Global Journal of Pharmacology 5 (3): 191-200, 2011
ISSN 1992-0075

Therapeutic Potency of Ocimum KilimandscharicumGuerke - A Review

[1]C.P. Kashyap, [2]Kaur Ranjeet, [1]Arya Vikrant and [1]Kumar Vipin

[1]College of Ayurvedic Pharmaceutical Sciences, Jogindernagar, Mandi, H.P. India
[2]Department of Pharmacognosy, Shoolini University, Solan, H.P. India

Abstract: This review paper involves Ethnomedicinal, Phytochemical and Pharmacological survey of Ocimum kilimandscharicum Guerke. a medicinal plant of genus Ocimum having immense therapeutic potential. Ocimum kilimandscharicum Guerke. a perennial evergreen shrub, native of East Africa have been used traditionally in Kenya against measles, abdominal pains, diarrhoea, particularly against mosquitoes (insect repellent), congested chest, cough and cold. In Indian system of medicine (Ayurveda) Ocimum kilimandscharicum(Kapur tulsi) have been used as an antiinflammatory, indigestion, insecticidal, mosquito repellent, aromatic. In this review an attempt has been made to depict the tremendous usefulness of Ocimum kilimandscharicum found in various regions of Asia, Africa, Central and Southern America. Various oxygenated monoterpenes have been reported in hydrodistilled essential oil of Ocimum kilimandscharicumGuerke, which were determined using capillary Gas Chromatography (GC), Gas Chromatography-Mass Specrometry (GC-MS), Gas-Liquid Chromatography (GLC). Camphor has been reported as a chief essential oil component from Ocimum kilimandscharicum Guerke. Other important compounds found to be phenyl propane derivatives or terpenoids, including methyl eugenol, 1, 8-cineole, bornyl acetate, germacrene-D, E-myroxide, germacrene-B, caryophylene oxide andp-cymene, 1,8-cineole, limonene, caryophylene, camphene, 4-terpineol, α-terpinol, linalool which have been responsible for various pharmacological activities (insecticidal, mosquito repellent, antimicrobial, antioxidant, wound healing, antimelanoma, radioprotective). In such a way, this review makes us enable to explore more about the Ocimum kilimandscharicum Guerke. a therapeutic effective drug belonging to genus Ocimum.

Key words: Ocimum · Essential Oil · Insecticidal · Mosquito Repellent

INTRODUCTION

Ocimum Genus: The genus Ocimum, member of Lamiaceae family comprised of almost 200 species of herbs and shrubs[1] and is graded high among some of the astonishing herbs for having tremendous medicinal potentialities. There are large numbers of distinct species and varieties falls in this genus [2-4]. Genus Ocimum is widespread over Asia, Africa, Central and Southern America. The genus Ocimum is cultivated for its extraordinary essential oil which display many therapeutic usages such as in medicinal application, herbs, culinary, perfume for herbal toiletries, aromatherapy treatment and as flavouring agent. Due to the difficulties in identifying the species, it has concluded that identification can be optimized by combined analysis of morphological traits, essential oil composition and molecular markers as well as biological activity [3]. Leaf flavonoid glycoside (Luteolin 5-O-glucoside) considered as chemosystematic characters inO. americanum, O. basilicum, O. gratissimum, O. Kilimandscharicum, *O. lamiifolium, O. minimum, O. selloi, O. gratissimum, O. citriodorum*. Essential oils are ambrosial, highly concentrated essences of plants which are considered to illuminate the vitality of the plant [5-7]. Quality and quantity of essential oil afforded by aromatic plants rely on heterogeneous factors such as seasonal variation, method of harvest, leaf development stages, climate and soil type [7-10].

Therapeutic Efficacy of Genus Ocimum: Genus Ocimum major molecular markers comprised of β-bisabolene, methyl chavicol, 1, 8-cineole, eugenol, (E)-α-bisabolene, α-terpineol, linalool, (Z)-cinnamic acid methyl ester, camphor exerting wide range of therapeutic effects like antimicrobial, antispasmodic, bactericide, carminative, anthelmintic, hepatoprotective, antiviral, larvicidal,

Corresponding Author: Vikrant Arya, M. Pharmacy (Pharmacognosy), College of Ayurvedic Pharmaceutical Sciences, Jogindernagar, Mandi, H.P., India. Tel: +09736234150.

Fig. 1: *Ocimum kilimandscharicum* Guerke.

antinociceptive, anti-fungal, antipyretic, phototoxic activity, antiaflatoxigenic, anti-diarrheic, α-amylase inhibitory etc. which have been shown in Table 1 [11-45, 61-75].

Plant Description: It is perennial evergreen shrub having oblong, ovate green coloured leaves (0.5-5 m), oppositely arranged having pubescent leaf surface, narrow at the base and deeply serrated. One seeded fruits are indehiscent type found in clusters, hermaphrodite flowers are found in clusters, tap roots are deep and soft wooded. The leaves accommodate aromatic oils, which represents the essence of the plant. The essential oil is extracted using distillation, expression or solvent extraction methods. The oil constitutes liquid oil and white solid crystals, where the pure crystals possess a characteristic odour and taste of natural Camphor [46-47].

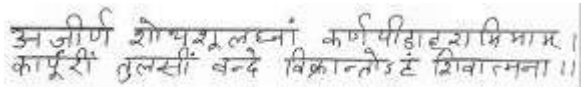
Taxonomic classification of Ocimum kilimandscharicum Guerke [48]

Kingdom	:	Plantae
Subkingdom	:	Tracheobionta
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Subclass	:	Asteridae
Order	:	Lamiales
Family	:	Lamiaceae
Genus	:	Ocimum L.
Species	:	Kilimandscharicum Guerke.
Vernacular Names		
English	:	Camphor basil
Hindi	:	Kapur tulsi
Ayurvedic	:	Karpura tulasi
Common name	:	Kilimanjaro basil, Camphor basil

GeographicalSource: OcimumkilimandscharicumGuerke. is native of East Africa (Kilimanjaro, Kenya) and was introduced and cultivated in India and some parts of Turkey. Cultivated in India (West Bengal, Assam, Tamil Nadu, Karnataka, Kerala, Dehradun, North India) [49-50].

Ethnomedicinal Uses: Traditionally, extracts ofOcimum kilimandscharicumGuerke. were used to mitigate many disorders in East Africa comprising remedy of coughs, colds, measles, abdominal pains, diarrhoea, insect repellent, particularly against mosquitoes and storage pest control [51-52]. The essential oils obtained from this plant as repellent against nuisance biting insects and malaria vector have been practised in North-Eastern Tanzania for centuries [53]. Ocimum kilimandscharicumis an important aromatic medicinal plant in Kenyan communities as mentioned in Table 2 [54].

Karpura Tulasi in Ayurveda: Ayurvedic benefits of Kapura Tulsi well understood by this Sloka in Sanskrit



''For your (Kapura Tulsi) immense therapeutic potential (used in indigestion, as antiinflammatory, as analgesic (cure ears pain). I (Vikrant Arya) obligated you (Kapura Tulsi) for your courtesy to humanity''

In Indian system of medicine (Ayurveda) Ocimum kilimandscharicum(Kapur tulsi) have been used as an antiinflammatory, indigestion, insecticidal, mosquito repellent, aromatic [55].

Other Uses [50]: Whole plant of Ocimum kilimandscharicumused as spasmolytic, antibacterial and the decamphorized oil obtained from leaves have been employed as insecticidal, mosquito repellent. Ocimum kilimandscharicum(Kapur tulsi) essential oil used in preparation of portable liquid disinfection. [56]

Chemistry of Ocimum Kilimandscharicum Guerke: The hydrodistilled essential oil of Ocimum kilimandscharicumGuerke. (Northern India region) studied by capillary gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS) and have been reported to accommodate oxygenated monoterpenes (95.8%), represented by camphor (1) (64.9%), limonene (2) (8.7%), camphene (3) (6.4%) and (E)-β-ocimene (4) (3.0%) [57] . The essential oil ofOcimum kilimands charicumGuerke, growing wild in Rwanda region of Africa, investigated by LSC, GLC and GC-MS and its essential oil found to contain 62% 1,8-cineole (5), 16 oxygen-containing compounds and 14 monoterpene hydrocarbons including limonene (6) and β-pinene (7). [58-59] The essential oil of Ocimum kilimandscharicum Guerke, grown in Indiana region of USA have been analyzed by GC and GC/MS and seventeen constituents have been identified in oil. The essential oil content varied

Table 1: Therapeutic efficacy of Genus Ocimum

Species	Common name	Pharmacological activity
O.*basilicum*	Common basil	Antiviral, larvicidal antinociceptive antimicrobial
O.*citriodorum*	Lemon basil	Antioxidant
O.*sanctum*	Holy basil	Antifungal, anticandidal, antioxidant, activity, lipid-lowering effect, antifungal, antiaflatoxigenic, anthelmintic, hepatoprotective
O.*gratissimum*	African basil	Against convulsions, antimicrobial, phototoxic activity, cancer-fighting, anti-trypanosomal, anti-nociceptive, antifungal
O.*tenuiflorum*	Thai basil	Potent α-amylase inhibitory
O.*lamiifolium*	Basil	Antiinflammatory
O.*suave*	Scented basil	Antipyretic
O.*canum*	Kali tulasi	Acaricidal activity
O.*americanum*	American basil	Antimicrobial
O.*suave*	Mtule basil	Antimicrobial
O. kenyense	Kenya basil	Insecticidal
O.*selloi*	Pepper Basil	Anti-diarrheic, antispasmodic and anti inflammatory
O.*micranthum*	Peru basil	Radical scavenging activity, antibacterial
O.*forskolei*	Basilikum	Mosquito repellent
O.*minimum*	Bush basil	Phytoremediatory effect
O.*campechianum*	Least basil	Antidiabetic
O. *Kilimandscharicum*	Camphor basil	Wound healing, insecticidal, mosquito repellent, acaricidal action, antimelanoma, radioprotective, antioxidant, antimicrobial, antibacterial

Table 2: Vernacular names and ethnomedicinal uses of Ocimum kilimandscharicumin Kenya

Kenya regions	Location	Vernacular names	Ethnomedicinal use
Meru	Central Kenya	Gethereti/Makori	The strongcamphorscented leaves treat congested chest, cough and cold, by sniffing crushed leaves or inhaling vapour of boiling leaves. Infusion is a cure for measles. It is also used to repel insects
Luhya	Western Kenya	lisuranza/Mwonyi	
Marakwet	Eastern Kenya	Mbirirwa	
Kikuyu	Central province of Kenya	Mutei	

Table 3: Pharmacology of Ocimum kilimandscharicum [66-73,65,74-75]

Extract/Plants	Secondary metabolite	Biological activity	In vivo/ in vitro screening model	Result of study
O. kilimandscharicum (aqueous extract)	Essential oil	Wound healing	Excision, incision and dead space	Significant increase in skin breaking strength, granuloma breaking strength, wound contraction, dry granuloma weight and decreased in epithelisation period was observed in animals of both the treated groups compared to control
O.kilimandscharicum, O. kenyense combined leaf extract	Essential oil	Insecticidal	Lethal toxicity determination against Sitophilus zeamais and Rhyzopertha dominica	Essential oil of O. kilimandscharicum was found to be largely responsible for the toxic action against R. dominica, the results with the other treatments indicated that the toxic action of the essential oils were due to the combined effects of different components, either with or without significant individual toxic action of their own against the insects
O.kilimandscharicum leaf extract	Camphor, 1, 8-cineole limonene caryophylene camphene4- terpineol, α-terpinol linalool	Mosquito repellent	Experimental huts and selected local houses against Anopheles gambiae	O. kilimandscharicum, revealed significant protective effect by reducing both the indoor resting mosquitoes and inhibiting mosquito blood- feeding
Combined plants O.kilimandscharicum, O. suave, Corymbia citriodora, Azadirachta indica, Tagetes minuta, Hyptis suaveolens	Essential oil	Mosquito repellent	Experimental huts under semi-field conditions inside a screen-walled greenhouse against Anopheles gambiae	O.kilimandscharicum, O. suave, Corymbia citriodora, Azadirachta indica, Tagetes minuta, Hyptis suaveolens did not significantly repel mosquitoes for all treatments

Table 2: Continue

Kenya regions	Location	Vernacular names	Ethnomedicinal use	
Combined plants *O. suave, O.kilimandscharicum* materials and their essential oils	Essential oil	Mosquito repellent	Experimental huts and selected by burning of *Ocimum* and other plants	The protective effect of essential oils from Ocimum plants were compared with N, N-diethly-3- methylbenzamide (DEET), a standard synthetic repellent. Study shows the potential of *O. suave*, *O.kilimandscharicum* crude extracts for use in protecting against human biting while the burning of plants reduces significantly the indoor resting mosquitoes
Combined plants Corymbia citriodora, leaves and seeds of O.kilimandscharicum, O. suave, C.citriodora	Essential oil	Mosquito repellent	Modified traditional stoves	All plant species showed significant repellency against Anopheles gambiae with the highest repellency by C. citriodora followed by an equal level of repellency of O.kilimandscharicumand O. suave during application of plant material by thermal expulsion. All three plant species also showed a residual effect against Anopheles gambiae with 36-44% repellency after a period of thermal expulsion
Hydro-distilled extracts of Artemisia annua, A.vulgaris, O.kilimandscharicum, oil seeds of Pongamia glabra kilimandscharicumexhibited	Essential oil	Acaricidal action Boophilus microplus	In vitroefficacy against	Hydro-distilled extracts of three medicinal plantsArtemisia annua, A. vulgarisandO. kilimandscharicumand oil seeds ofPongamia glabrawere tested for theirin vitroefficacy against Boophilus microplus. O. highest efficacy (98.34%) followed byP. glabra (96.67%), A. annua(95.00%) andA. vulgaris (93.34%)
50% alcoholic aqueous leaf extract O. sanctum, O.canum gratissimum O. basilicum, O.kilimandscharicum	Essential oil	Antimelanoma, radioprotective	Determined on the basis of tumor volume, body weight and survival rate of animals. Chromosomal aberration assay	The 50% alcoholic aqueous extract of different species of Ocimum administered orally reduction in tumor volume, increase in O. average body weight and survival rate of mice. The various extracts showed modulatory influence against lethal irradiation doses of gamma radiation in terms of radiation-induced chromosomal damage, while at the same time induced an increase in reduced glutathione level and GST activity
O. kilimandscharicum leaf extract 4- terpineol,	Flavonoid, camphor, limonene, camphene, β- ocimene,	Antioxidant	TBARS assay (in vitro), Enzymatic antioxidant estimation (in vivo)	Free radical scavenging capacity antioxidant potential of O. kilimandscharicum cultivars were proved in vivo, using the TBARS assay. In liver and muscle assay systems of ovarian models results suggested that UV-B doses have modulated the antioxidative machinery of Ocimum plants. Differences in responses were closely related to the differences in the activities of antioxidants and overall growth responses
Aerial parts of O. basilicum, O. kilimandscharicum, O. gratissimum	Methyl chevicol, linalool, methyl eugenol and methyl cinnamate	Antimicrobial	Broth Dilution method	The essential oil of Ocimum species were tested against standard bacterial strains S. aureus, E. faecalis, E. coli, P. aeruginosa and the yeast Candida albicans. Among the three oil samples, O.gratissimum oil was found to be more active against all tested micro-organisms, especially against C. albicans and Gram +ve bacteria. The oil of O. basilicum showed best MIC against C.albicans, whereas oil of O. kilimandscharicum did not show any remarkable activity against all tested micro-organisms

Table 2: Continue

Kenya regions	Location	Vernacular names	Ethnomedicinal use	
Aerial parts of O.americanum, O. *basilicum,* O. *campechianum,* *O. citriodorum,* *O. kilimandscharicum*	Essential oil	Antibacterial	Filter paper disc agar diffusion technique	Preliminary screening of antibacterial activity was done against a number of common *pathogens E. faecalis, E. faecium, Escherichia coli, Listeria monocytogenes, Listeria ivanovii, Proteus vulgaris, Staphylococcus aureus, S. epidermis.*E. coliwasinhibited by O. asilicumwhile O. americanumandO.citriodorumessential oil swerethemosteffectiveagainst*Enterococcus faecalis, Enterococcus faecium, P. vulgaris*,S. aureusandS. epidermis. Broad variation in the antibacterial properties of investigated essential oils was observed

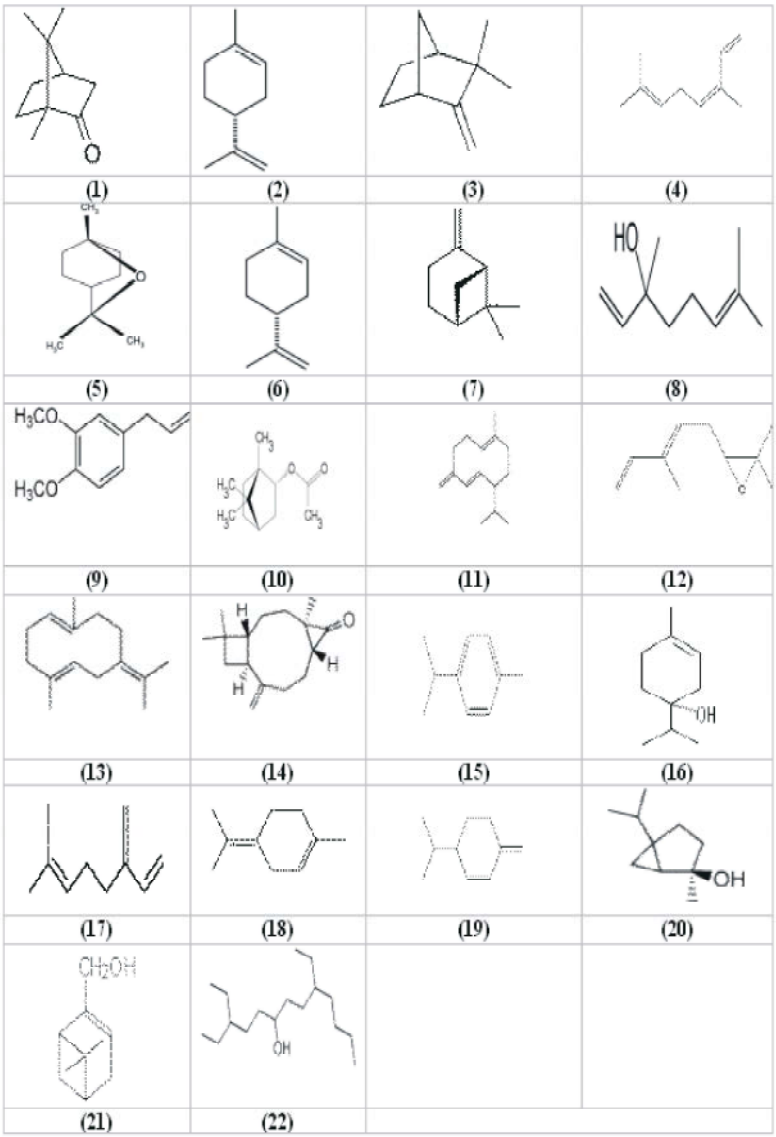


Fig. 2: Essential oil components of Ocimum kilimandscharicum Guerke.

between the leaves (0.77-1.12% dry wt. basis) and the flowers (1.96-2.8% dry wt.). Oil composition was similar between the leaves and flowers with linalool (8) as the major constituent, leaves (41.94%), flowers (58.85%). Other major constituents included camphor, leaves (17.02%), flowers (15.82%) and 1, 8-cineole (5) leaves (10.18%), flowers (6.38).[60] Six samples of essential oils from fourOcimumspecies (O.basilicum,O. kilimandscharicum,O. lamiifolium,O. suave) in Tanzania (East Africa) were analyzed by GC and GC-*MS. Eighty-one compounds, corresponding to 81.1-*98.2% of the chemical components of the oils, have been identified. Major compounds were phenyl propane derivatives or terpenoids, including methyl eugenol (9), 1, 8-cineole (5), camphor (1), bornyl acetate (10), germacrene-D (11), E-myroxide (12), germacrene-B (13), caryophylene oxide (14) andp-cymene (15). [61] Camphor (1) have also been reported as a chief essential oil component from Ocimum kilimandscharicum.[62-64] GC-MS analysis of Ocimum kilimandscharicum oil from Uttrakhand region of India showed camphor as the major component (1) (56.07%). Besides camphor, DL- limonene (2) (13.56%), camphene (3) (7.32%), 4- terpineol (16) (3.50%), β- ocimene (4) (2.00%), linalool (8) (1.70%), β- myrcene (17) (1.58%) and α-terpinolene (18) (1.33%) have also been reported. L-phellandrene (19) was found in least concentration of about 0.26%. Other components includes sabinene hydrate (20), Myrtenol (21), Ethyl amyl carbinol (22).[65] Major essential oil components of Ocimum kilimandscharicum have been shown in Figure 2.

Pharmacology of Ocimum Kilimandscharicum Guerke: Various extracts of Ocimum kilimandscharicumGuerke. have been evaluated for screening in-vitro/ in-vivo pharmacological models. Essential oil isolated from the leaf extract exhibited significant wound healing [66], insecticidal [67], mosquito repellent [68] effects. Furthermore, essential oils isolated from hydro-distilled extracts of Artemisia annua, A.vulgaris, O.kilimandscharicum, oil seeds ofPongamia glabrashowed significant acaricidal action [72]. 50% alcoholic aqueous leaf extract O. sanctum, O.canum O. gratissimum, O. basilicum, O.kilimandscharicumexhibited antimelanoma and radioprotective activity [73]. Phenolics and essential oil from O. kilimandscharicum leaf extract exhibited antioxidant activity estimated by TBARS assay (in vitro) and enzymatic antioxidant estimation (in vivo) [65]. Methyl chevicol, linalool, methyl eugenol and methyl cinnamate isolated from aerial part of O. basilicum, O. kilimandscharicum, O. gratissimum exerted antimicrobial
activity evaluated by broth Dilution method [74]. O.americanum, O. *basilicum, O. campechianum, O. citriodorum, O. kilimandscharicum*leaf extract exerted antibacterial activity evaluated by filter paper disc agar diffusion technique [75]. Various pharmacological activities of O. kilimandscharicumGuerke. (Kapura Tulsi) has been mentioned in Table 3.

CONCLUSION

The experimental research on Ocimum kilimandscharicum Guerke. convey a huge pharmacological potential of this plant. It is firmly considered that detailed enlightenment on this plant as displayed in this review on the ethnomedicinal, phytochemical, pharmacological might dispense detailed evidence for the use of this plant in diverse medicines.

REFERENCES

1. Charles, D.J. and J.E. Simon, 1990. Comparison of extraction methods for the rapid determination of essential oil content and composition of basil. J. Amer. Soc. Hort. Sci., 115: 458-462.
2. Mondello, L., G. Zappia, A. Cotroneo, I. Bonaccorsi, J.U. Chowdhury, M. Yusuf and G. Dugo, 2002. Studies on the essential oil-bearing plants of Bangladesh. Part VIII. Composition of some Ocimum oils O.basilicum L.var. purpurascens; O.sanctum L. green, O. sanctum L. purple, O. americanum L. citral type; O.americanum L. camphor type. Flavour and Fragrance J., 17: 335-340.
3. Labra, M., M. Miele, B. Ledda, F. Grassi, M. Mazzei and L.F. Sala, 2004. Morphological characterization, essential oil composition and DNA genotyping of Ocimum basilicum cultivars. Plant Sci., 167: 725-731.
4. Klima´nkova, E., K. Holadová, J. Hajšslová, T. Èajka, J. Poustka and M. Koudela, 2008. Aroma profiles of five basil (Ocimum basilicum L.) cultivars grown under conventional and organic conditions. Food Chemistry, 107: 464-472.
5. Grayer. R.J., G.C. Kite, N.C. Veitch, M.R. Eckert, P.D. Marin, P. Senanayake and A.J. Paton, 2002. Leaf flavonoid glycosides as chemosystematic characters in Ocimum. Biochemical Systematic and Ecol., 30: 327-342.

6. Ashurst, P.R., 1991. Food Flavorings. Chapman and Hall, UK, 2: 25-35.
7. Nakatsu, T., A.T. Lupo, J.W. Chinn and R.K.L, 2000. Kang Biological activity of essential oils and their constituents. Studies in Natural Product Chemistry, 21: 571-631.
8. Laskar, S. and S.G. Majumdar, 1988. Variation of major constituents of essential oil of the leaves of Ocimum Sanctum Linn. Indian J. Chem. Society, 65: 301-302.
9. Kothari. S.K., A.K. Bhattacharya and S. Ramesh, 2004. Essential oil yield and quality of methyl Eugenol rich Ocimum tenuiflorum L.f. (syn. O.sanctum L.) Grown in south India as influenced by method of harvest. J. Chromatograph. A, 1054: 67-72.
10. Dey. B.B. and M.A. Choudhuri, 1983. Effect of leaf development stage on changes in essential oil of Ocimum sanctum L. Biochemistry and Physiol., 178: 331-335.
11. Nagai, A., L.M. Duarte and DY. Santos, 2011. Influence of viral infection onessential oilcomposition ofOcimumbasilicum (Lamiaceae). Nat. Prod Commun., 6: 1189-92.
12. Kalaivani, K., S. Senthil-Nathan and A.G. Murugesan, 2011. Biological activity of selected Lamiaceae and Zingiberaceae plantessentialoilsagainst the dengue vector Aedes aegypti L. (Diptera: Culicidae). Parasitol Res., [Epub ahead of print].
13. Venâncio, A.M., A.S. Onofre, A.F. Lira, P.B. Alves, A.F. Blank, A.R. Antoniolli, M. Marchioro, S. Estevam Cdos and B.S. De Araujo, 2011. Chemical composition, acute toxicity and antinociceptive activity of theessential oilof a plant breeding cultivar of basil (Ocimumbasilicum L.). Planta Med., 77: 825-9.
14. Bassolé, I.H., A. Lamien-Meda, B. Bayala, S. Tirogo, C. Franz, J. Novak, R.C. Nebié and Dicko M.H. 2010. Composition and antimicrobial activities of Lippia multiflora Moldenke, x. Mentha, L.piperita andL.Ocimumbasilicumessentialoilsand their major monoterpene alcohols alone and in combination. Molecule, 15: 7825-39.
15. Adwan, G. and M. Mhanna, 2008. Synergistic effects of of plant extract and antibiotics on Staphylococcus aureus strains isolated from clinical specimens. Middle-East J. Scientific Res., 3(3): 134-139.
16. Marwat, S.K. and M.A. Khan, 2011. Intrepretation and medicinal potential of Ar-Rehan (Ocimum basilicum L.)-A Review. American-Eurasian J. Agric. And Environ. Sci., 10(4): 478-484.
17. Hakkim, H.L., G. Arivazhagan and R. Boopathy, 2008. Antioxidant property of selected Ocimum species and their secondary metabolite content. J. Medicinal Plant Res., 2: 250-257.
18. Bansod, S. and M. Rai, 2008. Antifungal activity of essential oils from Indian medicinal plants against human pathogenic Aspergillus fumigates and A. niger. World J. Medical Sci., 3(2): 81-88.
19. Khan, A., A. Ahmad, F. Akhtar, S. Yousuf, I. Xess and LA. Khan, N. Manzoor, 2010. Ocimumsanctumessential oiland its active principles exert their antifungal activity by disrupting ergosterol biosynthesis and membrane integrity. Res Microbiol., 161: 816-23.
20. Amber, K., A. Aijaz, X. Immaculata, K.A. Luqman and M. Nikhat, 2010. Anticandidal effect ofOcimumsanctumessential oiland its synergy with fluconazole and ketoconazole. Phytomedicine, 17: 921-5.
21. Suanarunsawat, T., N.A. Devakul, W. Ayutthaya, T. Songsak and S. Thirawarapan, 2010. Poungshompoo Antioxidant Activity and Lipid-Lowering Effect of Essential Oils Extracted from Ocimumsanctum L. Leaves in Rats Fed with a High Cholesterol Diet. J. Clin. Biochem Nutr., 46: 52-9.
22. Kumar, A., R. Shukla, P. Singh and N.K. Dubey, 2010. Source Chemical composition, antifungal and antiaflatoxigenic activities of Ocimumsanctum L. Essential oil and its safety assessment as plant based antimicrobial. Food Chem Toxicol., 48: 539-43.
23. Asha, M.K., D. Prashanth, B. Murali, R. Padmaja and A. Amit, 2001. Anthelmintic activity ofessential oil of Ocimumsanctum and Eugenol. Fitoterapia. 72: 669-70.
24. Lahon, K. and S. Das, 2011. Hepatoprotective activity ofOcimumsanctum alcoholic leaf extract against paracetamol-induced liver damage in Albino rats. Pharmacognosy Res., 3: 13-8.
25. Galindo, LA., M. Pultrini Ade and M. Costa, 2010. Biological effects ofOcimumgratissimum L. are due to synergic action among multiple compounds present inessential oil. J. Nat. Med., 64: 436-41.
26. Ahonkhai, I., A. Ba, O. Edogun and U. Mu, 2009. Antimicrobial activities of thevolatile oils of Ocimumbacilicum L. and Ocimum gratissimumL. (Lamiaceae) against some aerobic dental isolates. Pak J. Pharm Sci., 22: 405-9.
27. Matias, E.F., K.K. Santos J.G. Costa and H.D. Coutinho, 2010. Screening for in vitro phototoxic activity of methanol extracts of Croton campestris A. OcimumgratissimumL. & Cordia verbenaceae DC. Indian J. Med. Res., 132: 520-2.

28. Ekunwe, S.I., M.S. Thomas, X. Luo, H. Wang, Y. Chen, X. Zhang and G.B. Begonia, 2010. Potential cancer-fighting Ocimumgratissimum (OG) leaf extracts: increasedanti-proliferation activity of partially purified fractions and their spectral fingerprints. Ethn. Dis., 20: S1-12-6.
29. Adamu, M., C.O. Nwosu and R.I. Agbede, 2009. Anti-trypanosomal effects of aqueous extract of Ocimumgratissimum(Lamiaceae) leaf in rats infected with Trypanosoma brucei brucei. Afr. J. Tradit. Complement Altern. Med., 6: 262-7.
30. Tanko, Y., G.M. Magaji, M. Yerima, R.A. Magaji and A. Mohammed, 2008. Anti-nociceptive andanti-inflammatory activities of aqueous leaves extract of Ocimumgratissimum (Labiate) in rodents. Afr. J Tradit. Complement Altern Med., 5: 141-6.
31. Alabi, D.A., M.Z. Onibudol and N.A. Amusa, 2005. Chemicals and nutritional composition of four botanicals with fungitoxic properties. World J. Agricultural Sci., 1(1): 84-88.
32. Alabi, D.A., Oyero, I.A. Jimoh and N.A. Amusa, 2005. Fungitoxic and phytotoxic effects of Vernonia amygadalina (L), Bryophyllum pinnatus, Ocimum gratissimum and Eucalyptus globules water extracts on Cowpea and Cowpea seedling pathogens in Ago-Iwoye, South Western Nigeria. World J. Agricultural Sci., 1(1): 70-75.
33. Kothari, S.K., A.K. Bhattacharya and S. Ramesh, 2004. Essential oil yield and quality of methyl eugenol richOcimumtenuiflorum L.f. (syn. O. sanctum L.) grown in south India as influenced by method of harvest. J. Chromatogr, A, 1054: 67-72.
34. Sudha, P., S.S. Zinjarde, S.Y. Bhargava and A.R. Kumar, 2011. Potent α-amylase inhibitory activity of Indian Ayurvedic medicinal plants. BMC Complement Altern Med., 11: 5.
35. Woldesellassie Mequanint, Eyasu Makonnen andKelbessa Urga, 2011. In vivo anti-inflammatory activities of leaf extracts ofOcimumlamiifolium in mice model. J. Ethnopharmacol., 134: 32-6.
36. Makonnen, E., A. Debella, L. Zerihun, D. Abebe and F. Teka, 2003. Antipyretic properties of the aqueous and ethanol extracts of the leaves ofOcimumsuave andOcimumlamiifolium in mice. J. Ethnopharmacol., 88: 85-91.
37. Jayaseelan, C and A.A. Rahuman, 2011. Acaricidal efficacy of synthesized silver nanoparticles using aqueous leaf extract ofOcimumcanum against Hyalomma anatolicum anatolicum and Hyalomma marginatum isaaci (Acari: Ixodidae). Parasitol Res., [Epub ahead of print]
38. Thaweboon, S. and B. Thaweboon, 2009. In vitro antimicrobial activity ofOcimumamericanumL. essential oil against oral microorganisms. South East Asian J. Trop. Med. Public Health, 40: 1025-33.
39. Chogo, J.B. and G. Crank, 1981. Chemical Composition and Biological Activity of the Tanzanian Plant Ocimum Suave J. Nat. Prod., 44: 308-*311.
40. Bekele, J. and A. Hassanali, 2001. Blend effects in the toxicity of the essential oil constituents ofOcimumkilimandscharicum andOcimum kenyense (Labiateae) on two post-harvest insect pests. Phytochemistry. 57: 385-91.
41. Moraes, L.A., R. Facanali, M.O. Marques, C.M. Lin and MA. Meireles, 2002. Phytochemical characterization of essential oil from Ocimumselloi. An Acad. Bras. Cienc., 74: 183-6.
42. Sacchetti, G., A. Medici, S. Maietti, M. Radice, M. Muzzoli, S. Manfredini, E. Braccioli and R. Bruni, 2004. Composition and functional properties of the essential oil of amazonian basil,Ocimummicranthum Willd. Labiatae in comparison with commercial essential oils. J. Agric. Food Chem., 52: 3486-91.
43. Dekker, T., R. Ignell, M. Ghebru, R. Glinwood and R. Hopkins, 2011. Identification of mosquito repellent odours fromOcimumforskolei. Parasit Vectors. 4: 183.
44. Ramírez-Sandoval, M., G.N. Melchor-Partida, S. Muñiz-Hernândez, M.I. Girón-Pérez A.E. Rojas-García, I.M. Medina-Díaz, M.L. Robledo-Marenco and J.B. Velαzquez-Fernαndez, 2011. Phytoremediatory effect and growth of two species ofOcimumin endosulfan polluted soil. J. Hazard Mater, 192: 388-92.
45. Lans, C.A., 2006. Ethnomedicines used in Trinidad and Tobago for urinary problems and diabetes mellitus. J. Ethnobiol. Ethnomed. 2: 45.
46. Saha, S., T. Dey and P. Ghosh, 2010. Micropropagation of Ocimum kilimandscharicum Guerke.Acta. Biologica Cracoviensia. 52: 50-58.
47. Darrah, H.H., 1974. Investigation of the cultivators of Basils (Ocimum). Economic Botany, 28: 63-67.
48. Paton. A.,1992. A synopsis ofOcimumL. (Labiatae) in Africa. Kew Bull., 47: 422.
49. Warrier, P.K. and A.V. Sala, 1996. Indian Medicinal Plants: A compendium of 500 Species,
50. Khare, C.P., 2007. ‘‘Indian Medicinal Plants’’ 1st Edn. Berlin/Heidlburg, Springer Verlang.
51. Kokwaro, J.O., 1976. Medicinal plants of East Africa EA .Lit Bureau Nairobi.

52. Jembere, B., A. Hasannali, D.O. Ofori and G.N.N. Nyamasyo, 1995. Products derived from leaves ofOcimum Kilimandscharicum(Labiatae) as post-harvest grain protectants against the infestation of three major stored product insect pests.Bulletin of Entomological Res., 85: 361-367.
53. Kweka, E.J., F. Mosha, A. Lowassa, A.M. Mahande, J. Kitau, J. Matowo, M.J. Mahande, C.P. Massenga, F. Tenu, E. Feston, E.E. Lyatuu, M.A. Mboya, R. Mndeme, G. Chuwa and E.A. Temu, 2008. Ethnobotanical study of some of mosquito repellent plants in north-eastern Tanzania. Malar. J., 7: 152.
54. Githinji, C.W. and J.O. Kokwaro, 1993. Ethnomedicinal study of major species in the family Labiatae from Kenya. J. Ethnopharmacol., 39: 197-203.
55. Trivasi, K.P., 2005. Dhanwantari Vanoshadi Vishenshakn. Jawala Ayurved Bhawan Aligarh India,
56. United States Patent (No. 7074439). Preparation of essential oil composition for portable liquid Disinfection, 2006.
57. Padalia, R.C. and R.S. Verma, 2011. Comparative volatile oil composition of four Ocimum species from northern India. Nat. Prod. Res., 25: 569-75.
58. Ntezurubanza, L., J.J.C. Scheffer, A. Looman and A.B. Svendsen, 1987. Composition of Essential Oil ofOcimum kilimandscharicum Grown in Rwanda. Planta Medica, 53: 421-423.
59. Ntezurubanza, L., J.J.C. Scheffer, A. Looman and A.B. Svendsen, 1984. Composition of Essential Oil ofOcimum kilimandscharicum Grown in Rwanda. Planta Medica, 50: 385-388.
60. Charles, D.J. and J.E. Simon, 1992. Essential oil constituents of Ocimum kilimandscharicum Guerke. J. Essential Oil Res., 4(2): 125-128.
61. Runyoro, D., O. Ngassapa, K. Vagionas, N. Aligiannis, K. Graikou and I. Chinou, 2010. Chemical composition and antimicrobial activity of the essential oils of four Ocimumspecies growing in Tanzania. Food Chemistry, 119: 311-316.
62. Obeng-Ofori, D., C.H. Reichmuth and A.J. Bekele, 1998. Hassanali Toxicity and protectant potential of camphor, a major component of essential oil of Ocimum kilimandscharicum, against four stored product beetles. International J. Pest Manage., 44(4): 203-209.
63. Chowdhari, B.L. and C.N. Haksar, 1964. Chemical separation of camphor from the essential oil of Ocimum kilimandscharicum. Perfumery and Essential Oil Record, pp: 121-122.
64. Chakravarti, R.N. and S.N. Dash, 1963. Camphor from Ocimumkilimandscharicum. Bull Calcutta Sch. Trop. Med., 11: 105-6.
65. Singh, S.K., A. Anand, S.K. Verma, M.D.A. Siddiqui and A. Mathur, 2011. Saklani Analysis of phytochemical and antioxidant potential of Ocimumkilimandscharicum. Int. J. Curr. Pharm. Res., 3: 40-46.
66. Paschapur, M.S., M.B. Patil and R. Kumar 2009. Patil Evaluation of aqueous extract of leaves of Ocimum kilimandscharicum on wound healing activity in albino wistar rats. International J. Pharm Tech. Res., 1(3): 544-550.
67. Bekele, J. and A. Hassanali, 2001. Blend Effects in the Toxicity of the Essential Oil Constituents of Ocimum kilimandscharicum and Ocimum kenyense (Labiataea) on Two Post-harvest Insect Pests. Phytochemistry, 57: 385-391.
68. Eliningaya, J.K., M.N. Hassan, L. Lucile, E.K. Epiphania and J. Beda, 2009. Mwang'onde and Aneth MM. Efficacy of Ocimum kilimandscharicum plant extracts after four years of storage against Anopheles gambiaess. J. Cell and Animal Biol., 3: 171-174.
69. Seyoum, A., E.W. Kabiru, W. Lwande, G.F. Killeen, A. Hassanali and B.G. Knols, 2002. Repellency of live potted plants against Anopheles gambiae from human baits in semi-field experimental huts. Am. J. Trop. Med. Hyg., 67: 191-5.
70. Kweka, E.J., FW. Mosha, A. Lowassa, A.M. Mahande, M.J. Mahande, C.P. Massenga, F. Tenu, E.E .Lyatuu, M.A. Mboya and E.A. Temu, 2008. Longitudinal evaluation of Ocimum and other plants effects on the feeding behavioral response of mosquitoes (Diptera: Culicidae) in the field in Tanzania. Parasit Vectors. 1: 42.
71. Seyoum, A., G.F. Killeen, E.W. Kabiru, B.G. Knols and A. Hassanali, 2003. Field efficacy of thermally expelled or live potted repellent plants against African malaria vectors in western Kenya. Trop. Med. Int. Health, 8: 1005-11.
72. Vatsya, Stuti, C.L. Yadav, R.R. Kumar and P.S. Banerjee, 2006. In vitroacaricidal effect of some medicinal plants againstBoophilus microplus. J. Veterinary Parasitol., 20(2): 141-143.
73. Monga, J., M. Sharma, N. Tailor and N. Ganesh, 2011. Antimelanoma and radioprotective activity of alcoholic aqueous extract of different species of Ocimum in C (57)BL mice. Pharm Biol., 49: 428-36.

74. Anand, A.K., M. Mohan, S.Z. Haider and A. Sharma, 2011. Essential oil composition and antimicrobial activity of three Ocimum species from Uttarakhand. International J. Pharmacy and Pharmaceutical Sci., 3: 223-225.

75. Carović-Stanko, K., S. Orlić, O. Politeo, F. Strikić, I .Kolak, M. Milos and Z. Satovic, 2010. Composition and antibacterial activities of essential oils of seven Ocimumtaxa. Food Chemistry, 119: 196-201.