Chapter 5

Conclusion

In this study, three different rice types, including white, brown and black glutinous rices, were investigated to find the possibility of rice milks as a food carrier to deliver a probiotic bacterium, *Lactobacillus acidophilus*. The three studied rice types contained 12.0 – 12.5% (w/w) moisture content, 7.0 – 8.0% (w/w) protein, 77.0 – 79.5% (w/w) carbohydrates, 0.2 – 1.1% (w/w) ash and 0.2 – 0.9% (w/w) fiber. The 10% (w/v) rice milks of these rice grains had 97.5 – 99.5% (w/v) moisture contents and significantly contained lower amounts of nutrients compared to those of the rice grains.

In the first section of this study, experiments were conducted to understand different levels, which were 5, 7 and 10% (w/v), and types, including white, brown and black glutinous rice, of rice milks on the viability of *L. acidophilus* during storage at 6°C for 15 days. Various levels and types of rice milks affected the viscosities and color values of the rice milks. As the levels of rice milks increased, the viscosities of the milks would also be increased, particularly for the white rice milks. The black glutinous rice milks had significantly darker and more red color compared to those of the other rice milks. The viscosities and color of different rice milks did not significantly changed during the storage period at 6°C.

For the viability of *L. acidophilus* in different levels and types of rice milks, the survival rate of the probiotic bacteria was reduced during the storage period. The lowest reduction rate for the viability of *L. acidophilus* was shown when the

bacterium was inoculated in 5% (w/v) brown rice milks. The viability of *L. acidophilus* in this rice milk was reduced up to 1.0 log CFU/ml in the middle of the storage period and increased to its inoculation level at the end of the storage period. Other microorganisms in the rice milks that survived a pasteurization process could also grow during refrigerated storage of the milks, but they did not give any significant effect on the viability of *L. acidophilus*. Consistent with the microorganism growth/survived in the rice milks, the acidity of different levels and types of rice milks was increased during storage at 6°C. A low concentration of total soluble solid was detected in different rice milk treatments and the amount of total soluble solid did not change significantly during 15 days at low storage temperature.

In the second part of the study, three different pH levels of 4.5, 5.5 and 6.5 together with two inoculation levels, which were 6 and 8 log CFU/ml, of *L. acidophilus* were investigated for their effects on the survival rate of the probiotic bacterium in 5% (w/v) brown rice milks during storage at 6°C for 15 days. Different treatments of the rice milks did not significantly affect the viscosities, color and total soluble solids of the rice milks at the beginning of the storage period. The viscosity and color of the rice milks only had minor changes during 15 days storage at refrigerated temperature.

The survival rate of *L. acidophilus* in the 5% (w/v) brown rice milks with different initial pH values and different inoculation rates was not significantly affected by different treatments. In general, the viability of *L. acidophilus* was reduced in the middle of the storage period before recovering to its initial inoculation levels or higher at the end of the storage period. The highest survival rate of *L. acidophilus* in the 5% (w/v) brown rice milks was found in the rice milks with an

initial pH value of 4.5 and an inoculation level of 6 log CFU/ml *L. acidophilus* that had a viability slope of 0.029 ± 0.024. There was not any significant differences in the term of the *L. acidophilus* survival rate when 6 or 8 log CFU/ml *L. acidophilus* was added into the rice milks. Other microorganisms that survived a pasteurization process could also grow in the rice milks during low storage temperature. The acidities of different treatments of the 5% (w/v) brown rice milks was found to be significantly increased throughout the storage period.

For the third part of the study, the effects of honey and sugar of three different addition levels of 0, 4 and 7% (w/v) on the viability of *L. acidophilus* in 5% (w/v) brown rice milks were evaluated. The addition of different levels of honey and/or sugar affected the viscosities, color values, especially a* and b* values, total soluble solid, reducing and invert sugars of 5% (w/v) brown rice milks. However, the values of these physical and chemical properties did not change significantly during the storage period. The presence of sugar was found to give a better support for the survival rate of *L. acidophilus* compared to those of the rice milks with honey or a combination of sugar and honey. Adding 4% (w/v) sugar into the rice milk produced a *L. acidophilus* viability slope of 0.032 ± 0.028. The presence of other microorganisms in the rice milks was significantly increased during the storage period for the rice milks with 4% (w/v) sugar, 4% (w/v) honey and a combination of 7% (w/v) sugar and 7% (w/v) honey. At the same time, the amount of lactic acid was significantly increased throughout the storage period at 6°C for 15 days.

In the last part of the study, an immobilization technique using an extrusion method was studied to find out whether the survival rate of *L. acidophilus* in the 5% (w/v) brown rice milks could be improved by the technique. The collected data

clearly demonstrated that the viscosities, color, total soluble solids, reducing and invert sugars of the rice milks were not affected by different forms of *L. acidophilus* cells. A higher survival rate of *L. acidophilus* free cells (a viability slope of 0.008 ± 0.008) was recorded compared to that of the immobilized *L. acidophilus* cells. Consistent with this finding, the acidity development of the rice milks with *L. acidophilus* free cells was significantly higher than that of the rice milks with immobilized *L. acidophilus* cells.