Investigation of Essential Oil Constitutes for Biofilm Prevention and Resistance Modification with Applications on Orthopedic Implants

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Biofilms are antibiotic-resistant clusters of bacteria that bond to a surface and can establish potentially-fatal infections on orthopedic implants; these infections are painful and damage the implant, and treatments are overwhelmingly surgical and expensive with long recovery times. Additionally, combating biofilm formation is becoming unattainable due to antibiotic resistance. This research evaluated the essential oil constitutes Carvacrol, Thymol, and Thymoquinone for biofilm prevention and eradication in antibiotic-resistant strains of Staphylococcus epidermidis and Pseudomonas aeruginosa and determined the resistance modification of Thymoquinone in combination with antibiotics. It was hypothesized that Thymoquinone would inhibit and eradicate biofilms at the lowest concentration and modify bacterial resistance. A microdilution and spectrophotometer analysis revealed that Thymoquinone inhibited biofilm growth at the lowest concentrations, with minimum inhibitory concentrations ranging from 8-512 µg/mL; Carvacrol was the only constitute able to eradicate pre-formed biofilms. Results from Etests and disk diffusions indicated Thymoquinone resistance modification, including increasing P. aeruginosa susceptibility to Erythromycin by at least 4-fold and having possible synergy with Carbenicillin and Erythromycin. Therefore, the hypothesis was accepted that Thymoquinone would modify antibiotic resistance and be the most inhibitory constitute, although it could not eradicate biofilms. Due to its biofilm-inhibition capabilities, Thymoquinone could be utilized as an external coating on orthopedic implants to act as an inexpensive, non-surgical biofilm preventer. Additionally, resistance modification in Thymoquinone suggests its use for combating antibiotic resistance.

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