CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSION

Results from this study could be concluded as followed:

1. The suitable concentration of hi-maize starch was 1.0% (w/v) for preparing the immobilized *L. acidophilus* with 1.8% (w/v) sodium alginate and 0.1 M calcium chloride by extrusion technique.

2. The suitable vacuum dried condition was at $40^{\circ}C$ for 20 h and the free cells of *L. acidophilus* were survived more than that of the encapsulated cells. The viable survival rate of probiotic bacteria was 89.90 ± 0.03 and 65.11 ± 3.40% for the free cells and immobilized cells, respectively. When the vacuum drying time was increased, the yoghurt containing probitic bacteria could have lower moisture content and water activity. However, the rehydration (%) and dispersibility property (%) of the yoghurt powder at different vacuum temperatures and vacuum times were not significantly different ($p<0.05$). The yield of yoghurt powder from the vacuum drying condition was around 21-24%.

3. For the chemical properties, including moisture content and water activity of the yoghurt powder, they were increased when the outlet temperature of a spray dryer deceased, whereas other physical and chemical parameters such as bulk density, rehydration (%) and water holding capacity were not significantly affected by the outlet temperature of the spray drier except for the solubility parameter. The solubility of the yoghurt powder dried at $90^{\circ}C$ was the lowest compared to those of the outlet drying temperatures, which could be due to milk protein denaturation that made them difficult to be soluble in water. The pH and total titratable acidity of the yoghurt powder were not significantly be affected by the drying outlet temperatures. Higher survival rate of lactic acid bacteria was found in the yoghurt powder dried at an outlet temperature of $80 \pm 2^{\circ}C$.

4. Temperature of rehydrated water affected the survival rate of lactic acid bacteria in the reconstituted yoghurt solution. At a water temperature of 90°C, *L. bulgaricus* could not be detected, whereas *L. acidophilus* had a higher survival rate compared to *S. thermophilus*. Lower temperatures of rehydrated water could produce higher survival rates for the studied microorganisms. The rehydrated water temperatures did not significantly affect the physical and chemical parameters of the yoghurt powder.

5. Storage temperature was found to have more effect on the survival rates of *S. thermophilus*, *L. bulgaricus* and *L. acidophilus* compared to the packaging materials. At the end of 14 weeks storage, it was only *S. thermophilus* that could be detected in the yoghurt powder. At room temperature, *S. thermophilus*, *L. bulgaricus* and *L. acidophilus* could not be detected in the yoghurt powder after 10, 10 and 8 weeks, respectively. The moisture content and water activity of the yoghurt powder were increased during storage. Packing the powder in nylon/PE packaging had a higher increasing rate for the moisture content and water activity of the powder compared to that in PET/PP/Al packaging. Laminated PET/PP/Al packaging and storage temperature of 4°C were found to be the best combination in maintaining the physical, chemical and microbial qualities of the yoghurt powder containing *L. acidophilus*.

5.2 RECOMMENDATIONS

1. Smaller bead diameters should be investigated to improve the survival rate of *L. acidophilus* during drying.

2. A further study about the immobilized probiotic cells during drying process should be carried out to explain the situation of the probiotic inside the beads when it is dried.

3. For the yoghurt powder storage, the next experiment should study about the ratio of nitrogen and oxygen in the packaging or using other treatments to prevent the microorganism from dying and produce a longer shelf life of yoghurt powder.