CHAPTER VIII
CONCLUSIONS AND RECOMMENDATIONS

The biosurfactant extracted from the liquid culture of *Pseudomonas aeruginosa* SP4, isolated from petroleum-contaminated soil in Thailand, was identified as a mixture of eleven rhamnolipid species. The major component in the biosurfactant product was identified as monorhamnolipid (Rha-C_{10}-C_{10}). Compared to the synthetic surfactant, the biosurfactant showed comparable physicochemical properties in terms of the surface activities and stabilities, suggesting its potential use as an alternative to the synthetic surfactants. The ability to form stable emulsions with vegetable oils of the biosurfactant indicated the possible exploitation as an emulsifying agent in the food industry, while its good stabilities were beneficial for applications under extreme conditions of temperature and pH, such as in oil recovery and in the bioremediation of a polluted environment. The biosurfactant also has great potential for biomedical field due to its good heat tolerance even after being submitted to autoclave sterilization.

The biosurfactant was able to self-assemble to form spherical vesicles at the concentration greater than its critical micelle concentration (CMC). By the addition of an additive (NaCl or C_2H_5OH or cholesterol) to the biosurfactant solution, the higher the additive concentration, the smaller the size of the biosurfactant vesicle. The ability of the biosurfactant vesicles to entrap Sudan III, a model hydrophobic substance, both in the absence and presence of the additives suggests their potential use as a vehicle for active ingredients in either cosmetics or pharmaceuticals applications.

To further investigate the utilization in the biomedical field, the biosurfactant was used to modify the surface characteristics of silk fibroin and chitosan films via the adsorption process. The silk fibroin and chitosan films showed more hydrophobicity after the biosurfactant adsorption, but the surface topographies of both substrates was not significantly modified. The adsorbed biosurfactant layer was found to differently affect the biological responses of the test cells—human dermal fibroblasts and human dermal keratinocytes. The results suggest that the biosurfactant could be used as a tool

for tailoring the surface characteristics of materials to achieve the desired bioresponse. The use of the rhamnolipid biosurfactant in the biomedical fields perhaps introduces this surface-active compound into high value-added applications.

The biosurfactants have shown potential use in several industries; however, the utilization of biosurfactants has been restricted because of the high cost of biosynthesis and the downstream processing. The bioreactor systems should be developed for large-scale biosurfactant production in order to increase the production yield and to reduce the cost of the biosynthesis. For the downstream processes in biosurfactant production, they normally involve recovery, concentration, and purification. Most of the biosurfactants can be easily recovered from the culture medium by using a combination of traditional techniques, such as precipitation, centrifugation, and solvent extraction. However, these conventional recovery methods are time-consuming. Moreover, volatile organic solvent and chemical substances used in the solvent extraction are costly, air-polluting, and toxic to health. Therefore, it is necessary to develop a more economical and environmentally friendly technique to recover the biosurfactant products, such as foam fractionation. The integration of a foam fractionator into the bioreactor with the recycle of microbial cells is another possible strategy to enhance the commercial exploitation of the biosurfactants.

Although the results of the present work showed that the biosurfactant vesicles could be served as a vehicle for active ingredients in either cosmetics or pharmaceuticals applications, the release profile of the encapsulated substances from the biosurfactant vesicles should be further investigated. In addition, the bioresponses to the biosurfactant-modified tissue engineering materials should be further studied *in vivo* or should be tested with other cells, such as osteoblasts.