Chapter 2
An Underutilized Tropical Plant *Psidium cattleianum* (Strawberry Guava)

Abstract *Psidium cattleianum* Sabine or strawberry guava is an exotic, tropical plant belonging to Myrtaceae family. This shrub bears prolific fruits, yet it is more recognized as an ornamental than an edible plant. Its emergence as an invasive species in Hawaii and defiance towards biological control agents has further lowered its desirability. However, recent findings have shed light on its food potential. It has been identified as a reserve of savory fruit and pectin. Copious phytochemicals have validated its antioxidant, antimicrobial and antiproliferative activities. This chapter presents an overview of its current status and prospect in functional food formulation.

Keywords *Psidium cattleianum* · Phenolic compounds · Antioxidant · Anticancer · Antimicrobial

2.1 Introduction

Psidium cattleianum commonly known as strawberry guava, Chinese guava, cattley guava, Jeju guava, cherry guava, purple guava, waiawi, guayaba or araçá is a member of Myrtaceae family. Native to the Atlantic coast of Brazil, it has adapted to the tropical climates of Hawaii and several Caribbean islands. For its dense contour, hardiness, evergreen glossy foliage, white flowers and bountiful red fruits, it is desired in landscaping (Fig. 2.1a, b). This shrub is grown as ornamental fruit plant in Florida, California, South America and Central America, West Indies, Bermuda and the Bahamas. Since, past two decades, *P. cattleianum* has got a bad name for assuming invasive form and endangering the native flora of Hawaii's rain forests and Seychelles Island (Pino et al. 2001; Gerlach 2004). Brazilian scale insect *Tectococcus ovatus* was determined as a suitable candidate for biological control of *P. cattleianum* in Florida, yet the threat to biodiversity continues (Wessels et al. 2007). The ripe fruit is eaten fresh or used to flavour beverages, ice creams and desserts. Its leaf extract has traditionally been used in some Oriental countries (for the treatment of diarrhoea and diabetes) and French Polynesia. Recently, the leaf extract has been administered in the therapy of cancer, pathogenic infections and inflammation

S. Patel, *Emerging Bioresources with Nutraceutical and Pharmaceutical Prospects*,
Applied Environmental Science and Engineering for a Sustainable Future,
DOI 10.1007/978-3-319-12847-4_2

Fig. 2.1 *Psidium cattleianum* plant **a** whole shrub. **b** ripe fruits

in experimental models (Im et al. 2012). Patel (2012) published a holistic review on this plant, discussing its potentials and obstacles in popularity. These reports prompted to explore the nutraceutical potential of *P. cattleianum*.

2.2 Phytochemical Analysis

P. cattleianum boasts of a repertoire of phytochemicals. Volatile compounds have been isolated from the fruits by simultaneous steam distillation-solvent extraction followed by capillary GC-MS. Two hundred and four compounds have been identified in the aroma concentrate of which ethanol, α-pinene, (Z)-3-hexenol, (E)-beta-caryophyllene and hexadecanoic acids have been identified as the major constituents. The aliphatic esters and terpenic compounds impart the unique flavour of the fruit. Medina et al. (2011) studied the constituents of aqueous and acetone extracts of the fruits. High level of phenolic compounds (768 mg/100 g), with the predominance of epicatechin was observed. Carotenes, ascorbic acid and anthocyanins were present as minor constituents. Several immunoreactive isoflavones, namely glycitein, glycitin, ononin, sissotrin were detected in water-ethanolic extracts of *P. cattleianum* leaves (Lapčík et al. 2005). Vriesmann et al. (2009) studied the monosaccharide composition of its mesocarp fraction and reported uronic acid, galactose, arabinose, glucose, mannose, methyl fucose and xylose to be the major components. The leaf oil constituents were identified to be β-caryophyllene, α-pinene, myrcene α-thujene, 1, 8-cineole, epi-α-muurolol, α-cadinol, epi-α-cadinol and caryophyllene oxide. Jun et al. (2011) also isolated the sesquiterpene β-caryophyllene oxide from the leaves and identified the chemical structure by various spectroscopic analyses. Recently, Adam et al. (2011) examined its leaf oils by GC/MS. The oil was rich in sesquiterpene hydrocarbons (48.8 %) and monoterpene hydrocarbons (10.1 %). The main sesquiterpene in the oil was confirmed to be β-caryophyllene (31.5 %), followed by α-humulene (4.4 %). Also, a small amount of the phenylpropanoid, methyl-isoeugenol as both isomeric forms E (0.6 %) and Z (0.1 %) were detected in the oil (Fig. 2.2).

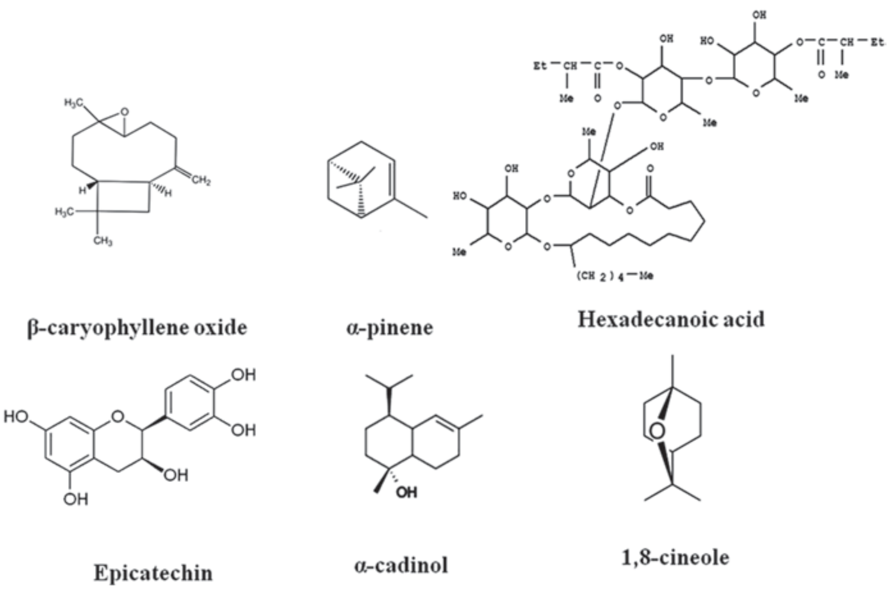

Fig. 2.2 The active compounds isolated from *Psidium cattleianum*

2.3 Uses of *P. cattleianum*

Despite the looming dangers, there are several advantages of growing a *P. cattleianum* plant in home garden. The benefits and potential uses are presented below.

2.3.1 As Food Source

The aromatic fruits with sweet-tart taste are consumed when ripe. Also, the fruits are processed into fillings, jams, jellies, puree, sauce or punch. In a Latin dessert "cascos guayaba", the fruit is stewed and served with cream cheese. Haminiuk et al. (2006) investigated the effect of temperature on rheological behaviour of *P. cattleianum* pulp. Shear thinning behaviour was reported, in which the viscosity decreased with an increase in temperature. Pectins have myriad applications in food formulations and new sources of these polysaccharides are constantly searched for. In this regard, *P. cattleianum* pulp holds promise as a rich source. These fruits might contribute cheap raw materials for the industrial production of pectin in Brazil and Hawaii (Vriesmann et al. 2009). The seed oil content was determined to be 12 % and was rich in linoleic acid (81.38 %). Also, it proved fit for human consumption (Kobelnik et al. 2012). Chalannavar et al. (2013) analyzed the phytochemicals of the oil extracted dried leaves of *P. cattleianum* and reported the food preservative potential of the principal component caryophyllene oxide.

2.3.2 Antioxidant and Anti-Inflammatory Activity

Luximon-Ramma et al. (2003) studied the possible antioxidant capacity of *P. cattleianum* Sabine fruits, in terms of total phenolics, proanthocyanidins, flavonoids and vitamin C content. High antioxidant content with potential beneficial effects on health was reported. Medina et al. (2011) also confirmed that the fruit extract possesses considerable antioxidant activity, tested through yeast assay and DPPH radical scavenging assay. Biegelmeyer et al. (2011) conducted the chemical characterization of the fruit extract by HPLC-DAD and investigated its antioxidant activity by TRAP method. High polyphenolic content was reported (501.33 mg/100 g), where hyperoside was identified to be one of the major flavonoids. In addition to flavonoids, the extract presented the anthocyanin, cyanidin. Ho et al. (2012) isolated seven flavonoids along with a benzoic acid from the leaves of *P. cattleianum*. The antioxidant potencies of these compounds were validated by ALP, DPPH, ABTS and ORAC assays. McCook-Russell et al. (2012) compared the total phenolics, proximate contents, antioxidant and anti-inflammatory properties of *P. cattleianum* with that of *P. guajava*. The former scored higher in the above properties, also possessed more vitamin C and fibre content. The hexane and ethyl acetate extracts of *P. cattleianum* fruits (250 μg/ml) showed COX-2 enzyme inhibitory activities of 18.3 and 26.5 %, respectively. The anti-inflammatory activity proves its beneficial effect on health.

2.3.3 Antiproliferative Activity

Moon et al. (2011) evaluated the antiproliferative activity of the chloroform fraction of *P. cattleianum* Sabine leaf extract against several cancer cell lines. Maximum cytotoxicity was observed in human gastric carcinoma SNU-16 cells, at concentrations of 50–100 μg/ml. The induction of apoptosis was confirmed by immunological and molecular tools. The phytochemicals in the fractions of the leaf extract are assumed to be the bioactive ingredients. Medina et al. (2011) also reported antiproliferative effects of the fruit extract against breast cancer MCF-7 and colorectal Caco-2 cells. Jun et al. (2011) conducted an MTT assay against several cancer cell lines to study the cytotoxic effects of β-caryophyllene oxide. Its potent cytotoxic activity against HepG2, HeLa, SNU-1 and SNU-16 cells were evidenced. Im et al. (2012) investigated the molecular mechanism behind the antimetastatic effects of the butanol fraction of its leaf extract. The extract suppressed MMP-9 as well as MMP-2 expression and activity in part through the downregulation of the ERK1/2 activation in lung cancer cells. Also, the major components of the fraction were identified as glucuronic acid, quercetin 3-glucuronide, loganin and xanthyletin. Collectively, the findings indicate that the leaf and fruit extracts of *P. cattleianum* could restrain various forms of malignant tumours.

2.3.4 Antimicrobial Activity

Brighenti et al. (2008) assessed the effects of *P. cattleianum* leaf water extract on pathogenic *Streptococcus mutans*. The biofilms exposed to 1.6% extract for 2 h showed significant change in protein expression of the pathogens and inhibited their acid production. It was concluded that the leaf extract kills most of the *S. mutans* when applied at high concentrations i.e. 25, 50 or 100%. Crivelaro de Menezes et al. (2010) evaluated the influence of *P. cattleianum* Sabine aqueous extracts on *S. mutans* counts and dental enamel micro-hardness of rats with caries. The extracts decreased *S. mutans* accumulation and enamel demineralization. De Menezes et al. (2010) also studied and corroborated that *P. cattleianum* aqueous extract significantly reduces the *S. mutans* counts and decreases the enamel demineralization rate. The leaf extract was also shown to exert anti-caries effects in rats (Jun et al. 2011). Medina et al. (2011) reported the antimicrobial effect of fruit extract against *Salmonella enteritidis*, which was attributed to the abundance of phenolic compounds. Brighenti et al. (2012) evaluated the effect of its leaf extract on enamel demineralisation, extracellular polysaccharide formation, and the microbial composition of dental biofilms. The volunteers wore enamel blocks that were dripped with 20% sucrose 8 times a day. Twice a day, *P. cattleianum* extract was trickled on the sugar-soaked enamel blocks. After 2 weeks of this treatment, the various parameters were measured. The subjects with extract-applied enamels showed lower total streptococci, *S. mutans* and exopolysaccharides, indicating the anticariogenic effect of the extract.

2.4 Hurdles in Popularity and Future Scopes

Despite plentiful production of fruits and therapeutic values of various parts, *P. cattleianum* is yet to attract attention of consumers, horticulturists and food technologists. Out of the many likely reasons, the notoriety as invasive and perishability of fruits are most critical. Development of better cultivars may tackle these demerits and help consolidate its status as a nutrition source.

2.5 Conclusion

As the findings testify, *P. cattleianum* has immense potential to be developed as a popular fruit tree. The investigations conducted till now are too scanty to appreciate its full importance. A lot needs to be explored, and given due attention, it can certainly nourish, boost antioxidant status and keep cancer at bay. Also, there is urgent need to resove its invasiveness. The family Myrtaceae is rich in species with food and medicinal values *viz*. Acca, Callistemon, Eucalyptus, Eugenia, Syzgium, Leptospermum, and this species seems equally promising.

References

Adam F, Vahirua-Lechat I, Deslandes E, Menut C (2011) Aromatic plants of French Polynesia. V. Chemical composition of essential oils of leaves of *Psidium guajava* L. and *Psidium cattleianum* Sabine. J Essent Oil Res 23:98–101

Biegelmeyer R, Andrade JMM, Aboy AL, Apel MA, Dresch RR, Marin R, Raseira MDCB, Henriques AT (2011) Comparative analysis of the chemical composition and antioxidant activity of red (*Psidium cattleianum*) and yellow (*Psidium cattleianum* var. *lucidum*) strawberry guava fruit. J Food Sci 76:991–996

Brighenti FL, Luppens SBI, Delbem ACB, Deng DM, Hoogenkamp MA, Gaetti-Jardim E Jr, Dekker HL, Crielaard W, ten Cate JM (2008) Effect of *Psidium cattleianum* leaf extract on *Streptococcus mutans* viability, protein expression and acid production. Caries Res 42:148–154

Brighenti FL, Gaetti-Jardim E Jr, Danelon M, Evangelista GV, Delbem AC (2012) Effect of *Psidium cattleianum* leaf extract on enamel demineralisation and dental biofilm composition in situ. Arch Oral Biol 57:1034–1040

Chalannavar RK, Narayanaswamy VK, Baijnath H, Odhav B (2013) Chemical constituents of the essential oil from leaves of *Psidium cattleianum* var. *cattleianum*. J Med Plants Res 7:783–789

Crivelaro de Menezes TE Botazzo Delbem AC Lourencao Brighenti F Caludia Okamoto A Gaetti-Jardim E Jr (2010) Protective efficacy of *Psidium cattleianum* and *Myracrodruon urundeuva* aqueous extracts against caries development in rats. Pharm Biol 48:300–305

De Menezes TEC Delbem ACB Brighenti FL Okamoto AC Gaetti-Jardim Jr (2010) Protective efficacy of *Psidium cattleianum* and *Myracrodruon urundeuva* aqueous extracts against caries development in rats. Pharm Biol 48:300–305

Gerlach J (2004) A 10-year study of changes in forest vegetation on Silhouette island, Seychelles. J Nat Conserv 12:149–155

Haminiuk CWI, Sierakowski MR, Vidal JRMB, Masson ML (2006) Influence of temperature on the rheological behaviour of whole araca pulp (*Psidium cattleianum* Sabine). LWT—Food Sci Technol 39:427–431

Ho R, Violette A, Cressend D, Raharivelomananan P, Carrupt PA, Hostettmann K (2012) Antioxidant potential and radical-scavenging effects of flavonoids from the leaves of *Psidium cattleianum* grown in French Polynesia. Nat Prod Res 26:274–277

Im I, Park K-R, Kim S-M, Kim C, Park JH, Nam D, Jang H-J, Shim KS, Mosaddik A, Sethi G, Cho SK, Ahn KS (2012) The butanol fraction of guava (*Psidium cattleianum* Sabine) leaf extract suppresses MMP-2 and MMP-9 expression and activity through the suppression of the ERK½ MAPK signalling pathway. Nutr Cancer 64(1–12):255–266. doi:10.1080/01635581.2012.642455

Jun NJ, Mosaddik A, Moon J-Y, Jang K-C, Lee D-S, Ahn KS, Cho SK (2011) Cytotoxic activity of β-Caryophyllene oxide isolated from Jeju guava (*Psidium cattleianum* Sabine) leaf. Rec Nat Prod 5:242–246

Kobelnik M, Cassimiro DL, dos Santos Dias D, Ribeiro CA, Crespi MS (2012) Thermal behavior of araça oil (*Psidium cattleianum* Sabine). J Therm Anal Calorim 108:1281–1286

Lapčík O, Klejdus B, Kokoška L, Davidová M, Afandi K, Kubáň V, Hampl R (2005) Identification of isoflavones in *Acca sellowiana* and two *Psidium* species (Myrtaceae). Biochem Syst Ecol 33:983–992

Luximon-Ramma A, Bahorun T, Crozier A (2003) Antioxidant actions and phenolic and vitamin C contents of common Mauritian exotic fruits. J Sci Food Agric 83:496–502

McCook-Russel KP, Nair MG, Facey PC, Bowen-Forbes CS (2012) Nutritional and nutraceutical comparison of Jamaican *Psidium cattleianum* (strawberry guava) and *Psidium guajava* (common guava) fruits. Food Chem 134:1069–1073

Medina AL, Haas LIR, Chaves FC, Salvador M, Zambiazi RC, da Silva WP, Nora L, Rombaldi CV (2011) Araca (*Psidium cattleianum* Sabine) fruit extracts with antioxidant and antimicrobial activities and antiproliferative effect on human cancer cells. Food Chem 128:916–922

Moon JY, Mosaddik A, Kim H, Cho M, Kyoon Choi HK, Kim YS, Cho SK (2011) The chloroform fraction of guava (*Psidium cattleianum* Sabine) leaf extract inhibits human gastric cell proliferation via induction of apoptosis. Food Chem 125:369–375

Patel S (2012) Exotic tropical plant *Psidium cattleianum*: a review on prospects and threats. Rev Environ Sci Biotechnol 11:243–248

Pino JA, Marbot R, Vazquez C (2001) Characterization of volatiles in strawberry guava (*Psidium cattleianum* Sabine) fruit. J Agric Food Chem 49:5883–5887

Vriesmann LC, de Oliveira Petkowicz CL, Carneiro PIB, Costa ME, Beleski-Carneiro E (2009) Acidic polysaccharides from *Psidium cattleianum* (Araçá). Braz Arch Biol Technol 52:259–264

Wessels FJ, Cuda JP, Johnson MT, Pedrosa-Macedo JH (2007) Host specificity of *Tectococcus ovatus* (Hemiptera: Eriococcidae), a potential biological control agent of the invasive strawberry guava, *Psidium cattleianum* (Myrtales: Myrtaceae), in Florida. BioControl 52:439–449

http://www.springer.com/978-3-319-12846-7

Emerging Bioresources with Nutraceutical and
Pharmaceutical Prospects
Patel, S.
2015, XXIII, 131 p. 18 illus., 14 illus. in color., Hardcover
ISBN: 978-3-319-12846-7