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## Pharmacological Aspects of *Psidium guajava*: An Update

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**Abstract:** In recent years, the use of herbal products has been increasing in developing countries such as Nigeria. The common guava tree (*Psidium guajava*) is a medium sized tree belonging to the family Myrtaceae which is native to tropical and subtropical countries. It is popular in an indigenous system of folk medicine. Traditionally guava is used for the treatment of various ailments like diarrhoea wounds, rheumatism, lung problems, ulcers etc. *Psidium guajava* L. contains a number of major pharmacologically active ingredients such as flavonoids, guayavolic acid, guavanoic acid, guajadial, guajaverin and so many other active principles. This review summarizes the current knowledge of major pharmacological constituents with major emphasis on traditional and pharmacological activities. This plant reported to display various biological activities like anti-diarrhoeal, antimicrobial, antioxidant, hepatoprotective, anti-allergy, anti-plasmodial, anti-spasmodic, cardioactive, anti-diabetic, anti-inflammatory anti-nociceptive and antitussive activity. In view of its wide pharmacological and biological activities, it seems to be having a great therapeutic potential.

**Key words:** *Psidium guajava*, antipyretic, pharmacological properties

### INTRODUCTION

*Psidium guajava* L. is found in Kingdom: Plantae, Division: Magnoliophyta, Class: Magnoliopsida, Sub class: Rosidae, Order: Myrtales, Family: Myrtaceae, Sub family: Myrtoideae, Tribe: Myrteae, Genus: *Psidium* and Species: *guajava* (Joseph and Priya, 2011b) The synonyms of *Psidium guajava* are guava, goiaba, guayaba, goavier, perala, guave, guayave, bayabas, pichi, posh, enand. *Psidium guajava* L. is a native plant of tropical America but now cultivated throughout the tropics especially where the climate is suitable for the growth of the plant. *Psidium guajava* is a medium sized tree with evergreen, opposite, aromatic short-petioled leaves. The inflorescence axillary 1-3 flowered trees are used for treatment of various disease conditions especially in the developing countries (Geidam *et al.*, 2007). Different parts of the plant are used in folk medicine for the treatment of various human ailments such as wounds, ulcers, bowels and cholera (Begum *et al.*, 2002). In some countries, the whole plant or shoots are used in form of infusion, decoction and paste as a skin tonic and astringents in dysmenorrhoea, miscarriages, uterine bleeding, premature labor and treatment of wounds. The bark is reddish brown, thin and smooth used as an astringent in form of decoction and poultice for the

treatment of ulcers wounds and diarrhea. The decoction of the leaves is used as febrifuge, antispasmodic and for rheumatism in India (Hernandez, 1971). The fruit has a pear-shaped appearance with strong musky odor (Morton, 1987) when ripened, the fruit is a good aperient and should be eaten with the skin for effective results. The unripe fruit however, is indigestible and causes vomiting and feverish conditions yet sometimes employed for diarrhoea (Conway, 2001). Further studies on the pharmacological properties of the bark, fruit and leaves indicates antibacterial, hypoglycaemic, anti-inflammatory, antipyretic, spasmolytic and central nervous system depressant activities (Begum *et al.*, 2002). Among the major effects of the plant extract are antibacterial and trypanocidal activities which may be attributed mainly to the broad antimicrobial property of the flavonoids and the iron chelating property of tannins (Adeyemi *et al.*, 2009). A great progress has been achieved in discovery of the potential pharmacological agents of the plant from natural sources. Natural products have been used as lead compounds because of its specific activity and low toxicity. In view of the immense medicinal importance of *P. guajava* plant evidenced in the various studies mentioned above and the fact that the plant is readily available in the tropics and within the reach of the local populace, potential beneficial effects need to be

communicated to the public while further research into the pharmacological activities of *P. guajava* plant extract against common infectious diseases should be conducted.

**Pharmacological properties of *Psidium guajava*:**

*Psidium guajava* is a well known traditional medicinal plant and is used in various indigenous systems of medicine. The fruits are often included among super fruits, being rich in dietary fiber, vitamins A and C, folic acid and dietary minerals such as potassium, copper and manganese. Having a generally broad, low-calorie profile of essential nutrients, a single common guava (*P. guajava*) fruit contains about four times the amount of vitamin C as an orange (Hassimotto *et al.*, 2005). These constituent of *Psidium guajava* L. has made it possible to be used traditionally for treatment of various ailments since a long time in history. More recent ethno pharmacological studies showed that *Psidium guajava* is used in many parts of the world for the treatment of a number of diseases such as anti-inflammatory, for diabetes, hypertension, carries wounds, analgesic and antipyretic effects (Gutierrez *et al.*, 2008). The part of the plant mostly used is the leaves, fruits, bark and the roots. However, the plant as a whole is sometimes used for various medicinal purposes (Geidam *et al.*, 2007). The traditional uses of the plant are compiled according to the part of the plant used.

**Leaf extract:** The decoction or infusion of the leaves is used as febrifuge, antispasmodic and for rheumatism in India (Hernandez, 1971). It is also used to treat diarrhea and stomach ache in Columbia, Mexico, Maya, Nahuatl, Zapotec, USA and Mozambique. The leaves are used in USA as an antibiotic in the form of poultice or decoction for wounds, ulcers and tooth ache (Heinrich, 1998; Leonti *et al.*, 2001). In South Africa and Caribbean, extract of the leaves is used in management of diabetes and hypertension. Latin America, Central and West Africa and South East Asia use decoction of the leaves as gargle for sore throats, swelling of the mouth, laryngitis, external ulcers on the skin and vaginal irritations (Ojewole, 2005; Rouseff *et al.*, 2008; Yang *et al.*, 2007; Idstein and Schreier, 1985; Nagar and Rao, 1981). The leaves are used for bacterial infections, diarrhea, blood cleansing and dysentery in Trinidad while in New Guinea, Samoa, Tonga, Niue, Futuna and Tahiti are used in the form of boiled preparation for itchy rashes caused by scabies. It is also used as an astringent and in lung problems (Yang *et al.*, 2007) *Psidium guajava* leaves are applied externally on inflammations in Panama, Cuba, Costa Rica,

Mexico, Nicaragua, Venezuela Mozambique, Guatemala and Argentina. In Uruguay, a decoction of the leaves is used as a douche in vagina and uterus especially in leucorrhoea (Conway, 2001; Geidam *et al.*, 2007; Gutierrez *et al.*, 2008). In Nigeria, south Africa, Ghana and Kenya, the leaves are used in treatment of conditions such as malaria, gastroenteritis, vomiting, diarrhoea, dysentery wounds, ulcers, toothache, coughs, sore throat, inflamed gums and a number of other conditions (Jaiarj *et al.*, 1999; Abdelrahim *et al.*, 2002; Lutterodt, 1989).

**Bark and root:** The bark in the form of decoction and poultice is used as an astringent in the treatment of ulcers wounds and diarrhea in Philippines while in Panama, Bolivia and Venezuela, the bark is used in treatment of dysentery and skin ailments (Conway, 2001). In Kinshasa and Congo the bark is used as antiamebic as an infusion or decoction (Geidam *et al.*, 2007). In the form of decoction and poultice, it is used to expel the placenta after childbirth and in infections of the skin, caries, vaginal hemorrhage wounds, fever, dehydration and respiratory disturbances (Gutierrez *et al.*, 2008). The root is used in West Africa as a decoction to relieve diarrhea, coughs, stomachache, dysentery, toothaches, indigestion and constipation while in Philippines, Fiji and South Africa, the roots are used in the form of decoction and poultice as an astringent in ulcers wounds and in treatment of diarrhea (Gutierrez *et al.*, 2008).

**Whole plant:** In general, the whole plant or it shoots are used in the form of infusion, decoction and paste as skin tonic in Tahiti and Samoa and as analgesia in painful menstruation, miscarriages, uterine bleeding, premature labor and wounds (Gutierrez *et al.*, 2008).

**Therapeutic activities:** The *Psidium guajava* L. plant is used for a number of ailments in the history of folk medicine. *Psidium guajava* L. contains a number of major pharmacologically active ingredients responsible for major biological activities such as anti-diarrhoeal, antimicrobial, antioxidant, cardioactive and hepatoprotective effects, anti-allergic and inflammatory effects, anti-plasmodial, anti-spasmodic, anti-nociceptive and anti-diabetic and finally antitussive activity. Therefore, the therapeutic potentials of *Psidium guajava* L. plant include.

**Antidiarrhoeal effect:** Diarrhoea was reported to be a major problem in the world especially in developing countries where about 2.2 million people suffer from stomach upset which consequently leads to diarrhea

(Tona *et al.*, 1999). As a quick remedy for the condition, the leaf infusion is taken in Ghana, Senegal and Nigeria for stomach complaints such as constipation and dysentery (Jaiarj *et al.*, 1999). In Gambia the leaves are chewed for queezy tummy to relief abdominal discomfort (Burkill, 1997). Although the ripe fruit is mildly laxative, it is used to relief constipation and as aperients when eaten with the skin. However, the unripe fruit is mostly used as an astringent and anti-diarrheic (Burkill, 1997) while when taken in large quantity causes indigestion, vomiting and feverishness condition (Conway, 2001).

In recent Peruvian herbal medicine systems, the plant is employed for diarrhoea, gastroenteritis, intestinal worms, gastric disorders and vomiting (Joseph and Priya, 2011b). The leaves of the guava tree decoction are recommended for gastroenteritis and chronic diarrhoea whereas the young leaves and the shoots are used for dysentery and diarrhoea (Ticzon, 1997; Lutterrodt *et al.*, 1999). The antidiarrhoeal effect of guava is probably due to the inhibition of the increase watery secretions that occur in acute diarrhoeal diseases e.g., cholera (Lutterrodt, 1992; Tona *et al.*, 1999; Lozoya *et al.*, 2002). The extract was effective against *Staphylococcus aureus* which is a major contaminant in wounds. It has been proposed that the quercetin present in the leaves can inhibit the intestinal movement and reduce capillary permeability in the abdominal cavity that explains the antidiarrhoeal mechanism of *P. guajava* extract (Zhang *et al.*, 2003). In Costa Rica, the decoction of the flower buds is considered an effective remedy for diarrhoea (Ayensu, 1978). As a traditional medicine the leaves and shoot extract are used to cure stomach ache and other associated conditions (Zakaria and Mohd, 1994).

In India and Ghana the roots bark are used as astringent in childhood diarrhoea and dysentery (Ayensu, 1978). A study of galactose specific lectin in guava was shown to bind to *Escherichia coli* preventing its adhesion to the intestinal wall and thus preventing infection resulting diarrhea (Coutino-Rodriguez *et al.*, 2001). The methanolic extract of *P. guajava* (leaves) showed significant inhibitory activities against the growths of two isolates of *Salmonella* and *Shigella* spp. (*Shigella flexneri*, *Shigella virchow* and *Shigella dysenteriae*) and two isolates of the enteropathogenic *Escherichia coli*. The results have confirmed the effectiveness of the medicinal plant as an antidiarrhoeal agent (Lin *et al.*, 2002). It was confirmed in a study that guava sprout extracts constitute a feasible treatment option for diarrhoea caused by *E. coli* or *Staphylococcus aureus*-produced toxins with characteristic fast therapeutic action, easy availability in tropical countries and low cost (Vieira *et al.*, 2001).

**Antimicrobial activity:** The extracts of *Psidium guajava* leaves were tested for antibacterial potential and found to be effective against *Staphylococcus aureus*, *Streptococcus mutatis*, *Pseudomonas aeruginosa*, *Salmonella enteritidis*, *Bacillus cereus*, *Proteus* spp. *Shigella* spp. and *Escherichia coli*; the major causal agents of intestinal infections in humans (Chah *et al.*, 2006; Nair and Chanda, 2007). The methanolic root extract of *Psidium guajava* that consists of quercetin was also found to be fungicidal (Nair and Chanda, 2007). Both aqueous and methanolic extracts of the leaves are found to be effective inhibitors of spore formation and enterotoxin production of *Clostridium prefringens* type A (Garcia *et al.*, 2002). The bark tincture showed fungicidal activity at different concentrations but exhibited only fungistatic property in case of *Candida albicans* (Dutta *et al.*, 2000; Estrada-Luna *et al.*, 2000). The *in vitro* antibacterial activity of *Psidium guajava* leaf extract on *Staphylococcus aureus* was possibly due to protein degrading activity of the extracts (Belemtougri *et al.*, 2006).

The active flavonoid compound guaijaverin extracted from leaves of same plant was reported to have high potential antiplaque activity (Brotz-Oesterhelt *et al.*, 2005; Limsong *et al.*, 2004). The aqueous extracts were more potent in inhibiting the growth of pathogenic *Proteus mirabilis*, *Streptococcus pyogenes*, *Escherichia coli*, *Staphylococcus aureus* and *Pseudomonas aeruginosa* than the organic extracts. The Gram negative bacteria were less susceptible to the effects of the crude drugs (Abubakar, 2009). The *Psidium guajava* leaf extracts have trypanocidal activity which may be attributed mainly due to the broad antimicrobial property of the flavonoids and the iron chelating property of tannins (Adeyemi *et al.*, 2009). Four antibacterial compounds were isolated from the leaves of *P. guajava* and the flavonoids extracted from guava leaves were found to be effective against the several strains of food borne pathogenic bacteria (Akanji *et al.*, 2009). In a study carried out with the leaf extracts of *Psidium guajava* have shown potent antimicrobial activities against *Propionibacterium acnes* and may be beneficial in treating acne (Qadan *et al.*, 2005). The  $\gamma$ -terpinene and  $\gamma$ -pinene obtained by hydro distillation showed antimicrobial activity against *Propionibacterium acnes* (Athikomkulchai *et al.*, 2008). In another work the extract also showed *in vitro* antimicrobial activity against *Escherichia coli*, *Salmonella typhi*, *Staphylococcus aureus* (Gnan and Demello, 1999), *Proteus mirabilis* and *Shigella dysenteriae* (Iwu, 1993). The leaves are rich in tannin and have both antiseptic (Hernandez, 1971) and antimicrobial action on Gram-positive and Gram-negative organisms (*Sarcina lutea* and *Staphylococcus aureus*)

and also on *Mycobacterium phlei*. The flavone derivatives isolated were reported to inhibit the growth of *Staphylococcus aureus* in a dilution of 1:10,000 (Oliver-Bever, 1986). The barks was also shown to exhibit antibacterial effects; this activity could be attributed to the present tannins (Lutete *et al.*, 1994). The effectiveness of Guava as an antimicrobial was confirmed by Abdelrahim *et al.* (2002). *Psidium guajava* leaf and bark tincture was subjected to *in vitro* sensitivity tests by serial dilution at concentration ranging from 5 to 15% against six test dermatophytes viz. *Trichophyton tonsurans*, *T. rubrum*, *Trichosporon beigelii*, *Microsporum fulvum*, *M. gypseum* and *Candida albicans*. Bark tincture exhibited higher efficacy in controlling the mycelial growth of dermatophytes than the leaf tincture. The tincture showed fungicidal property in different concentrations but exhibited only fungistatic property in case of *C. albicans* (Dutta *et al.*, 2000). Another study showed good effect with the methanolic extract (Rabe and Van Staden, 1997). A leaf extract enters into a Nigerian remedy for skin infections and examination has shown a positive action on Gram-positive microbial organisms but no action on Gram-negative organisms, nor any antifungal action. Three antibacterial substances have been detected in the leaves which are derivatives of quercetin as in the bark polyphenols and many other substances are present (Burkill, 1997).

**Antiplasmodial and other antiparasitic activities:** The aqueous leaf, stem bark and fruit extracts of *Psidium guajava* L. were used to examine anti-plasmodial activity via *in vitro* parasite lactate dehydrogenase assay method (Ponce-Macotela *et al.*, 1994). The leaves are used in Africa as an ingredient in the preparation of fever teas and are also used as part of pot herb used in steam treatment for malaria, the main ethnotherapeutic use in Africa is said to be for malaria. In addition, KwaZulu-Natal province of South Africa, *Psidium guajava* was found to be effective for the treatment and/or prophylaxis of malaria as the stem-bark extract contains anthraquinones, flavonoids, seccoirridoids and terpenoids. This was confirmed by an *in vitro* antiplasmodial assay was carried out using a chloroquine-sensitive strain of malaria parasite (Nundkumar and Ojewole, 2002; Ojewole, 2006).

**Antitussive activity:** A study showed that water infusion from *Psidium guajava* leaf extract decreases the frequency of coughing induced by capsaicin aerosol (Jaiarj *et al.*, 1999). These results suggest that guava leaf extract could be used as a cough remedy. Also in Senegal and Peru *Psidium guajava* leaves boiled together with lemon grass (*Cymbopogon citratus*) to make a decoction

is very effective for cough and treatment of tracheobronchitis (Burkill, 1997; Joseph and Priya, 2011a).

**Hepato-protective activity:** Research using a Wister rat demonstrated that aqueous leaf extract of *Psidium guajava* was confirmed to possess the hepatoprotective effect. The leaf extract at doses of 500 mg kg<sup>-1</sup> produced significant hepatoprotection (Roy *et al.*, 2006). Pretreatment with asiatic acid (a triterpenoid extracted from *Psidium guajava* L. leaves and fruit at doses of 25, 50 mg kg<sup>-1</sup> or 100 mg kg<sup>-1</sup> significantly blocked the LPS (lipopolysaccharide) and (D-galactosamine) D-GalN-induced increases in both serum aspartate amino transferase and serum alanine amino transferase levels, showing improved nuclear condensation and ameliorated proliferation with less lipid deposition (Gao *et al.*, 2006).

**Antioxidant activities:** Cellular damage or oxidative injury arising from free radicals or Reactive Oxygen Species (ROS) now appears to be the fundamental mechanism underlying a number of infections, human neurodegenerative disorders, diabetes, inflammation, viral infections, autoimmune pathologies and digestive disorders. Free radicals are generated through normal metabolism of drugs, environmental chemicals and other Xenobiotics as well as endogenous chemicals especially stress hormones (Masuda *et al.*, 1999). *Psidium guajava* L. has been used as health tea (Jimenez-Escrig *et al.*, 2001) and contains copious amounts of phenolic phytochemical which inhibit peroxidation reaction in the living body and therefore, can be expected to prevent various chronic diseases such as diabetes, cancer and heart diseases (Kimura *et al.*, 1985). The decrease of free radicals has antioxidising effect in the body due to the guava leaf polyphenols that prevent arterial sclerosis, thrombosis, cataract and inhibition of senescence changes of the body and skin (Kimura *et al.*, 1985). The antioxidant activity of lyophilized leaf extracts was determined using free radical DPHH (2, 2-diphenyl-1-picrylhydrazyl) in tissues and the results obtained showed that the ascorbic acid component of the leaves was substantially more powerful antioxidant than the extracts from guava leaf (Qian and Nihorimbere, 2004). These antioxidant properties are associated with its phenolic compounds such as protocatechic acid, ferulic acid, Quercetin, guavin ascorbic acid, gallic acid and caffeic acid (Thaipong *et al.*, 2005). Guava leaf extracts and fruits are a potential source of natural antioxidants (Yan *et al.*, 2006). Several studies revealed that guava fruits also exert antioxidant action, collagen formation and radio protective activity in the assay with technetium-99 m (Yan *et al.*, 2006).

**Anticancer effects:** Some recent reports have indicated that *Psidium guajava* possess anticancer activity. The aqueous extract of *Psidium guajava* leaves inhibited the viability of cancer cell line DU-145 in a dose dependent manner. At 1.0 mg mL<sup>-1</sup>, the extract reduced the viability of Pca DU-145 (the androgen independent Pca cells) to 36.1% and 3.6%, respectively after 48 and 72 h of incubations (Salib and Michael, 2004). Essential oil leaf extracted from *Psidium guajava* L. was reported to be highly effective in reducing the growth of human mouth epidermal carcinoma and murine leukemia (P388). Guava leaf oil showed the highest antiproliferative activity with an IC<sub>50</sub> value of 0.0379 mg mL<sup>-1</sup> (four times more potent than vincristine) on P388 cell lines (Salib and Michael, 2004). Another study also demonstrated a chemo preventive activity of a methanol leaf extract on mice, in case of induced cancer inoculated with B16 melanoma cells. Anti tumor effect was evaluated from jacoumaric acid (isolated from guava seeds). It was also reported to reduce the incidence of tumors significantly (Salib and Michael, 2004). These findings suggested that *Psidium guajava* L. extracts have the potential to be developed as new chemotherapeutic agent to inhibit the growth of tumors and cancers (Salib and Michael, 2004).

**Cardiovascular effects:** Cardiovascular activities of *Psidium guajava* has been reported in a study of an aqueous leaf extract of *Psidium guajava* L. which showed cardioprotective effects against myocardial ischemia-reperfusion injury in isolated rat hearts. Ojewole (2005) reported using cholinergic mechanisms of an aqueous leaf extract of *Psidium guajava* that caused hypotension in the experimental animal model. Significant reduction in systemic arterial blood pressures and heart rates of hypertensive animal were noticed after acute intravenous administrations of the leaf extract. An Aqueous leaf extract of *Psidium guajava* L. produce contraction of the aorta rings significantly in a dose-dependent manner (0.25-2 mg mL<sup>-1</sup>). The sensitivity of the aortic rings to cumulative doses of *Psidium guajava* L. was significantly enhanced in the presence of phentolamine, suggesting that the effect of *Psidium guajava* L. was to a large extent mediated by activation of an alpha-adrenoceptor and to a lesser extent by activating via calcium ion channels (Olatunji-Bello *et al.*, 2007).

**Antihyperglycemic activity:** The alarming increase in diabetes mellitus is becoming a serious problem to human health in all parts of the world particularly Nigeria. With the distinctive ethno medical opinions and natural medicines mainly originated in herbs, traditional medicine offers good clinical opportunities and shows a brighter

future in the therapy of diabetes mellitus and its complications. During various episodes of screening of medicinal plant extract from *Psidium guajava*. The decoction of the leaves was screened for hypoglycemic activity in alloxan induced diabetic rats. In both acute and sub acute tests, the extract showed a significant hypoglycemic activity (Mukhtar *et al.*, 2004). Another study revealed that treatment with *Psidium guajava* L. aqueous leaf extract (0.01-0.625 mg mL<sup>-1</sup>) also showed significant inhibition on LDL glycation in a dose-dependent manner. Tannins, flavonoids, pentacyclic triterpenoids, guajaverin, quercetin and other chemical compounds present are speculated to account for the observed hypoglycemic and hypotensive effects of the leaf extract (Wang *et al.*, 2005). The antiglycation activities of guava fruit are directly related to its polyphenolic content (extractable polyphenols 2.62-7.79%), yet fruit of *Psidium guajava* L. also possess specific and somewhat different degree of free radical scavenging ability (Cheng and Yang, 1983).

**Anti-inflammatory and analgesic effect:** A decoction of *Psidium guajava* L. leaves was used worldwide for the treatment of various inflammatory diseases including rheumatism. The anti-inflammatory property of an aqueous leaf extract was investigated in rats using fresh egg albumin induced paw edema while the analgesic effect of the plant extract was evaluated by the hot plate and acetic acid test models of pain in mice (Ojewole, 2006). Anti-inflammatory and analgesic activities of 70% ethanol extract of leaves were also investigated in rats. Extracts which exhibited an anti-inflammatory activity were screened for analgesic activity using the Randall-Selitto method in rats. *Psidium guajava* L. leaves showed significant anti-inflammatory activity at a dose of 300 mg kg<sup>-1</sup>, p.o. The essential oil at 0.8 mg kg<sup>-1</sup> significantly reduced edema formation induced by carrageenan while at 0.4 and 0.8 mg kg<sup>-1</sup> the oil also significantly reduced granuloma formation induced by cotton pellets (Winter *et al.*, 1962; Hess *et al.*, 1972; Kavimani *et al.*, 1997; Olajide *et al.*, 1999). The hexane, ethyl acetate and methanol extracts of *Psidium guajava* L. leaves exhibited most antinociceptive effects in chemical and thermal tests of analgesia. The young leaves and shoots are used for inflammation of the kidney and kidney problems (Ticzon, 1997) especially in India (Ayensu, 1978).

**Central nervous system related activity:** A study showed that the leaves of the guava tree in decoction is used for spasms, epilepsy and other cerebral affections (Ticzon, 1997). The relaxant properties of *Psidium guajava* L.

extract are largely due to the presence of terpenes, especially caryophylleneoxide and  $\beta$ -selinene which potentiate pentobarbital sleeping time and the latency of convulsions induced by leptazol in mice (Meckes *et al.*, 1996). The leaf infusion is used in India for cerebral infections (Ayensu, 1978) while the tincture has been employed by rubbing it into the spine of children suffering from convulsions and in psychiatry when used as tonic (Zakaria and Mohd, 1994). An extract were used for epilepsy and chorea (any of several degenerative nervous disorders characterized by spasmodic movements of the body and limbs) (Quisumbing, 1978).

**Antiseptic effects:** A decoction of the leaves is used as a vaginal and uterine wash, especially in leucorrhoea in Uruguay where it can be infused and applied as a douche (Conway, 2001). The leaves in decoction are recommended for uterine hemorrhage. The same decoction is used as a wash for vaginal and uterine problems and especially where an astringent remedy is needed (Ticzon, 1997). In Senegal water boiled with the leaves has been used to assist menstruation (Burkill, 1997). While In Brazilian and Peruvian medicine the leaves are used for vaginal discharges, menstrual pain and hemorrhages. Also in Brazil a decoction is used externally for vaginal irritation and discharges (Joseph and Priya, 2011b).

**Oral care:** The presence of bioactive compounds comprised of saponins, tannins, flavonoids and alkaloids are responsible for their effectiveness when used as chew-sticks in the lagoon area of coastal Ivory Coast (Burkill, 1997). The tender leaves are chewed for bleeding gums and bad breath and it is said to prevent hangovers especially if chewed before drinking. Indians throughout the Amazon gargle a leaf decoction for mouth sores and bleeding gums while in Brazil guava is considered as an astringent and diuretic as for the same conditions as in Peru (Joseph and Priya, 2011b). Another study conducted in southern Nigeria using chewing sticks without toothpaste in cleaning teeth yielded an efficient, effective and reliable result. The teeth were physically strong, clean, fresh and devoid of dental plaques and carries. These results indicate the basis for the preventive and protection of the teeth against caries and plaques (Burkill, 1997). In Ghana and Nigeria the leaves are chewed to relieve toothache (Burkill, 1997) and a decoction of the root-bark is also recommended as mouthwash for swollen gums whereas the leaves makes an efficacious gargle for swollen gum, ulceration of the mouth and bleeding gums (Conway, 2001).

**Effects on skin:** The benefits are many as the plant can provide astringency in terms of wound healing and skin damage repair properties that follows the ethnopharmaceutical traditions of the plant. In Mexico the leaves are used as a remedy for itches and the leaves in decoction are used as a wash for ulcers especially where an astringent remedy is needed (Ticzon, 1997). Decoctions of the bark, leaves or flower infusion were used topically for wounds, ulcers and skin sores in the Amazon (Joseph and Priya, 2011a). The use of the flowers may be applicable in eye products for their soothing effect. A solvent extraction of the *Psidium guajava* leaves had an antiallergic activity. *Psidium guajava* cream may be a valuable adjunctive therapy in the management of atopic dermatitis (Suzuki *et al.*, 2000). The astringent, unripe fruit, the leaves, the cortex of the bark and roots in a form of a decoction were used for washing ulcers and wounds in the Philippines (Quisumbing, 1978). Locally, decoction of the leaves is employed in scurvy and for unhealthy ulcers (Nadkarni and Nadkarni, 1999). The decocted leaves are used in Mexico for cleansing ulcers and the grounded leaves makes an excellent poultice (Nadkarni and Nadkarni, 1999) particularly when mixed with kaolin and water to make a paste which is applied in Ghana to the body as an ointment for measles (Burkill, 1997). In Brazil guava is used in decoction externally for skin ulcers (Joseph and Priya, 2011a).

**Conjunctivitis:** The flowers are used as a poultice for conjunctivitis (Ayensu, 1978). In the Amazon, the flowers are also mashed and applied to painful eye conditions such as sun strain, conjunctivitis or eye injuries (Joseph and Priya, 2011a).

**Anti stress activity:** A study showed that an ethanol extract of the *Psidium guajava* L. were investigated for anoxia stress tolerance test and swimming endurance test in Swiss mice and showed significant adaptogenic activity against the stress models (Echemendia and Moron, 2004).

**Anti-allergic effects:** Apart from these above mentioned activities *Psidium guajava* also showed antiallergic effects. An aqueous and methanolic extract of *Psidium guajava* L. were reported to cause potent inhibition of histamine release from mast cells. *Psidium guajava* L. leaf extracts also showed anti-allergic activity on T cell immunity in mice (Manosroi *et al.*, 2006).

## CONCLUSION

In a decade of extensive research, great progress has been achieved in the discovery of potential

pharmacological agents from natural sources. A number of natural products have been used as lead compounds because of its specific activity and low toxicity. This review presented numerous evidences of its strong antidiarrhoeal, antimicrobial, antioxidant, antihyperglycemic, anti inflammatory, analgesic, antinociceptive and so many other activities. *Psidium guajava* L. has received much attention in the literature over the past 10 years and a variety of potential beneficial effects have been elucidated. The fruit as well as its juice is freely consumed for its great taste and nutritional benefits however, it is imperative that more clinical and pharmacological studies should be conducted to investigate the unexploited potential of this plant.

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