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Improving Shelf-Life of Peeled-Garlic Coated with Carboxymethyl Cellulose Solution

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Abstract

This study was conducted to analyze long-term stored peeled-garlic coated with edible carboxymethyl cellulose (CMC) films in order to delay browning and weight loss during storage until distribution. Weight losses of peeled-garlic were significantly different after 2 weeks in CMC coatings compared to control. As viscosity and concentration of CMC solution increased, weight losses decreased. Under consideration of peeled-garlic by using CMC material for storage, viscosity and concentration of CMC solution should be 1,000~2,000 mPa·s and over 2%, respectively. The L value of peeled-garlic during storage was not different between CMC treatment and control, but the a and b value were decreased as CMC concentration and viscosity were increased. Browning of peeled-garlic was accelerated after 2 weeks in control, while peeled-garlic color of CMC treatment were almost not changed until 5 weeks in storage condition.

Keywords: peeled-garlic, carboxymethyl cellulose (CMC), weight loss, L value, browning

Introduction

Garlic is one of condiment vegetables, which is indispensable in dairy meal to Korean. The consumption of garlic is constantly increasing annually. Therefore, it is necessary to supply fresh garlic all the year round. However, demand and supply of garlic is always unstable. A selling price of garlic is fluctuant because harvest is largely depended on weather, and the storage life is short as well. Garlic is harvested between late May and mid June, and shipped right after harvest (Lee, 1979). Distribution process of garlic consist of more than 5 steps which are producer, district distributor, middleman, retailer, and consumer. Garlic producers sell the garlic to a producers' cooperative (25%), district distributor (40%), storage enterprise (25%), and direct transaction (<10%).

For last five years, 70~80% of the total market traded garlic was a peeled-form which had certain disadvantages during the storage and distribution period (RDA, 2001). The percentage of rotten garlic reaches 23.6% including rotten in storage (9.1%). The browning is one of major problems, which is done by oxidation of phenol compounds like pyrogallol from quinone by polyphenoloxidase during the storage and distribution (Watanabe, 1988). There are problems that rot of cloves during storage and distribution of peeled-garlic. Therefore, it is necessary to develop storage system for maintaining high quality and freshness of peeled-garlic during storage and distribution through the year. For this reason, many researches (Kester & Fennema, 1986; McHung, 1996) were focused on development of functional packaging materials for suppressing deteriorative microorganisms. Edible coating materials on fruits or vegetables will be one of the solutions to prolong storage life. Coatings can be formulated from different materials including lipid, resins, polysaccharides, protein, and synthetic polymers. Several types of edible films have been applied successfully for fresh fruits to extend shelf life minimise quality changes(Chen & Nussinovitch, 2000a; Hagenmaier, 2000; Jiang & Li, 2001; Mannheim & Soffer, 1996; Park et al., 1994). Surface coatings can also improve the

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postharvest quality of horticultural commodities by reducing water loss, improving the finish of the skin (Nathalie et al., 1992; Delmy et al., 1990; Brandenburg et al., 1993; Yvonne et al., 1994; Kamper & Fennema 1984; Gontard et al., 1994).

Technologies about functional films or coating materials for maintaining freshness during storage after harvest have been applied to practical uses, but these are limited to a few crops. Coating films are mainly made of hydrophobic phase, hydrophilic polymer, emulsifying agent, and water. Carboxymethyl cellulose (CMC) is the most excellent water-soluble cellulose derivative in many applications in the food industry (Olaru et al., 1998).

This study were analyzed the quality changes of peeled-garlic during storage and distribution using carboxymethyl cellulose.

Materials and Methods

Materials

In this experiment, garlic produced in Seosan, Chungchung-namdo area were 6-clove garlic harvested in 2006 and stored refrigerator until used.

Preparation of CMC coating solution

The manufacture of CMC coating solution in distilled water 200 ml until 5~20 g after adding in 5g intervals, all to make CMC quantity with 70°C and from the solution to be clear until at the time of quality, when continuously to stir, from in order about under adding the total solution to become 500 ml, distilled water 200㎖. It followed in each consistency and CMC coating solution which is manufactured cooled from room temperature. CMC coating process executed from room temperature (25°C) and the viscosity the low-end CMC coating solution about under direct injection controlled in the thin skin garlic and CMC coating solution where the viscosity is high about 5 first editions digested in CMC coating solution. After CMC coating solution control ends, the thin skin garlic about the surface removal process of misfortune hazard coating from room temperature about 8~10 hour used the thin skin garlic which is controlled in the experiment which it tries to construct. The Table 1 is to show CMC physical characteristics it is used in the experiment which it sees.

Weight loss and chemical analysis

Peeled-garlics culled out before weight loss and chemical analysis were made and spoiled peeled-garlics were removed. The influence of the coating on weight loss(%) was determined by weighting coated and uncoated peeled-garlic during storage. Weight loss was monitored daily over 30 days at 25°C. The rate of weight losses was calculated weight losses over initial weight during storage and expressed as percentage. Color change during storage was measured by using colorimeter (TC-3600, Japan). L-, a- and b- value of standard plate were 93.8, 0.313 and 31.94, respectively. Test for browning was absorbed by the wavelength of 420 nm of spectrophotometer (UV1601, USA). The 5g of garlic with 7 ml of distilled water was centrifuged at 3,000rpm for 30 minutes. Supernatant was filtered through Whatman No. 2 and then added 5 ml of distilled water into 3.5 ml of filtrate. The filtrate was measured by spectrophotometer. Each measurement was replicated three times. The average values of measurements of these replications were used.

Statistical analysis

An each experiment uses SPSS statistics program experimenting repeat more than 3th and analyzed. When there is significant after ANOVA test to verify synonymy, enforced Duncan's multiple range test in $p<0.05$ level between experimental group.

Results and Discussion

Effect of CMC coating to peeled-garlic in weight loss

Fig. 1 and 2 show weight losses of peeled-garlic by using different viscosity from CMC concentrations of 1%, 2%, 3%, and 4% respectively. The initial moisture content in peeled-garlic was 58%. The weight losses after 2 weeks were obviously decreased in all CMC treatments compared to control. The differences were also obvious by concentrations.

As seen from Fig. 1, Control, however, was gradually

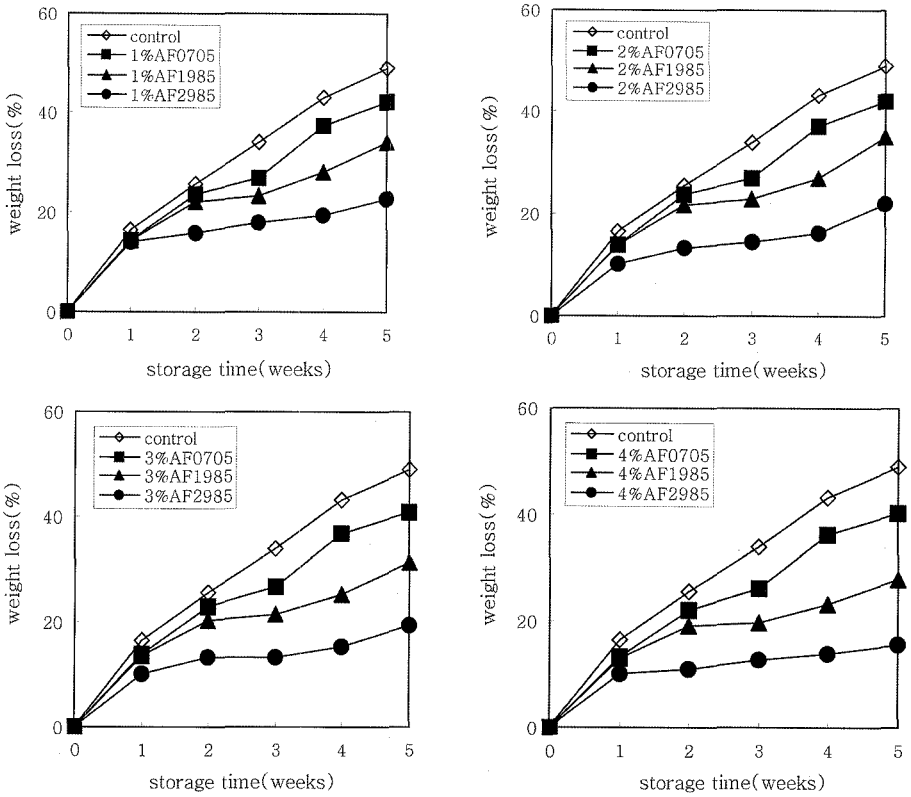

Fig. 1. Effect of weight losses of peeled-garlic on different CMC types during storage time by Duncan's multiple range test at 5% level.

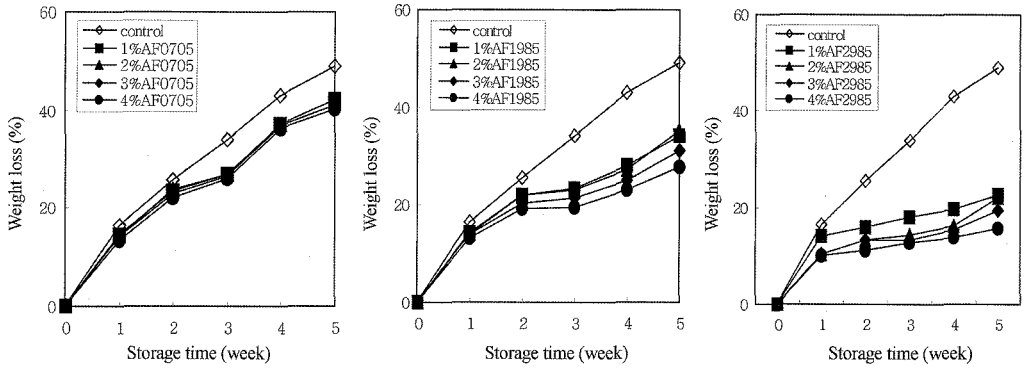

Fig. 2. Effect of weight losses of peeled-garlic on different CMC concentration during storage time by Duncan's multiple range test at 5% level.

lost its weight after 2 weeks, and 50% of weight loss within 5-week storage. Compared to 1% of CMC concentration, 4% of peeled-garlic of AF0705 in low viscosity lessened 4.7% of weight loss, but high viscosity of AF2985 lessened over 31%. This result is consistent to research results about depression of respiration and water evaporates by treatment of edible films used by gluten, cellulose, and wax to maintain fruit quality after harvest (Hagenmaier, 2000).

As seen from Fig. 2, there were not significant

Table 1. Physical property of carboxymethyl cellulose used this experiment

Types	Viscosity range (mPas)	Concentration (%)	Color value L	a	b
AF 2985	5,000~8,000	0	111.26[z1)]	-1.67z	6.01z
		1	78.38yx	-0.33yx	-0.76x
		2	73.89yx	0.05yx	-1.12y
		3	67.19yx	0.55yx	-0.83x
		4	64.90yx	0.61yx	-1.07yx
AF 1985	110~200	0	105.66z	-0.59z	12.63z
		1	78.45y	-0.26y	-1.28y
		2	77.23y	-0.32y	-0.98yx
		3	77.20y	-0.35y	0.95yx
		4	73.78y	-0.39y	0.56x
AF 0705	20~30	0	99.97z	0.41z	8.20z
		1	80.39y	-0.23y	-1.24x
		2	78.35y	-0.11x	-1.65yx
		3	77.01y	-0.23y	-1.80y
		4	76.59y	-0.13x	-1.66yx

[1)]Mean separation within columns by Duncan's multiple range test at 5% level

differences in weight losses from different concentrations within viscosity of CMC coatings. AF0705 had weight loss about 1% within and without regardless of treatment concentrations from 1% to 4%. This result was similar to AF2985 of 2% within and without weight loss.

Consequently the weight losses of peeled-garlic by using edible coating film, CMC, during storage were largely affected by viscosity of CMC solutions, not by CMC concentrations. It is also recommended that the viscosity of CMC should be over 1,000~2,000mPa·s and concentration is over 2% for reducing weight loss of peeled-garlic during storage.

Color changes with storage time

L and b value were looked decreased tendency as CMC concentration increases as early chromaticity value of CMC coated solution to apply to peeling garlic appears in table 1. However, in occasion of a value horoscope of relatively low tendency that AF 1985 and AF 2985 increase than initial value as concentration is high while is looked tendency that AF 0705 decreases as concentration is high appear. On the other hand, early L value of peeling garlic, a and b value that use in this experiment L and a value were looked high tendency and tendency was seen low except AF 1985 that do not go b when compare with CMC coating solution that appear in table 1 as each 53.18, - 2.23 and 9.58.

Figure 3 applies CMC coating solution by each CMC concentration and kind to peeling garlic and displayed chromaticity change of garlic by storage period. As see in figure 3, control plot was looked decreased tendency that is sudden from storage period 3 weeks onward while decrease slowly to CMC concentration 2% at 3 weeks unlike that peeling garlic that L value change of peeling garlic by storage period handles CMC coating solution decreases exiguously to save maximum 5 weeks. As change of each L value by CMC coating solution concentration increases concentration of CMC coating solution, change of L value was no change almost than initial value and displayed decrement of 4% low to storage period 5 weeks than early L value in 4% AF2985. On the other hand, change of a value by storage period controls plot and coating garlic increase to save 3 weeks and tendency that decrease from the after this was seen and tendency that b value decreases from 1 week onward while increase to save 1 week. Specially, displayed value such as both control plot and coating garlic in maximum holding period 5 weeks while sudden increase and decrement were seen than initial value as CMC horoscope and concentration are high.

Change of chromaticity by storage period of peeling garlic that treat CMC coating solution that do not go L than peeling garlic that do not handle early coating that do not go L, a, and b low, that do not go a and b high, appear. And tendency that changes of L value decreases as CMC horoscope and concentration are high as storage period increases was low. Tendency that change of a and b value fluctuates or decrease by width that grow during storage period as CMC horoscope and concentration are high was seen but displayed value similar control plot in storage period maximum 5 weeks.

Browning

The browning reaction is largely affected by temperature and moisture content(Sapers et al., 1994).

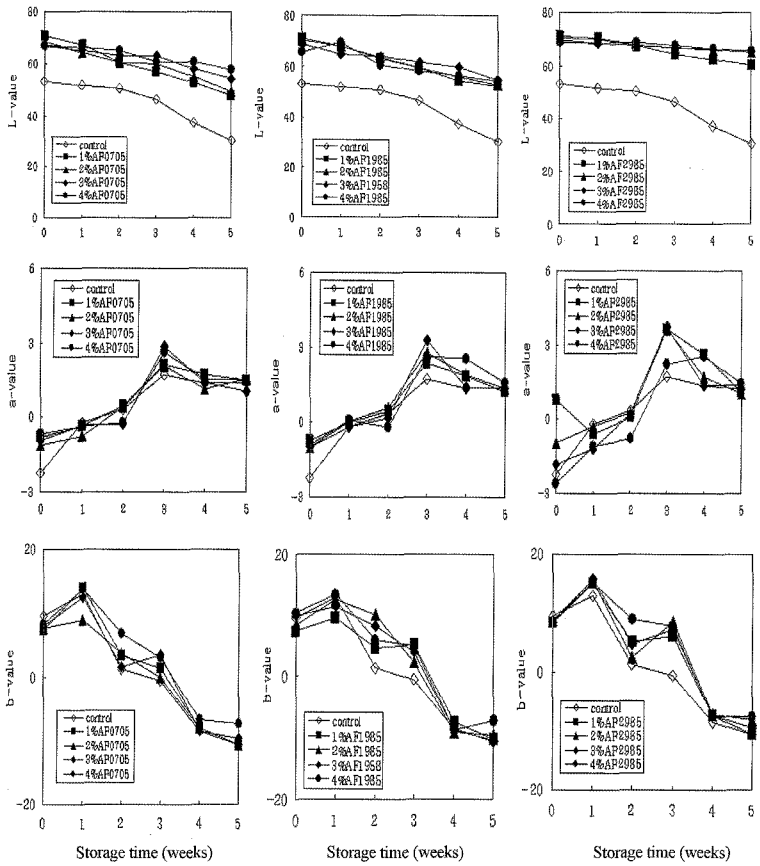

Fig. 3. Changes of color value of peeled-garlic on different CMC types and concentrations during storage time by Duncan's multiple range test at 5% level.

Especially the browning of garlic is accelerated by phenol compounds after oxidation according to high temperature and moisture content (Carson, 1987). Therefore, in order to suppress browning of garlic in storage, measured browning of garlic from various storage regime by CMC types and concentrations.

Fig. 4 shows the analysis of browning of peeled-garlic from various storage regime by CMC types and concentration of 4%. As seen Fig. 4, browning in control was accelerated after 2 weeks. Dissimilarly there were no differences until 2 weeks in coated peeled-garlic. Browning was accelerated between 3 weeks and 5 weeks, and was 3% increment compared to initial color.

On the other hands, as seen from Fig 5, increased CMC concentration suppressed browning of peeled-garlic. Generally browning process by enzyme starts from quinone compounds after oxidation of phenol compounds by polyphenoloxidase. Strong reactive compound, quinone, starts to form brown pigmented polymer, melanin. Some researches (Saper, et al., 1994;

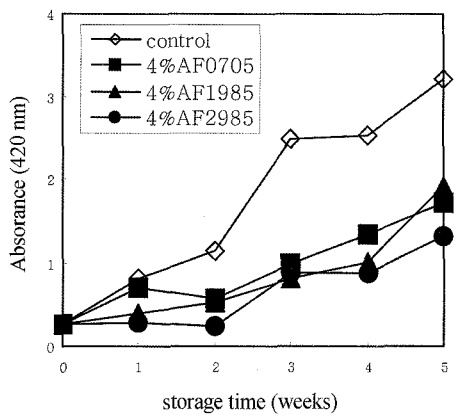

Fig. 4. Changes of browning color intensity of peeled-garlic coated with 4% concentration of various CMC types by Duncan's multiple range test at 5% level.

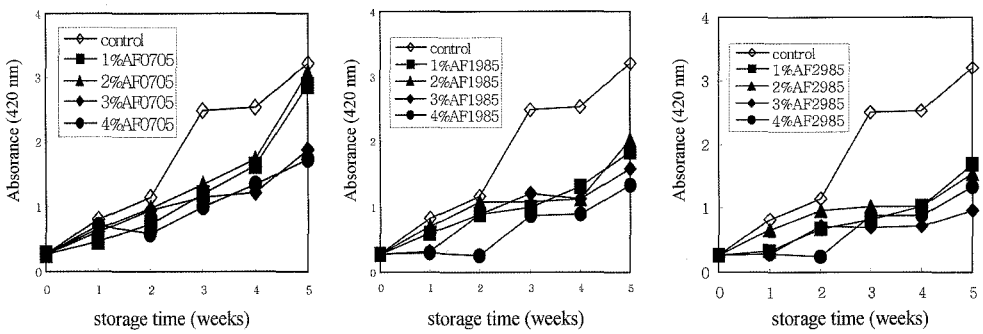

Fig. 5. Changes of browning color intensity of peeled-garlic coated with various CMC concentration by Duncan's multiple range test at 5% level.

Lozano et al., 1994; Skrede G, 1985) focused on suppress of browning reported that the use of citric acid, cysteine, or ascorbic acid could delay browning in vegetables especially in garlic and onion.

Summary

In this study, apply to peeling garlic using CMC coating solution and we wished to use basic data for enlargement of peeling garlic hereafter by analyzing quality by storage period. This study makes different CMC coating solution by each concentration to 1~4% because horoscope buys CMC of different 3 kinds and investigated weight damage, chromaticity and browning degree to storage period maximum 5 weeks. Generally, maximum 4% low was seen in weight of early peeling garlic than control as CMC horoscope and concentration are high in occasion of peeling garlic that handle CMC coating solution. Change of chromaticity by storage period of peeling garlic that treat CMC coating solution that do not go L than peeling garlic that do not handle early coating that do not go L, a, and b low, that do not go a and b high, appear but change of L value tendency that decrease as CMC horoscope and concentration are high was low and tendency that change of a and b value fluctuates or decrease by width that grow during storage period as CMC horoscope and concentration are high was seen as holding period increases but displayed value similar control plot in holding period maximum 5 weeks. Peeling garlic processed by CMC coating solution while control is displaying browning present state that is fast from save 2 weeks at browning was not shown big change to save 4 states and these tendency appeared clearly as CMC horoscope and concentration are high.

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