

Ocimum gratissimum: Therapeutic Uses and Phytochemical Constituents

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ABSTRACT

Ocimum gratissimum is a conventional herb with a wide range of phytochemical constituents and has been reported for its diverse physiological and medicinal properties. *O. gratissimum* is a standout amongst the most utilized therapeutic plants as an overall wellspring of flavors and furthermore as a consolidated supply of extracts with several pharmacological activities. This review delineates with all essential oil composition, traditional uses and pharmacological aspects of *O. gratissimum* that will help the various practitioners and clinicians to get aware of the modern and traditional uses of this plant which may be further helpful in pharmaceutical industry and formulation of drug principles.

Keywords- Lamiaceae, Medicinal, *Ocimum gratissimum*, Pharmaceutical, Therapeutic.

INTRODUCTION

Herbs are organizing a rebound everywhere throughout the world and natural products are considered as a symbol of safety when compared with synthetics, which are generally viewed as hazardous for human utilization and for the environment [1]. The status of restorative plants in India is in transitory phase and the demand for these plants is increasing day by day. Amid most recent couple of decades there has been an expansion in the investigation of therapeutic plants and their traditional use in various parts of the world [2]. Around 80% populace of the earth depends on herbal drugs for their essential health care [3,4]. Numerous higher plants are significant wellsprings of natural products utilized as pharmaceuticals, agrochemicals, flavors, fragrance ingredients, food additives and pesticides (Wink, 2007) and therefore medicine can be used as a contrasting option to some commercial drugs [5]. During the last few years, utilization of therapeutic plants in curing different medical issues has been increased as they are from natural origin and have less side-effect [6]. The primary advantage of utilizing plant derived drug is that they are relatively safe, economical & effective as their ease of accessibility [7] than synthetic alternatives, providing profound therapeutic advantages and affordable treatment [8].

THERAPEUTIC USES

The genus 'Ocimum' (Family: Lamiaceae) together and usually called as 'Basil' is a diverse and rich wellspring of fragrant vital oils endorsed for their pharmaceutical, culinary and aromatic

properties. The variety *Ocimum* is positioned high among the herbs and is an incredibly versatile group comprising of around 160 species [9] with a geographic distribution spread over tropical, areas of Asia, Africa, South and Focal America and hotter parts of temperate districts of the world [10]. Among the plants known for restorative esteem, the plants of genus *Ocimum* are rich in phenolic compounds and very essential for their healing potentials [11]. *Ocimum sanctum* L. (Tulsi), *Ocimum gratissimum*, *Ocimum canum*, *Ocimum basilicum*, *Ocimum kilimandscharicum*, *Ocimum ammericanum*, *Ocimum camphora* and *Ocimum micranthum* are examples of known important species of genus *Ocimum* which grow in different parts of the world and are regarded to have curative properties [12].

O. gratissimum is known by various names in different parts of the world *O. gratissimum* is called as the “Camphor Basil” in English and “Ram Tulsi” in Hindi. In India it is known by its numerous vernacular names, the most commonly used ones being Vriddhu tulsi (Sanskrit), Ram tulsi (Hindi), Nimma tulasi (Kannada). In the southern part of Nigeria, the plant is called “effinrin-nla” by the Yoruba speaking tribe. It is called “Ahuji” by the Igbos, while in the Northern part of Nigeria; the Hausas call it “Daidoya” [13].

Among all groups of the plant kingdom, individuals from the Lamiaceae have been utilized for quite a long time in human beings prescription drug to deal with diverse diseases. *Ocimum gratissimum* L. (Lamiaceae) is naturally used in folk medicine to treat distinctive infections, e.g. upper respiratory tract infections, tooth and gum disorder, diarrhea, headache, ophthalmic, skin diseases, pneumonia, cough, rheumatism, paralysis, epilepsy, sunstroke, influenza, gonorrhoea, mental illness [14], malaria [15], barrenness, convulsions ear infections, regulation of menstruation and as a cure for prolapse of the rectum [16].

They are likewise utilized as anti-diarrhoeal agent and for the treatment of conjunctivitis by imparting specifically into the eyes; the leaf oil when mixed with alcohol is applied as a cream for skin diseases and brought internally for bronchitis. The dried leaves are used to mitigate migraines and fever [17]. The leaves are rubbed between the hands and sniffed as a treatment for blocked nostrils [16]. A mixture of leaves, referred to as ‘*Ocimum* tea,’ is administered as a treatment for diaphoresis [17]. The roots are utilized as sedative for kids [18].

Ocimum gratissimum is anticeptic [19] and has exposed extensive use in toothpastes and mouth washes and additionally in some topical ointments [20]. It is utilized as a superb gargle for sore throats and tonsillitis. It is likewise utilized as an expectorant and a cough suppressant. The plant extract is utilized against gastrointestinal helminths of animals and man [21]. Furthermore, *O.gratissimum* carminative properties make it an excellent option for abdomen upset and haemorrhoids [22]. It is used by the Igbo’s in southern Nigeria in the management of baby's cord. It is believed to keep the baby's cord and wound surfaces sterile [23]. *O.gratissimum* has been reported to be active against several species of bacteria and fungi [24].

In culinary, it is used in salads soups, pastas, vinegars and jams in many parts of the world. Likewise, the plant is additionally utilized as a flavor and topping in the southern part of Nigeria [14]. *O.gratissimum* is a leafy vegetable, and a good supply of nutritional fibre, carotenoids, vitamin C, foliate, photochemicals and certain minerals, however contain little concentrations of proteins, digestible carbohydrates and lipids [25]. It is simple to cultivate and gives a modest methods of combating vitamin and mineral deficiency in less developed regions of the world. The blossoms and the leaves of this plant are rich in basic oils so it is utilized as a part of arrangement of teas and imbue. The leaves have strong aromatic odor and are usually used to flavor soup and spice

meat. The entire plant and the volatile oil are utilized as a part of conventional pharmaceutical especially in Africa and India [26].

Evaluation of its biological activities discovered that *Ocimum gratissimum* possess many therapeutic activities, such as anti-inflammation [27], spasmolytic and analgesic [28], antidiarrheal [29], antimicrobial [30], antitumor [31], antiviral [32], antihyperglycemic [33], antibacterial [24], antifungal [34], antimalarial [35] antiprotozoal [20] antidermatophytic activities [36] and the improvement of the phagocytic function without affecting the humoral or cell-mediated immune system [37]. Therefore, it is recommended that *O. gratissimum* is suitable for the treatment of oxidative stress induced disorders. It also has been demonstrated that *O. gratissimum* contains and synthesizes prostaglandin-like compounds and smooth-muscles contracting activity [38]. Aqueous extract of *O. gratissimum* leaves have been accounted to hinder tumor development and angiogenesis [31].

Recent investigations on *O. gratissimum* demonstrated that plant extract can be a supply of pharmaceutical for individuals living with Human Immunodeficiency Infection, (HIV) and Acquired Immune Deficiency Virus, AIDS [39]. The *Ocimum* oil is likewise dynamic against numerous species of microscopic organisms (*Staphylococcus aureus*, *Listeria monocytogenes*, *Escherichia coli*, *Shigella*, *Salmonella* and *Proteus*) and fungi (*Trichophyton rubrum*, *T. mentagrophytes*, *Cryptococcus neoformans*, *Penicillium islandi* and *Candida albicans* [40]. Extracts of *O. gratissimum* have antimicrobial [30, 40], antibacterial [24], antifungal [34], antimalarial [35] and antiprotozoal [20] chemopreventive, anticarcinogenic, radio protective activities and various other pharmacological uses [26].

PHYTOCONSTITUENTS

Phytoconstituents are naturally occurring chemicals in plants which serve as therapeutic for the assurance of human illness, these phytoconstituents work with nutrients and fibers to form an integrated part of defence system against various diseases and stress conditions. Phytochemicals are basically divided into two groups, i.e. primary and secondary constituents; according to their functions in plant metabolism [41]. *O. gratissimum* Linn (Labiatae) is grown for the essential oils in its leaves and stems. Phytochemical analysis confirmed the presence of alkaloids, flavonoids tannins, phenolics, saponins, glycoside, resins, steroids and terpenoids [42,43]. Alkaloids are also considered as nitrogenous bases that occur in plants, lots of them have marked physiological effects on people. Some alkaloids (morphine, caffeine and coffee) used as remedy and stimulates nervous system [44]. Flavonoids are polyphenolic compound having antiviral and antiallegic activities and might be responsible for its use as anti-inflammatory consequences on both acute and chronic inflammation [45]. Flavonoids have been found to have membrane stabilizing properties and additionally affect some process of intermediary metabolism and inhibit lipid peroxidation in different systems [46]. Tannins were pronounced to act on proteins to form protective layer on mucus membranes [47]. Phenols have antioxidant properties which perform their shielding activity on cells either via preventing the production of free radicals or by means of scavenging free radicals produced inside the body [48]. The presence of saponins serves as a hallmark in the direction of viable antibacterial activity. Saponins are a class of herbal merchandise involves and can be utilized to enhance penetration of micro molecules such as protein via cell membrane [43]. Almost all the phytoconstituents of *O. gratissimum* are recognized to influence biological system activities [49].

GC/MS of its essential oil (ocimum oil) proven the presence of eugenol (68.8%) as a major component [24,40] whereas thymol (46%), p-cymene (12%) and γ terpene + trans-sabien hydrate (17%), germacrene, bisabolene, citral, geraniol and linalool, monoterpenes-1, 8-cineole, β -pinene, cis-Ocimene, trans-Ocimene, camphor, methyl eugenol, Caryophyllene, Germacrene-D, xanthonenes, lactones and other volatiles as minor components [40,50,51]. [52] mentioned essential oil obtained from the seeds of *O. gratissimum* comprise thymol and eugenol in amounts ranging from 32% to 65%. Fresh leaves of *O. gratissimum* yielded 0.49% w/w of the essential oil and its density was 0.75 g/ml [51]. Other reports (40) have shown chemical composition percentages comparable or higher than [51] with eugenol (57.82%) followed by bisabolene (17.19%) and thymol (9.8%).

It has been investigated that eugenol have insecticidal [53], nematocidal [54], antihelminthic [19], antibacterial [30] and antifungal [40] properties. Methyl eugenol has additionally antifungal and antibacterial properties [55]. The sesquiterpene found in appreciable amounts like germacrene D has been reported to activate a major type of antennal receptor neuron of the tobacco budworm moth *Heliothis virescens* [56]. Cis-ocimene and beta-pinene possess antibacterial and antifungal activities respectively [55]. It has been demonstrated that monoterpenes have antimicrobial actions as they diffuse into and damage the cell membrane structures [57]. Previous reports also demonstrate that the active metabolites of *O. gratissimum* such as rosmarinic acid, sinapic acid, apigenin, luteolin and methyl eugenol exert an anxiolytic activity [58,59].

CONCLUSION

Ocimum gratissimum is a multipurpose medicinal plant and has enormous potential in cosmetic and drug industry. Among the plants known for restorative esteem, the plants of genus *Ocimum* belonging to family Lamiaceae are imperative for their healing potentials. Rise in population, insufficient delivery of medicine, restrictive cost of medicines, side effects of numerous allopathic medications and development of resistance to currently used drugs for infectious diseases have attracted the interest of people in herbal drugs or derivatives of natural molecules used in treatment of wide remedy of human sicknesses. *O. gratissimum* have extraordinary therapeutic esteems for treating diverse medical issues and were utilized throughout the world.

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REFERENCES

- 1) S. Jawla, A.K. Gupta, R. Singla and V. Gupta, "General awareness and relative popularity of allopathic, ayurvedic and homeopathic systems," J. Chem. and Pharm. Res, vol. 1, pp. 105-112, 2009.
- 2) E. Lev, "Ethno-diversity within current ethno-pharmacology as part of Israeli traditional medicine-A review," J. Ethnobiol. and Ethnomed. vol 2, pp 4, 2006.

- 3) W.S. Zhang, S.Q. Hang, R.C. Deng, L.X.M Wujm, P.J. Shi and J.P. Han, “ Exploring Chinese medicinal resources and building traditional medicinal bases in Yunnan province,” Res. Sci., vol.26, pp. 44-48, 2004.
- 4) M.D. Colvard, G.A. Cordell, R. Villalobos, G. Sancho, T. Echeverri, W. Pestle, K.M. Perkwitz and J. Michel, “Survey of medical ethnobotanicals for dental and oral medicine conditions and pathologies,” J. Etano, 107:134-142, 2006.
- 5) C.O. Anyamene and J.O. Ezeadila, “Antibacterial activity of water, ethanol and methanol extracts of *Ocimum gratissimum*, *Vernonia amygdalina* and *Afromomum melegueta*,” J. App. Sci., vol. 13, pp. 8940-8948, 2010.
- 6) M. Modak, P. Dixit, J. Londhe, S. Ghaskadbi, A. Paul and T. Devasagayam, “ Indian herbs and herbal drugs for the treatment of diabetes,” J. Clin. Biochem. Nutr., vol. 40, pp. 163-173, 2007.
- 7) V. Kumar, H.C. Andola, H. Lohani and N. Chauhan, “Pharmacological Review on *Ocimum sanctum* Linnaeus: A Queen of herbs,” J. Pharm. Res., vol. 4, pp. 366-368, 2011.
- 8) M. Suffnes and J. Dowos, “Current stating of the NCI Plant and Animal product program,” J. Nat. prod. Vol. 45, pp. 1-14, 1982.
- 9) S.S Balyan and P. Pushpagandan, “A studies on the taxonomic status and geographical distribution of the genus *Ocimum*,” PAFAI, vol. 10, pp. 13-19, 1988.
- 10) P. Pushpagandan and L. Bradu, “Basil. In: K.L. Chadha, R. Gupta, editors. Medicinal and aromatic plants,” India: Malhotra publishing House; pp. 627-658, 1995.
- 11) D. Tewari, A.N. Sah , H.K. Pandey, H.S. Meena, “ A Review on Phytoconstituents of *Ocimum* (Tulsi),” Int. J. Ayu. Med., vol. 3, pp. 1-9, 2012.
- 12) P. Sen, “Therapeutic potentials of Tulsi: from experience to facts,” Drugs News & Views, vol.1, pp.15–21, 1993.
- 13) K.D. Effraim, T.W. Jacks and O.A. Sodipo, “Histopathological studies on the toxicity of *Ocimum gratissimum* leave extract on some organs of rabbit,” Afr. J. Biomed. Res., vol. 6, pp. 21-5, 2003.
- 14) D. Sulistiarini, L.P.A. Oyen, and X.D. Nguyen, “*Ocimum gratissimum* L. In: Plant Resources of South-East Asia. No. 19: Essential oils Plants,” Prosea Foundation, Bogor, Indonesia. pp. 140-142, 1999.
- 15) F. Tchoumboungang, P.H.A. Zollo, E. Dagne, Y. Mekonnen, “ In vivo antimalarial activity of essential oils from *Cymbopogon citratus* and *Ocimum gratissimum* on the mice infected with *Plasmodium berghei*,” Planta Medica. Vol 7, pp. 20-23, 2005.
- 16) J.O. Kokwaro, “Medicinal plants of East Africa, East Africa Literature,” Bureau, Kampala, Nairobi, and Dar-es-Salaam. pp. 106-115, 1993.
- 17) MM. Iwu, “Handbook of African Medicinal Plants. CRC Press Inc. Boca Raton, Floridamm, 1993.

- 18) L.C. Stasi, G.P. Oliveira, M.A. Carvalhaes, M. Queiroz Junior, M. O.S. Tiena, S.H. Kakinamia and M.S. Reis, "Medicinal plants popularly used in the Brazilian Tropical Atlantic Forest," *Fitoterapia*, vol.73, pp. 69–91, 2002.
- 19) L.M. Pessoaa, S.M. Moraisb, C.M.L. Bevilaquaa and J.H.S. Lucianob., "Anthelmintic activity of essential oil of *Ocimum gratissimum* Linn. and eugenol against *Haemonchus contortus*," *Vet. Parasitol.*, vol. 109, pp. 59–63, 2002.
- 20) F.B. Holets, T. Ueda-Nakamura, B.F.D. Filho, D.A.G. Cortez, J.A. MorgadoDiaz, C.V. Nakamura, "Effect of essential oil of *Ocimum gratissimum* on the trypanosomatid *Herpetomonas samuelpessoai*," *Act. Protonzool.*, vol.42, pp. 269-276, 2003.
- 21) D.J. Chitwood, "Phytochemical based strategies for nematode control," *Annu. Rev. Phytopathol.*, vol.40, pp. 221-249, 2003.
- 22) E.A. Essien, A.O. Adebajo, C.O. Adewunmi, P.O. Adebisi, "Antiinfective agents of higher plant origin 3rd edition.K. Wright,Pp.170, 1983.
- 23) M.M. Iwu, "Handbook of African Medical Plant," CRE Press Boca ration: pp. 214-215, 1986.
- 24) C.V. Nakamura, T.U. Nakamura, E. Bando, A.J.N. Melo, D.A.G. Cortez, and F.B.P. Dias, "Antibacterial activity of *Ocimum gratissimum* essential oil," *Mem. Inst. Oswaldo Cruz.*, vol. 94, pp. 675-678, 1999.
- 25) R.B.M. Wills, D. Graham and D. Joyce, "Postharvest: An Introduction to the physiology and handling of fruit vegetables and ornamentals," *CAB Int.*, (4th Edition) pp. 15-32, 1998.
- 26) S.K. Gupta, J. Prakash and S. Srivastav, "Validation of claim of Tulsi, *Ocimum sanctum* Linn as a medicinal plant," *J. Expt. Biol.*, vol.40, pp. 65-773, 2002.
- 27) C.C. Lin, C.C. Tsai and M.H. Yen, "The evaluation of hepatoprotective effects of Taiwan folk medicine 'Teng-Khia-U'," *J. Ethnopharmacol.*, vol. 45, pp. 113–123, 1995.
- 28) P.I. Aziba, D. Bass and Y. Elegbe, "Pharmacological investigation of *Ocimum gratissimum* in rodents," *Phytother. Res.*, vol. 13, pp. 427–429, 1999.
- 29) M. Ilori, A.O. Sheteolu, E.A. Omonigbehin, A.A. Adeneye, "Antibacterial Activity of *Ocimum gratissimum* (Lamiaceae). *J. Diarrhoeal. Dis. Res.* Vol.14, pp. 283 – 285, 1996.
- 30) T. T. Adebolu and S.A. Oladimeji, "Antimicrobial activity of leaf extracts of *Ocimum gratissimum* on selected diarrhoea causing bacteria in southwestern Nigeria," *Afr. J. Biotechnol.*, vol. 4, pp. 682-684, 2005.
- 31) P.N. Makker, L. Tait and M. P. V. Shekhar, "Inhibition of breast tumor growth and angiogenesis by a medicinal herb: *Ocimum gratissimum*," *Int. J. Cancer.* vol. 121, pp. 884–894, 2007.
- 32) N. K. Ayisi and C. Nyadedzor, "Comparative in vitro effects of AZT and extracts of *Ocimum gratissimum*, *Ficus polita*, *Clausena anisata*, *Alchornea cordifolia*, and *Elaeophorbium drupifera* against HIV-1 and HIV-2 infections," *Antiviral Res.* vol. 58, pp. 25–33, 2003.
- 33) J. C. Aguiyi, C. I. Obi, S. S. Gang, and A. C. Igweh, "Hypoglycaemic activity of *Ocimum gratissimum* in rats," *Fitoterapia*, vol. 71, pp. 444–446, 2000.

- 34) J.A. Lemos and J.R. Paula, "Antifungal activity of *Ocimum gratissimum* towards dermatophytes," *Mycoses*, vol. 8, pp.172-175, 2005.
- 35) C.N. Ezekwesili, K.A. Obiora and O.P. Ugwu, "Evaluation of antidiarrhoeal property of crude aqueous extract of *Ocimum gratissimum* L. (Labiatae) in rats," *Biokemistri*. vol. 16, pp. 122-131, 2004.
- 36) M.R..Silva, J.G. Oliveira , O.F. Fernandes, X.S. Passos, C.R. Costa and L.K. Souza, "Antifungal activity of *Ocimum gratissimum* towards dermatophytes," *Mycoses*. vol. 48, pp. 172-175, 2005.
- 37) C.K. Atal, M L. Sharma, A. Kaul and A. Khajuria, "Immunomodulating agents of plant origin. Preliminary screening," *J. of Ethnopharmacol*, vol. 18, pp. 133–141, 1986.
- 38) F.D. Onajobi, "Smooth muscle contracting lipid-soluble principles in chromatographic fractions of *Ocimum gratissimum*," *Journal of Ethnopharmacology*, vol.18, pp. 3-11, 1986.
- 39) A.A. Elujoba, "Medicinal plants and herbal medicines in the management of opportunistic infections in people living with HIV/AIDS," National Scientific Conference organized by the Nigerian Society of Pharmacognosy (NSP) at Zaria. Nigeria. pp. 11–12, 2005.
- 40) J.A. Lemos, X.S Passos, O.F.L Fernandes, J.R.Paula, P.H. Ferri, L.K.H Souza, A.A. Lemos, & M.R.R. Silva, "Antifungal Activity from *Ocimum gratissimum* L. towards *Cryptococcus*, Neoformans, vol. 100, pp. 55-58, 2005.
- 41) P.G. Dhawale, "Phytochemical analysis of some medicinal plants from Yavatmal district (Ms) India," *Int. J. Eng. Sci.* vol. 2, pp. 65-66, 2013.
- 42) L.D.K. Koche, P.S. Kokate, S.S. Suradkar and D.G. Bhadange, "Preliminary phytochemistry and antibacterial activity of ethanolic extract of *Ocimum gratissimum*," *Biosci. Discovery*, vol.3, pp. 20-24, 2012.
- 43) P. Alexander, "Phytochemical screening and mineral composition of the leaves of *ocimum gratissimum*," *Int. J. Appl. Sci. Biotechnol.* vol 4, pp. 161-165, 2016.
- 44) D. Stanley (*Anogeissus Leiocarpus* (DC). Grill. And per. No 119, 2007.
- 45) B.A. Boham, and R. K.,Abyazan , "Flavonoids and condensed Tannins from leaves of *Hawallan vaccinium vaticultum* and *Vaccinium calycinium*," *Pacific Sci.* vol. 48, pp. 458- 463, 1994.
- 46) J. Jendrasick and P. Grof, "Vereinfachte photometrische method. Zur Bestimmung des Blubiliruin," *Biochem. Z.* vol. 297, pp. 81-89, 1938.
- 47) J. Alanko, A. Riuffa, P. Holm, I. Mulda, H. Vapatalo and T.M. Ketela, "Modulation of Arachidonic acid Metabolism by plants: Relation to their structure and antioxidant per-oxidant properties," *Free Radic. Biol. Med.* vol. 28, pp. 193-201, 1999.
- 48) S. Sherlock, "Liver disease (determination of total and direct bilirubin, colorimetric method," Churchill, London , pp. 204, 1951.
- 49) O.A. Ojo, O.I. Oloyede, O.I. Olarewaju, A.B. Ojo, B.O. Ajiboye and S.A. Onikanni, "Toxicity Studies of the Crude Aqueous Leaves Extracts of *Ocimum gratissimum* in Albino Rats," *J. Env. Sci. Toxicol. Food Technol.* vol. 6, pp. 34-39, 2013.

- 50) S.M. Keita, C.V Incent, S. J. Pierreandand and A. Belanger, "Essential oil composition of *Ocimum basilicum* L, *O. gratissimum* L, and *O. suave* L in the Republic of Guinea," *Flav. Frag.*, vol. 15, pp. 339–41, 2000 .
- 51) L.G. Matasyoh, J.C. Matasyoh, F.N Wachira, M.G., Kinyua, A.W.T. Muigai and T.K. Mukiama, "Chemical composition and antimicrobial activity of the essential oil of *Ocimum gratissimum* L. growing in Eastern Kenya," *Afr. J. Biotechnol.* vol 6, pp.760-765 , 2007.
- 52) B.A. Iwalokun, G.O. Gbenle, T.A. Adewole, K.A. Akinsinde, "Shigelloidal properties of three Nigeria Medicinal Plants: *Ocimum gratissimum*, *Terminalia avicennoides* and *Mormordia balsamina*," *J. Health Popul. Nutr.* vol. 19, pp. 331-335, 2001.
- 53) S.R. Chavan, S.T. Nikam, "Mosquito larvicidal activity of *Ocimum basilicum* Linn. India," *J. Med. Res.*, vol. 75, pp. 220-222, 1982.
- 54) Chatterje, N.C. Sukal, S.Laskel, S. Ghoshmajumadar, "Nematicides principal from two species of Lamiaceae," *J. Nematol.* vol. 4, pp. 118-120 1982.
- 55) C.W. Wright, "Medicinal & Aromatic Plants-Industrial Profiles," *Artemisia*, pp.344, 2002.
- 56) T. Rostelien, A.K. Borg-Karson, J. Fäldt, J. Jacobson and H. Mustaparta, "The Plant sesquiterpene Germacrene D specifically activates a major type of antennal receptor neuron of the Tobacco Budworm moth. *Heliothis virescen*," *Chem. Senses.* vol. 25, pp. 141-148, 2000.
- 57) J Sikkema, J.A.M de Bont, B. Poolman, "Mechanisms of membrane toxicity of hydrocarbons," *Microbiol. Rev.* vol. 59, pp. 201-222, 1995.
- 58) B.H Yoon, J.W.Jung, J.J. Lee, Y.W. Cho, C.G. Jang, C. Jin, T.H. Oh, J.H. Ryu, "Anxiolytic like effects of sinapic acid in mice," *Life Sci.* vol. 81, pp. 234–240, 2007 .
- 59) M. Coleta, M.G. Campos, M.D. Cotrim, T.C. Lima, A.P, Cunha., Assessment of luteolin (3',4',5,7 tetrahydroxyflavone) activity," *Behav. Brain Res.* Vol. 189, pp.75–82, 2008.