Phytochemical and Biopharmaceutical Aspects of *Psidium guajava* (L.) Essential Oil: A Review

B. Joseph and R.M. Priya
Interdisciplinary Research Centre, Department of Biotechnology, Malankara Catholic College, Mariagiri, Kaliakkavilai, Kanyakumari District, Tamil Nadu, 629153, South India

*Corresponding Author: Dr. Baby Joseph, Interdisciplinary Research Centre, Department of Biotechnology, Malankara Catholic College, Mariagiri, Kaliakkavilai, Kanyakumari District, Tamil Nadu, 629153, South India*

**ABSTRACT**

Essential oils distilled from aromatic and medicinal plants have been used both cosmetically and therapeutically. Nowadays, *Psidium guajava* L. plant parts are commonly used as medicinal plant. Although, there is considerable anecdotal information about the biological activity of guava essential oils much of this has not been substantiated by scientific evidence. Among the claims made for *Psidium guajava* (L.) essential oil is that have antimicrobial, antinociceptive, repellent, insecticidal, anticancer and anti-inflammatory effects. In this study we detail the current state of knowledge about the effect of guava essential oils and phytochemicals.

**Key words:** *Psidium guajava* L., essential oil, phytochemicals, anticancer activity, antimicrobial activity, insecticidal activity, anti-inflammatory effect

**INTRODUCTION**

Many complementary and alternative medicines have enjoyed increased popularity in recent decades. Essential oils are valuable natural products used as raw materials in many fields, including perfumes, cosmetics, aromatherapy, phytotherapy, spices and nutrition (Buchbauer, 2000). Aromatherapy is the therapeutic use of fragrances or at least mere volatiles to cure mitigate or prevent diseases, infections and indispositions by means of inhalation (Buchbauer et al., 1995). This has recently attracted the attention of many scientists and encouraged them to screen plants to study the biological activities of their oils from chemical and pharmacological investigations to therapeutic aspects.

*Psidium guajava* L. (Myrtaceae) is one of such plants in folk medicine that has been used for the management of various disease conditions and is believed to active. Various parts of the plant has been used in traditional medicine to manage conditions like malaria, gastroenteritis, vomiting, diarrhoea, dysentery, wounds, ulcers, toothache, coughs, sore throat, inflamed gums and a number of other conditions (Jaifarj et al., 1999; Abdelrahim et al., 2002; Lutterodt, 1989). It has a long history of folk medicinal uses in Egypt and worldwide as a cough sedative, an anti-diarrheic, in the management of hypertension, obesity and in the control of diabetes mellitus (Karawaya et al., 1999; Abdelrahim et al., 2002; Begum et al., 2004; Morales et al., 1994; Sunagawa et al., 2004; Tanaka et al., 1992). The leaf extract was found to possess antioestodal (Tangpu and Yadav, 2006), analgesic, anti-inflammatory properties (Ojewole, 2006), antimicrobial (Roy et al., 2006) hepatoprotective (Chen et al., 2006) and antioxidant activities (Nair and Chanda, 2007).
addition, the leaf extract is used in many pharmaceutical preparations as a cough sedative. The extracts contain flavonoids, mainly quercetin derivatives, which are hydrolyzed in the body to give the aglycone quercetin which is responsible for the spasmyloytic activity of the leaves (Morales et al., 1994). Quercetin has several pharmacologic actions; it inhibits the intestinal movement, reduces capillary permeability in the abdominal cavity (Zhang et al., 2003) and possesses dose-dependent antioxidant properties (Nakamura et al., 2000), anti-inflammatory activity (Havsteen, 1983; Middleton and Drzewiecki, 1984, 1985; Amella et al., 1985; Pearce et al., 1984; Busse et al., 1984; Yoshimoto et al., 1983) antiviral and antitumor activities (Murray and Pizzorno, 1999; Mucsi and Pragai, 1985; Kaul et al., 1985; Farkas et al., 1982; Guttner et al., 1982; Kaneuchi et al., 2003).

This study, is aimed primarily at summarizing the phytochemical study and the bioactivity of essential oil from *Psidium guajava* L. (Guava) as potential biological and pharmacological agent. Hopefully, this will lead to new information on this plant application and new perspective on the potential use of guava essential oil.

**Description of *Psidium guajava* L.:** It is a small branched tree, bark smooth, mottled, peeling. Young stems angled. Leaves arranged in opposite, 6 inches long by 3 inches wide, aromatic, lateral veins on underside prominent. Flowers white (Fig. 2), one or more leaf axils, many stamens. Fruits yellow (Fig. 1), 4 inches diameter, with pink flesh. Seeds tan colored, hard, many. Fruit used commercially to makes jams and drinks. In Latin America, the rind is canned as a dessert fruit. Guava is of tropical American origin, it is now widely distributed throughout the tropics. It is a weed of pastures and forests (Motooka et al., 2003).

**Scientific classification**

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Plantae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order</td>
<td>Myrtales</td>
</tr>
<tr>
<td>Family</td>
<td>Myrtaceae</td>
</tr>
<tr>
<td>Subfamily</td>
<td>Myrtoideae</td>
</tr>
<tr>
<td>Genus</td>
<td><em>Psidium</em></td>
</tr>
<tr>
<td>Species</td>
<td><em>guajava</em></td>
</tr>
<tr>
<td>Binomial name</td>
<td><em>Psidium guajava</em></td>
</tr>
</tbody>
</table>

![Fig. 1: *Psidium guajava* L. leaf and fruit](image)
Chemical constituents of Guava essential oil: Analysis of chemical constituents of essential oils is generally performed using GC (quantitative analysis) and GC-MS (qualitative analysis). Identification of the main component is carried out by the comparison of both the GC retention times and MS data against those of the reference standards (with known source); as previously reported (Lahlou et al., 2001a, b; Lahlou and Berrada, 2003).

The fruit: The Guava fruit (Fig. 1) contain number of vitamins minerals and essential oil. Quite a few reports have been published covering the volatile compounds of guava fruits (Jordan et al., 2003; Pino et al., 2001a, 2002; Paniandy et al., 2000; Yen and Lin, 1999; Chyau et al., 1992; Yen et al., 1992; Ekundayo et al., 1991; Vernin et al., 1991; Nishimura et al., 1989; Chyau and Wu, 1989; Hashinaga et al., 1987; Idstein and Schreier, 1985; MacLeod and Troconis, 1982; Wilson and Shaw, 1978; Stevens et al., 1970). However, there are few studies on the sensory significance of volatile constituents in guava fruits. One of early reports concerning the volatile components in guava was given by MacLeod and Troconis (1982), who described that the mixture of 2-methylpropyl acetate, hexyl acetate, benzaldehyde, ethyl decanoate, β-caryophyllene and α-selinene had a guavalike aroma among 40 volatile compounds identified in guavas from Venezuela. Pino et al. (2001b) identified 204 compounds out of the aroma concentrate of strawberry guava fruits, of which ethanol, α-pinene, (Z)-3-hexenol, (E)-β-caryophyllene and hexadecanoic acid were the major constituents. The presence of many aliphatic esters and terpenic compounds is thought to contribute to the unique flavor of the guava fruits. Pino et al. (2002) also characterized 173 volatile components in Costa Rican guava and sensorily characterized them by GC-sniffing. The major constituents were β-caryophyllene, α-terpineol, α-pinene, α-selinene, β-selinene, δ-cadinene, 4,11-selinadiene and α-copaene. Again the amounts of aliphatic esters and terpenic compounds were thought to contribute to the unique flavor of this fruit. Jordan et al. (2003) studied the aromatic profile in commercial guavas and identified a total of 51 components as the principal components in guava essence and fresh fruit puree by GC-MS. In the olfactometric analyses, totals of 43 and 48 aroma active components were detected by the panelists in commercial essence and fruit puree, respectively. Principal differences between the aromas of the commercial guava essence and the fresh fruit puree could be related to the presence of acetic acid, 3-hydroxy-2-butano, 3-methyl-1-butanol, 2,3-butanediol, 3-methylbutanoic acid, (Z)-3-hexen-1-ol, 6-methyl-
5-hepten-2-one, limonene, octanol, ethyl octanoate, 3-phenylpropanol, cinnamyl alcohol, α-copaene and an unknown component. (E)-2-hexenal seems more important to the aroma of the commercial essence than that of the fresh fruit.

Chen et al. (2007) identified the volatile compounds of Psidium guajava L. (Taiwan) major constituents are α-pinene, 1,8-cineole, β-caryophyllene, nerolidol, globulol, C6 aldehydes, C6 alcohols, ethyl hexanoate and (Z) 3-hexenyl acetate. The presence of C6 aldehydes, C6 alcohols, ethyl hexanoate, (Z)-3-hexenyl acetate, terpenes and 1,8-cineole is thought to contribute to the unique flavor of the guava fruits. Steinhaus et al. (2008) studied volatiles present in fresh, pink-fleshed Colombian guavas (Psidium guajava L.), variety regional rojo, were carefully isolated by solvent extraction followed by solvent-assisted flavor evaporation and the aroma-active areas in the gas chromatogram were screened by application of the aroma extract dilution analysis. This study revealed that the identification experiments in combination with the FD factors revealed 4-methoxy-2,5-dimethyl-3(2H)-furanone, 4-hydroxy-2,5-dimethyl-3(2H)-furanone, 3-sulfanylhexyl acetate and 3-sulfanyl-1-hexanol followed by 3-hydroxy-4,5-dimethyl-2(5H)-furanone, (Z)-3-hexenal, trans-4,5-epoxy-(E)-2-decenal, cinnamyl alcohol, ethyl butanoate, hexanal, methional and cinnamyl acetate as important aroma contributors. Enantioselective gas chromatography revealed an enantiomeric distribution close to the racemate in 3-sulfanylhexyl acetate as well as in 3-sulfanyl-1-hexanol. In addition, two fruity smelling diastereomeric methyl 2-hydroxy-3-methylpentanoates were identified as the (R,S)- and the (S,S)-isomers, whereas the (S,R)- and (R,R)-isomers were absent. Seven odorants were identified for the first time in guavas, among them 3-sulfanylhexyl acetate, 3-sulfanyl-1-hexanol, 3-hydroxy-4,5-dimethyl-2(5H)-furanone, trans-4,5-epoxy-(E)-2-decenal and methional were the most odor-active.

The leaves: The constituents of essential oils from the leaves of Guava were analysed by GC-MS qualitatively and quantitatively. The leaves contain fixed oil and volatile oil. The leaves of P. guajava contain an essential oil rich in cineol, tannins, triterpenes, flavonoids, resin, tannin, eugenol, mallic acid, fat, cellulose, chlorophyll, mineral salts and a number of other fixed substances (Olajide et al., 1999; Burkell, 1997; Nadkarni and Nadkarni, 1999). The essential oil with the main components being α-pinene, β-pinene, limonene, menthol, terpenyl acetate, isopropyl alcohol, longicyleene, The major volatiles β-caryophyllene, (E)-nerolidol (Ogunwande et al., 2003), β-bisabolene, caryophyllene oxide, β-copanene, farnesene, humulene, selinene, cardinene, curcumene (Zhang et al., 1994), α-Selinene, capaene, [1αR-(1α α, 4α α, 7 α, 7a β, 7b α)]-decahydro-1,1,7-trimethyl-4-methylene-1H-cyclopenta[e] azulene, eucalyptol (Li et al., 1999), α-caryophyllene and δ-selinene (Sagrero-Nieves et al., 1994). Leaf oil samples prepared from solvent extracts found menthol and R-terpenyl acetate along with ethanol and propanol (Osman et al., 1975). Early leaf volatile studies examined terpene concentrations in leaf essential oils for chemotaxonomy purposes (Smith and Siwatibu, 1975). The volatile fraction was rich in sesquiterpene compounds. Fifty-seven components including 27 terpenes (or sesquiterpenes) along with 14 alcohols and 4 esters were identified obtained from a hydrodistillation of the leaves (Pino et al., 2001a) and forty-two constituents including 29 hydrocarbon terpenes were observed in the air-dried and steam-distilled guava leaf oil from Nigeria (Ogunwande et al., 2003). Chief among the terpenes were limonene, β-caryophyllene, γ-bisabolene and zingiberene nerolidol, β-sitosterol, ursolic, erucagolic, guayavolic acids, guajavolide and guavenoic acid along with one known triterpene oleanolic acid were isolated from the leaves of Psidium guajava L. (Pino et al., 2001a; Iwu, 1993; Begum et al., 2002). Recent reports are confirmed the presence of
β-caryophyllene, α-pinene and 1,8-cineole as major compounds in Guava leaf essential oil (Chen and Yen, 2007; Ogunwande et al., 2003). In addition, the essential oil rich in cineole and four triterpenic acids as well as three flavonoids; quercetin, its 3-L-4-4-arabinofuranoside (avicularin) and its 3-L-4-pyranoside with strong antibacterial action (Bep, 1986). We are identified flavanon-2 2-ene, prenol, dihydro benzophenamrhidine and cryptonine. These four new compounds are first identified from guava leaf essential oil (Joseph and Priya, 2010). Recent report identified new sulfur volatile compounds namely, dimethyl disulfide, dimethyl trisulfide, benzothiazole, 3-mercaptohexanol and 3-mercaptohexyl acetate. Two of these compounds have not previously been reported as occurring in guava (3-mercapto-hexanol and 3-mercaptohexyl acetate). These compounds have a cassis-like odor and are thought to make an important contribution to the odor of guava (Clery and Hammond, 1998).

Pharmaceutical effect of Guava essential oil
Antimicrobial activity: The mechanisms by which essential oils can inhibit microorganisms involve different modes of action and in part may be due to their hydrophobicity. As a result, they get partitioned into the lipid bilayer of the cell membrane, rendering it more permeable, leading to leakage of vital cell contents (Burt, 2004; Juven et al., 1994). Some antimicrobial screening has been done selectively by different researcher in Guava essential oil. Sacchetti et al. (2005) reported the Psidium guajava L. oil showed strong resistance against Yarrowia lipolytica (pathogenic yeast). The antimicrobial effect of essential oil from guava leaves tested against strains of Staphylococcus aureus, Salmonella and Escherichia coli isolated from seabob shrimp [(Xiphopenaeus kroyeri (Heller)]. The essential oil extract showed inhibitory activity against S. aureus and Salmonella spp. (Goncalves et al., 2008; Joseph et al., 2010), a higher concentration of active chemical compounds in essential oils explain their stronger inhibitory action (Jaijarj et al., 1999; Neto et al., 1994). Recently, we are reported the essential oil from the leaves of guava exhibited inhibitory effect against Bacillus cereus, Enterobacter aerogenes and Pseudomonas fluorescens (Joseph et al., 2010). Within the genus Psidium, essential oil constituents are principally comprised of monoterpenes, 1,8-cineol, p-cimene and acetate of α-terpin. The complex composition of essential oils offers a variety of pharmacological resources and great potential for the development of novel drugs.

Antinociceptive effect: Santos et al. (1998) reported that the Psidium guajava leaf essential oil and its major constituents, β-caryophyllene and α-pinene having antinociceptive effect on adult male albino mice. It was assessed by using chemical (formalin and acetic acid) and thermal (hot-plate) nociceptive tests. The possible mechanisms involved in the antinociceptive effect of the essential oil, animals received caffeine or naloxone 15 min before oral administration of this essential oil.

Insecticidal activity: Essential oils are also reported to have insecticide properties, essentially as ovicidal, larvicidal, growth inhibitor, repellency and antifeedant (Saxena and Koul, 1978; Dale and Saradamma, 1981; Scherer, 1984; Krishnarajah et al., 1985; Nath et al., 1986; Koul, 1987; Isman et al., 1990; Shaaya et al., 1991; Lalhou et al., 2001a, b). Recently identified the potential component(s) responsible for guava’s protective effect against the Asian citrus psyllid (Diaphorina citri Kuwayama), which is the insect vector of Huanglongbing (HLB) or citrus greening disease. Seven sulfur volatiles were detected Volatiles from crushed and intact guava leaves (Psidium guajava L.). Among these 7 compounds, DMDS (dimethyl disulfide) is an insect.
toxic; defensive volatile produced only by wounded guava. It is the major component it may responsible for the protective effect of guava against the HLB vector (Rouseff et al., 2008).

**Repellent activity:** Nowadays, the use of plant essential oils in mosquito repellent is an alternative personal protective measure against the noxious effects of synthetic repellents on the users and environment (Thorsell et al., 1998). Rajkumar and Jebanesan (2007) reported repellent activity against malarial fever mosquito *Anopheles stephensi* using the human-bait technique. *P. guajava* showed repellency. Another report proved that the essential oil of guava showed excellent repellency against *B. germanica* cockroaches and moderate activity showed *N. rhombifolia* cockroaches (Thavara et al., 2007). This essential oil did not cause skin irritation, hot sensations or rashes on the arms of the test volunteers during the study period (Rajkumar and Jebanesan, 2007).

**Anticancer activity:** Many essential oil components have been screened in the search for anticancer agents. Essential oils and their individual aroma components showed cancer suppressive activity when tested on number of human cancer cell lines including glioma, colon cancer, gastric cancer, human liver tumor, pulmonary tumors, breast cancer, leukemia and others (Angelis, 2001). In a recent study, essential oil from the leaves of the plant was reported to exhibit anticancer activities on KB and P388 cell lines. It was reported that essential oil from the leaves of *P. guajava* exhibited the highest antiproliferative activity towards KB cells compared to sixteen other Thai medicinal plants screened (Manosroi et al., 2005). Recently, we reported the potential cytotoxic effect on human cervical cancer cell lines and it may have probable apoptosis (Joseph et al., 2010).

**Anti-inflammatory effect:** Olajide et al. (1999) reported that the anti-inflammatory effects of methanol extract from leaves were probably due to the essential oils present in the guava plant. According to this result, the flavonoid content on the plant could also be responsible for the anti-inflammatory activity.

**Future prospectus:** The cytotoxic capacity of the essential oils based on a pro-oxidant activity can make them excellent antiseptic and antimicrobial agents for personal use, i.e., for purifying air, personal hygiene, or even internal use via oral consumption and for insecticidal use for the preservation of crops or food stocks. Recent studies have demonstrated that the pro-oxidant activity of some essential oils or some of their constituents, as also that of some polyphenols is very efficient in reducing local tumor volume or tumor cell proliferation by apoptotic and/or necrotic effects. We have shown that the guava leaf essential oil has a cytotoxic activity on the human cervical cancer cell lines (Joseph et al., 2010). (Manosroi et al. (2005) have shown anticancer activities on KB and P388 cell lines. Many tumor cells are characterized by severe changes in energy metabolism, mitochondrial overproduction and permanent oxidative stress (Czarnecka et al., 2005). Essential oils, due to their capacity to interfere with mitochondrial functions, may add pro-oxidant effects and thus become genuine anti-tumor agents. Many radical producing agents are in fact used in antitumor treatments. In the case of essential oils, radical production could be very well controlled and targeted without presenting by it any toxic or mutagenic side-effects to healthy tissues. Essential oils or their active constituents could be included in vectorized liposomes that would allow bettering defining the quantities applied. Thus, the *Psidium guajava* L. essential oil could make their way into the modern medical domain.
CONCLUSION

This study attempts to shed light on the therapeutic potential of *Psidium guajava* L. essential oil and their aroma volatile constituents in the prevention or therapy of disease. From this study we can concluded that the preliminary studies only reported from essential oil of *Psidium guajava* L. (Guava). The results reviewed in this study are aimed at attracting the attention of researchers seeking new drugs from guava essential oil and its chemical compounds. The data presented provide basic information’s about guava plant, essential oil, chemical constituents and its pharmacological effects described here. This essential oil and their constituents can hopefully be considered in the future for more clinical evaluations and possible applications and as adjuvant to current medications. We should maintain our efforts in considering and valorizing our natural patrimony, as well as conducting more scientific research on *Psidium guajava* L. from chemical analysis, biological, toxicological and pharmacological investigations to therapeutic aspects.

ACKNOWLEDGEMENT

The authors are indebted to our Malankara Catholic College Correspondent Fr. Prem Kumar (M.S.W.) given encouragement and supports for our research and preparation of this manuscript. We wish to express our sincere thanks to Mr. Shankar Ganesh, Dr. Sujatha and Research scholars in the Interdisciplinary Research Centre, for all efficient supports of this Review paper preparation and Publication.

REFERENCES


