CHAPTER V
CONCLUSIONS

This research has proposed a novel nanoparticulate formulation, prepared from PLGA copolymers, which was applied for incorporating curcuminoids via the modified spontaneous emulsification solvent diffusion (modified-SESD) method. The nanoparticles were prepared with three formulation ingredients, which were PLGA copolymers, curcuminoids and stabilizers. Three PLGA copolymers were studied, consisting of different ratios of PLA and PGA at 50:50, 75:25 and 85:15. The curcuminoids loaded in the formulation varied in three concentrations; 2, 6 and 10%. The stabilizer used in the preparation with various concentrations was vitamin E TPGS (3, 5 and 7%), poloxamer 407 (9, 12 and 15%) or polyvinyl alcohol (3, 5 and 7%). The obtained curcuminoids-PLGA nanoparticles were characterized on five different responses, which were %recovery, particle size, size distribution (referred as polydispersity index), %curcuminoids content and %encapsulation efficiency. A three-factor, three-level Box-Behnken design was used to analysis the correlation between the various formulation ingredients and the five responses described above.

For the curcuminoids-PLGA nanoparticles using vitamin E TPGS as stabilizer, it was found that the %recovery, particle size, size distribution (or polydispersity index), of all formulations were not statistically different from each other. However, the % curcuminoids content was increased as increasing the amount of curcuminoids loaded in the formulation.

In case of the curcuminoids-PLGA nanoparticles using poloxamer as stabilizer, the %recovery was not affected by any formulation ingredients. The particle size and size distribution was reduced as increasing the concentration of poloxamer in aqueous phase. The %curcuminoids content was decreased as an increase of poloxamer.

For the curcuminoids-PLGA nanoparticles using PVA as stabilizer, %recovery was not statistically different among all formulations. The particle size was increased when the PLA-PGA ratio in PLGA was increased, but the size distribution was almost indifferent. The %curcuminoids content was increased by an increase of PLA-PGA ratio in PLGA and the amount of curcuminoids loaded in the formulation, however, the particle size was also increased.

In order to achieve the optimal formulation, which can provide the satisfactory responses, the simultaneous optimization technique was used to correlate all effects with all responses at the same time. The formulation optimization was performed using desirability function approach, in which the goal of both independent (factors) and dependent variables (responses) were set. Three optimal formulations were established. The first formulation was composed of PLGA 50:50, curcuminoids 10%, and vitamin E TPGS 3%. The second formulation was composed of PLGA 50:50, curcuminoids 4.56%, and poloxamer 407 15%. The last formulation was composed of PLGA 50:50, curcuminoids 10%, and PVA 3%. The curcuminoids-PLGA nanoparticles prepared from the optimal formulations were characterized in term of %recovery, particle size, size distribution (or polydispersity index), %curcuminoids content and %encapsulation efficiency. They were found to almost agree within the predicted interval at 95% confidential. The surface and morphology study from scanning electron microscopy technique (SEM) indicated that the obtained nanoparticles were nearly spherical in shape with almost smooth. In addition, the *in vitro* release study of entrapped curcuminoids from nanoparticles was carried out. It was found that the release profile of the nanoparticles consisted of two distinct phases, which were an initial exponential phase followed by a slow release phase, indicating that the nanoparticles released the content in a sustained manner. Thus, the curcuminoids-PLGA nanoparticles obtained from this study could provide a sustained release system.

This thesis research would provide useful information about the preparation of nanoparticles containing curcuminoids. In addition, the obtained PLGA nanoparticles containing curcuminoids could serve as a controlled release raw material, which can be incorporated within formulations used via various routes of administration, such as parenteral, oral and topical administration. The effect of the formulation ingredients on the physicochemical characteristics of the nanoparticles inverstigated here would be helpful in understanding the formation of PLGA nanaparticles. Consequently, this study could be applied to develop PLGA nanoparticles containing other substances in the future.