids with unusual skeletons, along with a pair of known epimers, psidial A and guajadial.

Shu et al. [56] identified one diphenylmethane, one benzophenone, and eight flavonoids from guava fresh leaves(2,6-dihydroxy-3-formaldehyde-5-methyl-4-O-(6″-O-galloyl-β-D-glucopyranosyl)-diphenylmethane; 2,6-dihydroxy-3,5-dimethyl-4-O-(6″-O-galloyl-β-D-glucopyranosyl)-benzophenone; kaempferol; quercetin; quercitrin; isoquercitrin; guaijaverin; avicularin; hyperoside and reynoutrin. Guaijaverin has high potential antiplaque agent by inhibiting the growth of the *Streptococcus mutans*. Avicularin and guaijaverin work as urease inhibitors (against *Helicobacter pylori* urease) [57,58].

Shao et al. [59] isolated four new triterpenoids, psiguanins A-D (1-4), and with 13 known compounds from the leaves of guava.

Guava aqueous leaf extract showed anti-trypanosomal properties in rats experimentally infected with *Trypanosoma brucei brucei* [60].

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 antigiardial 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, hypertriglyceridemia and hypoadiponectinemia 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 shown that aqueous extract of *Psidium guajava* contains components with LDL-c antiglycation activity, suggesting its contribution to the prevention of neurodegenerative and cardiovascular

diseases [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].

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 Psiguadials 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 atopic 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

	Compound	Effects	Reference
Leaves	Phenolic compounds, isoflavonoids, gallic acid, catechin, epicathechin, rutin, naringenin, kaempferol	Hepatoprotection, antioxidant, anti-inflammatory, anti-spasmodic, anti-cancer, antimicrobial, anti-hyperglycemic, analgesic	Ryu et al.[11]; Metwally et al.[13]; Roy et al.[34]; Ojewole [35]; Nair and Chanda [36]; Hui-Yin and Gowdhin [37]; Peng et al. [79]; Chen et al. [80]
Pulp	Ascorbic acid, carotecoids (lycopene, β-carotene, β-cryptoxanthin	Antioxidant, anti-hyperglycemic, Anti-neoplasic	Huang et al [14]; Bomtempo et al. [15]; Oliveira et al. [18]; Thuaitong and Anprung [30]
Seed	Glycosids; Carotenoids, phenolic compounds	Antimicrobial	Pelegrini et al. [12]; Castro-Vargas et al. [92]
Skin	Phenolic compounds	Endothelial progenitor cells and improvement of their intestinal absorption	Nascimento et al.[16]; Felice et al. [90]
Bark	Phenolic compounds	Strong antibacterial activity (against multi-drug-resistant *Vibrio cholera*); stomachache and diarrhea	Ryu et al. [11]; Rahin et al. [61]

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 glycemia, 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, seccoirridoids 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 an adjuvant 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 disorders.

Author Disclosure Statement

All the authors report no conflicts of interest.

References

1. Sharma H, Chandola HM (2011) Prameha in Ayurveda: correlation with obesity, metabolic syndrome, and diabetes mellitus. Part 1-etiology, classification, and pathogenesis. J Altern Complement Med 17: 491-496.
2. Remington PL, Brownson RC, Centers for Disease Control and Prevention (CDC) (2011) Fifty years of progress in chronic disease epidemiology and control. MMWR Surveill Summ 60: 70-77.
3. Wu J, Wan Z, Yi J, Wu Y, Peng W, et al. (2012) Investigation of the extracts from Bidens pilosa Linn. var. radiata Sch. Bip. for antioxidant activities and cytotoxicity against human tumor cells. J Nat Med.
4. Barbalho SM, Damasceno DC, Spada AP, da Silva VS, Martuchi KA, et al. (2011) Metabolic Profile of Offspring from Diabetic Wistar Rats Treated with Mentha piperita (Peppermint). Evid Based Complement Alternat Med: 430237.
5. Bamosa AO, Kaatabi H, Lebdaa FM, Elq AM, Al-Sultanb A (2010) Effect of Nigella sativa seeds on the glycemic control of patients with type 2 diabetes mellitus. Indian J Physiol Pharmacol 54: 344-354.
6. Zaima K, Takeyama Y, Koga I, Saito A, Tamamoto H, et al. (2011) Vasorelaxant effect of isoquinoline derivatives from two species of Popowia perakensis and Phaeanthus crassipetalus on rat aortic artery. J Nat Med.
7. Esfahani HM, Esfahani ZN, Dehaghi NK, Hosseini-Sharifabad A, Tabrizian K, et al. (2011) Anti-inflammatory and anti-nociceptive effects of the ethanolic extracts of Alkanna frigida and Alkanna orientalis. J Nat Med.
8. Párraga I, López-Torres J, Andrés F, Navarro B, del Campo JM, et al(2011) Effect of plant sterols on the lipid profile of patients with hypercholesterolaemia. Randomised, experimental study. BMC Complement Altern Med 11: 73.
9. Kaneria M, Chanda S (2011) Phytochemical and Pharmacognostic Evaluation of Leaves of Psidium guajava L. (Myrtaceae). Pharmacog 23: 32-41.
10. Haida KS, Baron A, Haida KS (2011) Phenolic compounds and antioxidant activity of two varieties of guava and rue. Rev Bras Ciênc Saúde 28: 11-19.
11. Ryu NH, Park KR, Kim SM, Yun HM, Nam D, et al. (2012) A Hexane Fraction of Guava Leaves (Psidium guajava L.) Induces Anticancer Activity by Suppressing AKT/Mammalian Target of Rapamycin/Ribosomal p70 S6 Kinase in Human Prostate Cancer Cells. J Med Food 15: 231-241.
12. Pelegrini PB, Murad AM, Silva LP, Dos Santos RC, Costa FT, et al. (2008) Identification of a novel storage glycine-rich peptide from guava (Psidium guajava) seeds with activity against Gram-negative bacteria. Peptides 29: 1271-1279.
13. Metwally AM, Omar AA, Harraz FM, El Sohafy SM (2010) Phytochemical investigation and antimicrobial activity of Psidium guajava L leaves. Pharmacogn Mag 6: 212-218.
14. Huang CS, Yin MC, Chiu, LC (2011) Antihyperglycemic and antioxidative potential of Psidium guajava fruit in streptozotocin-induced diabetic rats. Food Chem Toxicol 49: 2189-2195.
15. Bontempo P, Doto A, Miceli M, Mita L, Benedetti R, et al. (2012) Psidium guajava L. anti-neoplastic effects: induction of apoptosis and cell differentiation. Cell Prolif 45: 22-31.
16. Nascimento RJ, Araújo CR, Melo EA (2010) Antioxidant from agri-industrial wastes of the guava fruits (Psidium guajava L) Alim Nutr 21: 209-16
17. Oh WK, Lee CH, Lee MS, Bae EY, Sohn CB, et al. (2005) Antidiabetic effects of extracts from Psidium guajava. J Ethnopharmacol 93: 411-415.
18. Oliveira Dda S, Lobato AL, Ribeiro SM, Santana AM, Chaves JB, et al. (2010) Carotenoids and Vitamin C during Handling and Distribution of Guava (Psidium guajava L.), Mango (Mangifera indica L.), and Papaya (Carica papaya L.) at Commercial Restaurants. J Agric Food Chem 58: 6166-6172.
19. Ordóñez-Santos LE, Vázquez-Riascos A (2010) Effect of processing and storage time on the vitamin C and lycopene contents of nectar of pink guava (Psidium guajava L). Arch Latinoam Nutr 60: 280-284.
20. Ramírez A, Delahaye EP (2011) Composición química y compuestos bioactivos presentes en pulpas de piña, guayaba y guanábana. Interciencia 36: 71-75.
21. Lorenz M, Fechner M, Kalkowski J, Fröhlich K, Trautmann A, et al. (2012) Effects of Lycopene on the Initial State of Atherosclerosis in New Zealand White (NZW) Rabbits. PLoS One 7: e30808.
22. Sesso HD, Wang L, Ridker PM, Buring JE (2012) Tomato-based food products are related to clinically modest improvements in selected coronary biomarkers in women. J Nutr 142: 326-333.
23. Thaipong K, Boonprakob U, Cisneros-Zevallos L, Birne DH (2005) Hydrophilic and lipophilic antioxidant activities of guava fruits. Southeast Asian J Trop Med Public Health 4: 254-257.
24. Monárrez-Espino J, López-Alarcón M, Greiner T (2011) Randomized placebo-controlled trial of guava juice as a source of ascorbic acid to reduce iron deficiency in Tarahumara indigenous schoolchildren of northern Mexico. J Am Coll Nutr 30: 191-200.
25. Thuaytong W, Anprung P (2011) Bioactive compounds and prebiotic activity in Thailand-grown red and white guava fruit (Psidium guajava L). Food Sci Technol Int 17: 205-212.
26. Shu J, Chou G, Wang Z (2009) Triterpenoid constituents in fruits of Psidum guajava. Zhongguo Zhong Yao Za Zhi 34: 3047-3050.
27. Shanmugam MK, Ong TH, Kumar AP, Lun CK, Ho PC, (2012) Ursolic acid inhibits the initiation, progression of prostate cancer and prolongs the survival of TRAMP mice by modulating pro-inflammatory pathways. PLoS One 7: e32476.
28. Shu J, Chou G, Wang Z (2010) Two new benzophenone glycosides from the fruit of Psidium guajava L. Fitoterapia 81: 532-535.
29. Zhang Y, Qian Q, Ge D, Li Y, Wang X, et al. (2011) Identification of benzophenone C-glucosides from mango tree leaves and their inhibitory effect on triglyceride accumulation in 3T3-L1 adipocytes. J Agric Food Chem 59: 11526-11533.

30. Thuaytong W, Anprung P (2011) Bioactive compounds and prebiotic activity in Thailand-grown red and white guava fruit (Psidium guajava L). Food Sci Technol Int 17: 205-212.

31. Singh RB, Rastogi SS, Singh NK, Ghosh S, Niaz MA (1992). Effects of guava intake on serum total and high-density lipoprotein cholesterol levels and on systemic blood pressure. Am J Cardiol 70: 1287-1291.

32. Singh RB, Rastogi SS, Singh NK, Ghosh S, Gupta S, et al. (1993) Can guava fruit intake decrease blood pressure and blood lipids. J Hum Hypertens 7: 33-38.

33. Farinazzi-Machado FMV, Barbalho SM, Guiguer EL, Souza MSS, Bueno PCS et al. (2012) Effects of Psidium guajava on the metabolic profile of Wistar rats. Journal of Med Plant Reserch.

34. Roy CK, Kamath JV, Asad M (2006) Hepatoprotective activity of Psidium guajava Linn leaf extract. Indian J Exp Biol 44: 305-311.

35. Ojewole JA (2006) Anti-Inflammatory and analgesic effects of Psidium guajava Linn (Myrtaceae) leaf aqueous extracts in rats and mice. Methods Find Exp Clin Pharmacol 28: 441-446.

36. Nair R, Chanda S (2007) In-vitro antimicrobial activity of Psidium guajava L leaf extracts against clinically important pathogenic microbial strains. Braz J Microbiol 38: 452-458.

37. Hui-Yin Chen, Gow-Chin Yen (2007) Antioxidant activity and free radical-scavenging capacity of extracts from guava (Psidium guajava L) leaves. Food Chem 101: 686-694.

38. Lozoya X, Reyes-Morales H, Chavez-Soto M, Martínez-García Mdel C, Soto-González Y, et al. (2002) Intestinal anti-spasmodic effect of a phytodrug of Psidium guajava folia in the treatment of acute diarrheic disease. J Ethnopharmacol 83: 19-24.

39. Hawrelak J (2003) Medicinal herb monograph: Guava (Psidium guajava) . J Aust Tradit-Med Soc 9: 25-29.

40. Jiménez-Escrig A, Rincón M, Pulido R, Saura-Calixto F (2001) Guava Fruit (Psidium guajava L.) as a New Source of Antioxidant Dietary Fiber. J Agric Food Chem 49: 5489-5493.

41. Wang B, Jiao S, Liu H, Hong J (2007) Study on antioxidative activities of Psidium guajava Linn leaves extracts. Wei Sheng Yan Jiu 36: 298-300.

42. Wu JW, Hsieh CL, Wang HY, Chen HY (2008) Inhibitory effects of guava (Psidium guajava L) leaf extracts and its active compounds on the glycation process of protein. Food Chem 113: 78-84.

43. Melo PS, Bergamaschi KB, Tiveron AP, Massarioli AP, Oldoni TLC, et al. (2011) Phenolic composition and antioxidant activity of agroindustrial residues. Cienc Rural 41: 1088-1093.

44. Ngamukote S, Mäkynen K, Thilawech T, Adisakwattana S (2011) Cholesterol-lowering activity of the major polyphenols in grape seed. Molecules 16: 5054-5061.

45. Yang J, Han Y, Sun H, Chen C, Guo DHJ, et al. (2011) "(-)-Epigallocatechin Gallate Suppresses Proliferation of Vascular Smooth Muscle Cells Induced by High Glucose by Inhibition of PKC and ERK1/2 Signalings". J Agricult Food Chem 59: 11483-11490.

46. Park JH, Jin JY, Baek WK, Park SH, Sung HY, et al. (2009) Ambivalent role of gallated catechins in glucose tolerance in humans: a novel insight into non-absorbable gallated catechin-derived inhibitors of glucose absorption". J Physiol Pharmacol 60: 101-109.

47. Gosmann G, Barlette AG, Dhamer T, Arçari DP, Santos JC, (2012) Phenolic Compounds from Maté (Ilex paraguariensis) Inhibit Adipogenesis in 3T3-L1 Preadipocytes. Plant Foods Hum Nutr.

48. Bigović D, Savikin K, Janković T, Menković N, Zdunić G, et al. (2011) Antiradical and cytotoxic activity of different Helichrysum plicatum flower extracts. Nat Prod Commun 6: 819-822.

49. Kim TY (2011) Antiproliferation and redifferentiation in thyroid cancer cell lines by polyphenol phytochemicals. J Korean Med Sci 26: 893-899.

50. Fu HZ, Luo YM, Li CJ, Yang JZ, Zhang DM (2010) Psidials A-C, three unusual meroterpenoids from the leaves of Psidium guajava L . Org Lett 12: 656-659.

51. Matsuzaki K, Ishii R, Kobiyama K, Kitanaka S (2010) New benzophenone and quercetin galloyl glycosides from Psidium guajava L. J Nat Med 64: 252-256.

52. Kim SH, Cho SK, Hyun SH, Park HE, Kim YS, et al. (2011) Metabolic profiling and predicting the free radical scavenging activity of guava (Psidium guajava L.) leaves according to harvest time by 1H-nuclear magnetic resonance spectroscopy. Biosci Biotechnol Biochem 75: 1090-1097 .

53. Ghosh P, Mandal A, Chakraborty P, Rasul MG, Chakraborty M, et al. (2010) Triterpenoids from Psidium guajava with Biocidal Activity. Indian J Pharm Sci 72: 504-507.

54. Yadav VR, Prasad S, Sung B, Kannappan R, Aggarwal BB (2010) Targeting inflammatory pathways by triterpenoids for prevention and treatment of cancer. Toxins 2: 2428-2466.

55. Shao M, Wang Y, Liu Z, Zhang DM, Cao HH et al. (2010) Psiguadials A and B, two novel meroterpenoids with unusual skeletons from the leaves of Psidium guajava. Org Lett 12: 5040-5043.

56. Shu JC, Chou GX, Wang ZT (2011) One new diphenylmethane glycoside from the leaves of Psidium guajava L. Nat Prod Res.

57. Prabu GR, Gnanamani A, Sadulla S (2006) Guaijaverin -- a plant flavonoid as potential antiplaque agent against Streptococcus mutans. J Appl Microbiol 101: 487-495.

58. Shabana S, Kawai A, Kai K, Akiyama K, Hayashi H (2010) Inhibitory activity against urease of quercetin glycosides isolated from Allium cepa and Psidium guajava. Biosci Biotechnol Biochem 74: 878-880.

59. Shao M, Wang Y, Huang XJ, Fan CL, Zhang QW, et al. (2012) Four new triterpenoids from the leaves of Psidium guajava. J Asian Nat Prod Res 14: 348-354.

60. Adeyemi OS, Akanji MA (2011) Biochemical changes in the kidney and liver of rats following administration of ethanolic extract of Psidium guajava leaves. Hum Exp Toxicol 30: 1266-1274.

61. Rahim N, Gomes DJ, Watanabe H, Rahman SR, Chomvarin C, et al. (2010) Antibacterial activity of Psidium guajava leaf and bark against multidrug-resistant Vibrio cholerae: implication for cholera control. Jpn J Infect Dis 63: 271-274.

62. Birdi T, Daswani P, Brijesh S, Tetali P, Natu A et al. (2010) Newer insights into the mechanism of action of Psidium guajava L. leaves in infectious diarrhoea. BMC Complement Altern Med 10: 33.

63. Birdi TJ , Daswani PG, Brijesh S, Tetali P (2011) In vitro antigiardial and antirotaviral activity of Psidium guajava L leaves. Indian J Pharmacol 43: 616-617.

64. Rattanachaikunsopon P, Phumkhachorn P (2010) Contents and antibacterial activity of flavonoids extracted from leaves of Psidium guajava. J Med Plants Res 4: 393-396.

65. Dhiman A, Nanda A, Ahmad S, Narasimhan B (2011) In vitro antimicrobial activity of methanolic leaf extract of Psidium guajava L. J Pharm Bioallied Sci 3: 226-229.

66. Deguchi Y, Miyazaki K (2010) Anti-hyperglycemic and anti-hyperlipidemic effects of guava leaf extract. Nutr. Metabolism 7: 9.

67. Zhao XZ, Li XW, Jin YR, Yu XF, Qu SC, et al. (2012) Hypolipidemic effects of kaempferide-7-O-(4"-O-acetylrhamnosyl)-3-O-rutinoside in hyperlipidemic rats induced by a high-fat diet. Mol Med Report 5: 837-841.

68. Akinmoladun AC, Obuotor EM, Farombi EO (2010) Evaluation of antioxidant and free radical scavenging capacities of some Nigerian indigenous medicinal plants. J Med Food 13: 444-451.

69. Hsieh CL, Lin YC, Ko WS, Peng CH, Huang CN, et al. (2005) Inhibitory effect of some selected nutraceutic herbs on LDL glycation induced by glucose and glyoxal. J Ethnopharmacol 102: 357-363.

70. Yamashiro S, Noguchi K, Matsuzaki, Miyagi K, Nakasone J, et al. (2003) Cardioprotective effects of extracts from Psidium guajava L and Limonium wrightii, Okinawan medicinal plants, against ischemia-reperfusion injury in perfused rat hearts. Pharmacol 67: 128-135.

71. Chen KC, Chuang CM, Lin LY, Chiu WT, Chiu WT, et al. (2010) The polyphenolics in the aqueous extract of Psidium guajava kinetically reveal an inhibition model on LDL glycation. Pharm Biol 48: 23-31.

72. Ojewole JA (2005) Hypoglycemic and hypotensive effects of Psidium guajava Linn (Myrtaceae) leaf aqueous extract. Methods Find Exp Clin Pharmacol 27: 689-695.

73. Soman S, Rajamanickam C, Rauf AA, Indira M (2011) Beneficial effects of Psidium guajava leaf extract on diabetic myocardium. Exp Toxicol Pathol.

74. Singh A, Marar T (2011) Inhibitory Effect of Extracts of Syzygium Cumini and Psidium Guajava on Glycosidases. J Cell Tissue Res 11: 2535-39

75. Rai PK, Jaiswal D, Mehta S, Wathal G (2009) Anti-hyperglycaemic potential of Psidium guajava raw fruit peel. Indian J Med Res 129: 561-565.

76. Shen SC, Cheng FC, Wu NJ (2008) Effect of guava (Psidium guajava Linn) leaf soluble solids on glucose metabolism in type 2 diabetic rats. Phytother Res 22: 1458-1464.

77. Dutta S, Das S (2010) A study of the anti-inflammatory effect of the leaves of Psidium guajava Linn on experimental animal models. Pharmac Res 2: 313-317.

78. Kawakami Y, Nakamura T, Hosokawa T, Suzuki-Yamamoto T, Yamashita H, et al. (2009) Antiproliferative activity of guava leaf extract via inhibition of prostaglandin endoperoxide H synthase isoforms. Prostaglandins Leukot Essent Fatty Acids 80: 239-245.

79. Peng CC, Peng CH, Chen KC, Hsieh CL, Peng RY (2011) The Aqueous Soluble Polyphenolic Fraction of Psidium guajava Leaves Exhibits Potent Anti-Angiogenesis and Anti-Migration Actions on DU145 Cells. Evid Based Complement Alternat Med 2011: 219069.

80. Chen KC, Peng CC, Chiu WT, Cheng YT, Huang GT, et al. (2010) Action mechanism and signal pathways of Psidium guajava L aqueous extract in killing prostate cancer LNCaP cells. Nutr Cancer 62: 260-270.

81. Roy CK, Das AK (2010) Comparative evaluation of different extracts of leaves of Psidium guajava Linn for hepatoprotective activity. Pak J Pharm Sci 23: 15-20.

82. Chikezie PC (2011) Sodium metabisulfite-induced polymerization of sickle cell hemoglobin incubated in the extracts of three medicinal plants (Anacardium occidentale, Psidium guajava, and Terminalia catappa). Pharmacogn Mag 7: 126-132.

83. Chikezie PC, Uwakwe AA (2011) Membrane stability of sickle erythrocytes incubated in extracts of three medicinal plants: Anacardium occidentale, Psidium guajava, and Terminalia catappa. Pharmacogn Mag 26: 121-125.

84. Han EH, Hwang YP, Choi JH, Yang JH, Seo JK, et al. (2011) Psidium guajava extract inhibits thymus and activation-regulated chemokine (TARC/CCL17) production in human keratinocytes by inducing heme oxygenase-1 and blocking NF-κB and STAT1 activation. Environ Toxicol Pharmacol 32: 136-145.

85. Livingston Raja NR, Sundar K (2012) Psidium guajava Linn confers gastro protective effects on rats. Eur Rev Med Pharmacol Sci 16: 151-156.

86. Chah KF, Eze CA, Emuelosi CE, Esimone CO (2006) Antibacterial and wound healing properties of methanolic extracts of some Nigerian medicinal plants. J Ethnopharmacol 104: 164-167.

87. Fernandes KPS, Bussadori SK, Marques MM, Sumie N, Wadt Y, et al. (2010) Healing and cytotoxic effects of Psidium guajava (Myrtaceae) leaf extracts. Braz J Oral Sci 9: 449-454.

88. Jaiarj P, Khoohaswan P, Wongkrajang Y, Peungvicha P, Suriyawong P, et al. (1999) Anticough and antimicrobial activities of Psidium guajava Linn. leaf extract. J Ethnopharmacol 67: 203-212.

89. Felice F, Zambito Y, Di Colo G, D'Onofrio C, D'Onofrio C, et al. (2012) Red grape skin and seeds polyphenols: Evidence of their protective effects on endothelial progenitor cells and improvement of their intestinal absorption. Eur J Pharm Biopharm 80: 176-184.

90. Guo C, Yang J, Wei J, Li Y, Xu J, et al. (2003) Antioxidant activities of peel, pulp and seed fractions of common fruits as determined by FRAP assay. Nutr Res 23: 1719-1726.

91. Cooper R (2012) Green tea and theanine: health benefits. Int J Food Sci Nutr 1: 90-97.

92. Castro-Vargas HI, Rodríguez-Varela LI, Ferreira SRS, Parada-Alfonso F (2010) Extraction of phenolic fraction from guava seeds (Psidium guajava L) using supercritical carbon dioxide and co-solvents. J Supercrit Fluids 51: 319-324.

93. Salib JY, Michael HN (2004) Cytotoxic phenylethanol glycosides from Psidium guaijava seeds. Phytochemistry 65: 2091-2093.

94. Rai PK, Mehta S, Watal G (2012) Hypolipidaemic & hepatoprotective effects of Psidium guajava raw fruit peel in experimental diabetes. Indian J Med Res 131: 820-824.

95. Nundkumar N, Ojewole JA (2002) Studies on the antiplasmodial properties of some South African medicinal plants used as antimalarial remedies in Zulu folk medicine. Methods Find Exp Clin Pharmacol 24: 397-401.