CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

The SF/CLWs bionanocomposite sponges were fabricated by freeze-drying silk fibroin solution containing cellulose whiskers at different SF/CLWs weight ratios in order to obtain a porous material with interconnected pores. The incorporation with high CLWs content into SF sponge causing intermolecular hydrogen bond between –OH of CLWs and $–NH_2$ and/or –OH of SF and inducing beta-sheet conformation of SF resulted in good water stability of sponge. Furthermore, the increase in the CLWs content caused higher water stability, less shrinkage, and better mechanical properties of sponges. The methanol-treated bionanocomposite sponges had better water stability than non-treated ones because methanol treatment can significantly enhanced the conformation transition from random coil to beta-sheet structure of SF sponge. The SF/CLWs bionanocomposite sponge fabricated at the SF/CLWs ratio of 50:50 (MSF50) provided the largest average pore size about 112.65 μm and contained the highest number of yeast cells around $3.80x10^{10}$ cells/1g of sponge. The MSF50 sponge was chosen as a carrier for yeast cell immobilization using in continuous ethanol fermentation because MSF50 had highest pore size, water stability, dimensional stability, yeast cell density and lowest cell leakage. The continuous fermentation system was operated by the following operating condition: temperature at 30 °C, pH at 4.5-5, feed sugar concentrations of 100, 150, and 200 g/l, dilution rate (D) of 0.15, 0.20 and 0.25 hr^{-1}. The ethanol production and volumetric ethanol productivity which obtained from fermentation increased when the feed glucose concentration increased but the % sugar consumption decreased. On the other hand, the ethanol production was decreased at high dilution rate. The maximum ethanol production of 51.18 g/l with the volumetric ethanol productivity of 7.68 $gl^{-1}hr^{-1}$ was obtained at 0.15 hr^{-1} dilution rate and 200 g/l feed glucose concentration. Finally, after finished fermentation, sponge containing yeast cell can be as feed for animal because SF and yeast cell are excellent protein sources. In addition, continuous ethanol fermentation by using immobilized yeast cell in SF/CLWs sponges may be done with long-term running of ethanol production in order to observe ethanol productivity in long-run.