Vanilla planifolia

Scientific Name

***Vanilla planifolia* H.C. Andrews.**

Synonyms

Epidendrum vanilla L., *Myrobroma fragrans* Salisbury nom. illeg., *Notylia planifolia* (Andrews) Conzatti, *Vanilla aromatica* Sw., *Vanilla bampsiana* Geerinck, *Vanilla carinata* Rolfe, *Vanilla domestica* (L.) Druce, *Vanilla duckei* Huber, *Vanilla epidendrum* Mirb., *Vanilla fragrans* (Salisbury) Ames, *Vanilla majaijensis* Blanco, *Vanilla mexicana* P. Miller, *Vanilla rubra* (Lam.) Urb., *Vanilla sativa* Schiede, *Vanilla sylvestris* Schiede, *Vanilla viridflora* Blume.

Family

Orchidaceae

Common/English Names

Bali Vanilla, Bourbon Vanilla, Commercial Vanilla, Common Vanilla, Flat-Leaved Vanilla, Indian Ocean Vanilla, Indonesian Vanilla, Java Vanilla, Mauritius Vanilla, Mexican Vanilla, Seychelles Vanilla, Tahitian Vanilla, West Indian Vanilla, Vanilla, Vanilla Vine.

Vernacular Names

Amharic: Vanila;
Arabic: Al-Fanilya;
Armenian: Vanil;
Basque: Bainila;
Belarusian: Vaniĺ;
Brazil: Baunilha;
Bulgarian: Vanilia;
Chinese: Fan Ni Lan, Hsaing Ts'ao Lan, Xiang Cao, Xiang Cao Dou, Xiang Jia Lan, Xiang Lan, Xiang Zi Lan, Wahn Nei La;
Columbia: Bejuquillo, Bejuquillo, Vainilla;
Croatian: Vanilija;
Cuba: Cuyanquillo, Flor Negra, Lombricera;
Czech: Vanilka, Vanilka Pravá, Vanilovník Plocholistý;
Danish: Ægte Vanilje, Vanilje, Vanille;
Dutch: Vanielje, Vanieljesoort, Vanille;
Eastonian: Harilik Vanill;
Esperanto: Vanilo;
Farsi: Vanil;
Finnish: Vanilja;
French: Vanille Bourbon, Vanille D'indonésie, Vanille Des Seychelles, Vanille Du Méxique, Vanillier, Vanille, Vrai Vanillier;
Frisian: Fanylej, Fanille;
Gaelic: Faoineag;
Georgian: Vanili;
German: Echte Vanille, Gewürzvanille, Große Vanille, Vanille;
Greek: Vanilia, Vanillia;

T.K. Lim, *Edible Medicinal And Non-Medicinal Plants: Volume 4, Fruits*,
DOI 10.1007/978-94-007-4053-2_13, © Springer Science+Business Media B.V. 2012

Hebrew: Vanil;
Hungarian: Vanília;
Icelandic: Vanilla;
India: Bhenila (Bengali), Vanilla (Hindu), Vyanilla, Venila (Kannada), Bhenila (Maithili), Vanila (Malayalam), Vanile (Punjabi), Vanikkodi, Vanila (Tamil);
Indonesia: Panili (Javanese, Sundanese);
Irish: Fanaile;
Italian: Vaniglia;
Japanese: Banira;
Kazakh: Vanil;
Korean: Panilla;
Latvian: Smaržīgā Vaniļa, Vanilla;
Lithuanian: Vanilė, Kvapioji Vanilė;
Macedonian: Vanila;
Malaysia: Panili, Anggrek Panili;
Maltese: Vanilja;
Mexico: Tilisúchil, Tilisóchil, Tilijuche, Tiljuche, Tilsúchil, Tilsóchil, Tlilsóchil, Tlilxóchitl (Mayan), Segnexanté, Vainilla, Vainilla De Papantla, Semenquete, Vainilla Mansa (Spanish);
Nepal: Bhenila (Nepali), Bhenila (Nepalbhasa);
Norwegian: Vanilje;
Persia: Vanil (Farsi);
Philippines: Vanilia (Tagalog)
Polish: Wanilia, Wanilia Płaskolistna;
Portuguese: Baunilha, Baunilheira;
Romanian: Vanilie;
Russian: Vanil', Vanil'nyi, Vanil' Ploskolistnaia;
Serbian: Vanila;
Slovak: Vanilka;
Slovašcinan: Vanilija;
Spanish: Vainilla, Vainillero, Vainillero De Flores Aromáticas;
Sri Lanka: Vanila (Sinhala);
Swahili: Lavani;
Swedish: Vanilj;
Thai: Wanila, Waanilaa;
Turkish: Vanilya;
Ukrainian: Vanil';
Yiddish: Vanil.

Origin/Distribution

Vanilla planifolia originated from Mesoamerica – Mexico and Guatemala. The Totonac Indians of Papantla in north-central Vera Cruz, were the earliest to cultivate vanilla and the oldest use of vanilla use related to the pre-Columbian Maya of southeasten Mexico (Lubinsky et al. 2008). It has been cultivated and escaped or persisted in many areas of the tropics and the south Pacific. Today, the most important exporters are Madagascar and Réunion (formerly called Bourbon), even before México. In Asia, Indonesia is the most successful producer.

Agroecology

In its natural habitat, vanilla is found in the shade of humid, evergreen tropical forest and watershed areas climbing up trees. Vanilla performs best under hot humid tropical condition in areas with 1,500–3,000 mm annual rainfall uniformly distributed throughout the year and with optimum temperatures of 20–32°C. Most plantings are found within 20° north degrees and south of the equator from seal level to 1,500 m altitude. The vine is often cultivated under the shade under plantings of *Areca*, coconut and *Ficus* spp. It thrives in friable, well drained, loamy soil rich in organic matter in the pH range of 5.5–7. Mulching and regular fertilisation (especially with organic manures) are beneficial for good growth. Vanilla flowers although hermaphrodite requires cross-pollination for fruit set and in nature this is carried out by euglossine bees. Under commercial situation, artificial manual pollination is carried out and regular foliar fertilisation is also practised.

Edible Plant Parts and Uses

Vanilla is sold and used as dried fermented beans (Plate 4), vanilla extract, vanilla essence, vanilla powder and vanilla oleoresin. Most vanilla is used in the food industry in dairy products, followed by beverages, baked goods and confections etc. vanilla is often used as a background note or flavour enhancer to round out the flavour profiles of many products. The main application of natural vanilla is for flavouring ice creams and soft drinks. Vanilla is an important flavour component in colas and is also used in cream sodas, root beer, some fruit beverages, tea and coffee.

Plate 1 Vanilla vine

Plate 2 Vanilla flowers

Vanillin or vanilla flavours are used in many alcoholic beverages, such as whiskeys, cordials and cocktails, to round out and smooth the harsh edges of the alcohol. Vanilla is also used as a kitchen spice for domestic use.

Vanilla is widely used in the flavouring of chocolate, ice-cream, cakes, biscuits, sweets, candies, dry pastries, puddings, gruels, sauces, syrups, milk-based sweet drinks and other confectionary. Another popular product is vanilla

Plate 3 Young vanilla pods

Plate 4 Dried vanilla pods

sugar which is used for butter puddings, bread, crème brulée, sugar glazed fruits and other desserts. Vanilla sugar is prepared by adding a pierced vanilla pod to sugar in an air-tight container. Vanilla pods are often used whole (being split and the tiny seeds scraped into the mixture) to infuse flavour into cream and custard based sauces. Vanilla is also used as flavouring in medicinal syrup and tobacco.

Botany

A succulent, herbaceous, perennial vine climbing trees or other support to a height of 12–15 m by means of long adventitious roots opposite the leaves (Plate 1). Stem is cylindrical long 1–2 cm diameter, dark green simple or branched. Leaves are alternate, fleshy and sub-sessile. Lamina flat, oblong-elliptical to lanceolate 8–25×5–8 cm, apex acute to acuminate. Inflorescence a short axillary raceme, 5–10 cm long, having 6–30 flowers (Plate 2). Flowers: sepals and petals erect-spreading, yellow-green, fleshy, rigid; sepals 3 – oblanceolate, 3.5–5.5×1.1–1.3 cm, margins straight, apex acute to obtuse; petals elliptic-oblanceolate, abaxially keeled, thinner than sepals, 3.5–5.5×1.1–1.3 cm, apex acute to obtuse; lip adnate to column for 1.5–2 cm, yellow-green, becoming dark yellow toward apex, lamina gullet-like, cuneate, rhomboid, with apical retuse lobule; disc with central tuft of retrorse scales, an hairy to apex; column white, slender, 3–3.5 cm, margins slightly sinuate, adaxially bearded; pollinia – 2, yellow; ovary pedicellate, 3–5 cm. Fruit pendulous, narrow cylindrical capsule, 10–25 cm by 0.8–1.5 cm, obscurely 3 angled (Plate 3) splitting longitudinally when ripe. Seeds numerous, globose, 0.4 mm diameter and black.

Nutritive/Medicinal Properties

The nutrient value of vanilla extract per 100 g edible portion was reported as: water 52.58 g, energy 288 kcal (1,205 kJ), protein 0.06 g, fat 0.06 g, ash 0.26 g, carbohydrate 12.65 g, sugars 12.65 g, Ca 11 mg, Fe 0.12 mg, Mg 12 mg, P 6 mg, K 148 mg, Na 9 mg, Zn 0.11 mg, Cu 0.072 mg, Mn 0.230 mg, thiamine 0.011 mg, riboflavin 0.095 mg, niacin 0.425 mg, pantothenic acid 0.035 mg, vitamin B-6 0.026 mg, total saturated fatty acids 0.010 g, 16:0 (palmitic acid) 0.005 g, 18:0 (stearic acid) 0.001 g, total monounsaturated fatty acids 0.010 g, 18:1 undifferentiated (oleic acid) 0.008 g, total polyunsaturated fatty acids 0.04 g, 18:2 undifferentiated (linoleic acid) 0.003 g, 18: undifferentiated 0.001 g and ethyl alcohol 34.4 g (USDA 2011).

Vanilla planifolia bean was found to contain more than a hundred compounds such as alkaloids, flavonoids, glycosides, phenols, phenol ether, alcohols, carbonyl compounds, acids, esters, vitamins, minerals, reducing sugars, lactones, aliphatic and aromatic carbohydrates, heterocyclic compounds and other phytochemicals. The principal constituent was found to be vanillin, a methylprotocatechuic aldehyde comprising about 85% of the total volatiles other important compounds are *p*-hydroxybenzaldehyde (up to 9%) and *p*-hydroxybenzyl methyl ether (1%),4-hydroxybenzyl alcohol, vanillyl alcohol, 3,4-dihydroxybenzaldehyde, 4-hydroxybenzoic acid, vanillic acid, p-coumaric acid, ferulic acid, and piperonal. Two stereoisomeric vitispiranes (2,10, 10-trimethyl-1,6- and methylidene-1-oxaspiro (4,5)dec-7-ene), although only occurring in traces, also influenced the aroma of vanilla (Schulte-Elte et al. 1978).

Older vanilla pods (8 months after pollination were found to have a higher content of glucovanillin, vanillin, p-hydroxybenzaldehyde glucoside, p-hydroxybenzaldehyde, and sucrose, while younger pods (3 months or more after pollination) had more bis[4-(β-d-glucopyranosyloxy)-benzyl]-2-isopropyltartrate (glucoside A), bis[4-(β-d-glucopyranosyloxy)-benzyl]-2-(2-butyl) tartrate (glucoside B), glucose, malic acid, and homocitric acid (Palama et al. 2009). Quantification of compounds showed that free vanillin could reach 24% of the total vanillin content after 8 months of development in the vanilla green pods. Ten phenolic compounds, namely vanillic acid, 4-hydroxybenzyl alcohol, vanillyl alcohol, 3,4-dihydroxybenzaldehyde, 4-hydroxybenzoic acid, 4-hydroxybenzaldehyde, vanillin, p-coumaric acid, ferulic acid, and piperonal were quantitatively determined in vanilla beans using RP-HPLC method (Sinha et al. 2007).

Glucosides of vanillin, vanillic acid, p-hydroxy benzaldehyde, vanillyl alcohol, p-cresol, creosol and bis[4-(β-D-glucopyranosyloxy)-benzyl]-2-isopropyltartrate and bis[4-(β-D-glucopyranosyloxy)-benzyl]-2-(2-butyl)tartrate were identified in vanilla green extract (Dignum et al. 2004). In the overall vanilla aroma, minor compounds p-cresol, creosol, guaiacol and 2-phenylethanol were found to have a high impact as shown by GC-olfactometry analysis of cured vanilla beans. They investigated the kinetics of the β-glucosidase activity from green vanilla beans towards eight glucosides naturally occurring in vanilla and towards p-nitrophenol. For glucosides of p-nitrophenol, vanillin and ferulic acid the enzyme had a Km value (the concentration of substrate required to produce 50% of the Vmax value) of about 5 mM. For other glucosides (vanillic acid, guaiacol and creosol) the Km-values were higher (>20 mM). The Vmax (the maximal speed of activity of the enzyme) was between 5 and 10 IU/mg protein for all glucosides tested. Glucosides of 2-phenylethanol and p-cresol were not hydrolysed. Beta-glucosidase was found not to have a high substrate specificity for the naturally occurring glucosides compared to the synthetic p-nitrophenol glucoside.

Beta-d-glucosidase, was reported to be the enzyme responsible for hydrolysis of glucovanillin into vanillin and glucose. Odoux et al. (2003b) showed that ß-glucosidase activity increased from the epicarp towards the placental zone, whereas glucovanillin was exclusively located in the placentae and papillae of vanilla bean. Activity of the enzyme was observed in the cytoplasm (and/or the periplasm) of mesocarp and endocarp cells, with a more diffuse pattern observed in the papillae. A possible mechanism for the hydrolysis of glucovanillin and release of the aromatic aglycon vanillin was postulated to involve the decompartmentation of cytoplasmic (and/or periplasmic) ß-glucosidase and vacuolar glucovanillin.

Vanilla bean β-d-glucosidase was purified and characterised by Odoux et al. (2003a) and found to be a tetramer (201 kDa) made up of four identical subunits (50 kDa). The optimum pH was 6.5, and the optimum temperature was 40°C at pH 7.0. Km values (the concentration of substrate required to produce 50% of the Vmax value) of vanilla bean β-d-glucosidase for p-nitrophenyl-β-d-glucopyranoside and glucovanillin were 1.1 and 20.0 mM, respectively; Vmax values (the maximal speed of activity of the enzyme) were 4.5 and 5.0 µkat/mg. The β-d-glucosidase was competitively inhibited by glucono-δ-lactone and 1-deoxynojirimycin, and not inhibited by 2 M glucose. The β-d-glucosidase was not inhibited by N-ethylmaleimide and DTNB and fully inhibited by 1.5–2 M 2-mercaptoethanol and 1,4-dithiothreitol. The enzyme showed decreasing activity on p-nitrophenyl-β-d-fucopyranoside, p-nitrophenyl-β-d-glucopyranoside, p-nitrophenyl-β-d-galactopyranoside, and p-nitrophenyl-β-d-xylopyranoside. The enzyme was also active on prunasin, esculin, and salicin and inactive on cellobiose, gentiobiose, amygdalin, phloridzin, indoxyl-β-d-glucopyranoside, and quercetin-3-β-d-glucopyranoside.

Other phytochemicals like nine 4-demethylsterols were identified in *V. fragrans* beans; the 4-demethylsterol fraction of *V. fragrans* was characterized by a high content of 24-methylene cholesterol (27–40%) and of β-sitosterol (35–46%) (Ramaroson-Raonizafinimanana et al. 1998). The beans' age modified the ratio 24-methylene cholesterol/β-sitosterol in *V. fragrans*. Four other demethylsterols in *V. fragrans* (brassicasterol, 0.02%; stigmasta-5,23-dien-3β-ol, 1.43%; stigmasten-22-ol, 0.1%; and fucosterol, 0.5%) were identified from the 4-demethylsterol fraction. 24-Methylene cholesterol and β-sitosterol were also isolated. Four triterpene alcohols were identified in *V. fragrans*, including cycloartenol (0.9–1.6%) from the triterpene alcohol fraction, 24-dihydrotirucallol (17–23%) from the triterpene alcohol fraction, tirucall-7-en-3β-ol (6–7.5%) from the triterpene alcohol fraction, and in a higher content cyclosadol (66–69%) from the triterpene alcohol fraction. Beta-dicarbonyl compounds representing approximately 28% of the neutral lipids, that is, 1.5%, in the epicuticular wax of immature vanilla beans, and approximately 10% of the neutral lipids, that is, 0.9%, in mature beans (Ramaroson-Raonizafinimanana et al. 2000). Five β-dicarbonyl compounds have been identified including 16-pentacosene-2,4-dione; 18-heptacosene-2,4-dione; 20-nonacosene-2, 4-dione; 22-hentriacontene-2,4-dione; and 24-tritriacontene-2, 4-dione. Among them (Z)-18-heptacosene-2,4-dione, or nervonoylacetone, was synthesized in two steps starting from nervonic acid. The major constituent, nervonoylacetone, represented 74.5% of the beta-dicarbonyl fraction. Long-chain gamma-pyrones representing 7–8% of the neutral lipids in epicuticular wax of mature vanilla beans were identified (Ramaroson-Raonizafinimanana et al. 1999). Three γ-pyrones were identified, including 2-(10-nonadecenyl)-2, 3-dihydro-6-methyl-4H-pyran-4-one, 2-(12-heneicosenyl)-2, 3-dihydro-6-methyl-4H-pyran-4-one, and 2-(14-tricosenyl)-2, 3-dihydro-6-methyl-4H-pyran-4-one. The major constituent was 2-(14-tricosenyl)-2,3-dihydro-6-methyl-4H-pyran-4-one, which represented 70.3% of the γ-pyrone fraction.

Sixty-five volatiles were identified in a pentane/ether extract from cured vanilla beans by GC–MS analysis (Pérez-Silva et al. 2006). Aromatic acids, aliphatic acids and phenolic compounds were the major volatiles. By GC–O analysis of the pentane/ether extract, 26 odour-active compounds were detected. The compounds guaiacol, 4-methylguaiacol, acetovanillone and vanillyl alcohol, found at much lower concentrations in vanilla beans than vanillin, proved to be as intense as vanillin. Seven velvety orosensory active molecules were identified in cured vanilla beans (*Vanilla planifolia*) (Schwarz and Hofmann 2009). Among these, 5-(4-hydroxybenzyl)vanillin, 4-(4-hydroxybenzyl)-2-methoxyphenol, 4-hydroxy-3-(4-hydroxy-3-methoxybenzyl)-5-methoxybenzaldehyde, (1-O-vanilloyl)-(6-O-feruloyl)-β-d-glucopyranoside, americanin A, and 4′,6′-dihydroxy-3′,5-dimethoxy-[1,1′-biphenyl]-3-carboxaldehyde were previously not reported in vanilla beans. In another study, vanillin was found in higher amounts in cured beans of *V. planifolia* (1.7–3.6% of dry matter) than in *V. tahitensis* (1.0–2.0%), and anisyl compounds were found in lower amounts in *V. planifolia* (0.05%) than in *V. tahitensis* (1.4–2.1%) (Brunschwig et al. 2009). Ten common and long chain monounsaturated fatty acids (LCFA) were also identified LCFA derived from secondary metabolites have discriminating compositions as they reach 5.9% and 15.8% of total fatty acids, respectively in *V. tahitensis* and *V. planifolia*.

Natural vanilla extract and artificial vanilla extract were found to contain the polar aromatic flavour compounds vanillin, ethyl vanillin, 4-hydroxybenzaldehyde, 4-hydroxybenzoic acid, 4-hydroxybenzyl alcohol, vanillic acid, coumarin, piperonal, anisic acid, and anisaldehyde (Belay and Poole 1993). The ratio of 4-hydroxybenzoic acid, 4-hydroxybenzaldehyde and vanillic acid to vanillin in natural vanilla extracts was used to confirm the authenticity of extracts purchased in the United States of America and the United Kingdom. Natural vanilla extracts purchased in Mexico and Puerto Rico were identified as counterfeit products based on changes in the above ratio and the presence of synthetic flavour compounds such as ethyl vanillin and coumarin.

Vanillin extract is produced from vanilla beans. For production of vanillin (4-hydroxy 3-methoxy benzaldehyde) extract from vanilla beans, Waliszewski et al. (2007) recommended a hydration process in 5% ethanol during 48 hours enzymatic pretreatment with stable cellulolytic preparations up to 12 hours. This combination of pretreatment was found to double vanillin content in the ethanolic extract, yielding a product of excellent sensory properties. They found as much as 12–15% of vanillin on a dry basis to be present in mature vanilla pods before harvesting, and if enzymatic hydrolysis of glucovanillin was completed during an adequate curing process, as much as 6–7% of vanillin content could be expected in cured beans. They also found that after 24 hours of bean hydration, the results of reducing sugar after enzymatic digestion were higher compared to non-hydrated beans. Total mean cellulose content in vanilla bean was 26.7 g per 100 g dry weight. Studies by Ranadive (1992) reported that vanillin, *p*-hydrobenzoic acid, *p*-hydroxybenzaldehyde and vanillic acid are present in green vanilla beans as glycosides and are released by B-glucosidase enzymatic action during bean ripening or upon curing (fermentation process).

Young vanilla leaves were found to have higher levels of glucose, bis[4-(*β*-d-glucopyranosyloxy)-benzyl]-2-isopropyltartrate (glucoside A) and bis[4-(*β*-d-glucopyranosyloxy)-benzyl]-2-(2-butyl)-tartrate (glucoside B), whereas older leaves had more sucrose, acetic acid, homocitric acid and malic acid (Palama et al. 2010).

Antioxidant Activity

Vanilla has antioxidant activity. Vanilla exhibited the highest antioxidant activity in the peroxidase-based assay (H_2O_2) among seven dessert spices (anise, cinnamon, ginger, licorice, mint, nutmeg, and vanilla) analysed (Murcia et al. 2004). When the Trolox equivalent antioxidant capacity (TEAC) assay was used to provide a ranking order of antioxidant activity, the result in decreasing order of antioxidant capacity was cinnamon ≅ propyl gallate (common food antioxidant) > mint > anise > BHA (butylated hydroxyanisole, common food antioxidant) > licorice ≅ vanilla > ginger > nutmeg > BHT (butylated hydroxytoluene, common food antioxidant). Vanilla has also been reported to increase catecholamines in the human body (including epinephrine, more commonly known as adrenaline), which makes it mildly addictive. In another study, at a concentration of 200 ppm, the vanilla extract showed 26% and 43% of antioxidant activity by β-carotene-linoleate and DPPH methods, respectively, in comparison to corresponding values of 93% and 92% for BHA (Shyamala et al. 2007). Major compound identified in the extract included vanillic acid, 4-hydroxybenzyl alcohol, 4-hydroxy-3-methoxybenzyl alcohol, 4-hydroxybenzaldehyde and vanillin. Interestingly, 4-hydroxy-3-methoxybenzyl alcohol and 4-hydroxybenzyl alcohol exhibited antioxidant activity of 65% and 45% by β-carotene-linoleate method and 90% and 50% by DPPH methods, respectively. In contrast, pure vanillin exhibited much lower antioxidant activity. The present study suggested the potential use of vanilla extract components as antioxidants for food preservation and in health supplements as nutraceuticals.

Anti-sickle Cell Activity

Vanillin has also been reported to have promising potential in treating sickle cell disease in humans. Unlike normal red blood cells, the bent sickle cells are too stiff to pass through capillaries and into smaller blood vessels. As a result, they clog and damage the blood vessels. The results can include severe pain, stroke, anemia, life-threatening infections, and damage to the lungs and other organs. Studies found that vanillin, a food additive, covalently bound with sickle haemoglobin (Hb S), and inhibited cell sickling development (Zhang et al. 2004). Studies using transgenic sickle mice, which nearly exclusively develop pulmonary sequestration upon exposure to hypoxia, showed that oral administration of a vanillin prodrug, MX-1520 prior to hypoxia exposure significantly reduced the percentage of sickled cells in the blood. The survival time under severe hypoxic conditions was prolonged from 6.6 minutes in untreated animals to 28.8 minutes and 31 minutes for doses of 137.5 and 275 mg/kg respectively. Intraperitoneal injection of MX-1520 to bypass possible degradation in the digestive tract showed that doses as low as 7 mg/kg prolonged the survival time and reduced the percentage of sickled cells during hypoxia exposure. These results demonstrated the potential for MX-1520 to be a new and safe anti-sickling agent for patients with sickle cell disease.

Antimicrobial Activity

Vanilla was found in recent studies to inhibit bacterial quorum sensing (Choo et al. 2006). Bacteria quorum sensing signals function as a switch for virulence. The microbes only become virulent when the signals indicate that they have the numbers to resist the host immune system response. Vanilla extract was found to significantly reduced violacein production in Tn-5 mutant, *Chromobacterium violaceum* in a concentration-dependent manner. The results suggested that the intake of vanilla-containing food materials might promote human health by inhibiting quorum sensing and preventing bacterial pathogenesis.

Studies revealed that both leaf and stem extracts of *V. planifolia* to be potent antimicrobials against all the pathogenic organisms studied: *Escherichia coli* and its mutant K12, *Proteus vulgaris, Enterobacter aerogens, Bacillus cereus, Streptococcus faecalis, Klebsiella Pneumoniae, Salmonella typhi, Serratia marcescens* and *Pseudomonas aeruginosa* (Shanmugavalli et al. 2009). Among various solvent extracts studied, ethanolic leaf extract showed higher degree of inhibition followed by ethyl acetate and chloroform. In the present study, the antibacterial sensitivity was maximum in ethanolic leaf and lowest inhibition was observed in petroleum ether. The aqueous extract did not show any antibacterial activity. 18 unidentified alkaloids and 11 flavonoids were found in the extract.

The ethanol extract of *Vanilla planifolia* leaves was found to effectively inhibit the growth of both the gram-positive and gram-negative bacteria. High inhibitory activity was exhibited in vitro against *Escherichia coli, E. coli* mutant K12 and *Proteus vulgaris*, moderate inhibitory activity against *Enterobacter aerogens, Streptococcus feacalis* and *Pseudomonas aeruginosa;* and low degree of inhibition against *Klebsiella pneumonia* and *Salmonella typhi*.

Larvicidal Activity

Studies showed that the ethyl acetate and aqueous butanol fractions of the alcoholic extracts of leaves and stems of *Vanilla fragrans* exhibited toxic bioactivity against mosquito larvae (Sun et al. 2001). Bioactivity of the ethyl acetate fraction was found to be much greater than that from the butanol fraction in mosquito larvae toxicity. The water fraction appeared to contain no substances that impaired mosquito larval growth. The ethyl acetate fraction was found to contain 4-ethoxymethylphenol, 4-butoxymethylphenol, vanillin, 4-hydroxy-2-methoxycinnamaldehyde, and 3,4-dihydroxyphenylacetic acid. 4-Ethoxymethylphenol was the predominant compound, but 4-butoxymethylphenol showed the strongest toxicity to mosquito larvae.

Traditional Medicinal Uses

In traditional medicine, vanilla beans are used as aphrodisiac, carminative, emmenagogue and stimulant and has been claimed to reduce or cure fevers, spasms and caries. The vanilla pods have been used as drugs against nervous diseases and hypochondria.

Other Uses

Vanilla is also used in pharmaceutical products, perfumery, air-fresheners, incense, candles, house-hold, baby and personal care products, aromatherapy and as aroma for tobacco and alcoholic beverages. Apart from flavouring food products vanilla is widely used as an odour maskant for paints, industrial chemicals, rubber tires and plastics etc. It is also used as insect repellent.

Comments

Commercially, vanilla is always propagated by stem cuttings. Vanilla can also be established from tissue culture (micropropagation) of callus masses, protocorms, root tips and stem nodes (Ravishankar 2004).

Selected References

Ackerman JD (2003) *Vanilla* Miller. In: Flora of North America Editorial Committee (eds) 1993+. Flora of North America North of Mexico, 12+ vols, vol 26. Oxford University Press, New York/Oxford, p 510. Published on the internet. http://www.efloras.org. Accessed 2 Oct 2009

Belay MT, Poole CF (1993) Determination of vanillin and related flavor compounds in natural vanilla extracts and vanilla-flavored foods by thin layer chromatography and automated multiple development. Chromatographia 37(7–8):365–373

Brunschwig C, Collard FX, Bianchini JP, Raharivelomanana P (2009) Evaluation of chemical variability of cured vanilla beans (*Vanilla tahitensis* and *Vanilla planifolia*). Nat Prod Commun 4(10):1393–1400

Choo JH, Rukayadi Y, Hwang JK (2006) Inhibition of bacterial quorum sensing by vanilla extract. Lett Appl Microbiol 42(6):637–641

Correll DS (1953) Vanilla. Its botany, cultivation and economic importance. Econ Bot 7:291–358

Council of Scientific and Industrial Research (CSIR) (1976) The wealth of India. A dictionary of Indian raw materials and industrial products, raw materials 10. Publications and Information Directorate, New Delhi

Dignum MJW, van der Heijden R, Kerler J, Winkel C, Verpoorte R (2004) Identification of glucosides in green beans of *Vanilla planifolia* Andrews and kinetics of vanilla β-glucosidase. Food Chem 85(2):199–205

Huxley AJ, Griffiths M, Levy M (eds) (1992) The new RHS dictionary of gardening, 4 vols. Macmillan, London

Lubinsky P, Bory S, Hernández JH, Kim SC, Gómez-Pompa A (2008) Origins and dispersal of cultivated vanilla (*Vanilla planifolia* Jacks. [Orchidaceae]). Econ Bot 62(2):127–138

Murcia MA, Egea I, Romojaro F, Parras P, Jimenez AM, Martinez-Tome M (2004) Antioxidant evaluation in dessert spices compared with common food additives influence of irradiation procedure. J Agric Food Chem 52(7):1872–1881

Odink J, Korthals H, Knijff JH (1988) Simultaneous determination of the major acidic metabolites of catecholamines and serotonin in urine by liquid chromatography with electrochemical detection after a one-step sample clean-up on sephadex G-10; influence of vanilla and banana ingestion. J Chromatogr 424(2):273–283

Odoux E, Chauwin A, Brillouet J-M (2003a) Purification and characterization of vanilla bean (*Vanilla planifolia* Andrews) β-d-Glucosidase. J Agric Food Chem 51(10):3168–3173

Odoux E, Escoute J, Verdeil J-L, Brillouet J-M (2003b) Localization of ß-D-glucosidase activity and glucovanillin in vanilla bean (*Vanilla planifolia* Andrews). Ann Bot 92:437–444

Palama TL, Fock I, Choi YH, Verpoorte R, Kodja H (2010) Biological variation of *Vanilla planifolia* leaf metabolome. Phytochemistry 71(5–6):567–573

Palama TL, Khatib A, Choi YH, Payet B, Fock I, Verpoorte R, Kodja H (2009) Metabolic changes in different developmental stages of *Vanilla planifolia* pods. J Agric Food Chem 57(17):7651–7658

Pérez-Silva A, Odoux E, Brat P, Ribeyre F, Rodriguez-Jimenes G, Robles-Olvera V, García-Alvarado MA, Günata Z (2006) GC–MS and GC–olfactometry analysis of aroma compounds in a representative organic aroma extract from cured vanilla (*Vanilla planifolia* G. Jackson) beans. Food Chem 99(4):728–735

Porcher MH et al (1995–2020) Searchable world wide web multilingual multiscript plant name database. Published by The University of Melbourne, Australia. http://www.plantnames.unimelb.edu.au/Sorting/Frontpage.html

Ramaroson-Raonizafinimanana B, Gaydou EM, Bombarda I (1998) 4-Demethylsterols and triterpene alcohols from two *Vanilla* bean species: *Vanilla fragrans* and *V. tahitensis* 4-Demethylsterols and triterpene alcohols from two *Vanilla* bean species: *Vanilla fragrans* and *V. tahitensis*. JAOCS 75(1):51–55

Ramaroson-Raonizafinimanana B, Gaydou EM, Bombarda I (1999) Long-chain gamma-pyrones in epicuticular wax of two vanilla bean species: *V. fragrans* and *V. tahitensis*. J Agric Food Chem 47(8):3202–3205

Ramaroson-Raonizafinimanana B, Gaydou EM, Bombarda I (2000) Long-chain aliphatic beta-diketones from epicuticular wax of vanilla bean species. Synthesis of nervonoylacetone. J Agric Food Chem 8(10):4739–4743

Ranadive AS (1992) Vanillin and related flavor compounds in vanilla extracts and from beans of various global origins. J Agric Food Chem 40(10):1992–1994

Ranadive AS (1994) Vanilla – cultivation, curing, chemistry, technology and commercial products. In: Charalambous G (ed) Spices, herbs and edible fungi: development in food science 34. Elsevier Science Publishers, Amsterdam, pp 517–577; 780 pp

Ravishankar GP (2004) Efficient micropropagation of *Vanilla planifolia* Andrews under influence of thidiazuron and coconut milk. Indian J Biotechnol 3(1):113–118

Schulte-Elte KH, Gautschi F, Renold W, Hauser A, Fankhauser P, Limacher J, Ohloff G (1978) Vitispiranes, important constituents of vanilla aroma. Helv Chim Acta 61(3):1125–1133

Schwarz B, Hofmann T (2009) Identification of novel orosensory active molecules in cured vanilla Beans (*Vanilla planifolia*). J Agric Food Chem 57(9):3729–3737

Shanmugavalli N, Umashankar V, Raheem (2009) Antimicrobial activity of *Vanilla planifolia*. Indian J Sci Technol 2(3):37–40

Shyamala BN, Naidu MM, Sulochanamma G, Srinivas P (2007) Studies on the antioxidant activities of natural vanilla extract and its constituent compounds through in vitro models. J Agric Food Chem 55(19):7738–7743

Sinha AK, Verma SC, Sharma UK (2007) Development and validation of an RP-HPLC method for quantitative determination of vanillin and related phenolic compounds in *Vanilla planifolia*. J Sep Sci 30(1):15–20

Straver JTG (1999) *Vanilla planifolia* H.C. Andrews. In: de Guzman CC, Siemonsma JS (eds) Plant resources of South East Asia No 13. Spices. Backhuys Publishers, Leiden, pp 228–233

Sun RQ, Sacalis JN, Chin CK, Still CC (2001) Bioactive aromatic compounds from leaves and stems of *Vanilla fragrans*. J Agric Food Chem 49(11):5161–5164

U.S. Department of Agriculture, Agricultural Research Service (2011) USDA national nutrient database for standard reference, release 24. Nutrient Data Laboratory Home Page. http://www.ars.usda.gov/ba/bhnrc/ndl

Waliszewski KN, Ovando SL, Pardio VT (2007) Effect of hydration and enzymatic pretreatment of vanilla beans on the kinetics of vanillin extraction. J Food Eng 78(4):1267–1273

Zhang C, Li X, Lian L, Chen Q, Abdulmalik O, Vassilev V, Lai CS, Asakura T (2004) Anti-sickling effect of MX-1520, a prodrug of vanillin: an in vivo study using rodents. Br J Haematol 125(6):788–795