Effect of Storage Condition on the Quality and Microbiological Change of Strawberry "Minyubong" during Storage

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저장조건이 딸기 "미녀봉"의 저장 중 품질 및 미생물학적 변화에 미치는 영향

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Abstract

To examine the effect of storage condition on the quality and microbiological change of strawberry "Minyubong", the rate of weight loss, decay rate, pH and titratable acidity, and microbial (total bacterial count, mold and yeast) changes were determined during storage. Strawberry fruits were packaged with low-density polyethylene (LDPE). Strawberries were then stored at 4℃ and 20℃, respectively. LDPE package was effective on the decrease of decay rate of strawberry as well as the rate of weight loss, compared with the non-packaged. Microbial changes of strawberry stored at 4℃and 20℃ were monitored during storage. Packaging affected the microbial change, resulting in retarding the growth of total bacteria as well as mold and yeast, compared with the non-packaged, regardless of storage temperature. These results indicate that storage of strawberry fruits wrapped with LDPE at 4℃ should be recommended in terms of quality as well as its shelf-life.

Key words : strawberry Minyubong, storage, quality, microbial analysis

Introduction

Strawberry fruits have a very short postharvest life since they have high metabolic activity and incidence of microbial growth and rots (1, 2). Carbon dioxide-enriched atmosphere are used to extend the postharvest life of strawberry fruits by reducing respiration rates and by retarding incidence of decay (3, 4). However, it is not applicable in Korea due to the economic reason.

Typical strawberry fruits cultivated in Korea are Yeobong, Bokyo, and Miyubong. Recently, Minyubong is favored among these varieties, by strawberry growers, since it is better than Yeobong, which is the most popular one, in terms of the size and sweetness. Compared with Yeobong that has been studied extensively, Minyubong has not been studied on the quality change during storage yet. Therefore, the objective of this study was to examine the effect of storage condition such as packaging method on the quality and the microbiological change during storage of strawberry Minyubong.

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Materials and Methods

Materials

Strawberries "Minyubong" were purchased right after harvest in Daejeon, Korea. Fruits were immediately transported to Chungnam National University and used for this study.

Storage conditions

Storage temperature was 4℃ and 20℃. Low-density polyethylene (LDPE, 8 ㎛) was used as a packaging material.

Loss of weight measurement

During storage, the weight loss due to transpiration and respiration was determined by weighing the fruit each day. Loss of weight was expressed as a percentage of the original weight of the packaged fruit.

Decay rate

During storage, decay rate was determined by counting the rotten samples. The quality of strawberries was visually assessed and decay rate was expressed as a percentage of the total number of the fruit.

Soluble solid contents

Strawberry fruits were ground, filtered, and its soluble solid content (°Brix) was determined using a refractometer.

pH and titratable acidity

Strawberries were ground, filtered, and the pH of strawberry juice was measured using a pH meter. Titratable acidity of the filtered strawberry solution was determined. The amount of NaOH consumed was measured and expressed as the amount of malic acid.

Microbial analysis

One gram of fruit samples were collected aseptically and placed in a sterile corning tube with 9 ml of sterile peptone solution (0.1% sterile peptone, w/v). After grinding for 2 min and filtration, dilution was performed with sterile pepton solution and poured on plating count agar (Difco Co., Detroit, MI, USA) for total viable bacterial counts. Diluted samples were plated on potato dextrose agar (Difco) for yeast and mold count. Both plates were incubated at 30℃ for 48 hr. Microbial counts were determined as colony forming units (CFU) per gram of samples.

Statistical analysis

Analysis of variance and Duncan multiple range tests were performed to analyze the results statistically using a SAS program (SAS Institute, Inc., Cary, NC, USA).

Results and Discussion

Strawberry fruits were stored at 4℃ and 20℃ and LDPE was used as a packaging material. During storage up to 4 weeks under various storage conditions, the loss of weight was determined (Fig. 1,2). With the change in color and softening of the fruit, the loss of weight during storage is one of the main reasons for poor quality of the fruit. The loss of weight is mainly due to transpiration and respiration after harvest, yet it can be controlled by low-temperature storage, CA storage, or appropriate packaging. Our results showed that the loss of weight of strawberry fruits stored at 20℃ increased rapidly, compared with the packaged one (Fig. 1). In particular, after day 2, the loss of weight was 5.3%, which is over the limit for good quality of the fruit (5). Robinson et al. (5) reported that the loss of weight over 6% was the limit of quality of the strawberry fruit. Therefore, for the unpackaged fruit stored at 20℃, 3 day is the shelf life since the loss of weight was 6.4% after day 3 and its appearance was very poor because of decay. On the contrary, the packaged fruit with LDPE had not much change in the loss of weight after 2 day, where it was about 2%. However, it should be noted that the packaged one stored at 20℃ also showed the change in color as well as

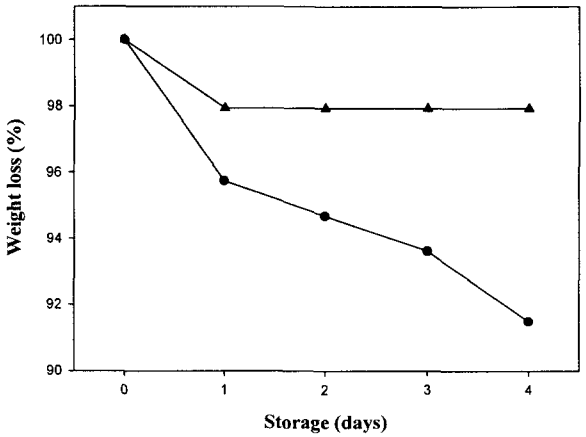

Fig. 1. Effect of packaging method on the weight loss of strawberry fruits during storage at 20℃.
● : Control, ▲ : LDPE packaging.

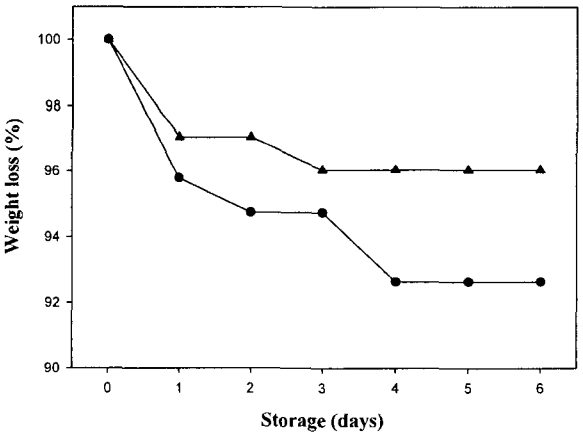

Fig. 2. Effect of packaging method on the weight loss of strawberry fruits during storage at 4℃.
● : Control, ▲ : LDPE packaging.

decay within 5 days. The strawberry fruits stored at 4℃ had the similar pattern as 20℃(Fig. 2). Although the packaged one kept the loss of weight within 5% up to 7 days, the quality was not acceptable after 6 days due to other factors such as decay.

Another important factor in terms of quality of the fruit is decay rate. It is based on visual assessment, which reflects the overall quality of the fruit and very easy and objective way to distinguish the quality of the fruit. Strawberry fruits are usually rotten by softening and growth of mold or pathogenic bacteria. Decay rate was shown in Fig. 3-4. During storage of strawberry fruits, decay rate was dependent on the storage temperature, since storage at 20℃ had a drastic increase in decay rate. After day 3, decay rate reached 16% for both the packaged one and the control. This could be explained by the increase of microbial growth by softening of the fruit. In contrast to 20℃, the fruits stored at 4℃ were better in terms of decay rate. The packaged one also had a lower decay rate regardless of storage temperature. These results clearly showed that storage temperature is more important factor with regard to decay rate. Decay caused by microbial growth is mainly due to the growth of molds. Microbial analysis was performed during storage. Total bacteria, and mold and yeast were counted during storage of the fruit (Fig. 5-8). For total bacteria, the initial microbial load was 2.3 log CFU/g. At 20℃, the unpackaged fruit had an increase of 1 log cycle, while the LDPE packaged had 0.1 log cycle increase. Storage at 4℃ had the similar pattern, although it could decrease the growth of bacteria. For mold and yeast, which is the main reason for decay of strawberry fruits, the initial number of mold and yeast was 2.0 log CFU/g. After day 3, it increased to 3.1 log CFU/g at 20℃ for the control, while it was 2.3 log CFU/g for the packaged one. At 4℃, it had the same trend, indicating that packaging method was very important to prevent the microbial growth along with storage temperature to keep the quality of the fruit.

Table 1. Effect of packaging method on the pH of strawberry fruits during storage

Temperature	Packaging method	Storage (days)			
		0	2	4	6
20℃	control	3.81±0.04[1)a]	3.70±0.11[a]	3.84±0.11[a]	-
	LDPE	3.81±0.04[a]	3.76±0.06[a]	3.78±0.08[a]	-
4℃	control	3.81±0.04[a]	3.77±0.06[a]	3.80±0.06[a]	3.85±0.04[a]
	LDPE	3.81±0.04[a]	3.77±0.06[a]	3.93±0.00[a]	3.76±0.17[a]

[1)] Mean±SD. Any figures in the same column with the same letter are not significantly different at $p < 0.05$ level by Duncan's multiple range test.

Table 2. Effect of packaging method on the titratable acidity of strawberry fruits during storage

(g malic acid/50 g fruit weight)

Temperature	Packaging method	Storage (days)			
		0	2	4	6
20℃	control	1.74±0.21[1)a]	2.09±0.28[a]	2.09±0.35[a]	-
	LDPE	1.74±0.21[a]	1.50±0.07[a]	1.63±0.22[a]	-
4℃	control	1.74±0.21[a]	1.81±0.01[a]	2.26±0.29[a]	2.25±0.13[a]
	LDPE	1.74±0.21[a]	1.84±0.20[a]	2.06±0.03[a]	1.82±0.11[a]

[1)] Mean±SD. Any figures in the same column with the same letter are not significantly different at $p < 0.05$ level by Duncan's multiple range test.

Table 3. Effect of packaging method on the soluble solid content of strawberry fruits during storage

(unit : °Brix)

Temperature	Packaging method	Storage (days)			
		0	2	4	6
20℃	control	10.1±0.30[1)a]	10.2±0.07[a]	9.0±0.42[a]	-
	LDPE	10.1±0.30[a]	10.2±0.07[a]	9.4±0.28[a]	-
4℃	control	10.1±0.30[a]	10.4±0.78[a]	10.2±0.14[a]	9.8±0.14[a]
	LDPE	10.1±0.30[a]	9.8±0.14[a]	9.6±0.00[a]	9.2±0.71[a]

[1)] Mean±SD. Any figures in the same column with the same letter are not significantly different at $p < 0.05$ level by Duncan's multiple range test.

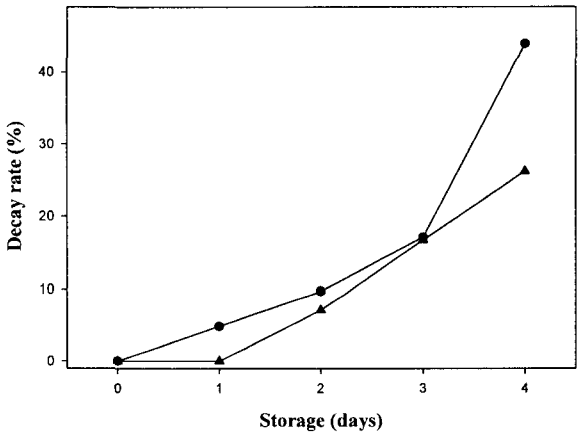

Fig. 3. Effect of packaging method on the decay rate of strawberry fruits during storage at 20℃.
● : Control, ▲ : LDPE packaging.

Regarding general quality of strawberry fruits during storage, pH, titratable acidity, and soluble solid content were determined (Table 1-3).The change in pH during storage was not observed regardless of temperature and packaging method. The initial pH was 3.8, which was in good agreement with other reports (3, 6). The small difference from the literature might be attributed

to the variety of the fruit studied. Changes in titratable acidity were not observed like pH (Table 2). However, it should be noted that it had a tendency to increase with increasing storage period because of decrease of organic acid during storage. Regarding soluble solid content, it decreased with increasing storage time regardless of storage temperature and packaging method (Table 3). It could be explained by the decrease of sucrose content (7).

In summary, this study indicates that storage of strawberry fruits wrapped with LDPE at 4℃ should be recommended in terms of quality as well as its shelf-life.

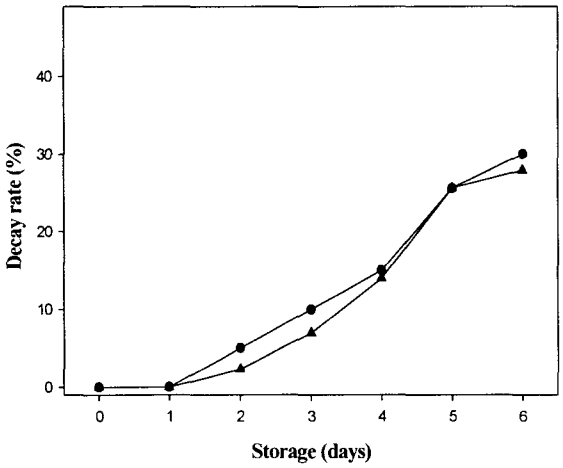

Fig. 4. Effect of packaging method on the decay rate of strawberry fruits during storage at 4℃.
● : Control, ▲ : LDPE packaging.

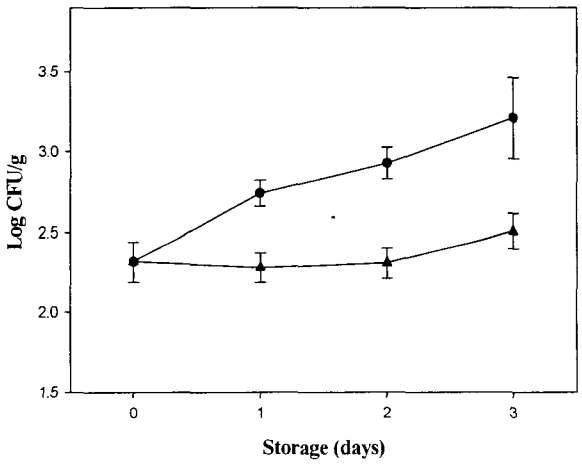

Fig. 5. Effect of packaging method on total bacterial change of strawberry fruits during storage at 20℃.
● : Control, ▲ : LDPE packaging.

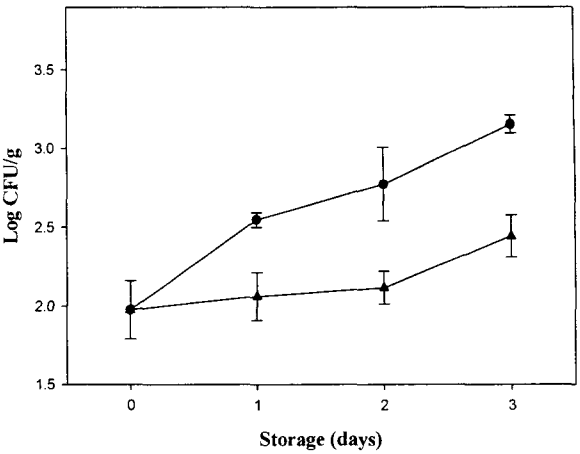

Fig. 6. Effect of packaging method on molds and yeast change of strawberry fruits during storage at 20℃.
● : Control, ▲ : LDPE packaging.

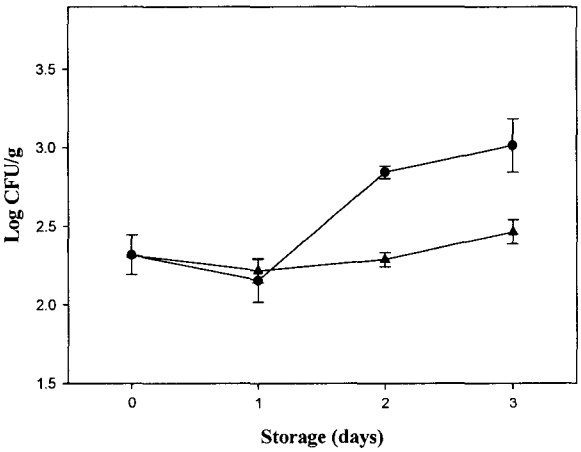

Fig. 7. Effect of packaging method on total bacterial change of strawberry fruits during storage at 4℃.
● : Control, ▲ : LDPE packaging.

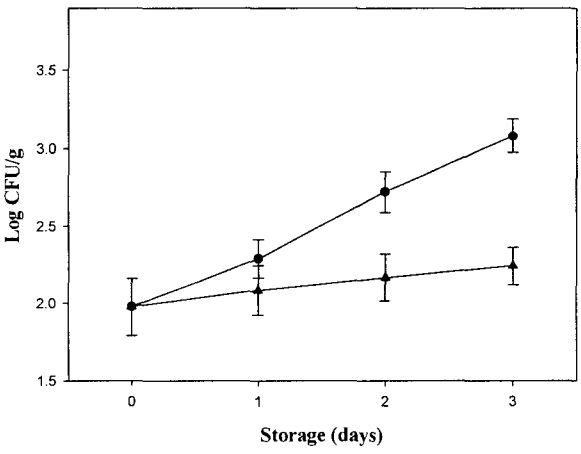

Fig. 8. Effect of packaging method on molds and yeast change of strawberry fruits during storage at 4℃.
● : Control, ▲ : LDPE packaging.

요 약

저장조건이 딸기 "미녀봉"의 저장 중 품질 및 미생물학적 변화에 미치는 영향을 연구하기 위하여 저장 중 중량감소율, 부패율, pH 및 적정산도, 총균수 및 곰팡이와 효모 수의 변화가 측정되었다. 딸기 시료는 LDPE로 포장하여 4℃ 와 20℃에서 각각 저장하였다. LDPE 포장은 대조구에 비해 중량감소율 및 부패율을 감소시켰다. 또한 포장방법은 저장 중 미생물학적 변화에 영향을 끼쳤는데 저장온도와 상관없이 대조구와 비교해서 효모와 곰팡이뿐만 아니라 총균수의 감소를 야기시켰다. 본 연구결과는 딸기 "미녀봉"의 유통기한을 고려할 때 4℃에서 LDPE 포장으로 저장하는 것이 바람직하다는 것을 나타냈다.

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