CHAPTER 5

Conclusion

In summary, this research investigated the effect of vacuum cooling on physico-chemical qualities of lettuce in order to obtain a better understanding of the mechanisms induced by vacuum cooling and cold storage. The applications of artificial neuron networks for prediction of optimum cooling parameters for vacuum cooling process were also studied. In addition, this research determined the possibility of using the flow injection with Coularray detector to classify the antioxidants between precooled treatment and control treatment of lettuce.

1. For initial produce temperature of 20-25 ºC, the optimum parameters of vacuum cooling process were at final pressure of 6.0 mbar with 25-30 min reserving time. However, if initial temperature of produce were between 18-20 ºC, the optimum parameters would be at final pressure of 6.0 mbar with 20-25 min reserving time as well as the initial temperature of produce were between 16-18 ºC, the optimum parameters would be at final pressure of 6.5 mbar with 15-20 min reserving time.

2. The rate of cooling using vacuum cooling at 6.0 mbar with 25 minutes reserving time was 0.458 ºC/min, which was 14.58 and 3.33 times faster than room cooling (0.177 ºC/min) and forced-air cooling (0.038 ºC/min), respectively. In term of energy consumption, vacuum cooling used 3.40 kWh which is less than forced-air cooling (33.20 kWh) and room cooling (44.20 kWh) Therefor, vacuum cooling represented the cost effective method.

3. Vacuum cooling appeared to remain the better qualities and bioactive compounds including crispiness coefficient (CC), ascorbic acid, chlorophyll content, antioxidant activity and total phenolic content which presented the significant difference ($p \leq 0.05$). The results of ultrastructure detected by transmission electron microscope (TEM) also

supported the loss qualities of control and forced-air cooling which exhibited the plasmolysis due to the loss water of the cells. Moreover, after 13 days of storage control and forced-air cooling samples exhibited the degradation of chloroplast which related to the reduction of chlorophyll content. On the other hand, sample from vacuum cooling remained the intact and integrity of cell after 13 days of storage. Vacuum cooling is the best precooling methods for prolonging shelf life of baby cos lettuce to 16 days at 4 ºC with 85% RH which longer than forced-air cooling, room cooling and control which had shelf life of 13,13 and 9 days, respectively.

4. Artificial Neural Network (ANNs) showed its potential and ability to predict the outputs of vacuum cooling which provided the lowest prediction error. ANNs model indicated a very good fits between actual and predicted parameters when compared with multiple linear regression (MLR). ANNs demonstrated that the network effectively generated sensitive results and had a sufficient accuracy and reliability rate in modeling final temperature according to higher performance than MLR in all criteria, namely R^2_{adjust}, RMSE, MRE and MAE of 0.890, 0.076, 10.28% and 0.504, respectively. Moreover, the predicted values of weight loss percentage obtained by ANNs model were found in a very good with actual values with the goodness of fit namely R^2_{adjust}, RMSE, MRE and MAE of 0.903, 0.078, 7.68% and 0.133, respectively.

5. An electronic tongue based on flow injection with Coularray detector was successfully applied to measure the antioxidant capacity of lettuce extracts. The method showed good correlation with traditional DPPH assay. The best extraction of antioxidants were achieved by lyophilization at 35 °C followed by methanol extraction. Effect of four precooling techniques was tested to increase the shelf life of the fresh lettuce. Lettuce samples exposed to vacuum cooling and fast cooling showed significantly higher antioxidant capacity after seven days of storage at 5 °C. The results showed that Coularray flow injection is a sensitive and rapid technique for evaluation of antioxidant capacity of fresh lettuce.