Chapter 6

Conclusions

6.1 Overall Conclusions

1. The Vietnamese pineapple cv. Ninhbinh is a member of the Queen pineapple group with an average weight and size. Its leaves are spiny, narrow and long, light green in color with a streak in the middle. Small and sharp thorns line the edges of the leaves throughout its entire length. In the main season, the pineapple is crispy, very sweet and a little sour. Skin color of the fruit changes from dark green to yellow while the pulp color changes from light yellow to orange-yellow when the pineapple ripen.

2. The storage temperature and high relative humidity affected the fruit quality. Weight loss in the pineapples increased with increasing temperature, while the level of firmness decreased. At 9°C and 85% RH, chilling injury symptoms appeared on the fruit within 10 days storage, and the level of these symptoms significantly increased until the end of storage period. The chilling injury did not appear for the pineapples preserved at 12, 15 and 20°C until the 30^{th} day of storage. The optimal storage temperature for the pineapple was 12°C combined with 85% RH. At this condition, after the 20^{th} day of storage, the pineapple maintained a good quality with yellow color, high firmness, and high total soluble solids content, low ethanol content and without chilling injury symptoms. The producing of ethanol content in fruit related to the storage temperature, TSS content and amount of microorganism developed on the surface of the fruit. Amount of total aerobic count on the surface of the pineapple at initial stage was $0.3x10^6$ CFU/fruit.

3. Carbendazim, an antimicrobial agent, affected chitosan/methylcellulose properties. The present of carbendazim changed film opacity and color. A higher content of carbendazim in films resulted in a higher film opacity and yellow color.

The addition of carbendazim into the films with higher 1.6 g/100 g solid of C/MC, slightly increased film permeability and decreased film mechanical properties. Carbendazim slightly reduced the solubility of the film matrix. C/MC films incorporated with carbendazim absorbed less water control films under the range of 11-85% relative humidity conditions. Addition carbendazim with 1.6 g/100 g solid of C/MC created the film that had the lowest value in solubility and moisture sorption.

4. There was a relationship between mechanical properties, solubility, moisture sorption isotherms and morphology of films with different carbendazim contents. The cross-section of the C/MC films became rougher and less homogenous with increasing ~~in~~ carbendazim contents. With the addition of carbendazim of more than 1.6 g/100g solid of C/MC there appeared some partial carbendazim insolubility. This result related to a decrease of tensile strength and elongation, an increase of water and oxygen permeability, and an increase in solubility and moisture sorption of the films at high carbendazim contents.

5. The antimicrobial activity of chitosan/methylcellulose film was improved strongly when incorporated with carbendazim. Addition of carbendazim into C/MC films increased the inhibitory effect of films on both yeast (*Saccharomyces cerevisiae*) and fungi (*Aspergillus oryzae*). The C/MC film incorporated with carbendazim, 1.6 g/100g solid of C/MC (which means 0.06 mg/cm^2 of film), was the best film that showed the biggest inhibitory zone and the lowest number of *A. oryzae.* The C/MC film incorporated with 1.6 g of carbendazim was used for coating pineapple fruit.

6. Coating pineapples by different antimicrobial coating solutions affected fruit quality. There were three types of coating solutions applied for pineapple coating including C/MC, C/MC with vanillin and C/MC with carbendazim. After coating, fruit surfaces became shinier, more smooth and homogenous and also gained a uniform cover. The coating delayed the changes in total soluble solids, flesh firmness, flesh color and ethanol content. Especially, pineapple fruit coated with C/MC-carbendazim showed the lowest value on ethanol content and the highest value on TSS, firmness and flesh color when compared with those in control. Significantly, both of three coating solutions provided inhibitory effect on microbial growth on fruit

surface, in which the best antimicrobial activity was recorded for C/MC-carbendazim, followed by C/MC-vanillin and C/MC. The level of carbendazim residue in the pineapple coated by chitosan/methylcellulose incorporated with carbendazim (1.6 g/100 g solid of C/MC) after 30 days storage was less than 0.01 mg/kg. This means that the pineapple after coating by the C/MC-carbendazim film solution and stored at low temperature during 30 days is still safe for people health. However, at 12°C and high relative humidity (85% RH), coating pineapple fruit by C/MC, C/MC-vanillin or C/MC-carbendazim did not reduce the weight loss of pineapple fruits.

6.2. Future Works

1. The coating pineapples at different relative humidity conditions from 60% to 80% RH will be investigated.

2. The inhibitory effect of chitosan/methylcellulose film incorporated with carbendazim should be developed with *Aspergillus flavus* and bacteria.