Review Article

Psidium guajava: Multipurpose Medicinal Herb

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Received: 18-09-2019; **Revised:** 26-10-2019; **Accepted:** 03-11-2019.

ABSTRACT

Guava (*Psidium guajava* L.) belongs to the Myrtaceae family, which has more than 80 genera and 3,000 species distributed throughout the tropics and subtropics. *Psidium guajava* is an evergreen shrub or small tree native to the Caribbean, Central America and South America. The following article describes information about medicinal uses of *P. guajava* leaves along with its description concerning about its botany, chemistry. Alkaloids, carotenoids, phenols, flavonoids especially Quercetin is found as a major component. The article contains information about effective uses of different parts of *P. Guajava* in human health maintenance as well as for veterinary purpose. *Psidium guajava* is widely cultivated in tropical and subtropical regions around the world; guava fruits can range in size from as small as an apricot to as large as a grapefruit. Various cultivars have white, pink, or red flesh, and a few also feature red (instead of green or yellow) skin.

Keywords: *Psidium guajava*, guava, myrtaceae, quercetin, carotenoids.

INTRODUCTION

Psidium guajava, the common guava, yellow guava, or lemon guava (known as goiaba in Portuguese and guayaba in Spanish) is an evergreen shrub or small tree native to the Caribbean, Central America and South America. It is easily pollinated by insects; in culture, mainly by the common honey bee, Apis Mellifera. In Indonesia, Guava leaves are commonly used to treat diarrhoea, gastroenteritis and other digestive complaints, while the Guava fruit has been used to increase platelets in patients with dengue fever.[1]

Quercetin is one of the most abundant flavonoids found in guava leaf. Much of guava's therapeutic activity is attributed to these flavonoids. The flavonoids have demonstrated antibacterial activity. Quercetin is thought to contribute to the anti-diarrhoeal effect of guava; it is able to relax intestinal smooth muscle and inhibit bowel contractions. Extract of guava leaves also showed anti-proliferative activity.[2] Guava leaves showed anti proliferative activity in in-vitro tests using leukaemia cells. Its activity was 4.37 times more than the activity of vincristine. Moreover, water extract of guava leaves was described to be effective against a number of microbial strains and anti-rotavirus activity.[2] In general, biological properties of guava have been already associated with its polyphenolic compounds such as, protocatechuic, ferulic, ascorbic, gallic and caffiec acids and quercetin. Polyphenols are secondary metabolites of plants. The polyphenolic compounds found in the extracts of guava fruits and leaves can act as an immunostimulant that may boost immune system and also attribute antioxidant properties. [3]

Guavas are rich in dietary fibres, vitamins A and C, folic acid, and the dietary minerals, 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.

The aim of the present review was to determine the potential of *Psidium guajava* plant in various health related problems. In addition, we would also determine about group of active compounds present in *Psidium guajava* that plays vital role in health management.

Synonyms:

Psidium cujavillus burm.; *Psidium pomiferum* L.; *Psidium pumilum* Vahl; *Psidium pyriferum* Linn.[4]

Common Names:

Guava, lemon guava, mpera (Kiswahili), mubera (Kikuyu), mupeera (Luganda).[5]

Family- Myrtaceae

Table 1: Scientific Classification

Kingdom:	Plantae
***Clade*:**	Angiosperms
***Clade*:**	Eudicots
***Clade*:**	Rosids
Order:	Myrtales
Family:	Myrtaceae
Genus:	*Psidium*
Species:	*Psidium guajava*

Figure 1: Image of guava leafs and flower

Figure 2: Image of Guava fruit

Related Species

The cattley, or strawberry guava (*Psidium cattleianum*) is considerably more frost-resistant than the common guava. It occurs in two forms: one has fruits with a bright yellow skin, and the other has fruits with a purplish red skin. The plant is a large shrub with thick glossy green oval leaves and white flowers. This species is frequently planted in gardens throughout southern California and other subtropical regions but is not commercially important. The fruits are round, up to 5 cm (2 inches) in diameter, and contain many hard seeds. The soft pulp has a strawberry-like flavour.

Figure 3: *Psidium cattleianum* plant[6]

Other guavas include the *cás,* or wild guava, of Costa Rica (*P. friedrichsthalianum*) and the *guisaro,* or Brazilian guava (*P. guineense*), both of which have acidic fruits. The so-called pineapple guava, or feijoa (*Acca sellowiana*), is an unrelated species. [6]

History

Guava is native to the American tropics. English name Guava probably came from the Haitian name, Guajaba. The Spanish explorers took the guava to the Philippines and Portuguese disseminated it from the Philippines to India. Then it spreaded easily and rapidly throughout the tropics because of the abundance of the seeds with long viability and became naturalized to such extent that people in different countries considered guava to be indigenous to their own region. It is now known in subtropics.[7]

DESCRIPTION

Psidium guajava is a shrub or small tree usually growing 1-6 m tall, but occasionally reaching 10 m in height. The older stems are covered in a light reddish-brown, smooth bark that peels off in flakes. This sometimes gives the trunks a mottled appearance, because the newly revealed bark is somewhat greenish-brown in colour. Younger stems are greenish in colour, hairy (pubescent), and somewhat four-angled (quadrangular).

The flowers are usually borne singly in the upper leaf forks (axils). These flowers are about 25 mm across and are borne on a hairy stalk (pubescent peduncle) 1-2.5 cm long. Each flower has four or five green sepals (6-15 mm long) that are fused together at the base and four or five white petals (10-20 mm long). They also have large numbers (200-250) of small white stamens (6-10 mm long) and a style (6-12 mm long) topped with a stigma.

The fruit is either rounded (globose), egg-shaped (ovoid) or pear-shaped (pyriform) and turns from green to yellowish in colour as it matures. These berries (2.5-10 cm long) are crowned with the remains of the persistent sepals (calyx lobes) and have a juicy pink, white or yellowish coloured pulp containing numerous seeds. The seeds are yellowish in colour and kidney-shaped (reniform). Both planted and wild trees are used for fruit which aids their spread.

The leaves are simply oppositely arranged along the stems and are borne on short stalks (petioles) 4-10 mm long. The leaf blades (7-15 cm long and 3-7 cm wide) are somewhat oval in shape (ovate-elliptic or oblong-elliptic) with rounded or pointed tips (obtuse or acute apices) and rounded (obtuse) bases. They have hairy (pubescent) undersides (especially when young are generally dull green in colour), and have entire margins. Each leaf has a prominent central vein (midrib) and 10-20 pairs of side veins (lateral veins).[5]

Forage Management

Guava is propagated both by seeds and vegetatively. In the wild, the seeds are spread by birds and in some places it has become a troublesome weed of pastures. Average yields of fruit from improved trees may be between 12-15 t/ha and up to 50 t/ha have been obtained. Guava trees that have been vegetatively propagated start bearing fruit 2-3 years after planting and are fully productive at 8-9 years. Guava trees propagated from seed require more time for fruit production. In India, 8-10 year old trees from seedlings may produce 400-500 fruits per year while grafted trees at the same age may produce 1000-2000 fruits. Guava can be harvested all year round. The fruit is ready to be harvested when it is yellow. In agroforestry systems, guava can be intercropped with fodders plants such as maize, sorghum and cowpea. The fruits are most commonly harvested by hand. [4]

MICROSCOPY OF THE LEAF

Shape:

Leaves are dorsiventral with prominent midrib, 1.4 mm thick, broadly concave adaxial side and wavy shallow ridges with furrow and lamina being vertical in orientation (Fig 4).

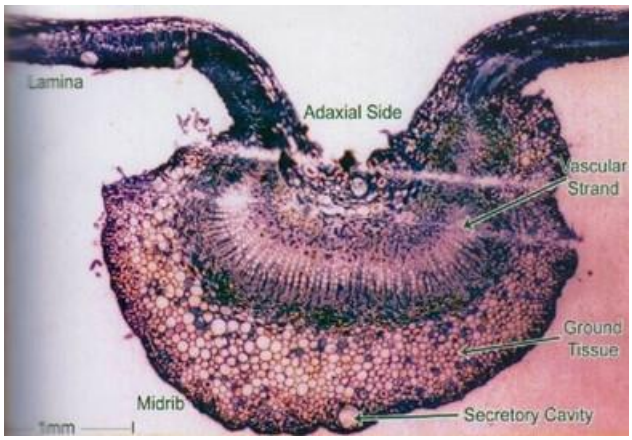


Figure 4: T.S through midrib of *Psidium guajava*

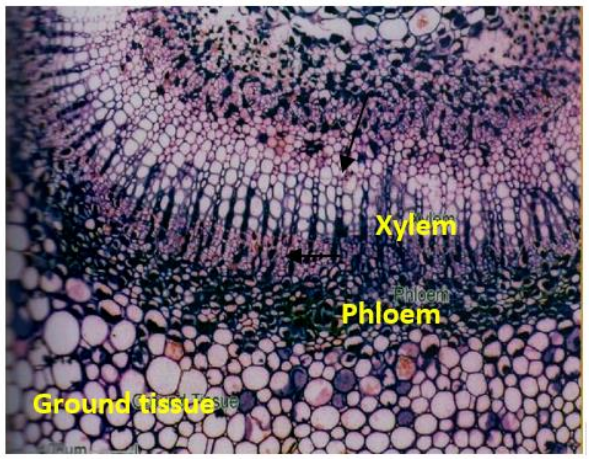


Figure 5: T.S showing Vascular Bundle

Vascular bundle

Wide, thin deeply bowl shaped. Xylem thin walled angular in outline occur in short parallel lines (1.9 mm in horizontal plane and 150µm thick. Phloem element occurs at the end of the xylem, as small nests (Fig 5).

Lateral vein: Elliptical collateral vascular bundle with parenchymatous bundle sheath.

Mesophyll: Palisade zone is one or two layered, short, cylindrical compact cells and five layers of short vertically compact cells.

Ground Tissue: Parenchymatous, thin walled less compact, less tanniferous. Secretory cavities are more frequent in the abaxial part.

Epidermis: 230µm thick, smooth and even. The adaxial epidermis is thin with narrow tubular cells. The subdermal layers of the cells are dilated, four layered, and rectangular without tannins. Calcium oxalate druses in a dilated cell are frequently seen in the adaxial epidermis (Fig 6).

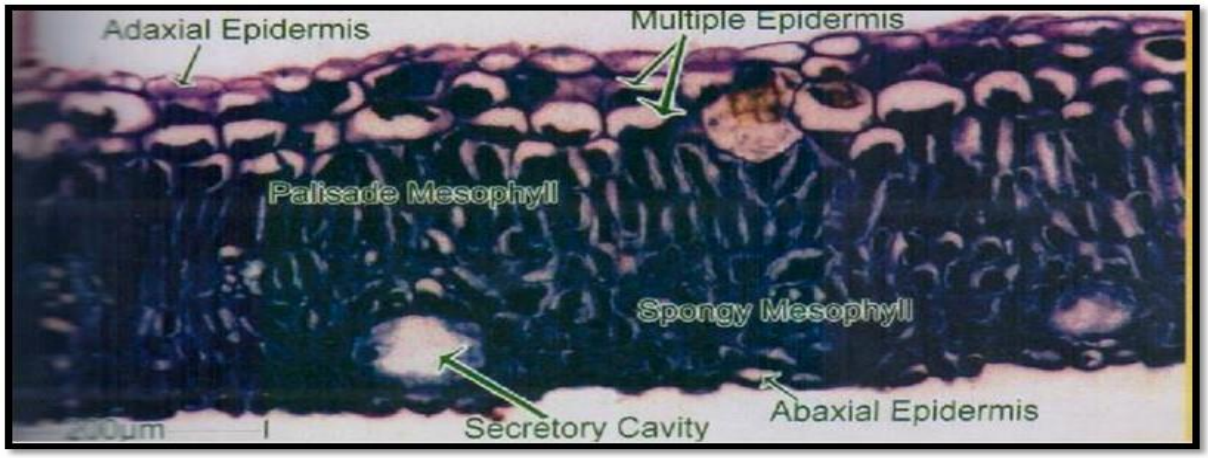
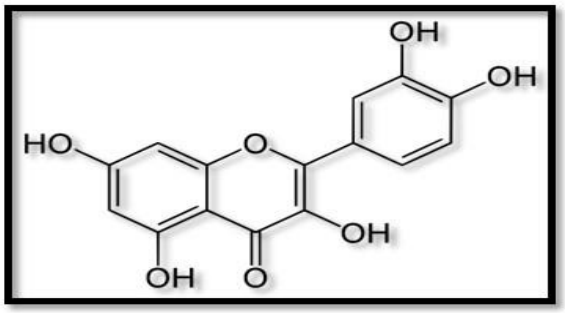


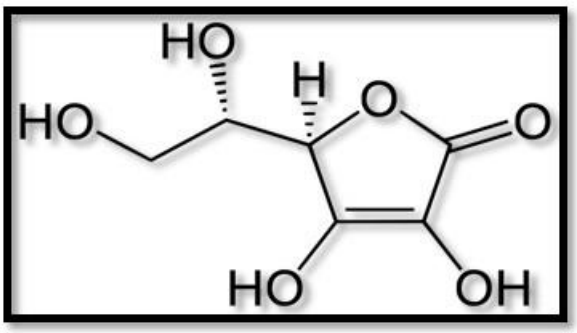
Figure 6: T.S of Lamina showing epidermis

CHEMICAL CONSTITUENTS OF *PSIDIUM GUAJAVA*

The guava fruit - contains vitamin A, C, phosphorus, iron and calcium. It contains more vitamin C than that of orange. The fruit contains saponin, oleanolic acid, lyxopyranoside, arabopyranoside, guaijavarin, quercetin and flavonoids.[8-10] Citric acid and acetic acid are the major ingredients of guava that play major role in anti-mutagenic activity.[8,11] The chemical structures of quercetin and ascorbic acid are given below-

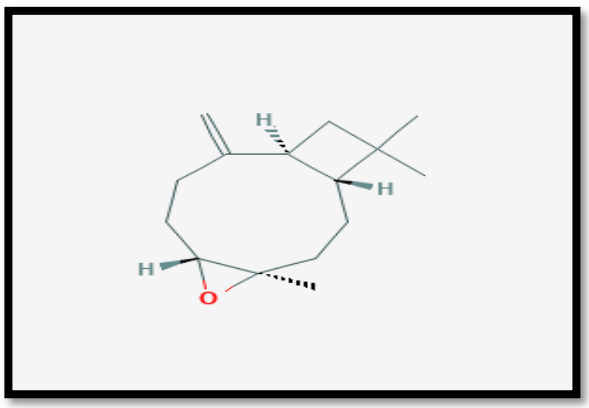


QUERCITIN



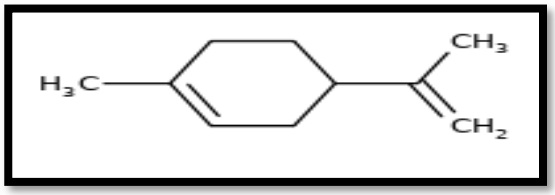
ASCORBIC ACID

The skin of fruit - contains ascorbic acid in very high amount; however, it may be destroyed by heat. Carbonyl compounds credits strong pleasent smell.[8, 12] Guava fruit contains terpenes, caryophyllene oxide and p-selinene in large quantity which produce relaxation effects.[8, 13] The methanolic extract of guava contains high content of flavonoids.[8, 14] There are 41 hydrocarbons 25 esters, 13 alcohols and 9 aromatic compounds in guava.[8, 15] Titratable acidity and the total soluble solids are present in fruit. Guajadial is also present in guava.[8, 16]



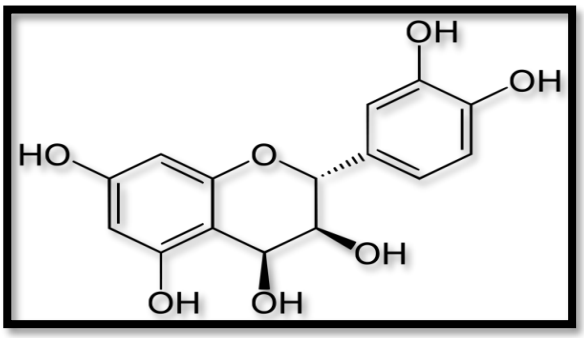
CARYOPHYLLENE OXIDE

Leaves - which contains essential oils such as isopropyl alcohol, menthol, α-pinene, terpenyl acetate, limonene, β-pinene, caryophyllene, longicyclene and β-bisabolene. Oleanolic acid is also found in the guava leaves.[8, 17] Leaves have high content of limonene about 42.1% and caryophyllene about 21.3%.[8, 18] Leaves of guava have a lot of volatile compounds.[8, 19, 20]



LIMONENE

The bark includes - 12–30% of tannin and one of the sources declares that it includes tannin 27.4%, or polyphenols, resin and the crystals of calcium oxalate. Tannin is also present in roots. Leukocyanidins, gallic acid and sterols are also present in roots. Carbohydrates with salts are present in abundance. Tannic acid is also its part.[8]



LEUKOCYANIDINS

TRADITIONAL USES OF GUAVA LEAVES IN PRINCIPAL PRODUCER COUNTRIES

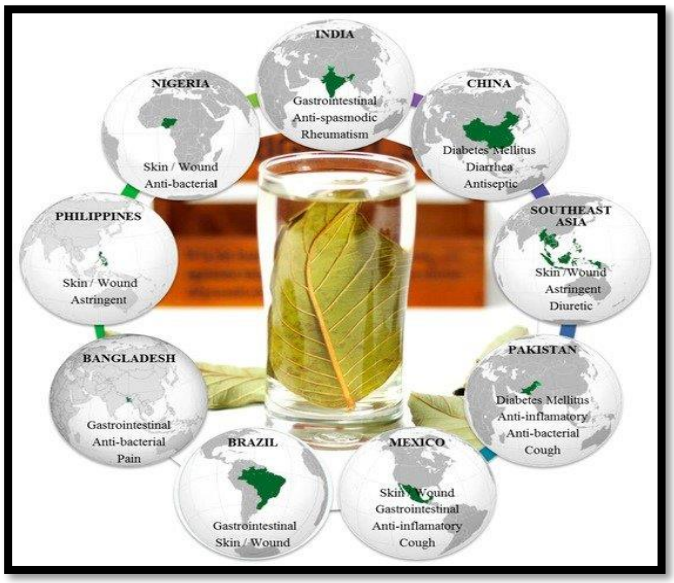


Figure 7: Traditional uses of *P. guajava* in different countries[21]

Multiple Uses of *Psidium guajava*

- **Diarrhoea**

Quercetin is a major flavonoid and one of the most reported active constituents found in guava leaf, which has been demonstrated to reduce capillary permeability in the abdominal cavity as well as it also inhibit intestinal movement in an *in vitro* model using guinea pig ileum. [22, 23] However, *Birdi et al.* demonstrated that quercetin alone had limited antidiarrheal activity and that the crude guava decoction was found to be more effective. [22, 24] Thus, it can be seen that guava can be used for the treatment of infectious diarrhoea caused by a wide spectrum of pathogens as well as physiological diarrhoea. [22]

Laboratory investigations

In study conducted for assessing antidiarrheal activity of aqueous extract of guava leaves in Sprague–Dawley rats, it was shown that fresh extract at a dose of 0.2 ml/kg (equivalent to 0.2 mg/kg of the standard morphine sulfate) produced 65% inhibition of propulsion in the small intestine of experimental animals treated with Microlax. [22, 25] Aqueous leaf extract when given orally (50–400 mg/kg) significantly delayed the onset of castor oil-induced diarrhoea, decreased the frequency of defecation, and reduced the severity of diarrhoea in mice and rats. [22, 26]

- **Respiratory Infections**

Guava leaves were mentioned as a remedy for cough during an ethnobotanical survey in Guerrero, México, in Malaysia, in South Africa, as well as of the Monpa ethnic group located in Arunachal Pradesh, India. [22, 27] In North Sikkim, India, use of raw young leaves and also tender shoots of guava has been cited to be effective for sore throat and cough. [22, 28] As a remedy for tuberculosis, the macerated bark of guava was cited by locals of Ogun State, Nigeria. Guava leaves are also used for treating tuberculosis in patients with HIV-AIDS in Tanzania. [22, 29]

Laboratory investigations

The anticough activity of aqueous guava leaf extract following induction with capsaicin aerosol has been evaluated in guinea pigs and rats. As compared to the control, when given orally, this study reported 35% and 54% decrease in frequency of cough at doses of 2 and 5g/kg, respectively. The dichloromethane-methanol extract (1mg/ml) and aqueous leaf extract (4mg/ml) were found to be effective against different respiratory pathogens such as Cryptococcus neoformans, K. pneumonia, Moraxella catarrhalis, Mycobacterium smegatis, and S. aureus. [22]

- **Skin Related problems**

In Tahiti, Samoa, guava shoots have been used as skin tonic, and in the Philippines, guava leaves are used for treatment of scabies by indigenous groups. [22, 30, 31]

Laboratory investigations

The antibacterial activity of organic extract of guava leaves against bacteria clinically isolated (*Proteus mirabilis*, *Streptococcus pyogenes*, *E. coli*, *S. aureus*, and *Pseudomonas aeruginosa*) from patients with surgical wound, burns, and skin and soft tissue infections has been reported by Abubakar. The MIC and minimum bacterial count values ranged between 6.25 and 50 mg/ml. In addition, in a mouse model, cream containing aqueous extract of guava leaves has been demonstrated to be effective on 2, 4-dinitrochlorobenzene-induced atopic skin lesions. Beneficial effect of ethyl acetate extract of guava leaves on atopic dermatitis has also been demonstrated. [22]

- **Cardiovascular and Hypertensive disorder**

Guava leaves have been used in treatment of hypertension in Cuba, [32] Nigeria, [33] and Togo [34]. It has been reported to show significant reduction in systemic arterial blood pressure and heart rates. [22]

Laboratory investigations

Aqueous leaf extract of guava showed cardioprotective effects when studied in models of ischemia. In addition, experiments following intravenous administration of the aqueous leaf extract (50–800 mg/kg) in Dahl salt-sensitive rats showed a dose-dependent, significant reduction in systemic arterial blood pressure and heart rates in hypertensive animals. In an in vitro study, Belemtougri *et al*. found that aqueous and ethanolic guava leaf extracts inhibited the release of intracellular calcium within the skeletal muscles of rats. Aqueous leaf extract also significantly contracted the aorta rings in a dose-dependent manner (0.25–2 mg/ml). [22]

- **Diabetes**

The use of powder of guava fruit with buttermilk, consumed twice a day for 15 days, was reported as a remedy for diabetes during an ethnobotanical survey in Andhra Pradesh, India. [22, 35] Similarly, leaves and fruits of guava were cited in a survey undertaken in Tamil Nadu, India. [22, 36] Guava was also listed among the most common plants used for diabetes in the central region of Togo. [22, 34]

Laboratory investigations

A number of animal and human studies support the antidiabetic potential of various parts of the guava plant. Ojewole reported a dose-dependent hypoglycemia in normal (normoglycemic) and streptozotocin (STZ)-treated, diabetic rats following oral administration of aqueous guava leaf extract (50–800 mg/kg). Besides the leaf extract, guava fruit and stem bark have been evaluated for their ability to reduce blood sugar levels. The significant hypoglycemic activity of the fruit extract (125 and 250 mg/kg) in STZ-induced diabetic animals and the ethanolic stem bark extract (250 mg/kg) in alloxan-induced hyperglycemic rats has been reported. Recently, different extracts of guava leaf were evaluated for their effect on glucose uptake and aldose reductase inhibitory activity at the cellular level. [22]

- **Cancer**

Based on an Ethnopharmacological survey for treating different types of cancer in West Bank Palestine, a

decoction prepared from 100g guava leaves taken daily was documented to be a remedy for curing lung and stomach cancers. [22, 37]

Laboratory investigations

Correa *et al*. recently reviewed literature related to the anticancer properties of guava. In this review, the authors have comprehensively discussed the available literature supporting the theories of its anticancer properties through various mechanisms, such as scavenging-free radicals, regulation of gene expression, modulation of cellular signalling pathways, including those involved in DNA damage repair, cell proliferation, and apoptosis. [22]

- **Immunomodulatory activity**

Psidium guajava leaf extract revealed immunomodulatory actitvity.

Laboratory investigations

Decoction of guava leaves was demonstrated to stimulate macrophages to kill E. coli strain (heat stable toxin producers) using murine monocytic cell line, J774. [38] Ethyl acetate fraction of guava leaves was shown to inhibit COX-2 expression, cytokine secretion, degranulation, and FceRI-mediated signalling in antigen-stimulated mast cells. A flavonoids fraction of guava leaf extract was shown to regulate nuclear factor KB activation in an in-vitro model system using Labeo rohita head kidney macrophages. [22]

- **Hepatoprotective**

Psidium guajava extract (250 and 500mg/kg) possesses good hepatoprotective activity.

Laboratory investigations

Aqueous leaf extract (250 and 500 mg/kg) on oral administration have shown too significantly reduce the elevated serum levels of alanine aminotransferase, alkaline phosphatise, bilirubin, and aspartate aminotransferase in acute liver damage induced by hepatotoxins in rats. [22, 39]

- **Nephroprotective**

Psidium guajava extract possesses nephroprotective activity.

Laboratory investigations

In an animal model for nephrotoxicity, ethanolic extracts of guava leaf were reported to prevent renal damage induced by paracetamol. The extracts, given orally, at 200 and 400 mg/kg normalized blood urea, blood creatinine, urinary sodium, urinary creatinine, in a dose- dependent manner. The observations were also supported by histopathology. [40]

A similar observation was also made in cisplatin-induced nephrotoxicity in rats. In addition, guava fruit extract has been shown to protect against kidney damage in diabetic rats. [22, 41]

- **Oral/Dental problems**

In Andhra Pradesh, India, leaves of guava have been documented for use in mouth ulcers, while in North Sikkim, raw young leaves and tender shoots of guava have been used for toothache and mouth ulcers. Guava leaves were commonly used by traditional healers of Cameroon for treating dental infections. Guava twigs being effective when used as “chewing sticks” has been reported by Okwu and Ekeke. [22, 42, 43]

- **Veterinary Use**

The antidiarrheal activity of guava buds and leaves has been reported in pet dogs.[44] In Java, farmers use guava leaves for treating diarrhoea in ruminants, and the root and stem of the plant are used in treating diarrhoea in sheep and goats.[45] Guava leaves, young fruits, and/or buds are boiled and mixed with mash or bran or a combination of both and given to horses suffering from diarrhoea in Trinidad. Guava has been shown to possess antibacterial activity against pathogenic bacteria in pigs.

In the Philippines, 5% and 10% guava leaf meal (dried and ground) added to pig diets was found to reduce diarrhoea in piglets. In Thailand, ground guava leaves when given as a supplement to weaned piglets prevented post weaning diarrhoea. [22, 46, 47]

CONCLUSION

In this regard, ethnomedicine applications of *Psidium guajava* L. Leaves have been verified by several researches over the last decade against many disorders, demonstrating its potential in the treatment of the most common worldwide diseases. In addition, the effects of the leaves have been related to individual compounds such as quercetin, catechin, gallic acid, peltatoside, hyperoside, isoquercitin, and guaijaverin. Its skin contains a lot of phytochemicals in fruits which is rich in vitamins (A & C), iron, phosphorus and calcium and minerals. The phenolic compounds in guava help to cure cancerous cells and prevent skin aging before time. The leaves contain many Bacteriostatic and fungistatic agents and important oxidants. Due to following biological activities it can be quite helpful for the preventions and treatments of various diseases.

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Source of Support: Nil, **Conflict of Interest:** None.