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CHEMICAL COMPOSITION AND BIOACTIVITIES OF ESSENTIAL OILS OF SOME *OCIMUM* SPECIES: A REVIEW

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ABSTRACT

Traditional medicine has played a significant role in treating health problems in both livestock and humans. Knowledge of medicinal plants and of their uses provides vital contribution to human and livestock health care needs throughout the world. The genus *Ocimum*, are widely used medicinal plant species of herbs and shrubs and is graded high among some of ambrosial, the astonishing herbs for having tremendous medicinal potentialities. The essential oils obtained from *Ocimum* plant species are used as repellent against nuisance biting insects and malaria vector, remedy of coughs, colds, measles, abdominal pains, diarrhea, and repellent, for storage pest control.

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INTRODUCTION

Knowledge can arise from scientific or traditional sources (Ermias Lulekal, Zemede Asfaw *et al*. 2011). Traditional medicine is used throughout the world as it is heavily dependent on locally available plant species and plant-based products and capitalizes on traditional wisdom-repository of knowledge. The wide spread use of traditional medicine could be attributed to cultural acceptability, economic affordability and efficacy against certain type of diseases as compared to modern medicines. Thus, different local communities in countries across the world have indigenous experience in various medicinal plants where they use their perceptions and experience to categorize plants and plant parts to be used when dealing with different ailments. Traditional healers, and particularly medicinal plant herbalists, in Africa have a detailed knowledge-base of traditional medicine which is transferred orally from one generation to the next through professional healers, knowledgeable elders and/or ordinary people (Dewick 2002).

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Traditional medicine continues to provide health coverage for over 80% of the world population, especially in the developing world. Many of the plant materials used in herbal medicine are readily available in rural areas and this has made it relatively cheaper than orthodox medicine; and the upsurge in the prevalence of side effects of many synthetic antimicrobial agents and incidence of multi-drug resistant bacteria and pests has spurred scientists onto the research for plant based antimicrobial of therapeutic and pesticide potentials. Chemical constituents with antioxidant activity present in high concentrations in plants determine their considerable role in the prevention of various degenerative diseases. The supplementation of human diet with herbs, containing especially high amounts of compounds capable of deactivating free radicals, may have beneficial effects, throughout recorded history, spices and herbs have been used for flavoring foods and beverages and for medicinal purposes. The preservative effect of many plant species and herbs suggests the presence of ant oxidative and antimicrobial constituents (Tilahun Teklehaymanot and Giday 2007). The trade and use of traditional medicines are increasingly receiving attention from policy makers, health officials, social scientists and environmentalists due to medicines role as supplementary and

alternative medicines as well as social and economic support system. Rapid urbanization and socio –cultural demand for low cost, easily accessible medicines have created an environment in which traditional medicines persists in spite of expanding modern health services (Helmut Kloos, Temesgen Menberu *et al*. 2014).

Taxonomic classification of Ocimum: Ocimum is classified in Kingdom: Plantae; Subkingdom: Tracheobionta; Division: agnoliophyta; Class: Magnoliopsida; Subclass: Asteridae; Order: Lamiales; Family: Lamiaceae; Genus: Ocimum L. The plants are predominantly herbs, shrubs or under importance shrubs, annuals or perennials in habit. They possess glandular hairs or sessile glands secreting strongly scented volatile oils. Flowers appear to be uniform in the appearance throughout the group but they are of great taxonomic importance for the demarcation of species. The seeds contain edible oils and a drying oil similar to linseed oil analysis of morphological traits, essential oil composition and molecular markers as well as biological activity (Janmoni Kalita and LatifKhan 2013).

Types of *Ocimum* species: Lamiaceae (syn. Labiatae) herb family includes one of the richest essential oil bearing plant family, consists of more than 252 genera and 7 000 species in the vicinity of plant kingdom. Lamiaceae family is known for the wealth of species with medicinal properties, which have been used since early times and many of these species are common in Mediterranean region. Many species of Lamiaceae have long history of uses in culinary spices and Folk medicine (Janmoni Kalita and LatifKhan 2013). The genus Ocimum, member of Lamiaceae family comprised of almost 200 species of herbs and shrubs and is graded high among some of ambrosial, the astonishing herbs for having tremendous medicinal potentialities. There are large numbers of distinct species and varieties falls in this genus. 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 flavoring agent. Leaf flavonoid glycoside (Luteolin 5-O-glucoside) considered as chemosystematics characters in O. americanum, O. basilicum, O. gratissimum, O Kilimandscharicum, *O. lamiifolium, O. minimum O. selloi, O. gratissiAmum, O. citriodorum* (C.P. Kashyap, Kaur Ranjeet *et al*. 2011). Ocimum L. is a versatile aromatic genus well known for medicinal properties and also for economically important essential oils. The genus is very variable and possesses wide range of intra- and inter-specific genetic diversity. The nomenclature of Ocimum species and varieties is complicated and confusing and in several instances, the oils extracted from morphologically identical plants (one phenotype) show different physico-chemical properties. Species like O. sanctum L, O. gratissimum, O. canum, O.basilicum. kilimandscharicum, O. camphora and O. micranthum, Ocimum lamiifolium are examples of known important species of the genus which grow in different parts of the world and are known to have medicinal properties (Janmoni Kalita and LatifKhan 2013). It is also a source of aroma compounds and essential oils containing biologically active constituents that possess insecticidal and nematicidal properties. However, the antioxidative potential of herbs and spices is well correlated with the presence of phenolic compounds due to its redox properties, which permit them to act as reducing agents, hydrogen donators and singlet oxygen quenchers. The major phenolic compounds found in plants are secondary metabolites possessing high antioxidant activity and it is wide spread in the species of Lamiaceae (F. Lukmanul Hakkim, Girija Arivazhagan *et al*. 2008). From industrial point of view, oil of Ocimum species are rich in camphor, citral, geraniol, linalool, linalyl acetate, methyl chavicol, eugeol, thymol, etc. and can be harnessed for successful utilization in industry. In India, the requirements of most of these are met by imports and the demand is on increase. O. basilicum and its varieties are the most worked out group so far and its various aspects have been dealt with in detail. Earlier screening and evaluation of basil oil led to the evolution of useful strains which have worldwide acceptability and utilization (Janmoni Kalita and LatifKhan 2013).

Chemical composition of Ocimum species: Researches on chemical composition of most of the essential oils were undertaken by various researchers using GC and GC-MS techniques. The other techniques used are Kovat's index from packed capillary column, retention time data from GC, HPLC, GC-MS, capillary GC, HRGG-FID, HRGGMS and IR, C13, NMR. The constituents were identified by calculation of their retention indices under temperature programmed condition for n-alkanes (C8-C20). Identification of individual component was assigned by retention time comparison with authentic components and oil of known composition and by mass spectra with those obtained from Wiley/NIST/Pfleger library spectra as well as with literature. Essential oils are very complex natural mixtures which contain about 20-60 components at quite different concentrations. They are characterized by two or three major components at fairly high concentration (20%-70%) as compared to other components present in trace amount. Essential oils are complex mixtures of natural organic compounds which are predominantly composed of terpenic hydrocarbons (myrecene, pinene, terpinene, limonene, p-cymene, α- and β- hellandrene) and terpenoids (oxygen containing hydrocarbons) like acyclic monoterpene alcohols (geraniol, linalool), monocyclic alcohols (menthol, 4-carvomenthol, terpineol, carveol, borneol), aliphaticaldehydes (citral, citronellal, perillaldehyde), aromatic phenols (carvacrol, thymol, safrol, eugenol), bicyclic alcohol (verbenol), monocyclic ketones (menthone, pulegone, carvone), bicyclic monoterpenic ketones (thujone, verbenone, fenchone), acids (citronellic acid, cinnamic acid) and esters (linalyl acetate Mono- and sesquiterpenoidal essential oil constituents are formed by the condensation of isopentenyl pyrophosphate units. Diterpenes usually do not occur in essential oils but are sometimes encountered as by-products. Lawrence classified the basil oils into three large groups' European type, exotic or reunion type and African type according to their chemical composition and geographical origin He established four essential oil chemotypes (methyl chavicol, linalool, methyl eugenol and methyl cinnamate) and also numerous subtypes of oils extracted from O. basilicum.

Compounds Isolated from the leaf of Ocimum lamiifolium: Plant phenolics constitute one of the major groups of compounds acting as primary antioxidants or free radical terminators. The total phenolic content was estimated by the Folin-Ciocalteu reagent method extract Ocimum lamiifolium as been extensively reported for its essential oil content however, the antioxidant capacity of the plant extracts is mainly dependent on phenolic compounds. The quantification of individual phenolic compounds of Ocimum lamiifolium, leaves extracts was accomplished using high-performance liquid chromatography (HPLC) with PDA detector. Phenolic

compounds were identified and quantified at 330 nm as phenolic acids, hydroxycinnamates and flavonoids. The components rosmarinic acid (1), lithospermic acid (2), hydroxybenzoic acid (3), syringic acid (4), caffeic acid (5), ferulic acid (6), cinnamic acid (7), and dihydroxy phenyllactic acid (8) (Figure 1) were identified by comparison to the retention time and UV spectra of authentic standards and quantitative data were calculated based on their peak area. Rosmarinic acid was the most abundant component identified in O. lamiifolium extract in comparison with other species and other compounds (F. Lukmanul Hakkim, Girija Arivazhagan *et al*. 2008).

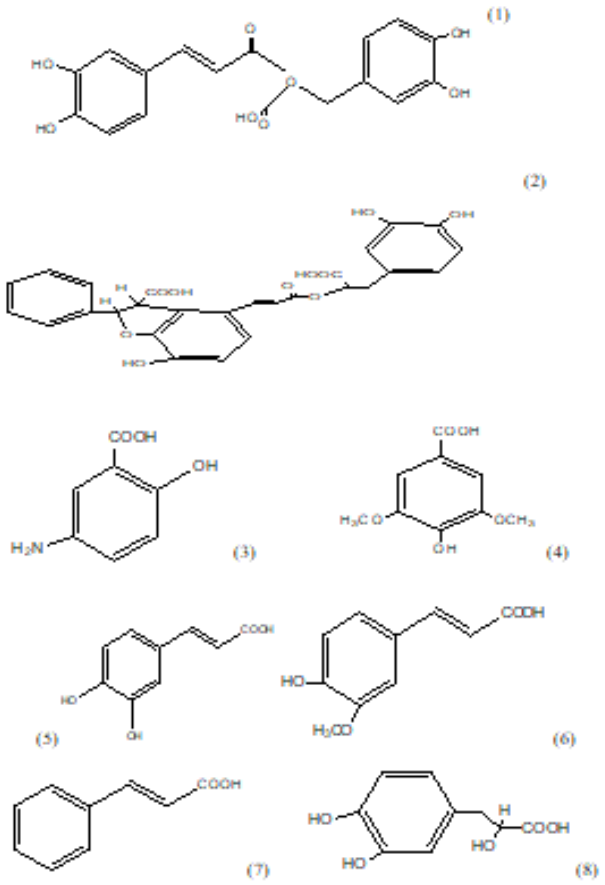

Fig. 1 Compounds isolated from the leaf of Ocimum lamiifolium

Compounds Isolated from root of Ocimum basilicum: TLC screening of different extracts from aerial parts and roots of *Ocimum basilicum* revealed a high content of triterpenes in the dichloromethane extract six triterpene acids identified as betulinic, oleanolic, ursolic, 3-epimaslinic, alphitolic and euscaphic acids have been isolated from a dichloromethane extract of hairy root cultures of *Ocimum basilicum* L. (Lamiaceae). These cultures were obtained by genetic transformation using *Agrobacterium rhizogenes*. The extract as well as the isolated compounds was evaluated for their hepatoprotective activity by measuring their effect on the oxidative stress status of liver, induced by carbon tetrachloride, in albino rats and in liver homogenate *in vitro*. All tested compounds displayed hepatoprotective activity comparable to oleanolic and ursolic acids (Marzouk 2009).

Traditional, medicinal and bioactivities of some Ocimum species: Worldwide demand of essential oils has increased during the past few years. Essential oils are reported in aromatic plants which are distributed in Mediterranean and tropical countries across the world where they are esteemed as an imperative component of the native medicine systems. Almost all plant organs (flowers, buds, stems, leaves, fruits, seeds and roots) of aromatic plants contain essential oils. These are accumulated in secretary cells, cavities, channels, and epidemic cells.

Traditional uses: Traditionally, extracts of Ocimum kilimandscharicum Guerke were used to mitigate many disorders in East Africa comprising remedy of coughs, colds, measles, abdominal pains, diarrhea, insect repellent, particularly against mosquitoes and storage pest control. The essential oils obtained from this plant as repellent against nuisance biting insects and malaria vector have been practiced in North-Eastern Tanzania for centuries. Ocimum kilimandscharicumis an important aromatic medicinal plant in Kenyan communities (Kashyap, Kaur Ranjeet *et al*. 2011). Among the medicinal plants of Ethiopia, Damakese (ocimum lamifolium) is one of the well celebrated and most widely used home remedies. It is also the locals by other vernacular name including Damakher Dargu and korcha-michi. Ocimuml lamifolium which belongs to subgenus Nautochilus family Lamiaceae, subfamily Nepetoideas, is a sub shrub or shrub that can grows to 0.7-3m tall. It grows at altitude levels of 1200-2900m often wild around clearings edges of mountain forests and abandoned fields, but is seldom cultivated as an ornamental. It is widely distributed in the region from East Africa to Malawi, in DR of Congo and Cameron (H.Kifie, A.Seyoum *et al*. 2007). In Ethiopia traditional medicine, Damakse is mostly used for the treatment of a disease condition locally known "Mitch". Mitch is characterized by headache, fever inflammation, joint pain, back pain, chills, and sweat and loose of appetite and in several case diarrheas it is believed to be used by exposure to strong sunlight immediately strong after baking, roasting cereals, heating of red pepper and spices, and in general after engaging in task that expose one to strong smell or smoke (H.Kifie, A.Seyoum *et al*. 2007). Damakese is also employed for the treatment of common cold and cough by sniffing the crushed leaves or inhaling the steam after boiling it together with leaves of other medicinal plants such as eucalyptus leaves. Other indications of the plants includes for eye infection by applying the decoction of the crushed leaves, and haematuria where the patient drinks the decoction. In local veterinary care, the water solution of the powdered leaf and root and other herbs such plant species is administered orally or as ear drops to treat wound sustained from hyena bite (H.Kifie, A.Seyoum *et al*. 2007).

Medicinal uses and bioactivities: Experiments on the essential oils of, various Ocimum species have indicated that the oil possess biological activities. Of these, antimicrobial, antibacterial, antifungal properties are very important. Efforts are being made to utilize these essential oils on commercial basis. Ocimum species have many uses, but the most common is for culinary purposes. As a fresh herb, they are used to flavor foods such as vegetables, poultry and fish jelly, honey, tea, and liquor. The flowers are edible and can make an attractive addition to salads and other dishes. The cosmetic industry uses oil in lotions, shampoos, perfumes, and soaps. Extracts of the plants are used in traditional medicines and have been shown different pharmacological activities (Janmoni Kalita and LatifKhan 2013). A high degree of polymorphism in the genus Ocimum determines a large number of subspecies, different varieties and forms producing essential oils with varying chemical composition offering variable level of

medicinal potential. Essential oils extracted from Ocimum plants have been reported to possess interesting biological properties. These volatile oils have been applied in perfumery, to inhibit growth of microorganisms, in food preservation and in aromatherapy. The potential uses of O. basilicum, O. canum O. gratissimum and O. sanctum essential oils, particularly as antioxidant and antimicrobial agents have also been explored. Recently reviewed the antimicrobial, adaptogenic, antidiabetic, hepato-protective, anti-inflammatory, anti-arcinogenic, radioprotective, immunomodulatory, neuro-protective, cardio-protective and mosquito repellent properties of O. sanctum.

In vivo anti-inflammatory activities of leaf extracts of Ocimum lamiifolium: Ocimum lamiifolium Hochst. ex Benth. (Lamiaceae) has been used in Ethiopian traditional medicine for the treatment of different inflammatory disorders such as oropharyngitis, wound, pain, fever, and others. Aqueous and ethanol crude extracts were screened for their antiinflammatory activities in mice using carrageen in induced paw edema. And then the aqueous extract, the most active extract, was further fractionated and the fractions were tested for their anti-inflammatory activities using carrageen in, histamine and serotonin induced mice paw edema. Distilled water and aspirin were employed as negative and positive controls, respectively. Acute oral toxicity of both extracts and fractions were also determined after giving graded doses. The aqueous and ethanol extracts were able to reduce inflammation significantly, but greater Anti-inflammatory activity was observed for the aqueous extract at all dose levels. Of all fractions the water residue showed highly significant anti-inflammatory activities. Ocimum lamiifolium leaf extracts exhibited significant anti-inflammatory activities with less acute inflammation (Woldesellassie Mequanint, Kelbessa Urga *et al*. 2010).

In vivo hepatoprotective activity the aerial parts and normal roots of O. basilicum: A triterpene-rich CH_2Cl_2 extract from hairy root cultures of *O. basilicum* was screened for its hepatoprotective activity against extracts from the aerial parts and normal roots of the explants. Recently, triterpenes such as oleanolic, ursolic and glycyrrhetinic acids as well as derivatives of. them were shown to be effective in inhibiting CCl4 Induced hepatotoxicity in experimental animals. CCl_4 , a well-known model compound for the induction of chemical hepatic injury, requires biotransformation by hepatic microtonal enzymes to produce the hepatotoxic trichloromethyl radicals (CCl_3)) and/or $CClOO^-$. The covalent binding of these free radicals to cell proteins is considered as initial step in a chain of events eventually leading to membrane lipid peroxidation and finally to cell necrosis. Injection of CCl_4 to rats' significantly increased the levels of liver transaminases (ALT and AST) over the normal group. Although oral administration of a hairy root extract at dose of 200mg\kg had a low capacity to lower the level of these enzymes it was effective in lowering the liver oxidative stress which was measured by monitoring the level of malondialdehyde (MAD). MAD is a major product of lipid per oxidation which is used as a marker of oxidative liver injury was not statistically different from that of silymarin (milk thistle extract) a widely used hepatoprotictive natural product (Marzouk 2009).

Invitro evaluation of of Ocimum lamifollium: Ocimum lamifollium were collected from their growing habitats. Dried leaf powders were extracted using methanol, distilled water and n- hexane, 25, 50 and 100mg\ml doses of the extracts made in tween 80(2%) were screened for the antimicrobial activities against Staphylococcus aurous, Escherichia coli, Pseudomonas aeruginosa and shigella boydii using disk diffuse on assay. The inhibition zone due to the methanolic extraction from 0 (in s.aureus due to 25mg\ml to 12mm in (E.coil due to 100mg /ml). In habitation zones due to the aqueous extract ranged from 8mm in S.aureus and S.boydil to 12mm in S.boydil at concentration of 25 and 100mg\ml respectively. Then n-hexane extract at 25mg\ml resulted in inhibition zone that ranges from 7mm (against S.aureus) to 11mm (aginst E.coil) at 50 and 100mg\ml dose. The minimum inhibitory concentration of S.boydii and E.col was 10mg/ml due to all the extracts. The minimum inhibitory concentrations on S.aureus were 10, 20 and 50mg/ml due to the aqueous, n-hexane and methanolic extraction respectively. P.aeruginosa was minimally inhibited at10mg/ml due to the methanol and aqueous extracs and 15mg/ml due to n- hexane extract. The methanol, aqueous and n-hexane extracts of O.lamlifolium leaf extracts inhibited the test bacteria with significantly higher levels of in habitation zone than the negative control.

The positive control (Tetracycline and chloramphenicol) also showed significantly higher inhibition zone than the 100mg\ml concentration of the extracts and except that chloramphenicol failed to inhibition S.aureus and P.aeruginosa. However combination of chloramphenicol with plant extraction raised their inhibition zone from zero to 23 and 25 mm in S.aureus from and P.aeruginsa, respectively (Destaw Damtie and Meonnen 2015). Crude extract of the leaves methanol were screened for antibacterial activities against *S. aureus*, *Pseudomonas spp*. and *Escherichia coli*. The in vitro antibacterial activity was performed by agar disc diffusion method and this shows that methanol extract of *Ocimum lamiifolium* revealed an elevated antimicrobial activity against *S. aureus*, *E. coli* and *Pseudomonas* spp. The in vitro antibacterial activities of the test samples were carried. The results of the antimicrobial activity of the methanol extract of fresh leaves of Ocimum lamifolium was found sensitive to S.aureus, E. coli and P. aeruginosa. Crude methanol extract produced zone of inhibition 12 mm and 13.5 mm against S. aureus and E. coli respectively and also exhibited highest zone of inhibition (12 mm) against P. aeruginosa The MIC value was also determined against the all tested bacteria. The MIC value of methanol extract of Ocimum lamifolium was found to be 200 mg and 100 mg against both S. aureus and E. coli respectivel (Teklit Gebregiorgis Amabye and Mussa 2015).

The indiscriminate use of antimicrobial agents has resulted in the emergence of a number of drug-resistant bacteria and fungi. To overcome the increasing resistance of pathogenic microbes, more effective antimicrobial agents with novel mode of action must be eveloped. Essential oils derived from several Ocimum species have been reported to be active against several Gram-positive and Gram-negative bacteria as well as against yeasts and fungi due to their terpenic constituents. Recently, essential oils and extracts of certain plants have been shown to have antimicrobial effects as well as imparting flavor to foods investigated the antimicrobial potential of four Ocimum species

Ocimum basilicum: The essential oil showed antibacterial, antifungal, insecticidal and larvicidal activity. Methyl chavicol and methyl cinnamate obtained from the essential oil of *O. basilicum* were found to be mainly responsible for the insecticidal activity of the oil against *Tribolium castaneum,*

Sitophilus oryzae, stagobium paniceum and *Bruchus chinensis* (Janmoni Kalita and LatifKhan 2013). Ethanol, methanol, and hexane extracts from Ocimum basilicum Labiatae (sweet basil) were investigated for their Inventor antimicrobial properties. The result showed that the three extracts tested has antifungal and antibacterial activities in different ranges (F. Lukmanul Hakkim, Girija Arivazhagan *et al*. 2005).

Ocimum canum: The essential oil from leaves showed antibacterial activity. Antitubercular activity against *Mycobacterium* strain was also reported. The oil showed wide range of antifungal activity (Janmoni Kalita and LatifKhan 2013).

Ocimum gratissimum: The essential oil showed antibacterial, antifungal, hypoglycaemic, antipyretic, anti-nociceptive, antioxidant, anti-inflammatory, anthelmintic, anticarcinogenic, free radical scavenging, radio protective, antidermatophytic activities and numerous others pharmacological use. Earlier reports had also shown the smooth muscle contracting and antimutagenic activityas well as its anti-diarrhoeal effects in experimental animals, high antiviral indices against HIV-1 and HIV-239 (Janmoni Kalita and LatifKhan 2013). *O. gratissimum* was active against enter aggregative *E. coli*. It is therefore conceivable that this extract can be used to treat cases of diarrhea caused by these organisms in infected individuals (T. T. Adebolu and Oladimeji 2005).

Ocimum sanctum: Antifungal, anticandidal, antioxidant, activity, lipid-lowering effect, antifungal, antiaflatoxigenic, anthelmintic, hepatoprotective (Janmoni Kalita and LatifKhan 2013).

Conclusion

Most of the evidences generated from the previous researches revealed that, Ocimum species are vital in the traditional and medicinal use for both human and livestock. It is strongly suggested that further researches need to be conducted for more detailed and ease of uses as a traditional medicine and modern drug mass production.

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