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GUAVA (*Psidium guajava* L.): A COMPREHENSIVE REVIEW

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Abstract: *Guava (Psidium guajava L.), now being recognized as "*fiberous food*" is getting very much attention in the agro-food industry due to the attractive characteristics of the fruit, such as health promoting bioactive components, functional elements etc. The fruit is considered as highly nutritious and fiberous because it contains a high level of ascorbic acid (50–300 mg/100 g fresh weight) and has several carotenoids such as phytofluene, β-carotene, β-cryptoxanthin, γ-carotene, lycopene, rubixanthin, cryptoflavin, lutein, and neochrome etc. Phenolic compounds such as myricetin and apigenin, ellagic acid, anthocyanins and flavonoids and phenolic compounds, and the total antioxidant activity present in a collection of guava and araçá accessions curated at the Embrapa Semiarido germplasm bank. Guava fruits with a red-coloured pulp flesh contained a significant amount of carotenoids, especially lycopene, and a high concentration of phenolic compounds. These compounds were largely responsible for the antioxidant activity of the araçá accessions. Among the guava accessions, phenolic compounds were also responsible for the antioxidant activity. Incorporation of fruits having several bioactive components, like guava in meat products would definitely enhance their physiological, functional and nutritional values. Till now there are no reports in the literature regarding use of guava in the meat products either as antioxidant or as a source of dietary fibre. Thus the present study reports the application of guava powder as a source of antioxidant dietary fibre in sheep meat nuggets and its effect on the various physicochemical, colour, textural and sensory characteristics of the product.*

The high antioxidant values of guava were noted by almost half the researchers as a possible contributing factor, but so were other constituents and mechanisms that continue to be researched. At least four different research groups reported high antioxidant content in guava fruit, in part from vitamin C, flavonoids (apigenin), lycopene, and possibly others.

Keywords: *Psidium guajava L., Antioxidant, Diabetes, Cancer, Antifungal and Free radical Scavenging.*

Introduction: Guava (*Psidium guajava* L.), also known locally as jambu batu, is grown commercially and in many home gardens in Malaysia. The tree is very hardy and can grow to about 7-8 metres high with characteristic smooth, pale mottled bark that peels off in thin flakes. The fruits vary in size, shape and flavour depending on the variety. The better varieties are sweet while others may be astringent. On average, the fruit contains 74–87% moisture, 13–26% dry matter, 0.5–1% ash, 0.4–0.7% fat and 0.8–1.5% protein [1]. It is rich in ascorbic acid (vitamin C), at levels far higher than most imported and local fruits. The fruit, in particular the pink flesh cultivar, has a fair amount of vitamin A (beta-carotene). Some vitamin B such as thiamin (B1), riboflavin (B2), niacin and pantothenic acid are also found in the fruit. In addition, it also contains a fair amount of phosphorous, calcium, iron, potassium and sodium [2].

Guava, as in many other fruits and vegetables, is also rich in antioxidants that help to reduce the incidence of degenerative diseases such as arthritis, arteriosclerosis, cancer, heart disease, inflammation and brain dysfunction. In addition, antioxidants were reported to retard ageing [3,4,5] besides preventing or delaying oxidative damage of lipids, proteins and nucleic acids caused by reactive oxygen species. These include reactive free radicals such as superoxide, hydroxyl, peroxyl, alkoxyl, and non radicals such

as hydrogen peroxide and hypochlorous acid. They scavenge radicals by inhibiting initiation and breaking of chain reaction, suppressing formation of free radicals by binding to the metal ions, reducing hydrogen peroxide, and quenching superoxide and singlet oxygen [6]. Among the most abundant antioxidants in fruits are polyphenols and ascorbic acid. The polyphenols, most of which are flavonoids, are present mainly in ester and glycoside forms [7]. In the case of guava, free elagic acid and glycosides of myricetin and apigenin are found to be present [8].

Guavas are common tropical fruits cultivated and enjoyed in many tropical and subtropical regions. *Psidium guajava* (common guava, lemon guava) is a small tree in the myrtle family (Myrtaceae), native to Mexico, Central America, and northern South America. Although related species may also be called guavas, they belong to other species or genera, such as the "pineapple guava" *Acca sellowiana*.

The most frequently eaten species, and the one often simply referred to as "the guava", is the apple guava (*Psidium guajava*). Guavas are typical Myrtoideae, with tough dark leaves that are opposite, simple, elliptic to ovate and 5–15 centimetres (2.0–5.9 in) long. The flowers are white, with five petals and numerous stamens. The fruits are many-seeded berries [9].

Apple guava (*Psidium guajava*) flower

The fruit, exuding a strong, sweet, musky odor when ripe, may be round, ovoid, or pear-shaped, 2 to 4 in (5-10 cm) long, with 4 or 5 protruding floral remnants (sepals) at the apex; and thin, light-yellow skin, frequently blushed with pink. Next to the skin is a layer of somewhat granular flesh, 1/8 to 1/2 in (3-12.5 mm) thick, white, yellowish, light- or dark-pink, or near-red, juicy, acid, subacid, or sweet and flavorful. The central pulp, concolorous or slightly darker in tone, is juicy and normally filled with very hard, yellowish seeds, 1/8 in (3 min) long, though some rare types have soft, chewable seeds. Actual seed counts have ranged from 112 to 535 but some guavas are seedless or nearly so.

Green mature guavas can be utilized as a source of pectin, yielding somewhat more and higher quality pectin than ripe fruits.

Classification of Guava

Botanical Name:	*Psidium guajava* L. *Var. pomiferum* L.
Family:	Myrtaceae
Used in:	Ayurveda, Siddha
English :	common guava
Hindi :	amrud, jamphal
Malayalam :	malacka-pela, pela

Marathi :	jamba, perunjaam, tupkel
Sanskrit :	amruta-phalam, aprithaktvacha, bahu-bija-phalam, dridhabija, madhuramla, mansala, mrduphalam, mridu, perala, peruka, perukah, perukam, pita, tuvara, vastula
Tamil :	amirtapala, ampalakkani, avakacitam, avakacitamaram, cenkoyyamaram, cikappu, cikappukkoyya, irattakkoyyamaram, irattakoyya, irattamatappal, irattamatappalmaram, jaram, kalarkacikam, kalarkacikamaram, kalippacitam, kalippacitamaram, palaccaram, palaccaramaram, perunkoyya, tavitatikam, tavitatikamaram, uyyakkontan , uyyakontan
Telugu:	errajama, gova, goyya, jaama pandu, jaamachettu, thellajaama

Food value per 100 g of edible portion

Calories	36-50
Moisture	77-86 g
Crude Fiber	2.8-5.5 g
Protein	0.9-1.0 g
Fat	0.1-0.5 g
Ash	0.43-0.7 g
Carbohydrates	9.5-10 g
Calcium	9.1-17 mg
Phosphorus	17.8-30 mg
Iron	0.30-0.70 mg
Carotene (Vitamin A)	200-400 I.U.
Thiamine	0.046 mg
Riboflavin	0.03-0.04 mg
Niacin	0.6-1.068 mg
Vitamin B3	40 I.U.
Vitamin G4	35 I.U.

Nutritional value per 100 g (3.5 oz)

Energy	285 kJ (68 kcal)
Carbohydrates	14.32 g
Sugars	8.92 g
Dietary fiber	5.4 g
Fat	0.95 g
Protein	2.55 g

Vitamins in Guava

Vitamins	**Quantity**	**Percentage**
Vitamin A equiv.	31 µg	4%
beta-Carotene	374 µg	3%
Thiamine (B1)	0.067 mg	6%
Riboflavin (B2)	0.04 mg	3%
Niacin (B3)	1.084 mg	7%
Pantothenic acid (B5)	0.451 mg	9%
Vitamin B6	0.11 mg	8%
Folate (B9)	49 µg	12%
Vitamin C	228.3 mg	275%
Vitamin K	2.2 µg	2%

Minerals in Guava

Minerals	**Quantity**	**Percentage**
Calcium	18 mg	2%
Iron	0.26 mg	2%
Magnesium	22 mg	6%
Manganese	0.15 mg	7%
Phosphorus	40 mg	6%
Potassium	417 mg	9%
Sodium	2 mg	0%
Zinc	0.23 mg	2%
Other constituents	**Quantity**	
Lycopene	5204 µg	

Ascorbic acid–mainly in the skin, secondly in the firm flesh, and little in the central pulp–varies from 56 to 600 mg. It may range up to 350-450 mg in nearly ripe fruit. When specimens of the same lot of fruits are fully ripe and soft, it may decline to 50-100 mg. Canning or other heat processing destroys about 50% of the ascorbic acid. Guava powder containing 2,500-3,000 mg ascorbic acid was commonly added to military rations in World War II. Guava seeds contain 14% of aromatic oil, 15% protein

and 13% starch. The strong odor of the fruit is attributed to carbonyl compounds.

Botany: P. *guajava* is a large evergreen shrub or small tree that grows up to 15 m in height. It is native to and widely distributed in Mexico and Central America and is common throughout all warm areas of tropical America and the West Indies. Today, the plant is cultivated from Asia to the west coast of Africa, with varieties originally introduced over the past 300 years from the United States.

History: Tea made of guava leaves are considered as medicinal. The tender leaves of the plant have been used as a tonic to treat digestive conditions such as dysentery and diarrhea in the indigenous medical systems of Brazil and Mexico. Mexican medicinal data document the treatment of acute diarrhea, flatulence, and gastric pain by using a guava leaf water decoction for oral administration 3 times daily. A decoction of tender leaves has been prescribed as a febrifuge and a spasmolytic. In Bolivia and Egypt, guava leaves have been used to treat cough and pulmonary diseases; they have also been used to treat cough in India and as an anti-inflammatory and haemostatic agent in China.

Guava bark has been used medically as an astringent and to treat diarrhea in children, while the flowers have been used to treat bronchitis, eye sores and to cool the body. The fruit has been used as a tonic and laxative and also for treatment of bleeding gums. The plant has been used in Africa and Asia to prevent and treat scurvy. It is used to treat hypertension in western Africa. Ethno medicinal reports document use of the plant in treating malaria.

Guavas are rich in dietary fiber, 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. However, nutrient content varies across guava cultivars. Although the strawberry guava (*P. littorale var. cattleianum*) has about 25% of the amount found in more common varieties, its total vitamin C content in one serving (90 mg) still provides 100% of the Dietary Reference Intake for adult males.

Plant Chemicals: Guava is rich in tannins, phenols, triterpenes, flavonoids, essential oils, saponins, carotenoids, lectins, vitamins, fiber and fatty acids. Guava fruit is higher in vitamin C than citrus (80 mg of vitamin C in 100 g of fruit) and contains appreciable amounts of vitamin A as well. Guava fruits are also a good source of pectin - a dietary fiber. The leaves of guava are rich in flavonoids, in particular, quercetin. 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-diarrhea effect of guava; it is able to relax intestinal smooth muscle and inhibit bowel contractions. In addition, other flavonoids and triterpenes in guava leaves show antispasmodic activity. Guava also has antioxidant properties which are attributed to the polyphenols found in the leaves.

Guava's main plant chemicals include: alanine, alpha-humulene, alpha-hydroxyursolic acid, alpha-linolenic acid, alpha-selinene, amritoside, araban, arabinose, arabopyranosides, arjunolic acid, aromadendrene, ascorbic acid, ascorbigen, asiatic acid, aspartic acid, avicularin, benzaldehyde, butanal, carotenoids, caryophyllene, catechol-tannins, crataegolic acid, D-galactose, D-galacturonic acid, ellagic acid, ethyl octanoate, essential oils, flavonoids, gallic acid, glutamic acid, goreishic acid, guafine, guavacoumaric acid, guaijavarin, guajiverine, guajivolic acid, guajavolide, guavenoic acid, guajavanoic acid, histidine, hyperin, ilelatifol D, isoneriucoumaric acid, isoquercetin, jacoumaric acid, lectins, leucocyanidins, limonene, linoleic acid, linolenic acid, lysine, mecocyanin, myricetin, myristic acid, nerolidiol, obtusinin, octanol, oleanolic acid, oleic acid, oxalic acid, palmitic acid, palmitoleic acid, pectin, polyphenols, psidiolic acid, quercetin, quercitrin, serine, sesquiguavene, tannins, terpenes, and ursolic acid. Euginol.

Other Uses

Wood: The wood is yellow to reddish, fine-grained, compact, moderately strong, weighs 650-750 kg per cubic meter; is durable indoors; used in carpentry and turnery. Though it may warp on seasoning, it is much in demand in Malaya for handles; in India, it is valued for engravings. Guatemalans use guava wood to make spinning tops, and in El Salvador it is fashioned into hair combs which are perishable when wet. It is good fuel wood and also a source of charcoal.

Leaves and Bark: The leaves and bark are rich in tannin (10% in the leaves on a dry weight basis, 11-30% in the bark). The bark is used in Central America for tanning hides. Malayans use the leaves with other plant materials to make a black dye for silk. In Southeast Asia, the leaves

are employed to give a black color to cotton; and in Indonesia, they serve to dye matting.

Wood flowers: In Mexico, the tree may be parasitized by the mistletoe, *Psittacanthus calyculatus* Don, producing the rosette-like malformations called "wood flowers" which are sold as ornamental curiosities.

Medicinal Uses: The roots, bark, leaves and immature fruits, because of their astringency, are commonly employed to halt gastroenteritis, diarrhea and dysentery, throughout the tropics. Crushed leaves are applied on wounds, ulcers and rheumatic places, and leaves are chewed to relieve toothache. The leaf decoction is taken as a remedy for coughs, throat and chest ailments, gargled to relieve oral ulcers and inflamed gums; and also taken as an emmenagogue and vermifuge, and treatment for leucorrhea. It has been effective in halting vomiting and diarrhea in cholera patients. It is also applied on skin diseases. A decoction of the new shoots is taken as a febrifuge. The leaf infusion is prescribed in India in cerebral ailments, nephritis and cachexia. An extract is given in epilepsy and chorea and a tincture is rubbed on the spine of children in convulsions. A combined decoction of leaves and bark is given to expel the placenta after childbirth.

Photochemical: phytochemicals, such as phenolic compounds, carotenoids and vitamins, mainly ascorbic acid (C) and tocopherol (E), are effective free-radical scavengers [10]. These substances are likely to be effective in the reduction of the stroke and cancer incidence, already attributed to the consumption of fruits and vegetables [11]. They act mainly preventing the oxidative cell damage caused by the inactivation of free radicals generated by the metabolism, inflammatory processes, environmental conditions, UV radiation etc [12, 13]. Considering the importance of antioxidants in the human body, the regular consumption of significant amounts of fruits and vegetables has been promoted by specialists to prevent degenerative and chronic diseases [14].

Phytochemical	Drumstick leaves	Guava leaves
Tannin	-	+
Saponins	+	+++
Flavonoids	++	++
Glucosinolates	+	-
Phenol	+	+
Amino Acids	+	+
Polysterols	-	-

Key: - = Absent +- Small Quantity ++ = Moderate Quantity +++ = Present in Abundant

Source: https://www.google.com/search?q=guava+phytochemicals+figure&biw=1366&bih=662&tbm=isch&tbo=u&source=univ&sa=X & ved=0ahUKEwj-navr4frbAhWLLo8KHaOIAl8QsAQIMw#imgrc=ROVEu-6b2Ko3bM:

Antioxidant and Free radical Scavenging Activities of Guava: The involvement of active oxygen and free radicals in the pathogenesis of certain human diseases, including cancer, aging and atherosclerosis is increasingly being recognized [15]. Active oxygen and free radicals, such as superoxide anion O_2^- Þ, hydrogen peroxide (H_2O_2) and hydroxyl radical (OH), are constantly formed in the human body by normal metabolic action. Their action is opposed by a balanced system of antioxidant defenses, including antioxidant compounds and enzymes. Upsetting this balance causes oxidative stress, which can lead to cell injury and death [16]. Therefore, much attention has been focused on the use of antioxidants, especially natural antioxidants, to inhibit lipid per oxidation, or to protect against the damage of free radicals [17]. Current research into free radicals has confirmed that foods rich in antioxidants play an essential role in the prevention of cardiovascular diseases and cancers [18] and neurodegenerative diseases [19].

Guava in Diabetes: Eating guava without its skin can reduce the sugar absorption in your blood, being rich in dietary fiber it helps ease constipation (a common diabetic complaint) and can even lower the chance of developing type two diabetes. Potassium found in guava helps regulate blood pressure. Guava contains more Vitamin C than an orange [20]. There is strong evidence to show that diabetes is associated with increased oxidative stress [21, 22]. Moreover, the generation of oxidative stress may play an important role in the etiology of diabetic complications, such as vascular complications [23], diabetic cataract [24] and diabetic nephropathy [25]. Administration of streptozotocin induces diabetes in experimental animals. The development of diabetes induced by

streptozotocin was related to the production of radicals, including superoxide anion and hydroxyl radicals [26, 27].

Also reported that the lipid peroxide level in the kidney of streptozotocin-induced diabetic rats was significantly higher than that of the control ($P < 0.05$) [28]. Evidence indicates that many biochemical pathways associated with hyperglycemia can increase the production of free radicals [29]. Diabetic patients have reduced antioxidant defenses and suffer from an increased risk of free radical-mediated damage [30]. The levels of plasma lipid peroxide products, including malondialdehyde in diabetic patients, were increased when compared with control subjects [31]. Fortunately, supplementation of vitamin E can lower lipid per oxidation in diabetic patients [32]. Indicated that gliclazide, commonly used in the treatment of diabetes, was not only effective in reducing blood sugar, but also might be useful in the scavenging of free radicals [33]. Suggested that an improved antioxidant status and reduced lipid peroxidation might be one mechanism by which dietary treatment contributes to the prevention of diabetic complications [34].

Carbohydrates: Carbohydrates break down into glucose, which your body's cells use for energy through Guava. The glucose is delivered to your cells through your bloodstream. When you eat something that contains carbohydrates your blood glucose level increases as the carbohydrates are converted to glucose. The sugar content metabolizes quickly, reaching your bloodstream rapidly.

Dietary Fiber: The fiber content in guava reduces the digestion of carbohydrates. Fiber is not digested by the body but passes through without affecting your blood glucose. When you want to determine the actual carbohydrate effect of a food, reduce the grams of carbohydrates per serving by half of the dietary fiber grams if there are 5 grams or more per serving. The net carbohydrate count indicates the overall glucose reaction your body may experience. For example, guava contains 13 g of carbohydrates per serving. Subtract half of the 5 grams of dietary fiber, because the fiber content has no glucose effect. The net carbohydrates for a guava serving is10 g.

Protein: Adding 5 g or more of protein to a carbohydrate serving can slow your body's digestion, creating a gradual blood glucose reaction that helps reduce the occurrence of blood sugar highs. Add a lean protein serving such as soft cheese or salmon when you eat fresh fruits that contain natural sugar such as guava to reduce the overall carbohydrate effect.

Controls Diabetes: The rich fiber content and low glycemic index of guava are extremely beneficial for diabetic people. While fiber helps regulate sugar levels, the low glycemic index inhibits a sudden spike in sugar levels. Eating 1 to 2 guavas without the peel can be helpful in maintaining your blood sugar level. Those who are at risk of developing diabetes can help prevent it by drinking guava leaf tea. To make the tea:

1. Dry the tender guava leaves and crush them into a powder.
2. Add 1 tablespoon of crushed guava leaves to a cup of hot water.
3. Cover and allow it to steep for 5 minutes, and then strain it.
4. Drink this tea once daily.

Uterine Tonic: Due to an estrogenic effect of the flavonoids or to anti-inflammatory effects of guava leaves it can be used in dysmenorrheal.

Guava in Immune System: Guava provides over 350% of the recommended daily value of Vitamin C, it can repair the immune system and keep it functioning properly. Vitamin C has long been associated with a healthy immune system, so getting in your daily recommended amount is crucial in keeping illnesses at bay. Guava fruits provide even more Vitamin C than an equal serving of oranges, quite surprisingly. Vitamin C helps to stop cell damage because of the antioxidants it possesses, so it can even help to heal arthritis, cancer, and heart disease.

Due to its high vitamin C content, guava plays an important role in improving your immunity. Your immunity is your body’s defense mechanism that protects it from numerous diseases and infections. In addition, guava’s anti-inflammatory action and its ability to inhibit inflammatory molecules like prostaglandins help keep you disease free. Eat 1 guava daily to develop resistance against common diseases like coughs, colds and the flu. You can also enjoy guava in smoothies or salads, or drink a cup of tea made from guava leaves daily.

Anticancer Activity of Guava: Researchers Chen and colleagues (2007) reported that the soluble polyphenolics of budding guava leaves may have potent anticancer activity. The high polyphenolic and flavonoid content of guava leaves (1.0 mg/mL) combated the brain-derived metastatic prostate DU-145 cell line in a dose-dependent manner to 36.1 percent (48

hours) and 3.59 percent (72 hours). They suggested that guava extracts "might be useful for treatment of brain derived metastatic cancers such as DU-145, by acting simultaneously as both a chemo preventive and a chemotherapeutic." In another study by the same researchers, budding guava leaf extract was reported to contain high concentrations of soluble polyphenolics including (in mg/g) gallic acid (348), catechin (102), epicatechin (60), rutin (100), quercetin (102), and rutin (100). They reported that an extract called rhamnoallosan from budding guava leaves, had potent anticancer activity against DU-145 human prostate carcinoma [35].

Guava leaf extracts were tested for their anti-inflammatory and antitumor activities [36]. These extracts were effective against L929sA (murine fibrosarcoma) and MCF7 (benign human breast cancer), but not MDA-MB (metastatic human breast cancer). Nuclear factor-kappa B (NF-kB) has been implicated in cancers and in many human chronic inflammatory diseases.

There is also molecular evidence that antitumoral or cytotoxic activities of guava may act via inhibition of the NF-kB pathway [36]. Another study followed examining the effect of fermented guava leaf extract (Fermentech Inc. Jeju, Korea) on liposaccharide (LPS)-induced NF-kB activation (Choi et al. 2008). Although cancer cell proliferation was not directly examined, the authors determined that guava leaf extract significantly inhibited NF-kB transcriptional activation. Guava leaf extract is also involved in the inhibition of nitric oxide synthase (iNOS) and COX-2 via the down-regulation of NF-kB pathway, revealing a partial molecular basis for the anti-inflammatory properties of guava leaf extract.

Researchers have suggested that guava's high antioxidant activity may interfere with cancers initiated by oxidative and free radical damage to DNA and cell components. Leong and Shui (2002) measured the antioxidant capacity (AEAC, ascorbic acid equivalent antioxidant capacity) of selected fruits based on edible portion (wet weight). Ciku (a tropical fruit known as sapodilla) was found to have the highest antioxidant capacity (3396 mg/100 g), followed by strawberry (472 mg/100 g), plum (312 mg/100 g), star fruit (278 mg/100 g), guava (270 mg/100 g), grape seedless (264 mg/100 g), and other selected fruits with lower values.

Another antioxidant related study was one investigating the ant proliferative effect of 14 plant food aqueous extracts, including guava. Tested the following plant food extracts against the breast cancer cell line MCF-7: avocado, guava, mango, prickly pear cactus stems, papaya, pineapple, prickly pear fruit, grapes, and tomato [37]. Each aqueous extract was measured for beta-carotene, total phenolics, and antioxidant capacity. Although guava extract had the highest phenolic activity, only papaya extract had a significant ant proliferative effect when measured using the methylthiazolydiphenyl-tetrazolium bromide assay. In this study, high phenolic content or antioxidant capacity did not relate to ant proliferative effect in cancer cells. Although they did not explain why their results opposed [36], they did state that common phenolic concentrations tested for biological activity are between 6 and 50 uM, but plasma concentrations after a phonolic-rich meal are only 0.1 to 10 uM. The researchers also tested complete and not fractionated extracts. They indicated that each extract has a unique quality and quantity of photochemical that determines its biological activity. It is not clear why only one food extract would have ant proliferative action, when many of the other tested foods have shown positive results in other studies [38].

Guava, particularly its leaves, contains secondary plant metabolites with certain polyphenols with potential intrinsic antioxidant, anti-inflammatory, and antiviral properties [39, 40, 41, 42]. Several guava components have been postulated as having anticancer effects in vitro, and the most frequently reported are ascorbic acid (vitamin C), flavonoids (apigenin), and lycopene.

Oral Health: Guava leaves have anti-inflammatory, analgesic and antimicrobial properties that help reduce gum inflammation and leave your breath fresh and clean. Plus, you can use guava leaves to cure toothaches, swollen gums and oral ulcers. You can also use the twigs of guava trees like a toothbrush or as a chewing stick for cleaning your teeth.

Heart Health: According to a 1993 study published in the Journal of Human Hypertension, regular guava fruit intake can help decrease blood pressure and blood lipids. This is due to its higher potassium, vitamin C and soluble fiber content. Potassium helps maintain a steady heartbeat and control high blood pressure, while vitamin C keeps the small blood vessels healthy. In addition, the lycopene found in pink-fleshed guava helps reduce the risk of cardiovascular

disease in people who eat this fruit on a regular basis.

Antifungal Activities of Guava: Microorganisms of the genus *Candida* can be found naturally composing the microbiota of the human organism inhabiting your gastrointestinal tract and mucous membranes [43, 44]. Changes in dynamic of the host organism too favor the proliferation of these fungi and the disturbance caused in homeostasis can lead to a range of infections that range in their level and location and can only be superficial, in skin and mucosal (oral, vaginal candidiasis) or systemic, compromising the life of an individual [45, 46].

Usually the infections caused by *Candida* spp. in its magnitude are assigned to the species *Candida albicans*, however, illness caused by *Candida* non-albicans (CNAM) had increased incidence over the years and yeasts of *Candida glabrata*, *Candida tropicalis*, *Candida krusei* and *Candida parapsilosis* have been increasingly identified as human pathogens [46, 47].

Mechanisms of resistance to commercial drugs developed by these microorganisms have been constantly investigated and reported and the continuous evolution for resistance is extremely worrying considering the limited number of antifungal classes currently available [48, 49]. The search for different therapeutic alternatives is a constant and the use of natural products of plant origin often serves as a reference to the search for active compounds and, in this sense, a ethno directed approach has directed pharmaceutical research [50], in this case, in order to antifungal discovery potential.

The P. *guajava* is popularly used in the treatment of infectious diseases, particularly against those caused by fungi, it is common practice registered in different countries such as Brazil, Cuba and South Africa where it is used to treat thrush, leucorrhoea, and vaginitis, pathologies associated with infections caused by Candida spp. [51,52,53,54]. Considering the pharmacological potential of the species *P. guajava* described in ethnobotanical reports, especially with regard to its therapeutic use in treatments against diseases caused by fungi.

Antimicrobial anti Helmenthic Activity of Guava: Leaf and bark extracts associated with flavonoids, such as morin glycosides, quercetin, and quercetin glycosides acts against a wide range of gram-positive and gram-negative human pathogens including Escherichia coli, Vibrio cholera, Giardia lamblia, and Shigella species, as well as Staphylococcus aureus and Pseudomonas aeruginosa demonstrated including prostate, colon, and epidermal cancers, as well as leukemia and melanoma.

CNS Effects: Quercetin induced a reduction in acetylcholineevoked release. The mechanism of action may be associated with an interaction with presynaptic calcium channels. In animal models, P. guajava extracts exhibited dose-dependent antinociceptive effects in chemical and thermal tests of analgesia in mice. In another study, the antinociceptive effect of P. guajava extracts was similar in potency to the nonsteroidal anti-inflammatory drug mefenamic acid and 10 times less potent to the opioid analgesic morphine. Guava is now a successful and a commercialized fruit very frequently used in food industry. Guava is richly used in Soft drinks, Jams, Jellies, Flavored tea, Ice creams, Fruit salads which are very popular today.

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 agro industrial wastes (seeds, skin and pulp) of guava, confirming its antioxidant activity [55, 56, 57].

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. [58, 59, 60, 61-62]

Castro-Vargas et al. [63] and Ojewole [57] extracted and identified significant levels of carotenoids and total phenolic compounds from guava seeds. Seeds exhibit antimicrobial, gastrointestinal and anticarcinogenic activities probably due to the presence of phenolic glycosides in the composition [64, 65].

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 [66].

Reported hypolipidemic and hepatoprotective effects in diabetic rats treated

with aqueous extract of lyophilized guava peel [67].

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. [68]

Treatments of Diarrhea: Guava leaf tea may help inhibit diarrhea-causing bacteria. According to a 2008 study published in the Revista do Instituto de Medicina Tropical de São Paulo, guava leaf extract inhibits the growth of *staphylococcus aureus* bacteria, a common cause of diarrhea. When suffering from diarrhea, drink guava leaf tea a few times a day. This tea will cause fewer stools, lessen abdominal pain, lessen watery stools and promote a quick recovery. Guava fruit is also good for the digestive tract. Its antibacterial property helps clean the digestive tract, discouraging bacterial and microbial growth and its fiber content promotes digestion and proper excretion. To prevent stomach-related problems, chew guava leaves or eat a raw guava daily.

Infectious diarrhoea accounts for nearly 3.2% of all deaths globally [69] and is the second largest cause of years of productive life lost due to premature mortality and disability [70]. It is a major health concern in developing countries and remains an important clinical problem even in developed countries despite improvements in public health and economic wealth [71]. It is estimated that during the next 20-30 years, diarrhoea along with other infectious diseases will remain a cause of global health concern [72].

Diarrhoea is an etiologically diverse condition unlike some other infectious diseases such as tuberculosis, HIV/AIDS and malaria since it is caused by a variety of enteric pathogens including bacteria, viruses and protozoa [73,74,75]. Oral rehydration therapy has been the key strategy for effective case management. However, it often fails in high stool output state. Moreover, symptomatic therapy with antimotility agents is contraindicated in infectious diarrhoea and there is an increasing threat of drug resistance to antibiotics [76]. Various attempts for developing vaccines against diarrhoea causing organisms have been made [74, 77,78,79]. However, the responses to vaccines in developing countries have not been encouraging [80-83]. In the recent past there have been advances towards the treatment of infectious diarrhoea with supportive therapy such as the use of probiotics; but these are still under development [71]. Hence, medicinal plants may aid in developing cost effective alternative approaches for treatment of diarrhoea.

Medicinal plants have recently gained popularity as prospective antidiarrhoeal agents as can be judged by the number of studies that have been undertaken. An online search on PubMed shows that more than 200 studies on the antidiarrhoeal activity of medicinal plants have been published in the last decade. Have reviewed more than 50 such studies conducted during the period 2000 to 2007 [84]. Whilst a few studies have reported antimicrobial activity, a majority of the studies have focused on the effect of the plants on intestinal motility in experimental models. Hence, though data is available on the effect of medicinal plants on physiological diarrhoea as studied in animal models there is a paucity of information on their mode of action on infectious diarrhoea.

Psidium guajava L., Myrtaceae, is used widely in traditional medicine throughout Latin America and the Caribbean for the treatment of diarrhoea, dysentery, gastroenteritis, stomachaches, and indigestion [85]. It is also used for diarrhoea and dysentery in countries such as China, Philippines, Senegal and USA, as an antiamoebic in Congo, antispasmodic in India and Ghana, antiseptic in China and as an antibiotic in USA. However, this plant is not very popular in India as an antidiarrhoeal agent. An ethnobotanical survey carried out by us in Parinche valley located 55 km south-east of Pune, Maharashtra, India revealed that *P. guajava* had very limited usage by the local community as a treatment for diarrhoea [86]. Only 2 out of 24 traditional healers interviewed had knowledge of *P. guajava* as an antidiarrhoeal agent. The antidiarrhoeal activity of *P. guajava* though widely reported has been mainly investigated with respect to its antimicrobial action and/or its effect on physiological diarrhoea in animal models. Thus its mechanism(s) of action in infectious diarrhoea is largely unknown. To the best of our knowledge there have been no studies till date on the effect of the leaf extract of *P. guajava* on the pathogenesis of infectious diarrhoea.

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.

Psidium guajava (Linn.) is popularly known as 'poor man's apple of the tropics', has a long history of traditional use for a wide range of ailments. The fruit as well as its juice is freely consumed for its great taste and nutritional benefits. Much of the traditional uses have been validated by scientific research. Toxicity studies in mice and other animal models as well as controlled human studies show both leaf and fruit are safe without any side effects. The plant has been extensively studied in terms of pharmacological activity of its major components, and the results indicate potent anti-diarrheal, antihypertensive, hepatoprotective, antioxidant, antimicrobial, hypoglycemic and anti-mutagenic activities.

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