Combined Antibacterial and Antifungal activities of *Eucalyptus citriodora* and *Syzygium aromaticum* Essential Oils

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ABSTRACT
The emergence of multi-drug resistant strains is a formidable threat to the fight against skin diseases and hence effective alternative regimes must be sought. Although many studies have been done on antimicrobial activities of Syzygium aromaticum and Eucalyptus citriodora oils, no information is available on their antimicrobial interaction and hence the purpose of this study. Bioactivity testing of Syzygium aromaticum and Eucalyptus citriodora oils was done using disc diffusion technique while the minimum inhibitory concentrations (MIC), the minimum bactericidal concentration (MBC) and the minimum fungicidal concentration (MFC) were determined by broth micro-dilution technique. Synergistic activity of the combination was determined using the Chequerboard assay. MRSA (IZD; 23 mm) and E. coli (IZD; 20 mm) were found to be extremely sensitive to Eucalyptus citriodora oil. Staphylococcus aureus ATCC 25923 (IZD; 19 mm), E. coli (IZD; 18 mm) and MRSA (IZD; 16 mm) were found to be very sensitive to Syzygium aromaticum oil. However Pseudomonas aeruginosa (IZD; 8 mm) was resistant to both Eucalyptus citriodora and Syzygium aromaticum oils. The fungi Microsporum gypseum (IZD; 20 mm) was extremely sensitive to Eucalyptus citriodora oil and this activity was more than for nystatin standard. Candida albicans ATCC 90028 (IZD; 15 mm) was very sensitive to Syzygium aromaticum oil. Eucalyptus citriodora exhibited the lowest MIC of 3.125% v/v against Staphylococcus aureus ATCC 25923 while Syzygium aromaticum oil exerted activity at the lowest MIC (1.56% v/v) against Staphylococcus aureus ATCC 25923, E. coli and Candida albicans ATCC. Eucalyptus citriodora oil had bactericidal activity against Staphylococcus aureus ATCC 25923 and MRSA and bactericidal effect against E. coli. The oil had fungicidal effect against Candida albicans ATCC 90028. Syzygium aromaticum oil exhibited bactericidal activity against Staphylococcus aureus ATCC 25923 and bactericidal effect on E. coli. It demonstrated fungicidal effect on Microsporum gypseum and Trichophyton mentagrophytes but had fungistatic activity against Candida albicans ATCC 90028 and Cryptococcus neoformans. The combination of the oils exhibited synergistic activity against MRSA (FICI; 0.48), Staphylococcus aureus ATCC 25923 (FICI; 0.48), Microsporum gypseum (FICI; 0.36) and E. coli ATCC 25922 (FICI; 0.50) but demonstrated indifferent activity against Candida albicans ATCC 90028 (FICI; 2.04). This study demonstrates that Eucalyptus citriodora and Syzygium aromaticum oils possess synergistic activity and may be combined for enhanced antimicrobial activity against skin diseases such as candidiasis, impetigo, acne and boils.

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