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Review Article

The Role of Essential Oils as the Treatment Alternatives for Multidrug Resistant Staphylococcus Aureus

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ABSTRACT

The emergence of multi-drug resistant Staphylococcus aureus (MDR-SA) has significantly abated the sensitivity to antibiotics, causing uncertainty in the effectiveness of antibiotics to combat multi-drug resistant Staphylococcus aureus. Therefore, new therapeutic options are in demand for adequate management of patients presented with multi-drug resistant Staphylococcus aureus. Scientists worldwide are working on the secondary metabolites of the medicinal plants, such as essential oils as potential antimicrobial agent/s with minimum resistance as an alternative to conventional medicine. This review summarized the evidence on the efficacy of essential oils against a range of bacterial strains which were considered resistant to many antibiotics.

Keywords: Effective alternatives, essential oils, Multi-drug resistant Staphylococcus aureus.

How to Cite This Article: *Raja SA, Mubarak N, Raja SA, Abbas K. The Role of Essential Oils as the Treatment Alternatives for Multidrug Resistant Staphylococcus Aureus. Pak Armed Forces Med J 2025; 75(Suppl-1): S128-S131. DOI: https://doi.org/10.51253/pafmj.v75iSUPPL-1.4341*

INTRODUCTION

Last two decades have witnessed a global concern on the prevalence of multidrug-resistantStaphylococcus aureus (MDR-SA).[1] The resistant strains not only affect clinical settings but also emerged as a stern risk to public health.[2] The variations in its epidemiology over the last four decades have demonstrated a different pattern of drug resistance which is a major contributor to treatment failure.[3] This has steered to increased morbidity & mortality among the clinical settings especially the intensive care patients.[4] Furthermore, in community-acquired infections, increased isolation of methicillin resistant Staphylococcus aureus (MRSA) imposed a serious threat to its spread in hospitals making it difficult to differentiate between community acquired methicillin-resistant Staphylococcus aureus (CA-MRSA) and hospital acquired methicillin-resistant Staphylococcus aureus (HA-MRSA).[5] New molecular typing techniques have clearly documented the ability of epidemic, disease-producing clones of MRSA to populate in hospitals and spread to diverse geographic regions expeditiously.[6,7] Keeping in view the current scenario of emerging resistance of these organisms to the various existing antimicrobial agents, it has been an inevitable concern and the scientists world-wide are in quest for newer effective and safer drugs to handle the load of such resistant pathogens in future.[8]

As the surge of multi-drug resistant Staphylococcus aureus resistant strains continues to swell and become a global issue, scientists worldwide are working on the secondary metabolites of the medicinal plants, such as essential oils as potential antimicrobial agent/s with minimum resistance as an alternative to conventional medicine.

Resistance Pattern of MRSA to current Antibiotics

During the last decade, data regarding resistant MRSA have shown an upward trend to various antimicrobials in clinical practice.[9] The foremost reason being the extensive and irrational use of antibiotics which has contributed in the emergence of resistant forms of such pathogens.[10] Till date, MRSA has been resistant to majority members of beta lactam antibiotics and other related antibiotics.[11] The main antibiotics used in the clinical management of MRSA include members of glycopeptides antibiotics and Oxazolidinone.[12] Currently, the major issue is the increased resistance to vancomycin due to its overuse and resulting in emergence of vancomycin-resistant Staphylococcus aureus.[4] Clinical isolates of MRSA with vancomycin resistance were reported for the first time in Japan in 1997.[13] Till to date three types of vancomycin resistant strains have been described vancomycin-resistant S. aureus (VRSA), glycopeptide-intermediate Staphylococcus aureus (GISA), and hetero-GISA (hGISA).[14] In view of the current

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Received: 20 May 2020; revision received: 04 Jan 2021; accepted: 20 Jan 2021

Table-I: Essential Oils with Anti- Methicillin-Resistant Staphylococcus Aureus Activity

Medicinal Plant Essential Oil	Family	Concentration of essential oil Minimum Inhibitory Concentration (MIC) breakpoints
Menthapiperita (peppermint)	Lamiaceae	0.50% v/v
Juniperuscommunis (juniper)	Cupressaceae	>2.00% v/v
Melaleuca alternifolia (tea tree)	Myrtaceae	0.16–0.32% (v/v)
Allium sativum (Garlic Oil), Allium odorum (Chinese leek oil)	Amaryllidaceae	8 µL/mL
Backhousiacitriodora (lemon myrtle)	Myrtaceae	0.20% v/v
Lavandula angustifolia (lavender)	Lamiaceae	8.60 mg/mL
Lavandulastoechas (French lavender)	Lamiaceae	Flower essential oil: 31.25 µg/mL Leaf essential oil: 125.00 µg/mL
Eucalyptus globulus (eucalyptus)	Myrtaceae	8.56–85.60 µg/mL
Rosmarinus officinalis (rosemary)	Lamiaceae	0.03% v/v
Armoracia rusticana	Brassicaceae	8.3 to 17µl/l
Origanumsyriacum	Lamiaceae	8.3-130µl/l
Allium sativum	Amaryllidaceae	8.3-530µl/l
Saturejahortensis	Lamiaceae	17-130µl/l
Saturejamontana	Lamiaceae	33-260µl/l
Thymus vulgaris	Lamiaceae	33-260µl/l
Thymus serpyllum	Lamiaceae	33-530µl/l
Eucalyptus globulus	Myrtaceae	250 µg/ml
Juniper officinalis (juniper)	Cupressaceae	20.00 mg/ml
Melaleucacajuputi (cajuput)	Myrtaceae	2.50 mg/mL
Pelargonium graveolens (Geranium oil)	Geraniaceae	0.25–2.50 µL/mL
Cymbopogancitratus (lemon grass)	Poaceae	30 µl/ml
Thymus vulgaris (Thyme)	Lamiaceae	4 µl/ml
Pelargoniumgraveolens (geranium)	Geraniaceae	1.00 mL/mL
Monarda punctate	Lamiaceae	>70 µg/ml
Schinusareira	Anacardiaceae	3.2 µL/mL and 15 µL/mL
Caryophyllusaromaticus(clove)	Myrtaceae	2.70 mg/mL
Matricariarecutita (German chamomile)	Asteraceae	26.50 mg/mL
Origanumtyttanthum	Lamiaceae	625 µg/mL
Galaganiafragrantissima	Apiaceae	39.1 µg/mL
Tetraenafontanesii, Tetraenanumidicus Menthapulegium	Lamiaceae	0.3 µL/mL - 4.7 µL/mL
Nigella sativa oil	Ranunculaceae	<0.25 –1.0 µg/mL
Ocimumtenuiflorum (Tulsi)	Lamiaceae	2.25–2.5 µg/ml
Thymus vulgaris	Lamiaceae	8µl/ml
Citrus nobilis (Citrus peel)	Rutaceae	10µl/ml
Cymbopogoncitratus (lemongrass)	Poaceae	10µl/ml
Cortex cinnamom (cinnamon)	Lauraceae	10µl/ml
Rosmarinus officinalis (Rosemary)	Lamiaceae	15 µl/ml
Ocimum sanctum (Holy basil)	Lamiaceae	15 µl/ml
Origanumvulgare (Oregano)	Lamiaceae	20µl/ml - 25µl/ml
Menthaarvensis (Mint asavi)	Lamiaceae	25 µl/ml
Menthapulegium (pennyroyal mint)	Lamiaceae	25 µl/ml
Etlingerasayapensis	Zingiberaceae	0.52 ± 0.23 mg/ml
Plectranthusamboinicus	Lamiaceae	0.5 mg/ml
Carumcopticum	Apiaceae	1.7- 4.2 µl /ml
Cuminumcyminum	Apiaceae	23-43.8 µl /ml 10.8±3.4 µl/ml
Zingiberofficinale	Zingiberaceae	

situation vancomycin is yet a consistent susceptible option but the number of reports of vancomycin resistance is increasing.[15] Many studies demonstrate worldwide MRSA being resistant to various classes of

antibiotics thus presenting great problems in its clinical management.[3]

Screening of Essential oils as potential anti-microbials

The problem of growing resistance requires search for new treatment options and to explore the medicinal plants for their bioactive molecules with antimicrobial properties.[16] Most of the compounds produced in plants because of secondary metabolism are known to possess variable degrees of antimicrobial properties.[17] These include alkaloids, flavonoids, tannins, phenolic compounds, steroids, resins, fatty acids and gums which are known to be physiologically active.[18] This is the most important motivational aspect that has always encouraged investigators to reconnoiter for novel antimicrobial substances from medicinal plants.[19]

Essential oils are the secondary metabolites used as defensive agents by the plants. They have been known through centuries for their beneficial effects and yet used as folk medicine in many parts of the world for their many useful properties as antibacterial, antifungal, antiviral, insecticidal and antioxidant attributes.[20,21] Their use is not only restricted to the medicine industry but in the food industry, cosmetic and perfumery. Within the last decade the interest is growing greater than before in considering their multiple uses as alternative substances and driving exploration of them in new uses and applications,[22] and so far, have shown potential results as antimicrobials against clinical isolates as well as food-borne pathogens upon in vitro testing.[23,20]

As the research on these bioactive molecules is increasing, many essential oils and their constituents have shown to exhibit antiviral, antibacterial, antioxidant and antimutagenic activities. Because of their protective properties can be potential candidates as anticancer drugs. [24,25]

As the growing resistance has been a global issue, scientists worldwide are working on the secondary metabolites of the medicinal plants and research on essential oils is gaining attention due to its great potential as antimicrobials with minimum risk of resistance increasing their importance and has been found to be effective against several gram- positive and gram- negative resistant species. [26, 27]

Essential Oils against Multidrug Resistant-Staphylococcus aureus

Over the years the resistance of Staphylococcus aureus has emerged not only to methicillin but to many previously sensitive antibiotics.[28] This has limited the number of available options for treatment of such diseases presented by these MDR-SA. In rush for new treatment alternatives to manage the microbial burden of such pathogens many medicinal plants essential oils have been explored for their anti-MRSA activity and have been reported to exhibit promising activity in-vitro making them potential candidates as effective treatment alternatives.[29,30] List of important essential oils reported to show activity against MRSA is presented in Table-1.

CONCLUSION

The evidence in literature advocates the effectiveness of the in vitro Minimum Inhibitory Concentration data available for different essential oils against MRSA strengthens the fact that essential oils possess promising potential to be explored as treatment alternatives against MDR-SA. Essential oils contain active constituents to be used in synergistic combination with existing sensitive antibiotics, as well as different essential oils may be blended in combinations possessing synergistic effect. Also, these can be used with the resistant antibiotics for their reversal.

ACKNOWLEDGMENT

Lahore Pharmacy College (A Project of Lahore Medical & Dental college).

Conflict of Interest: None.

Funding Source: None.

Authors Contribution

Following authors have made substantial contributions to the manuscript as under:

SAR & NM: Conception, study design, drafting the manuscript, approval of the final version to be published.

SAR & KA: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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