# CHAPTER V

# CONCLUSIONS

The Minimum Inhibitory Concentration (MIC) of nisin used in this study is 0.05 mg/mL and nisin could retain activity after 120 °C heating for 30 minutes. Viscosity and conductivity of gelatin-nisin solutions (pH 3) increased as the concentration of nisin and gelatin were increased. At different initial nisin concentrations and 22% w/v gelatin concentration, the nanofibers were continuous without beads and had no difference in the average size (220 – 250 nm). At 20% w/v gelatin concentration, nanofibers were not smooth and had beads on string, while at 22% w/v and 24% w/v gelatin concentration nanofibers were continuous without beads. Average diameter of antimicrobial gelatin nanofibers increased significantly ($p \leq 0.05$) with increasing gelatin concentration. The gelatin nanofibers and antimicrobial gelatin nanofibers mats which were crosslinked by saturated glutaraldehyde vapor at 37 °C for 5 minutes had their tensile strength, Young's modulus, and elongation that decreased with increasing initial nisin concentration. Tensile strengths and elongation of crosslinked nanofibers mats produced from gelatin-nisin solution at different gelatin concentrations were not different ($p > 0.05$) while their Young's moduli were significantly increased ($p \leq 0.05$) when increasing gelatin concentration from 22% w/v to 24% w/v. Crosslinked antimicrobial gelatin nanofiber mat containing higher nisin concentration caused the width of inhibition zone to increase significantly ($p \leq 0.05$). The widths of inhibition zone caused by crosslinked antimicrobial gelatin nanofiber mat at 22% w/v and 24% w/v gelatin concentration were not significantly different. After electrostatic spinning and crosslinking, the retention of nisin in crosslinked antimicrobial gelatin nanofiber mat was 1.08% - 1.22% w/w. It was found that increasing temperature could accelerate nisin release from crosslinked antimicrobial gelatin nanofiber mat, while releasing rate of nisin under water activity levels range 0.955 – 0.992 was not significantly different. Crosslinked antimicrobial gelatin nanofiber mat could inhibit *Staphylococcus aureus* and *Listeria monocytogenes* but not *Salmonella* Typhimurium. After storing for

5 months, crosslinked antimicrobial gelatin nanofibers morphology was not changed and retained its ability in inhibiting *Lactobacillus plantarum* TISTR 850.

**Suggestion**

Crosslinked antimicrobial gelatin nanofiber mat could inhibit *Staphylococcus aureus* and *Listeria monocytogenes* but not *Salmonella* Typhimurium because nisin is considered as effective at controlling a wide range of gram-positive bacteria. Nisin can be active against gram-negative bacteria when it is applied with the application of pulsed electric field (PEF), which increases the permeability of cell membranes. It was also used in combination with metal chelators, such as EDTA which disrupted the outer membrane and allowed the penetration of nisin, to control the growth of gram-negative pathogens such as *E. coli* O157:H7 and *Salmonella sp.* Therefore, the next experiment, crosslinked antimicrobial gelatin nanofiber mat should be produced from gelatin-nisin solution which is blended with EDTA for inhibiting gram-negative bacteria.