Organic and Medicinal Chemistry
International Journal
ISSN 2474-7610

Juniper Publishers
key to the Researchers

Mini Review
Volume 9 Issue 2 - February 2020
DOI: 10.19080/OMCIJ.2020.09.555759

Organic & Medicinal Chem IJ

Essential Oil Activity Against Methicillin-Resistant Staphylococcus aureus and Multidrug-Resistant Mycobacterium tuberculosis: A Mini-Review

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Submission: January 24, 2020; **Published:** February 18, 2020

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Abstract

Drug resistance among pathogenic bacteria has been a major concern for decades. Diseases caused by them have been the main cause of death in developing countries where this factor contributes around one third of the total number of deaths. With the gradual increase in microbial resistance and the side effects that synthetic medicines may cause, there has always been a need of finding natural medicines that can effectively treat such diseases. Among such potent resources are plant essential oils that have been reported in literature and is a recent topic of extraordinary interest. In this study, antimicrobial potential of essential oils of various plants against two resistant strains: methicillin-resistant Staphylococcus aureus (MRSA) and multidrug-resistant Mycobacterium tuberculosis (MDRTB), has been discussed.

Keywords: Essential Oils; MRSA; M. Tuberculosis; Antibacterial Activity; Drug-Resistant Microbes

Introduction

In present situation, where drug-resistant bacteria are widely spread, lesser options are available due to decreased number of novel drugs being manufactured. Generally known examples of such microbes are Methicillin-resistant Staphylococcus aureus, multidrug-resistant Mycobacterium tuberculosis vancomycin-resistant enterococci, and penicillin-resistant Neisseria gonorrhoeae etc. The situation is getting worse due to the origination of prevalent, MDR Stenotrophomonas maltophilia and Burkholderia cepacia [1,2].

In 1940s, penicillin was used to cure the infections caused by S. aureus. Subsequently, penicillin resistant S. aureus developed and spread all over the world due to the increased usage of penicillin. In 1960s, methicillin was prepared to cope up with penicillin-resistant S. aureus and widely used in US and Europe, but bacteria quickly developed the resistance against methicillin. This led to the conclusion that various antibiotics may no longer be used to treat the diseases caused by such bacteria, and threat of using other drugs is gradually increasing. Thus, several new antibiotics have been prepared for the treatment of drug resistant bacteria up to 5th generation where cephalosporin is a promising entity [3-5].

MRSA possesses specific threats to elderly or postsurgical patients. It is a resident microbe, which is innocuous for healthy individuals, but obstinate in immunosuppressed patients, and is found in organ abscesses, infectious endocarditis, bone infection (osteomyelitis) and post-operative wound infection [4]. Another drug resistant bacterium includes Mycobacterium tuberculosis that causes Tuberculosis (TB), a major cause of death since long with around 1.7 million deaths in 2006 [6]. TB control is challenging due to the development of MDR and XDR (extensively drug resistant) strains [7]. After the use of anti-TB drugs in 1940s, issue of drug resistance was reported among the patients receiving the treatment [8].

Drug resistance of this strain was continuously increasing all over the world which resulted in explosive emergence of MDRTB in early 1990s which was resistant to the two most effective first line anti-TB agents, isoniazid and rifampicin. Later on, 45 countries reported the cases of XDR-TB which was not only resistant to isoniazid and rifampicin but also to at least one of the fluoroquinolones and to any of the second line drugs which include capreomycin, amikacin and kanamycin [9,10]. cepacia Among the potent

natural resources are plant essential oils that have been reported in literature and became a recent topic of extraordinary interest. In this study, an overview of the effect of essential oils on MRSA and MDRTB has been presented.

Discussion

Essential oils that strongly inhibit MRSA include melissa, cinnamon, mountain savory, lemon myrtle and lemongrass. Several essential oils exhibit inhibitory activity against MRSA, when used in a combination and include Eucalyptus citriodora, peppermint, spruce, cypress, lavender, pine, myrtle, marjoram, Eucalyptus radiata, Eucalyptus australiana and Eucalyptus globulus oils. "Motivation", a combination of lavender, spruce, ylang ylang and Roman chamomile oils and "Longevity", a combination of thyme, orange, clove and frankincense oils, showed the maximum inhibitory activity [11].

These MDR strains were also inhibited by essential oils of Eucalyptus globulus and Thymus vulgaris with MIC values of 85.6 (µg/mL) and 18.5 (µg/mL) against MRSA respectively [11,12]. Strong inhibitory activity was observed by the essential oils of Clerodendrum serratum against MRSA whereas fruit oil of a common Sub-continent tree, Terminalia arjuna exhibited an MIC 0.16 mg/mL against MRSA [13,14]. Several other plants have been checked for their antibacterial potential against MRSA among which the most active essential oils include Cinnamomum verum, Satureja montana, Origanum heracleoticum, Cinnamomum cassia and Corydothymus capitatus. They showed an MIC ≤ 0.05% (v/v) for this strain [15].

The essential oil of M. communis exhibited promising activity; MIC 0.17 % (v/v), against all strain types of M. tuberculosis, including XDR strain. α-pinene, 1-8 cineole and limonene were tested for their antimicrobial potential against these strains. Limonene was found to be most active exhibiting an MIC value of 2 % (v/v) for all strains, followed by α-pinene with MIC value of 1-16 % and 1-8 cineole with MIC value, of 2-16 % (v/v). Essential oil activity was compared with 4 antitubercular drugs taken as standard including ethambutol, rifampin, isoniazid and streptomycin. All mycobacterial strains were resistant towards some or all of these drugs including an XDR strain. Screened essential oils showed a better antibacterial potential as compared to each single drug checked against all mycobacteria [16].

Essential oils of several plants were checked for their antimicrobial potential against different resistant variants of M. tuberculosis H37Rv and the significant activity was shown by O. europaea, N. officinale, C. sinensis and C. aurantifolia [17]. Similarly, essential oils of T. spicata and Origanum minutiflorum showed significant activity against Mycobacterium tuberculosis H37Ra with an MIC value of 196 µg/mL and 392 µg/mL [18]. Essential oils of S. aratocensis, T. diffusa and L. americana showed good activity against various MDR strains of M. tuberculosis with an MIC range of 50-125 µg/mL. This data suggests the use of these plants as an important sources of the compounds having antimicrobial potential against MDR M. tuberculosis [19].

Individual compounds such as Terpinolene, α-Terpinene, t-Anethole, Sabinene, Myrcene, Menthol, Linalool, (+) Limonene, Geraniol, Eugenol, Eucalyptol, Estragole, Cuminaldehyde, β-Citronellol, (+) Carvone, β-Caryophyllene, p-Cymene, 3-Carene, β-pinene, p-Anisaldehyde, Camphor, Cinnamic Acid etc. were tested and found to be potent against M. tuberculosis. Among terpenes, thymol and carvacrol exhibited the strongest activity with MIC 0.78 and 2.02 µg/mL respectively. Among phenylpropanes cinnamic acid and cinnamaldehyde showed the best activity with MIC 8.16 and 3.12 µg/mL respectively [20]. Although the employment of volatile and essential oils as antimicrobial agents is promising, it still needs more in vivo studies along with clinical trials involving several subjects to increase their reliability [21-23].

Conclusion

Essential oils may possibly be employed as a potential source in solving the problem of drug resistance. MRSA and MDR M. tuberculosis variants show susceptibility towards essential oils of numerous plants and individual compounds of essential oils. This leads to conclude that essential oils may provide the solution of treating those resistant microbes for which options of existing synthetic drugs are getting limited with the passage of time.

Conflict of Interest

Authors declare no conflict of interest

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How to cite this article: Azeem Intisar. Essential Oil Activity against Methicillin-Resistant Staphylococcus Aureus and Multidrug-Resistant Mycobacterium Tuberculosis: A Mini-Review. Organic & Medicinal Chem IJ. 2020; 9(2): 555759. DOI: 10.19080/OMCIJ.2020.09.555759

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DOI: 10.19080/OMCIJ.2020.09.555759

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