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Effects on Quality of Strawberry Fruit by Dipping of Calcium Solution and MA Packaging

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칼슘처리와 MA포장이 딸기의 품질에 미치는 영향

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Abstract

The strawberry was dipped into 1% $CaCl_2$ solution at 20℃ and 45℃ for 15 min. respectively, and then packaged with or without PE film (thickness : 0.011 mm) before putting into the cold storage at 5℃. The results showed the lowest rate of rot incidence and the highest firmness with higher Vitamin C content and the best superficial appearance in the treatment of $CaCl_2$ dipping at 45℃ with packaging. It also showed lower pH and higher titratable acidity in the treatment. However, no significant difference of SSC was found among various treatments. The results suggested that the combination of postharvest calcium dipping and packaging could result in more effective preservation for strawberry compared with the individual treatment.

Key words : calcium, strawberry, packaging, heat treatment

Introduction

The strawberry fruit tends to decay easily during the storage. Its storage life is less than a week. So new treatment methods to extend its storage life are needed. Some reports showed that heat treatments prior to storage, such as hot water dipping and heat air treatment, could inhibit fungal attack, and reduce decay significantly for many fruits (1,4). On the another hand, they proved that postharvest calcium application can be used to delay the senescence, and to reduce decay (5,6). Especially, the postharvest calcium treatment combined with the prestorage hot treatment could improve the fruit quality more effectively than the separate treatment for apple fruits (7,8). Dipping in $CaCl_2$ solution at high temperature could result in more efficient translocation for the fruits (9,10), and less decay in the strawberry fruit (10). Moreover MA package could reduce the weight loss, delay the fruit senescence, and keep freshness and high quality of the fruits. MA package and heat treatment could have the combination effects on the fruit preservation (11,12). In this paper, dipping in $CaCl_2$ solution at different temperature and MA package were carried out in order to improve the quality of strawberry fruit during the storage to the highest degree.

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Materials and Methods

Materials

The fruit (*Fragaria×ananssa*, cv. Nansan) was harvested early in the morning and transported to the laboratory. Undamaged fruits at the same red color and size were selected as test materials. Afterwards, the fruits were divided into 8 parts for treatment. First, the fruits were submerged into 1% $CaCl_2$ solution or not for 15 min at 20℃ and 45℃ respectively, and then the fruits were air dried. Half of them were packaged

with PE film bag(thickness at 0.011 mm), and then stored at 5℃. The others were transported directly to the cold room (5℃), where the H_2O dip at 20℃ without packaging was acted as the control. So there were 8 treatments totally as described in Table 1. 4 replicates each treatment, with 15 samples per replicate were used.

The decay index

The decay index (%)=(1A+2B+3C+4D+0E)/(4×(A+B=C+D+E))×100, where A=below 10%, B=10%~30%, C=31%~50%, D=more than 50% and E=0% decayed area of the fruit surface.

Firmness

The firmness was determined on two points around the equator of each fruit using a Rheomater (SUN scientific, Model CR-10K, Tokyo, Japan) equipped with a circular cone probe of 5 mm diameter.

Color

The color was measured by a color difference meter (Yasuda, Model 600 UC IV,Tokyo, Japan) and expressed as Hunter L (lightness), a (greenness-redness), and b (blueness-yellowness) values. Two readings were made at the base of fruit outside surface and inside longitudinal section.

SSC, pH and titratable acidity

The soluble solids content (SSC), pH and titratable acidity (TA) were assessed from the juice obtained from three replicates of 10 samples per treatment. The SSC (°Brix) was determined from the juice squeezed from the fruits by a refractometer. Five milliliters of the fruit juice were diluted in 50 ml distilled water and pH of the solution was measured prior to determination of TA by titration with 0.1 N NaOH to pH 8.1. TA results are given as percentage of citric acid.

Vitamin C content

The vitamin C was extracted from 50 gram of fruits by HPO_3 (5%), and determined as Joo et al (13) described by following the addition of 2 mL standard solution (1~5 mg/100 mL), 1 mL DCP (0.03%), 2 mL Thiourea (2%) and 1 mL DNP (2%) to the sample filtrate, and using 5 mL H_2SO_4 (85%) to stop reaction after 3 hrs at 37℃, the absorbance of the final reaction solution was recorded at 540 nm, the results were expressed as the content of L-ascorbic acid (mg) per 100 gram fruit.

Results and Discussion

Decay index

During the cold storage, the treatments with PE film packaging reduced significantly the rot incidence, compared with those without packaging Especially, the treatment of dip in $CaCl_2$ solution at 45℃ with packaging showed the lowest rate of rot. Meanwhile, a little reductive effect of the hot water (45℃) dip on the decay was found just 2 weeks after cold storage (Fig. 1).

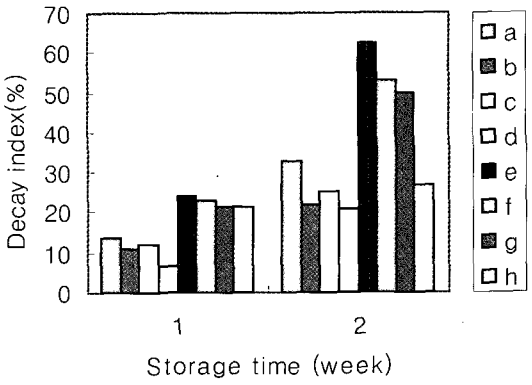

Fig. 1. The effect of calcium dip and MA package on the decay of strawberry.

a, b, c, d, e, f, g, h here were same as Table 1.

Firmness

The firmness increased at first, and then decreased during cold storage. There was no significant difference in firmness during the 1st week of storage time among various treatments. However, the firmness appeared the highest in the treatment of $CaCl_2$ dip at 45℃ with packaging during the 2nd week of storage (Fig. 2).

Color

The L value of fruits decreased during the cold storage time. The value in the treatment of $CaCl_2$ dip at 45℃ with packaging was the highest, and a, b value outside of the fruit surface was high too. On the other hand, the changes of the a, b value were different among the other treatments. But a, b value inside of the fruit was higher in the treatment of dips at 45℃ without packaging (Table 1) than the other treatments. Thus it indicated that the effect of various treatments on the color development was different.

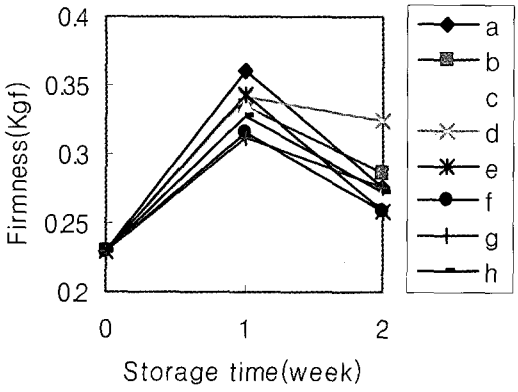

Fig. 2. The effect of calcium dip and MA package on the firmness of strawberry.

a, b, c, d, e, f, g, h here were same as Table 1.

Table 1 The treatments for strawberry

No.	Treatment		
	MA package	$CaCl_2$(1%)	Temperature(℃)
a	+	-	20
b	+	+	20
c	+	-	45
d	+	+	45
e		-	20
f		+	20
g		-	45
h		+	45

+: with -: without.

SSC, pH and titratable acidity

The SSC decreased during the storage time. There was no significant difference among various treatments (Table 2).

The pH value of fruits increased during the storage time except for the treatment of $CaCl_2$ dip with packaging. The pH value was the lowest in the treatment of $CaCl_2$ dip at 45℃ with packaging, while it was higher in the other treatments (Table 2).

The titratable acidity was higher in the treatment of $CaCl_2$ dip with packaging than the other treatments at the time of 1 week after the cold storage, while the marked difference among the other treatments was not found 2 weeks after storage (Table 2).

Vitmain C content

There was a slight decrease of vitamin C content in control during cold storage. Almost all treatments had more vitamin C than control, and especially, the hot water or calcium chloride treatments kept higher vitamin C content than the other ones after 2 week storage, independable of MA package (Fig. 3).

Table 2. The effect of calcium dip and MA package on the color of strawberry

Treatment		Storage time (week)	Outside color			Inside color		
MA package	$CaCl_2$ (1%)		L	a	b	L	a	b
Initial	Initial	0	40.61	33.23	27.53	63.78	20.49	27.90
+	-	1	39.25	34.82	25.23	61.35	25.19	30.93
+	+	1	39.81	35.99	26.73	62.77	21.59	28.59
+	-	1	38.76	34.47	23.81	61.50	23.11	29.17
+	+	1	39.43	35.19	26.31	64.41	20.64	27.81
	-	1	36.23	32.43	21.14	61.69	22.46	28.35
	+	1	38.54	34.90	23.79	62.43	23.32	29.16
	-	1	38.54	34.12	23.71	62.94	22.25	28.63
	+	1	37.97	33.56	22.77	61.91	23.06	29.11
+	-	2	39.43	33.77	25.89	61.08	17.15	22.72
+	+	2	38.41	33.86	25.07	62.29	20.36	26.22
+	-	2	38.59	35.05	25.18	62.96	18.72	23.93
+	+	2	39.50	34.69	26.34	63.28	19.71	25.71
	-	2	38.27	29.96	20.23	60.41	14.89	21.73
	+	2	37.02	32.11	20.43	61.15	17.42	23.04
	-	2	37.66	32.41	21.26	58.68	22.59	27.44
	+	2	37.36	33.00	21.12	59.53	22.68	27.40

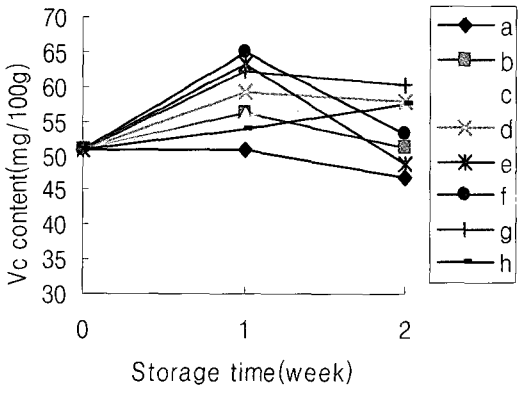

Fig. 3 The effect of calcium dip and MA package on the Vitamin C content of strawberry.

a, b, c, d, e, f, g, h here were same as table 1.

Discussion

Calcium plays an important role in delaying the ripening

and senescence of the strawberry. For example, calcium could reduce the respiration rate and ethylene production, and maintain the structure and function of cell wall and cell membrane firm. It also could improve the disease resistant, and reduce rot of fruits (5,6). The results of this research proved these points. Dipping in calcium solution at high temperature was more effective in keeping the firmness of the fruits. It maybe resulted from the fact that higher temperature could stimulate calcium transport into the fruits (9,10), and calcium could delay the degradation of cell wall, inhibit the activities of cell wall hydrolases (5,6), and therefore, the process of ripening and senescence could be inhibited by calcium alone. On the other hand, strawberry could be easily infected by fungal, and subsequently had a rapid rot. The heat treatment could inhibit the growth of fungal and could take part in the improvement of disease resistance (1,2). Thus the combination of postharvest calcium application and packaging could keep high quality of strawberry compared with the separate treatment. There showed the lowest rot incidence, the highest firmness, and the best outer appearance with lower pH or higher titratable acidity and higher vitamin C content in the treatment of $CaCl_2$ dip at 45℃ with packaging. However, the difference of SSC among various treatments was not significant. This was in agreement with previous reports that there were no significant changes about SSC, and reducing sugar and total sugar content in heated fruits (3,4).

Above all, the effect of the calcium and MA package was integrated in view of a useful application in future, so the combination of dipping in calcium solution and MA package prestorage would be a effective method to extend the storage life of strawberry. Related further research is undertaking now.

Table 3 The effect of calcium dip and MA package on the SSC, pH and acidity content of strawberry fruits

Treatment		SSC			pH			Acidity(%)		
MA package	$CaCl_2$ (1%)	Storage time(week)			Storage time(week)			Storage time(week)		
		0	1	2	0	1	2	0	1	2
+	_	8.7	7.5	6.8	3.81	3.91	4.03	0.80	0.78	0.69
+	+	8.7	8.2	7.0	3.81	4.06	4.02	0.80	0.68	0.65
+	_	8.7	7.9	7.4	3.81	4.03	4.08	0.80	0.82	0.68
+	+	8.7	8.8	8.0	3.81	3.79	3.85	0.80	0.90	0.76
	_	8.7	8.2	8.2	3.81	3.88	3.87	0.80	0.81	0.74
	+	8.7	7.5	7.5	3.81	3.93	3.97	0.80	0.74	0.79
	_	8.7	8.1	7.4	3.81	3.93	3.97	0.80	0.72	0.68
	+	8.7	8.6	7.9	3.81	3.9	4.03	0.80	0.80	0.69

요 약

딸기를 20℃와 45℃의 1% $CaCl_2$ 용액에 각각 15분간 침지시킨 후, PE film (0.011 mm)으로 포장한 군과 포장하지 않은 군으로 나누어 5℃에 저장하였다. 그리고 $CaCl_2$ 용액에 침지시키지 않고 PE film(0.011 mm)으로 포장한 군과 포장하지 않은 군으로 나누어 5℃에 저장하였다. 45℃ $CaCl_2$ 용액에 침지시킨 후 포장한 처리구에서 부패율은 낮고 경도가 높게 나타났다. 또한 비타민 C 함량이 높았고 외관이 가장 좋은 것으로 나타났으며 다른 처리군에 비해 pH가 낮고 산도가 높게 나타났다. 그러나 당도는 처리군간에 유의성이 없었다.

따라서 수확 후 칼슘 처리와 포장의 병행은 딸기의 저장에 효과적인 것으로 사료된다.

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