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REVIEW ON ESSENTIAL OIL: ANTIMICROBIAL ACTIVITIES OF *ORIGANUM MANJORAM* AND *THYMUS VULGARIS*

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ABSTRACT

Antimicrobial drugs derived from both chemical and microbial products, plays an important role in fight against pathogens. Overuse of antibiotics cause the emergence of multidrug resistance. The medicinal plants are used as a source for relief from antimicrobial resistance. EOs are mixture of volatile compounds, exhibit a wide spectrum of antimicrobial properties. Antimicrobial activity of EOs depends mainly on three characteristic such as character of essential oil, its chemical components and the type of organism that must attacks. The mechanism of action of EOs is to pass through the cell wall and cell membrane of microorganism that leads to the disruption of structure and thus permeabilize those membranes. Combination of essential oil with an antimicrobial agent produces synergistic effect. Interaction between EOs components may leads to the antagonistic, addictive or synergistic effect. Due to the presence of carvacrol and thymol in Oregano and thyme produces remarkable antibacterial effects. The combination of *T. vulgaris* and *O. marjoram* produces a synergistic activity. The EO from thyme has inhibition effect against 9 strains and oregano has inhibition effect against 6 strains. Antimicrobial activity is slightly more in oregano than thyme.

INTRODUCTION

Antimicrobial drugs derived from microbial or chemical product plays an important role in the fight against pathogens. However, with wide usage around the world, they have resulted in widespread drug resistance and side effects.[1] The primary stay of treatment for microbiological (bacterial and fungal) infections is antibiotics. The medical community had long believed that the development of these antibiotics and their application as chemotherapeutic agents would eventually result in the eradication of infectious diseases.

However, overuse of antibiotics has become the major factor for the emergence and dissemination of multidrug resistant strain of several groups of microorganisms.[2]

Antimicrobial resistance (AMR) poses a major threat to human health around the world. In 2019 estimated 4.95 million deaths associated with bacterial AMR, including 1.27 million deaths attributable to bacterial AMR.[3] Plants have long been utilized by humans to treat common infections, and certain ancient remedies are still used today to treat a variety of ailments. Some manuals of phytotherapy report, for instance, that cranberry juice (*Vaccinium macrocarpon*) and bearberry (*Arctostaphylos uva-ursi*) can be used to treat urinary tract infections, while species like garlic (*Allium sativum*), lemon balm (*Melissa officinalis*), and tee tree (*Melaleuca alternifolia*) are considered broad spectrum antimicrobial agents.[4]

The use of medicinal plant as a source for relief from illness can be traced back over millennia to written documents of the early civilization in China, India, and the north east, but it is thoughtless as art as old as mankind.[5] Both industrialized and developing nations use medicinal plants extensively and have done so for a very long time. According to the report of world health organization, 80% of the world's population relies mainly on traditional therapies, which involve the use of plant extracted or their active substance.[6] Some of the advantages of using antimicrobial compounds of herbal plants, such as fewer side effects, better patient tolerance, relatively less expensive, acceptable due to long history of use and being renewable in nature.[7]

Plants produce a high diversity of secondary metabolites. Among these secondary metabolites, it is estimated that over 3000 EOs are known, of which about 300 are commercially important and used by the flavor and fragrance industries.[8] EOs are generally used in the cosmetics, medical and food industries. Moreover volatile compounds obtained from plants, have known antimicrobial, antifungal and insecticidal activities.[9]

Essential oil

Essential oils are complex natural mixture of volatile secondary metabolites, isolated from plant by hydro and steam distillation and by expression (Citrus peel oil). The main constituent of essential oil is mono and sesquiterpenes including carbohydrates, alcohols, ethers, aldehydes and ketones are responsible for the fragrant and biological properties of aromatic and medicinal plants. Due to these properties, since ancient times spices and herbs have been added to the food, not only as flavoring agent but also as preservatives.[10]

Recently, research in essential oil has received increased attention from both industries and academic circles due to a growing interest in green consumerisms.[11]

Antimicrobial activities of essential oil

During last decade, a large number of studies have been performed concerning the antimicrobial activities of essential oils.[12] Essential oil are mixture of volatile compounds, exhibit a wide spectrum of antimicrobial properties. Antibacterial, antifungal, antiviral, nematicidal and antimite activities have been demonstrated. Furthermore, essential oils could present antioxidant properties and could be used as flavoring materials.[13] Many researchers mention that essential oils antimicrobial activity depends mainly on three characteristics: the character of essential oils (hydrophilic and hydrophobic), its chemical components and the type of organism that must attack. As typical lipophiles, EO's pass through the cell wall and cytoplasmic membrane of microorganism, disrupt the structure of their different layers of polysaccharides, fatty acids and phospholipids and permeabilize those membranes. In bacteria, the permeabilization of the membrane is associated with loss of ions and reduction of membrane potential, collapse the proton pump, depletion of ATP pool. EO's can coagulate the cytoplasm and damage the lipids and proteins. Damage to the cell wall and membrane can leads to the leakage of macromolecules and to lysis.[14] When essential oil and antimicrobial treatment are combined, they have a synergistic impact on multidrug-resistant S. aureus, and significant reductions in minimum inhibitory concentration (MIC) have been found in numerous situations.[15]

Table 1: Mechanism of action of some essential oils.

Species of plant from which essential oil is derived	Microorganism targeted	Mechanism of action	Reference
Cinnamomum verum	*Enterobacter aerogenes* *E. coli* *P. aeruginosa* *S. enteritidis* *S. aureus*	Released cellular content; reduced intracellular pH; affected membrane integrity	[17]
Syzygium aromaticum	*C. jejuni* *E. aerogenes* *E. coli* *S. aureus* *S. enteritidis*	Inhibited histidine decarboxylase	[17]
Allium sativum	*E. coli*	Induced leakage	[15]
Litsea cubeba	*E. coli*	Destruction of outer and inner membrane	[18]

Interaction between Components of Essential Oils

Most of the antimicrobial activity in essential oil is found in oxygenated terpenoids (example: alcohol and phenolic terpenes), while some hydro carbons also exhibit antimicrobial effects. The interaction of distinct terpenoid components in essential oils can diminish or enhance their antibacterial activity. Interaction between EOs components may leads to antagonistic, additives or synergistic effects.[8] An additive effect is observed when the combined effect is equal to the sum of the individual effects. Antagonistic behavior occurs when one or both chemicals work less effectively when applied jointly than when applied separately. When the combined effects of the substances outweigh the total of their separate effects, synergism is noticed. Some studies have concluded that whole EOs have a greater antibacterial activity than the major components mixed, which suggests that the minor components are critical to the activity and may have a synergistic effect or potentiating influence.[16]

Oregano, Thyme

Oregano essential oil

The genus Origanum consists of 38 species of annual, perennial and shrubby herbs, most of which are native to the eastern part of the Mediterranean area. Greek oregano or winter marjoram *(O. heracleoticum* L), Italian oregano or pot marjoram (*O. onites* L), Turkish wild oregano (*O. vulgare*), bible hyssop or Syrian oregano (*O. syriacum*), and sweet marjoram (*O. majorana* L) are some of the most significant aromatic plants in the world. All of these plants are commercially available and exportable and have significant market values.[19]

Origanum majorana is a bushy half- hardy perennial sub-shrub. The well dried leaves of the herb used in medicinal products.[20]

Taxonomy

Kingdom: Plantae

Subkingdom: Viridiplantae
Infrakingdom: Streptophyta
Superdivision: Embryophyta
Division: Tracheophyta
Sub-division: Spermatophytina
Class: Magnoliopsida
Super-order: Asteridae
Order: Lamiales
Family: Lamiaceae
Subfamily: Nepetoideae
Tribe: Mentheae
Genus: *Origanum* L.
Species: *Origanum majorana* L.

Steam distillation of leaves and flower heads yields a volatile oil, known in the trade as oil of Sweet marjoram, widely used in flavoring food and also in perfumery. Medicinally it is used in both Ayurveda and Unani system to cure various human ailments. The plant is pungent, bitter, hot, stomachic, anthelmintic, alexipharmic, useful in diseases of the heart and blood fevers, leucoderma and inflammation.[21] The main component was terpinen-4-ol in the marjoram essential oil, in the alcoholic and in the supercritical extract. This compound was obtained in nearly the same amount by the hydro-distillation and by SFE. The other characteristic compounds were determined; γ- terpinene, linalool, α-terpineol, α-terpinolene, α-terpinene, β-caryophyllene and spathulenol.[22]

Thyme essential oils

Thyme belonging to the family Lamiaceae, so far, 928 species of the genus *Thymus* has been identified in Europe, Northern Africa, Asia, Southern America, and Australia.[23] Thyme is a tiny perennial shrub, with a semi evergreen groundcover that seldom grows quite 40 cm tall it's each horizontal and upright habits.[24] It is aromatic and medicinal plant of increased commercial interest, with representatives species *T. serpyllum* (wild thyme) and *T. vulgaris* (common type).[23]

The rather meaty aerial components of T. vulgaris leaves, which range in shape from oval to rectangular, are utilized mostly in steam distillation to produce volatile oil. The essential oil

from *T. vulgaris* showed a high content of oxygenated monoterpenes and low contents of monoterpene hydrocarbons, sesquiterpenes hydrocarbons and oxygenated sesquiterpenes. The predominant compound among the essential oil component was thymol while the amount of all other components of oil was less than 19%.[24]

Taxonomic classification

Kingdom: Plantae

Class: Magnoliopsida

Order: Lamiales

Family: Lamiaceae

Subfamily: Nepetoideae

Genus: *Thymus* L.

Species: *Thymus vulgaris* L.

Antimicrobial activity of thyme and oregano EOs

The oregano and thyme EOs have remarkable antibacterial effects, which are associated with the presence of their phenolic components, carvacrol and thymol.[23] The combination of *Thymus vulgaris* and *O. marjoram* synergistically active against *E. cloacae.*[8] The methanol extract of marjoram showed considerable activity against *Aspergillus niger, Fusarium solani* and *Bacillus subtilis.*[25] SFE extracts of marjoram significantly stronger inhibition effects against *E. coli* and *B. cereus* than the Soxhlet extracts.[22] The EOs derived from leaves showed antibacterial effect on various bacteria. The ethanol and water extract of *O. marjoram* L have shown antimicrobial activity gram positive and gram negative bacterial and its possible application by minimum inhibitors concentration estimation.[23] Thyme has been thought to be antiseptic, antimicrobial, medication, astringent, anthelmintic, carminative, disinfectant, medicinal drug and tonic. The biological activity and chemical components of the essential oil (EO) from *Thymus vulgaris* L. gathered at four phases of the biological

process were assessed. Six strains of gram positive bacteria and nine strains of gram negative bacteria are inhibited by the thyme volatile oil.[24] Thyme oil and oregano oil produced the strongest antibacterial effect. The difference in antibacterial properties between them became less pronounced but the relative activity was still in the order oregano> light thyme> red thyme.[25]

CONCLUSION

Essential oils are complex natural mixture of volatile metabolites and having antimicrobial activity. EOs has antibacterial, antifungal, antiviral, nematicidal and antimite activities. Antimicrobial activity in EOs is found in oxygenated terpenoids. Interaction between EOs components may leads to antagonistic, additives or synergistic effects. EOs in Oregano and thyme has antibacterial effect and their combination is active against *E. cloacae.*

The present study showed that the medicinal plants can be used to treat microbial infection with less emergence of antimicrobial resistance.

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