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Development and formulation of liposome encapsulated silver nanoparticles and tea tree oil for skin infections

Ashraf O Abdellatif[1, 2] and **Suad Y Alkarib**[2]
[1]Karary University, Sudan
[2]Cairo University, Cairo, Egypt

Due to the overuse and incorrect prescribing of currently available conventional antimicrobials, resistance has emerged in common skin pathogens; therefore, a pre-antibiotic antimicrobial agent with broad-spectrum activity and a different mode of action against resistant microbes is urgently needed. Candidate agents include plant-derived essential oils and metal nanoparticles that have unique antimicrobial potencies. Recently, tea tree oil (TTO) obtained from *Melaleuca alternifolia (Myrtaceae)* leaves is frequently used as a topical antiseptic and disinfectant. On the other hand, silver nanoparticles (AgNPs) have received much attention due to their extraordinary antimicrobial effects against a wide range of microorganisms, including antibiotic-resistant strains. Their small sizes and large surface areas provide a good contact with microorganisms, confer enhanced bioactivity and bioavailability of Ag+, and allow better penetration into microbial cells. This study aims to develop liposome-encapsulated silver nanoparticles and TTO topical formulation and to evaluate the antimicrobial efficacy of the developed formula against selected skin-infecting pathogens, including bacteria, fungi, and viruses. The TTO was obtained by steam hydro-distillation of the plant leaves and the AgNPs was synthesized by green synthesis method using leaves aqueous extract. The in vitro antimicrobial activities of the TTO and AgNPs have been evaluated as single agent and/or in liposome-encapsulated combination formula against selected skin-infecting microbes, viz. *Staphylococcus aureus, methicillin-resistant Staphylococcus aureus, Staphylococcus epidermidis, Streptococcus pyogenes, Klebsiella pneumoniae, Pseudomonas aeruginosa, Trichophyton mentagrophytes, Candida albicans,* herpes simplex virus type 1 (HSV-1), and herpes simplex virus type 2 (HSV-2). Bioassay results showed that both TTO and AgNPs possess good antimicrobial properties against tested strains, producing marked inhibition zones (14.8–24.7 mm). On the other hand AgNPs and TTO liposome encapsulated formulation showed better antimicrobial activities with inhibition zones (21.3–26.4 mm). Additionally, tests against HSV-1 and HSV-2 showed that AgNPs and TTO liposome encapsulated form had the strongest antiviral activity, causing 52.0% and 55.1% reduction of the cytopathic effect for HSV-1 and HSV-2, respectively. Transmission electronic microscopy analysis showed severe distortion and loss of cell integrity with cell wall disruption. In conclusion, the liposome encapsulated form of TTO and AgNPs showed a synergistic antimicrobial activity against the selected skin pathogens and these findings could support its use to treat the related skin infections. These results showed the potential of using TTO and AgNPs in liposome encapsulated formulation as a promising delivery system against the possible skin infections caused by the tested strains.

Biography

Ashraf O Abdellatif is a PhD student at the Microbiology and Immunology Department, Faculty of Pharmacy, Cairo University and has published five papers in reputed journals.

ashrafpharm@hotmail.com

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