CHAPTER 5

CONCLUSIONS

5.1 Overall conclusions

Since the chitosan film was rigid, methylcellulose and hydroxypropyl cellulose were selected to blend with chitosan to improve the mechanical properties of the film. The ratio of chitosan:methylcellulose = 1.5:0.5 provided the best film in both appearance and mechanical properties. The film was thinnest and clearest. Film elongation was improved while tensile strength was slightly impaired. The tensile strength and percent elongation of all ratios of chitosan and hydroxypropyl cellulose blend films were worse compared to the film made only from 1.5% chitosan.

Vanillin, an antimicrobial agent, and PEG, a plasticizer, affected chitosan/methylcellulose film properties. Vanillin reduced while PEG increased film flexibility. The addition of vanillin to the film slightly improved film strength while PEG decreased film strength. Vanillin did not improve the water barrier of the film but did improve its oxygen barrier. Greater amounts of plasticizer had a negative effect on both water and oxygen barrier. Vanillin affected film opacity and yellowness more than PEG. Both vanillin and PEG reduced crystalline formation of film. A higher PEG content resulted in a higher film solubility. Addition of vanillin reduced the solubility of the film matrix. Vanillin reduced the water absorption of the film while PEG increased its water absorption. From morphologic observation, both chitosan/methylcellulose film and vanillin film were homogenous. Compared with the chitosan/methylcellulose film, more plasticizer was necessary to produce a flexible vanillin film. Vanillin film absorbed less water than the chitosan/methylcellulose film. When the vanillin film was applied to the fruit, it maintained its wet strength better and significantly less swelling from chitosan/methylcellulose film.

The release of vanillin from the film depended on the surrounding temperature, pH of the solvents and initial vanillin concentration in the film. A higher temperature resulted in a higher release rate. A lower pH medium caused film swelling and facilitated the release rate. Film swelling was observed after immersion in pineapple

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juice and citrate buffer pH 3.5. Therefore, low pH medium caused swelling of the vanillin film. Vanillin released faster in films containing low vanillin concentration due to higher water absorption. Water in the film acts as a plasticizer and facilitates the release of vanillin. The release of vanillin from the films onto fresh-cut cantaloupe and pineapple pieces is effected by their juices. A higher release was found on pineapple. However, the release rate was slower on fruit pieces compared to fruit juices. The migration of vanillin from film into food simulants was highest into 50% ethanol which represents a high alcohol containing food, followed by 10% ethanol which represents an acid food. The lowest amount of vanillin was released into corn oil which is a non-polar medium.

The inhibitory effect of chitosan/methylcellulose film and vanillin film on microorganism on agar plates was less effective compared to inoculation on fruit. Only vanillin film containing a high vanillin concentration inhibited both *Escherichia coli* and *Saccharomyces cerevisiae* on agar plates. While both chitosan/methylcellulose film and vanillin film resulted in inhibition of *Escherichia coli* and *Saccharomyces cerevisiae* inoculated on fresh-cut cantaloupe and pineapple. The effectiveness of vanillin with the different fruits varied with fruit type. The number of yeast on cantaloupe did not change but vanillin reduced the number of yeast on pineapple. Better inhibition on low pH fruit was observed due to the higher amount of vanillin released from the film onto the fruit surface. Molds were observed for all cantaloupe treatments except that wrapped with vanillin film. The other quality attributes of fresh-cut cantaloupe and pineapple were generally acceptable. An extreme reduction of L-ascorbic acid (vitamin C) was found for pineapple wrapped with vanillin film. L-ascorbic acid in pineapple juice supplemented with 1,000 mg/L and 2,000 mg/L diminished in storage. This confirms that there is a reaction between L-ascorbic acid and vanillin, not some other film components. The mechanism of interaction will need to be further investigated. The respiration rate of both fruit after cutting and wrapping was high, and decreased in storage, increasing again near the end of storage. Cantaloupe wrapped with chitosan/methylcellulose and vanillin film had a lower respiration rate than the control. Ethanol content increased in storage in both fresh-cut fruit. On day 12, both of the fruit wrapped in the vanillin film had the lowest ethanol content, which agrees with

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their respiration rate. Both chitosan/methylcellulose and vanillin films were inferior to stretch film in protecting against weight loss. Migration of vanillin resulted in more yellow on the surface of the pineapple and also affected sensory properties. Vanillin had an adverse effect on the sensory properties of both fruit, even more with pineapple. Panelists detected a bitter taste on the fruit surfaces due to migration of vanillin. The sensory characteristics of both fruit wrapped with chitosan/ methylcellulose film was acceptable.

5.2 Future works

5.2.1 Lower vanillin containing film should be tested on fresh-cut fruit especially in high acid fruit.

5.2.2 The interaction of vanillin and L- ascorbic acid should be investigated.

5.2.3 Application of films on other food should be investigated especially on bakery product because vanillin is effective in mold inhibition and the flavor of vanillin can improve the flavor of bakery product.

5.2.4 The release of chitosan and acetic acid which also provide an inhibitory effect against microorganisms should be studied.

5.2.5 The inhibitory effect of chitosan/methylcellulose film and vanillin film against pathogens is interesting for further study.

5.2.6 Vanillin may be used in combination with other natural or synthetic preservatives to inhibit the microorganism without the adverse effect on sensory.

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