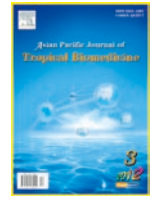




Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Biomedicine

journal homepage: www.elsevier.com/locate/apjtb

Document heading

doi:

©2012 by the Asian Pacific Journal of Tropical Biomedicine. All rights reserved.

A Review on biological and phytochemical investigation of plant genus *Callistemon*

Praveen Kumar Goyal^{1*}, Renuka Jain¹, Shweta Jain¹, Archana Sharma¹¹Department of Chemistry, University of Rajasthan, Jaipur–302055 (India)

ARTICLE INFO

Article history:

Received 10 June 2012

Received in revised form 19 June 2012

Accepted 20 November 2012

Available online 28 December 2012

Keywords:

Activity

Flavonoids

Callistemon

Steroid

Triterpenoid

ABSTRACT

Objective: The large flowering plant genus *Callistemon* belongs to family Myrtaceae and reported for its medical importance. Various parts of different species exhibit different medicinal importance and yet to be phytochemically investigated. In the different time various scientist have investigated the genus and reported the chemical constituents. A survey of literature on genus *Callistemon* reported the isolation of triterpenoids and steroids from leaves, seeds and stem bark of different species.

1. Introduction

Callistemon is a genus of 34 species of shrubs in the family Myrtaceae, all of which are endemic to Australia. It is sometimes considered a synonym of *Melaleuca*. *Callistemon* species are commonly referred to as bottlebrushes because of their cylindrical, brush like flowers resembling a traditional bottle brush. They are found in the more temperate regions of Australia, mostly along the east coast and south–west, and typically favour moist conditions so when planted in gardens thrive on regular watering. However, at least some of the species are drought–resistant. *Callistemon* can be propagated either by cuttings (some species more easily than others), or from the rounded seeds. Flowering is normally in spring and early summer (October–December), but conditions may cause flowering at other times of the year. In Australia,

Callistemon species are sometimes used as food plants by the larvae of hepialid moths of the genus *Aenetus* including *A. lignivorena*. These burrow horizontally into the trunk then vertically down. In India, bottlebrush plants/trees are grown in gardens. Their leaves have a lovely fragrance which gets released on crushing the leaves with hands. The genus *Callistemon* is known in folk medicine for its anticough, antibronchitis, and insecticidal effects and its volatile oils have been used as antimicrobial and antifungal agents^[1–3]

Biological evaluation

Diverse bioactivity studies on different species of genus *Callistemon* have been reported. *C. lanceolatus* is a small tree, indigenous to Australia and frequently grown in gardens in India. A survey of literature revealed the isolation of some phenolic derivatives, aliphatic acids and steroids from flowers^[4–7], fruits^[4,5], leaves^[8–15], stem bark and seeds^[16]. *Callistemon lanceolatus* D.C. (Myrtaceae) is a slow–growing ornamental shrub that grows to a height of around 10 meters. *C. lanceolatus* is a native tree to Australia, but is also widely distributed in Asian countries. It is commonly known as crimson bottle brush tree because of its spiky inflorescence that resembles a bottle brush. The inflorescence is crimson in color and cylindrical, and flowers are borne in spring and summer.

* Corresponding author: pgoyal_chem1981@yahoo.co.in
Address of Corresponding Author: Department of Chemistry, University of Rajasthan, Jaipur–302055.

Phone No. +91–141–2702306

Fax +91–141–2702306

The plant has been used by tribal communities of India for the treatment of gastrointestinal disorders, pain, and infectious diseases. Over the years, *C. lanceolatus* have been extensively analyzed scientifically and reported to possess anticholinestrase activity[17], wound healing activity[18], hepatoprotective activity[19], inhibit elastase activity[20], cardioprotective activity[21], antiinflammatory activity[22], antidiabetic activity, hypolipidemic activity and antioxidant activities[23]. These reports indicate the potential of *C. lanceolatus* to be a good source of bioactive compounds with several medicinal properties. Nitisinone has been isolated from the plant that exhibited a herbicidal activity. Nitisinone has also been successfully used in the management of human tyrosinaemia Type-I, The alpha amylase inhibitory activity of *Callistemon rigidus* in mouse's gastrointestinal tract has been documented that has blood glucose lowering effect at postprandial state [24]. Similarly antibacterial and anthelmintic activity of *callistemon viminalis* have also been documented[25,26]. The 1, 8-cineol and alpha-terpineol have been isolated as major compounds from the leaves and flowers of *Callistemon citrinus* that have anthelmintic and antimicrobial activity[27,28]. Moreover, antistaphylococcal nematocidal, larvicidal, pupicidal, antithrombotic activities of the genus *callistemon*, and antioxidant activities have been documented[29,30]. More over, Traditional uses of the aerial parts of *Callistemon lanceolatus* in ethnic tribal communities are in practice, and very little are known about its importance on scientific grounds[31]. The crude ethanolic extract of the aerial parts of *Callistemon lanceolatus*

exhibited insecticidal activity against the mosquito, *Culex quinquefasciatus*[32]. Essential oils and aqueous extract of aerial parts demonstrated antifungal, antibacterial, antiviral and antimycotic activity against a few dermatophytes[32,33] while that of the plant exhibited pesticidal and growth inhibitory activity[34,35]. The juice of bark exhibited mild activity against water melon mosaic virus[16]. Methylene chloride and methanol extract of plant demonstrated antitumor activity in bioassay system[36]. Decoction of leaves exhibited antibacterial and antifungal activity, its essential oils exhibited pesticidal[37], growth inhibitory[38], anthelmintic[39] and fungitoxic[40] activity. The essential oils obtained by hydrodistillation of the leaves of *Callistemon comboynensis* exhibited antioxidant activity and also antimicrobial; activity against both gram positive (*Bacillus subtilis* and *Staphylococcus aureus*), gram negative (*Proteus vulgaris*, *Pseudomonas aeruginosa*) and a pathogenic fungus *Candida albicans*. Nevertheless, Cc leaf oil extract exhibited high antioxidant activity[41]. An alcoholic extract of the *C. linearis* and leaf extract of *C. macropunctatus* exhibited antibacterial activity against various bacterial[42], while the aqueous extract of the flowers of *C. phoeniceus* and *C. salignus* were active against gram positive bacteria [43]. *Callistemon viminalis* is an ethnomedicinal plant used in Jamaica to treat intestinal illnesses. The oil of *C. viminalis* exhibited anthelmintic activity against tapeworm and hookworm while the aqueous extract of the flowers and leaves were active against gram positive bacterial[44]. Methanol, hexane and aqueous extracts of *Callistemon*

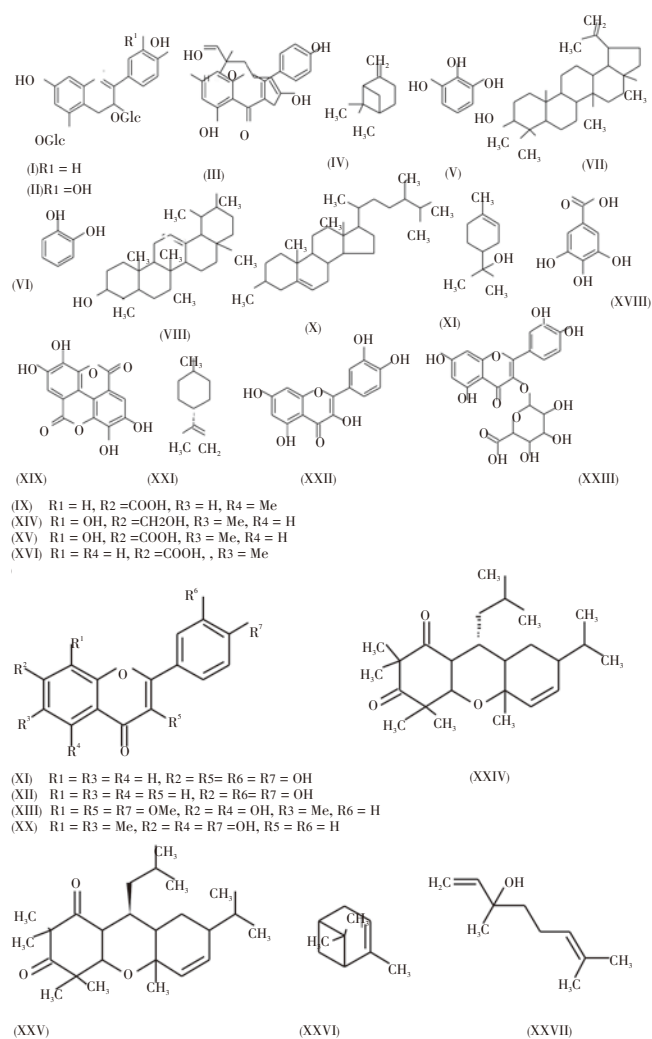
Table 1Compounds isolated from genus *Callistemon*.

Plant species	Part investigated	Compounds isolated	References
<i>C. lanceolatus</i> syn. <i>C. citrinus</i>	Flowers	Flavonoids: pelargonidin-3,5-diglucoside(I), cyanidin-3,5-diglucoside(II) and kaempferol(III); monoterpenoids: β -pinene(IV) and 1,8-cineol; tannins: pyrogallol(V) and catechol(VI); triterpenoids: betulinic acid(VII), α -amyrin(VIII) and oleanolic acid(IX) and β -sitosterol(X)	[4-7]
	Fruits	Monoterpenoids: 1,8-cineol and α -terpineol(XI); triterpenoids: α -amyrin(VIII) betulinic acid(VII) and oleanolic acid(IX) and β -sitosterol(X)	[4,5]
	Leaves	Flavonoids: 3',4',7-trihydroxy flavonol(XI), 3',4',7-trihydroxy flavone(XIII), 3',4',7-trihydroxy flavonol-3-glucoside, 3',4',7-trihydroxy flavone-7-galactoside, 5,7-dihydroxy-3,8,4'-trimethoxy-6-C-methyl flavone(XIII), kaempferol-3-O- β -D-galactopyranoside and quercetin-3-O-(2'-O-galloyl)- β -D-gluconopyranoside; monoterpenoids: 1,8-cineol, α -pinene and limonene; triterpenoids: α -lupenol, 2 α -hydroxy uvaol(XIV), 2 α -hydroxy ursolic acid(XV), ursolic acid(XVI), oleanolic acid(IX) and uvaol(XVII) and myrtucommulone and phloroglucinol derivative	[8-15]
	Seeds	Tannins: gallic acid(XVIII) and ellagic acid(XIX)	[16]
	Stem bark	Tannins: 3,3'-di-O-methyl ellagic acid, 3,3',4-tri-O-methyl ellagic acid and ellagic acid(XIX)	[16]
<i>C. coccineus</i>	Leaves	Flavonoids: 5,4'-dihydroxy-6-C-methoxy flavonone, 5,4'-dihydroxy-8-C-methyl-7-methoxy flavonone, 5,7-dihydroxy-3,8,4'-trimethoxy-6-C-methyl flavone and 6,8-dimethyl apigenin(XX)	[38]
<i>C. linearis</i>	Seeds	β -Sitosterol(X)	[39]
<i>C. rigidus</i>	Aerial parts	Triterpenoids: α -amyrin(VIII), betulinic acid(VII) and oleanolic acid(IX); tannins : pyrogallol(V) and catechol(VI) and β -sitosterol(X)	[6]
	Leaves	Flavonoids: 3',4',7-trihydroxy flavonol(XI), 3',4',7-trihydroxy flavone(XII), 3',4',7-trihydroxy flavonol-3-glycoside and 3',4',7-trihydroxy flavone-7-galactoside; monoterpenes: γ -terpinene, α -terpeneol, α -pinene, 1,8-cineol and limonene(XXI); melaleucin and melaleucin acetate	[12, 39-42]
<i>C. speciosus</i>	Leaves	Flavonoids: quercetin(XXII) and quercetin-3-O-glucuronide(XXIII); polyphenols: 2,3-(S)-hexahydroxy diphenyl-D-glucose; tannins: ellagic acid(XIX), tergallic acid dilactone, catechin and casuarinin; triterpenoids: betulinic acid(VII) and ursolic acid(XVI)	[43,44]
<i>C. viminalis</i>	Aerial parts	Viminadione A(XXIV) and viminadione B(XXV).	[45]
	Leaves	Monoterpenes: 1,8-cineol, α -pinene(XXVI), linalool(XXVII) and α -terpeneol(XI)	[46]

viminalis were tested against eight common bacteria and a single fungus of medical importance using a quantitative agar well diffusion test and tube dilution assay. All plant extracts showed antimicrobial activities against the selected microorganisms; the methanol extracts were most effective. The aqueous extract on the other hand, was very effective as a bactericidal agent against the intestinal pathogens. These results support the ethnomedicinal claim that *C. viminalis* is an effective treatment for bacterial causes of intestinal illnesses[45].

Phytochemical evaluation

Phytochemically, this genus has been found to be rich in triterpenoids, flavonoids, steroids and saponins. The compounds isolated from the various species are given in Table 1



Conclusion

Callistemon, the versatile genus of medicinal plant is the unique source of various types of compounds having diverse chemical structure. A very little work has been done on the biological activity and possible medicinal application of its phytochemicals. It is very useful traditional plant genus,

crude extract from various part of various species have a therapeutic uses from time immemorial, so that some active constituent can developed for future studies. The global scenario is changing their face towards herbal medicinal uses due to less side effect and emphasis given to develop a modern drug to cure many acute disease. Therefore this review given to find out new activity or new entity responsible for various therapeutic activity.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgements

Authors are thankful to UGC New Delhi for financial assistance.

References

- [1] Kirtikar, KR, Basu BD. Indian Medicinal Plants, Lalit Mohan Basu and Co., Allahabad, 1975, Vol. I, 384.
- [2] The Wealth of India, Raw Materials and Industrial Products, CSIR, New Delhi, 1956, Vol. IV, 266.
- [3] Chopra RN, Nayar SL, Chopra IC, Glossary of Indian Medicinal Plants, CSIR, New Delhi, 1956, 128.
- [4] Mishra LN, Hug F, Ahmad A, Dixit AK. Chemical composition of the essential oils of *Callistemon lanceolatus* DC and *C. polandii* F.M. Bailey *J. Ess. Oil Res.*, 1997; **9**(6): 625.
- [5] Hashim FM, Shamy AME, Shehata AH. The flavonoids of the leaves of *Callistemon lanceolatus* D. C. and *Callistemon rigidus* R. Br *Bull. Fac. Pharm.*, 1982; **19**(1): 139.
- [6] Jirovetz L, Fleischacker W, Buchbauer G, Ngassoum MB. Analysis of the essential oils of *Callistemon rigidus* (Myrtaceae) from Cameroun by GC/FID and GC/MS. *Scientia Pharmaceutica* 1997; **65**: 315.
- [7] Ming JC, Verra RR, Fraisso DJ. Chemical composition of essential oil of *Callistemon citrinus* (Curtis) Skeel from Reunion. *J. Ess. Oil Res.*, 1998; **10**: 429.
- [8] Sharma RK, Kotoky R, Bhattacharya PR. Volatile oil from the leaves of *Callistemon lanceolatus* D.C. grown in northeastern India. *Flav. Frag. J.*, 2006; **21**(2): 239.
- [9] Rajak DC, Singh HM. Comparative efficacy of pesticides against red pumpkin beetle on muskmelon. *Ann. Plant Prot. Sci.*, 2002; **10**(1): 147.
- [10] Ghuman HS, Singh D, Kohli JC. Chemistry of terpenoids from *Callistemon lanceolatus*. *Riechst. Aromen Koerperpflagn*, 1970; **22**(4): 113.
- [11] Hashim FM, Shamy AM, Shehata AH. The flavonoids of the leaves of *Callistemon lanceolatus* D. C. and *Callistemon rigidus* R. Br., *Bull. Fac. Pharm.*, 1982; **19**(1): 131.
- [12] Lounasmaa M, Puri HS, Widen CJ. A New Dioleate Compound from *Callistemon lanceolatus*. *Phytochemistry*, 1977; **16**(11): 1851.
- [13] Mohmoud FA, Mohrram, MSA, Marzouk MW, Salen MI. Polyphenolic constituents of *Callistemon lanceolatus* leaves, *Pharmazie*, 2002; **57**(7): 494.

- [14] Younes EGM. Chemical Examination of Local Plants. XIV. Triterpenoids From the Leaves of Egyptian *Callistemon lanceolatus*, Aust. J. Chem., 1975; 28(1): 221.
- [15] Younes EGM. Triterpenoids from the leaves of *Callistemon lanceolatus* *Phytochemistry*, 1975; 14(2): 592.
- [16] Bhatia LS, Bhatia MS, Sharma RS, Bajaj KL. Chemical composition of *Callistemon lanceolatus*. Indian J. Chem., 1972; 10: 959.
- [17] Gupta A, Gupta R. A survey of plants for anticholinesterase activity. *Phytochemistry* 1997; 46: 827.
- [18] Kumar B, Vijayakumar M, Govindarajan R, Pushpangadan P. Ethnopharmacological approaches to wound healing—Exploring medicinal plants of India. *J Ethnopharmacol* 2007; 114: 103.
- [19] Jain AK, Dubey SK, Sikarwar MS, Jain SK. Hepatoprotective activity of methanolic extract of leaves of *Callistemon lanceolatus*. *Internat J Plant Sci* 2007; 2: 185.
- [20] Kim JH, Byun JC, Bandi AKR, Hyun CG, Lee NH. Compounds with elastase inhibition and free radical scavenging activities from *Callistemon lanceolatus*. *J Med Plant Res* 2009; 3: 914.
- [21] Firoz M, Bharatesh K, Nilesh P, Vijay G, Tabassum S, Nilofar N. Cardioprotective activity of ethanolic extract of *Callistemon lanceolatus* leaves on doxorubicin-induced cardiomyopathy in rats. *Bangladesh J Pharmacol* 2011; 6: 38.
- [22] Kumar S, Kumar V, Prakash O. Pharmacognostic study and antiinflammatory activity of *Callistemon lanceolatus* leaf. *Asian Pacific Journal of Tropical Biomedicine* 2011; 1: 177
- [23] Kumar S, Kumar V, Prakash O. Antidiabetic, hypolipidemic and antioxidant activities of *Callistemon lanceolatus* leaves extract. *J Herbs Spices Med Plants* 2011; 17: 144.
- [24] Asif M, Khan MT, Rasool SA. Reduction of Aflatoxin-B1 and Ochratoxin-A levels in Polished Basmati Rice (*Oryza sativa* Linn.) by Different Cooking Methods *J. of the chemical Society of Pakistan*, 2009; 31: 329.
- [25] Adonizio AL, Downum K, Bennett BC, Mathee K. Anti-quorum sensing activity of medicinal plants in southern Florida. *J. of Ethnopharmacology*, 2006; 105(3): 427.
- [26] Iqbal Z, Jabber A, Akhtar MS, Muhammad G, Lateef M. Possible role of ethnoveterinary medicine in poverty reduction in Pakistan: use of botanical Anthelmintics as an example. *J. of Agriculture & Social Science*, 2005; 2: 187.
- [27] Riaz M, Chaudhary FM. The Chemical Composition of Pakistan *Callistemon citrinus* Oils. *J. of Essential Oil Research*, 1990; 2: 327.
- [28] Krishna KVV, Surendra G, Anjana M, Siva Nagini KSK. Phytochemical Screening and Antimicrobial Activity of *Callistemon citrinus* (L.) Leaves Extracts. *International Journal of PharmTech Research*, 2012; 2: 700.
- [29] Lee NH, Kim JH, Byun JC, Bandi AKR, Hyun CG. Compounds with elastase inhibition and free radical scavenging activities from *Callistemon lanceolatus*. *J. of Medicinal Plant Research*, 2009; 3(11): 914.
- [30] Oyedeji OO, Lawal OA, Shode OF, Oyedeji AO. Chemical Composition and Antibacterial Activity of the Essential Oils of *Callistemon citrinus* and *Callistemon viminalis* from South Africa. *Molecules*, 2009; 14: 1990.
- [31] Sudhakar M, Rao CV, Rao AL, Raju DB. Cardioprotective activity of ethanolic extract of *Callistemon lanceolatus*. *Acta Pharmaceutica Turcica*, 2004; 46: 131.
- [32] Mohsen JH, Jawed ALM, Al-Chal-Abi BM, Al-Naib A. Biological activity of *Callistemon lanceolatus* against *Culex quinquefasciatus*. *Fitoterapia*, 1990; 61: 270.
- [33] Riaz M, Chaudhary FM. Studies of the essential oil of the Pakistani *Laurus nobilis* Linn in different seasons Pak. J. Sci. Ind. Res., 1989; 32: 133.
- [34] Riaz M, Chaudhary FM. The Chemical Composition of Pakistani *Callistemon citrinus* Oils *J. Essen. Oil. Res.*, 1990; 2: 327.
- [35] Deshmukh SK, Jain PC, Agarwal SC. A note on mycotoxicity of some essential oils *Fitoterapia*, 1986; 57: 295.
- [36] Chistokhodova N, Nguyen C, Calvino T, Kachirskaia I, Cunningham G, Miles DH. Antithrombin activity of medicinal plants from central Florida *J. Ethnopharm.*, 2002; 81(20): 277.
- [37] Naik SN, Kumar A, Maheshwari RC, Guddewar MB, Chandra R, Kumar B. Pesticidal properties of sub critically extracted plant essential oils against storage pest *T. castaneum*(Herbst). *Indian Perfume*, 1995; 39(4): 171.
- [38] Sharma SS, Gill K, Malik MS, Malik OP. antifeedant and growth inhibitory activities of essential oils of some medicinal plants *J. Med. Arom. Pl. Sci.*, 2000; 22(4A): 23(1A): 373.
- [39] Garg SC. Anthelmintic activity of some medicinal plants. *Hamdard Medicus*, 1997; 40(3): 18.
- [40] Pandey DK, Chandra H, Tripathi NN. Volatile Fungitoxic Activity of Some Higher Plants With Special Reference to That of *Callistemon lanceolatus* DC. *Phytopathol.*, 1982; 105(2): 175.
- [41] Abdelhady MI, Hamdy AH. Antioxidant and antimicrobial activities of *Callistemon comboynensis* essential oil. *Free Radicals and Antioxidants*, 2012; 2(1): 37.
- [42] Joshi CG, Nagar NG. Antibiotic activity of some Indian medicinal plants, *J. Sci. Ind. Res.*, 1952; 11B: 261.
- [43] Garg VK, Khanduja SD. Mineral composition of leaves of some forest trees grown on alkali soils. *Indian For.*, 1979; 105: 741.
- [44] Garg SC, Kasera HL. Anthelmintic activity of *Callistemon viminalis*. *Fitoterapia*, 1982; 53: 179.
- [45] Delahaye C, Rainford L, Nicholson A, Mitchell S, Lindo J, Ahmad M. Antibacterial and antifungal analysis of crude extracts from the leaves of *Callistemon viminalis*. *J. of Medical and Biological Science*, 2009; 3(1): 190.
- [46] Wollenweber E, Wehde R, Dorr M, Lang G, Stevens JF. C-methyl-flavonoids from the leaf waxes of some Myrtaceae. *Phytochemistry*, 2000; 55(8): 965.
- [47] Jirovetz L, Buchbaver G, Ngassoum MB. Twenty *Eighth International Symposium on Essential Oils*, Turkey, 1979; 8: 60.
- [48] Kyoko K, Tamaki I, Eriko K, Toshio M, Fumihiko Y. Constituents of Stem Bark of *Callistemon rigidus* Showing Inhibitory Effects on Mouse a-Amylase Activity. *Biol. Pharm. Bull.* 2006; 29(6): 1275.
- [49] Islaki AO, Nureni OO, Adeleke AK, Ekundayo O, Wilfred AK. Essential oils of the leaves of *Callistemon rigidus*. *J. Ess. Oil-Bearing Plants*, 2002; 5(2): 55.
- [50] Joshef JP, Robert JGS, Paul IF, Lyn AG, Brendon JI. The leaf essential oils of the Australian members of the genus *Callistemon* (Myrtaceae). *J. Ess. Oil Res.*, 1998; 10(6): 595.
- [51] Bin HAF, Junaidah HO, Abd.MA. Flavonoid glycosides from *Callistemon speciosus*. *Ultra Sci. Phys. Sci.*, 1999; 11(3): 357.
- [52] Ito H, Saed A, Yoshida T. Polyphenolic Constituents of *Callistemon speciosus*. *Nat. Med.*, 2000; 54(4): 204.
- [53] Bhupinder PS, Khambay.SL. New Insecticidal Tetradehydroxanthenediones from *Callistemon viminalis*. *J. Nat. Prod.*, 1999; 62(12): 1666.
- [54] Srivastava, SK., Ahmad A, Syamsunder KV, Aggarwal KK, Khanuja SPS. Essential oil composition of *Callistemon viminalis* leaves from India. *Flavour and Fragrance Journal*, 2002; 18:361.