Development of starch-based edible coating enriched with essential oil for fresh strawberry preservation

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Title　：Application of 1-Methylcyclopropene (1-MCP) and Edible Coatings for Innovative Preservation of Fresh Agricultural Produce
(1-メチルシクロプロペン (1-MCP) と可食コーティングによる生鮮農産物の品質保持効果)

Category：Kou

Thesis Summary

Storage conditions and postharvest treatments are the important factors to determine the postharvest quality and the shelf life of fresh fruit and vegetables. Broccoli and strawberry are the highly perishable products and have a relatively short shelf life. Efficiency of edible coating and 1-Methylcyclopropane (1-MCP) on preservation of broccoli and strawberry was investigated.

In the first part of dissertation, the effects of 1-methylcyclopropene (1-MCP) and temperature on the quality of broccoli during storage period was studied. Broccoli (*Brassica oleracea* L., cv. MKS-B107) was treated with air (as control) and 1.0 μL L^{-1} 1-MCP for 15 h at 15 ^{o}C, and then was stored at 10 ^{o}C and 0 ^{o}C for 25 days and 50 days, respectively. The results showed that 1-MCP treated broccoli was in good quality during 50 days of storage at 0 ^{o}C and 20 days of storage at 10 ^{o}C compared to the control broccoli. The present study indicated that 1-MCP treatments suppressed the respiration rate and ethylene production, reduced the chlorophylls and ascorbic acid degradation and inhibited the color changes of broccoli during storage. Broccoli treated with 1.0 μL L^{-1} 1-MCP and stored at 0 ^{o}C represented remarkably better quality compared to broccoli of the other treatments.

In the second part of the research, the effect of 1-methylcyclopropene (1-MCP) on the quality of broccoli was investigated in this study. Broccoli (*Brassica oleracea* L., cv. Grandome) was treated with air (control) and 1-MCP (0.5, 1.0, 1.5, 2.5 and 5.0 μL/L) at 15^{o}C for 15 h, and then stored at 15^{o}C for 10 days in low density polyethylene (LDPE) film. The inhibition of postharvest degradation by 1-MCP treatment was remarkable. The color changes, weight loss and ethylene production of broccoli were inhibited. Furthermore, 1-MCP treated broccoli had higher content of ascorbic acid, total phenolic compounds, and carotenoids than the control sample. These results indicated that 1.0 and 2.5 μL/L of 1-MCP treatment was the most effective in extending the shelf life of broccoli with maintaining its quality.

In the third part of the research, edible film composed of chitosan (CH) and tea seed oil (TSO) was prepared by casting method and its physicochemical and structural properties were evaluated. Strawberries were coated with the edible coatings by dipping method and physicochemical properties (weight loss, moisture content, color change, firmness, pH and TSS) and internal

structures were determined during storage at 2ºC for 24 days. Non-destructive X-ray computed tomography (CT) was used to visualize strawberry internal structure, with CT measured in terms of gray scale (GS) values. As expected, the CH+TSO film decreased water vapor permeability (WVP), with TSO conferring a reduction of 24.92%. The CH+TSO film decreased moisture content and water solubility. Incorporation of TSO in CH films significantly increased opacity by 387.67%, greatly improving the ability to block light. Changes in the surface and structure of the films were obtained by SEM, AFM and FTIR analysis. The properties of CH +TSO film were improved compared to pure CH film. Moreover, the results from the coating application to strawberries showed that CH and CH+TSO coatings effectively reduced fruit weight loss, retained moisture content, total soluble solids (TSS), firmness, color, and delayed pH changes and ΔE over 24 days of storage. In particular, the CH and CH+TSO treated strawberries remained the firmness by 68.36% and 63.35%, respectively, compared to the control and the weight loss of CH and CH+TSO treated samples was 5.83% and 6.93%, respectively, compared to 8.11% for the control. X-ray CT observations revealed that the coating treatments could inhibit the development of voids in the strawberries. These results demonstrate CH and CH+TSO film maintain the physicochemical properties and internal structure of strawberries during storage.

In the final part of the research, the effect of two different coatings including chitosan (CH) and chitosan loaded lemongrass essential oil (CH+LMO) on the quality of strawberries during storage at 2ºC for 24 days was investigated. The CH and CH+LMO coatings could significantly maintain the weight, moisture content, total soluble solids (TSS), pH, firmness, and color of strawberries compared to the control. The X-ray computed tomographic (CT) was used to monitor the internal structure changes in strawberries during storage period and X-ray absorption was expressed in gray scale (GS) value. GS value of the coated strawberries was higher than that of the control. The coated strawberries have fewer low-density regions in the internal structure compared to the control. Tissue degradation occurred more rapidly in the control, whereas tissue damage occurred more slowly in the coated strawberries. A new approach to predict the weight loss, moisture content, TSS, pH, and firmness of control and treated strawberries by X-ray CT data and partial least squares (PLS) regression was investigated. The RMSE values of calibration set and data set for physiochemical parameters of the treated strawberries were lower than that of the control strawberries. Moisture content, TSS, pH, and firmness of all treatments were predicted more accurate than weight loss. According to these results, the CH and CH+LMO coatings were the effective coatings for extending shelf life and controlling qualities of strawberries. The combination of X-ray CT and PLS methods is concluded to be powerful approach for analysing quality of fruit.