

Chapter 5

Conclusion and Suggestion

1. The storage time and temperature had a significant influence on the quality of fresh lime juices, including the physical, chemical, microbiological, nutritional values and sensory characteristics. The total soluble solid, ascorbic acid and total acidity of the lime juice were decreased while the pH value and color attributes (L^* , a^* and b^* -value) were increased during one month storage. The rate of changes was relatively slower at 4-6°C than at ambient temperature. Therefore, low storage temperature is an important parameter for lime or citrus juices in the maintenance of good flavor and color as well as high retention of vitamin C.

2. The distribution of d-limonin in the different parts of lime fruit showed that the highest in the lime seed (194.1 ± 5.33 ppm) followed by segment membrane (19.28 ± 0.34 ppm), albedo (16.48 ± 1.34 ppm), flavedo (8.58 ± 0.26 ppm) and juice sacs (6.85 ± 0.06 ppm). The level of the d-limonin of 34.89 ± 0.16 and 23.34 ± 0.53 ppm was found as the highest level of the compound during storage at chilled and ambient temperature, respectively. After this time period, the d-limonin content in the juice was continuously decreased with a higher decreasing rate when the juice was kept at ambient temperature.

3. Addition of four hydrocolloids including, CMC (sodium salt), κ -carrageenan, pectin and gum acacia at concentrations between 0.5 to 1.5 g/l (w/v) were found to be suitable in reducing the d-limonin content in lime juices. However,

CMC was found to be the most effective hydrocolloid in masking the bitterness and the concentrations of 1.0 and 1.5 g/l (w/v) CMC were found to be significantly different in reducing the d-limonin content in the lime juice. The mechanism of debittering might be due to an increase in the pH value of juice or encapsulation and absorption properties of hydrocolloids.

4. Treated fresh lime juice and CMC added-lime juice with HPP at 400, 500 and 600 MPa for 15 minutes produced lower d-limonin contents compared to the control treatment (not being processed by HPP) directly after the processing and throughout the storage period. It could be due to two possible mechanisms. The first one was unfavorable conditions for conversion of limonoate-A-ring lactone (a precursor) to d-limonin in the presence of CMC. The other mechanism was a possibility of a complete inactivation without reversible mechanism of the limonoid D-ring lactone hydrolase in the lime juices after treated by HPP at 400-600 MPa for 15 minutes. The inactivation of the enzyme might not be reversible, since there was only an increase for up to 2.55 ± 0.25 ppm of the d-limonin content in the lime juices throughout the studied storage period at any storage temperatures.

5. For the overall qualities of the HPP treated-lime juice, the HPP treatment did not significantly affect the pH, color attributes (L^* , a^* and b^* -value), total soluble solid, ascorbic acid and total acidity of the lime juices after processing and was similar to the fresh lime juice. The HPP caused the juices to retain its vitamins and color, inactivated initial microorganisms and extended the shelf life of lime juice, particularly when the juice samples were kept at refrigerator temperature. Sensory evaluation of the lime juices, including bitterness, color, aroma, sourness and overall acceptability ranked the HPP treated-lime juices with 1.0 g/l (w/v) CMC as the juice

samples with the highest sensory score followed by the HPP treated-lime juices and the control samples. The HPP also provided better sensory properties of the lime juice during storage period, especially at chilled temperature. The HP processed lime juice possessed higher freshness quality. It is commercially feasible to pasteurize lime juice or citrus juice by the HPP technology.

Suggestion for further study

1. The advantage of the HPP in maintaining the content of ascorbic acid in lime juice should be supported by a good packaging material that could reduce the degradation of the component during storage. A further study for the appropriate packaging material to keep the HPP treated lime juice will be needed to support the result of this research.
2. The effect of HPP on the inactivation of limonoid-D-ring lactone hydrolase, which cause of the delayed bitterness in the citrus juices should be further investigated to have a better understanding about the inactivation mechanism of the enzyme by HPP.
3. A higher sensitivity technique, such as chromatography analysis and Nuclear magnetic resonance spectroscopy (NMR), in measuring and analysis the d-limonin compound in lime juice or citrus juice should be carried out to support the results of this research.