Quantitative modeling and design of essential oil nanoemulsion delivery systems for strong antimicrobial action against *Listeria monocytogenes*

Abstract

Food safety remains a concern owing to numerous cases of foodborne diseases resulting from bacterial pathogens. *Listeria monocytogenes* is one of the three most serious foodborne pathogens. Essential oils are volatile compounds found in the secondary metabolites of aromatic plants. Owing to their high terpenoid and phenolic compound content, these oils are potential natural antimicrobial agents for food preservation, but their low water solubility limits their efficacy and application in food. In the present study, 28 different essential oils were evaluated for their antimicrobial activities against *Listeria monocytogenes*. Various concentrations of essential oils were introduced into brain heart infusion broth to determine the minimum inhibitory concentration (MIC) for the pathogen. To quantitatively evaluate the effect of each oil on *L. monocytogenes* from a kinetic viewpoint, the experimental data were fitted to the modified Gompertz model, and the lag phase duration and maximum growth rate were calculated and compared for each essential oil at various concentrations. Overall, our experimental results indicate that frankincense, eucalyptus, and fire needle oils had the strongest inhibitory effects against *L. monocytogenes* with MICs lower than 2.4 μg/mL. Essential oils with moderate antimicrobial effects included key lime, cedar wood, Egyptian geranium, nutmeg, peppermint, valerian, and ylang ylang.

Keywords: Food safety, Essential oils, Nanoemulsion, *L. monocytogenes*, Growth kinetics