

Effect of Storage Temperature and Duration on Fruit Quality of Three Pomegranate Cultivars

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Abstract. This investigation was carried out during 1988 and 1989 seasons to study the effect of storage temperature (5°C, 10°C and 22-24°C room temperature) on weight loss % and some physical and chemical properties of the fruits of three pomegranate cultivars namely; Taeifi, Manfaloti and Ganati.

Results showed that weight loss % was gradually increased with time in storage and it was significantly higher in fruits that were stored at room temperature as compared with those stored at 5°C or 10°C. No significant differences were observed between the three cultivars in both seasons.

The physical properties of the fruits were affected by the storage treatments and significant differences were found among the cultivars in most cases. Regarding the chemical properties, TSS % was significantly higher in fruits stored at room temperature as compared with those stored at 5°C or 10°C. Acidity and vitamin C contents were not significantly affected by storage treatments. During storage, at all temperatures, TSS % was gradually increased with temperature raising. On the contrary, vitamin C content was decreased while acidity % did not show a consistent trend. Fruits of the three cultivars could be safely stored without shriveling and with a minimum decrease in fruit quality at 5°C for up to 8 weeks.

Introduction

Pomegranate fruits are considered one of the important fresh fruits in Saudi Arabia and other Arab countries. During the last few years many local and introduced pomegranate cultivars were planted at the Experimental and Research Station at Deirab, College of Agriculture, King Saud University.

Little informations are available regarding the storage ability of the different pomegranate cultivars. Storage temperature is the most important environmental factor affecting senescence of fruits, because it regulates the rate of all associated physiological and biochemical processes [1 p. 25-40]. The effect of storage temperature on the keeping quality of some pomegranate cultivars was studied by Heikel *et al.*, [2] in Egypt, Kader *et al.*, [3] in U.S.A. and Al-Mughrabi and Bacha [4] in Saudi Arabia.

Therefore, the present investigation was carried out to study the effect of different storage temperatures on changes in weight loss % and some fruit properties of three pomegranate cultivars namely; Taeifi (Saudi Arabia), Banati and Manfaloti (Egypt).

Materials and Methods

Pomegranate fruits used in this investigation were obtained from 10-year old trees grown at the orchard of the Experimental and Research Station at Deirab, College of Agriculture, King Saud University during the growing seasons of 1988 and 1989.

Three pomegranate cultivars namely; Taeifi, Banati and Manfaloti were employed to be used in this study. Four similar vigor trees were selected from each cultivar, each tree was represented as one replicate. All trees were subjected to the same cultural practices during the two years of the study. At ripening stage (September 15, 1988 and September 17, 1989), 135 fruits from each tree of the three cultivars were harvested. Fruit samples were washed several times with sodium hypochlorite solution at concentration of 0.5 % for t min., then thoroughly rinsed with tap water and left to dry at room temperature.

A sample of 30 fruits was taken from each tree (replicate) and weighed before the beginning of the storage treatments. These fruit samples were then kept in a plastic box for the determination of weight loss percentages at one week intervals. A sample of 15 fruits was taken from each tree for the physical and chemical properties determinations before the beginning of the storage treatments. The remaining fruits (90 fruits from each tree) were divided into 3 lots of 30 fruits each and were kept in a plastic box. The fruit samples for weight loss and fruit quality determinations were placed under three storage temperature regimes: 5, 10 and 22-24°C (room temperature).

Fruit samples (15 fruits from each tree) were taken after 4 and 8 weeks from the beginning of the storage treatments for the determinations of some physical and chemical properties. The physical properties included, fruit weight (g), diameter (cm), length (cm), rind weight (g), pulp weight (g) and juice quantity (cc). Whereas, chemical properties included, total soluble solids (TSS %), acidity % and vitamin C. Total soluble solids (TSS) were determined using Abbe refractometer. Both acidity (as citric acid) and vitamin C contents were determined by titration [5] and [6, pp. 136-144], respectively.

The data were statistically analyzed according to the methods described by Steel and Torrie [7, pp. 377-398].

Results and Discussion

Weight loss %

Data of this study indicated that weight loss % was gradually increased during storage in fruits stored at 5°C, 10°C and room temperature (22-24°C) in both seasons (Figs. 1 and 2). In addition, weight loss % was significantly higher in fruits stored at room temperature than those stored at both 5°C and 10°C. Differences between weight loss % of fruits stored at 5°C and 10°C were statistically significant only after 2 weeks of storage in 1988 season. While, in 1989 season, differences between the above two treatments were statistically significant on all sampling dates, except for those taken after 2 weeks. After 6 weeks of storage, weight loss % (as an average of the two seasons) was 18.32, 21.93 and 32.83 in fruits stored at 5°C, 10°C and room temperature, respectively.

The results also revealed that there were no significant differences among the three pomegranate cultivars with regards to weight loss % on all sampling dates in both seasons. The weight loss % (as an average of the two seasons) was 23.18, 25.67 and 24.23 in Taeifi, Banati and Manfaloti cultivars, respectively after six weeks of storage (Figs. 3 and 4).

Similar results were obtained by Heikel *et al.*, [2], Kader *et al.*, [3] and Al-Mughrabi and Bacha [4] also working on different pomegranate cultivars. They all stated that weight loss of pomegranate fruits was increased with increasing storage temperature and duration.

Fruit properties

1) Physical properties

The data of the present study showed that, in 1988 season, storage temperatures did not affect most of the studied physical properties of the fruits except fruit weight and fruit rind weight after 4 weeks of storage. Fruits that were stored at room temperature showed significantly lower fruit weight losses as compared with those stored at both 5°C and 10°C treatments, while fruit rind was significantly lower in fruits stored at room temperature than that in fruits stored at 5°C (Table 1). However, all physical properties of fruits decreased at the end of the storage period in the three storage treatments. Regarding the differences among the three cultivars, data indicated that Manfaloti cultivar had higher values for physical fruit properties as compared with the other two cultivars (Taeifi and Banati), and the differences were statistically significant in some cases (Table 1).

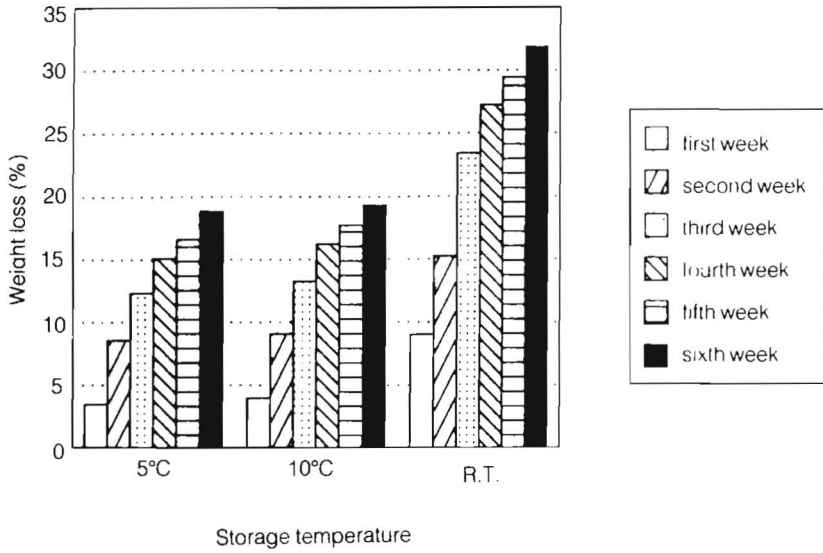


Fig. 1. Effect of storage temperature on weight loss % of the Pomegranate fruits (Season 1988)

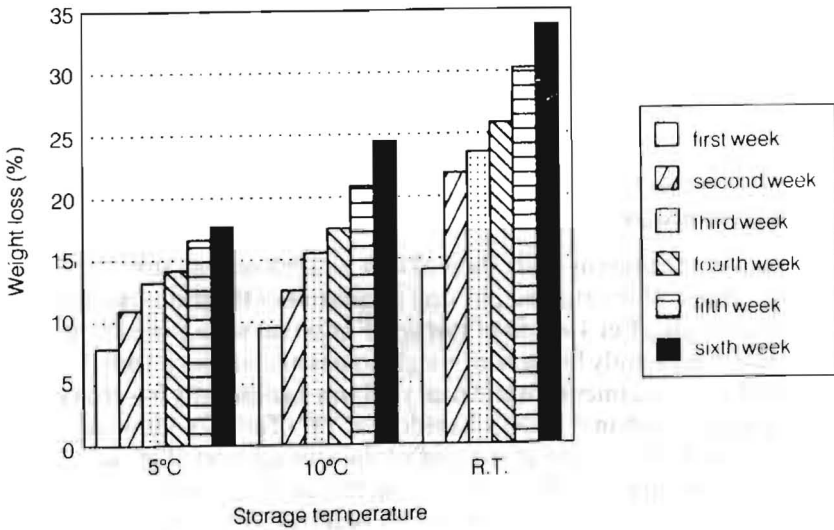


Fig. 2. Effect of storage temperature on weight loss % of the Pomegranate fruits (Season 1989)

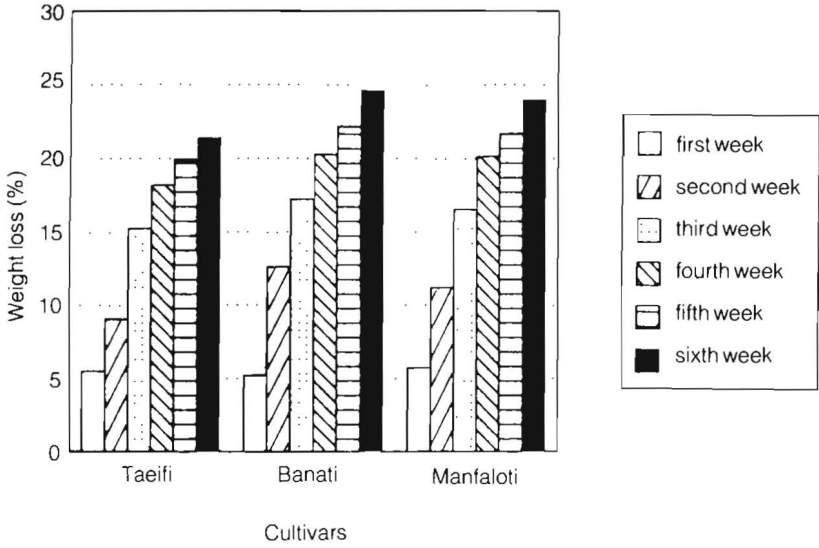


Fig. 3. Percent weight loss of three Pomegranate cultivars during six weeks of storage (Season 1988)

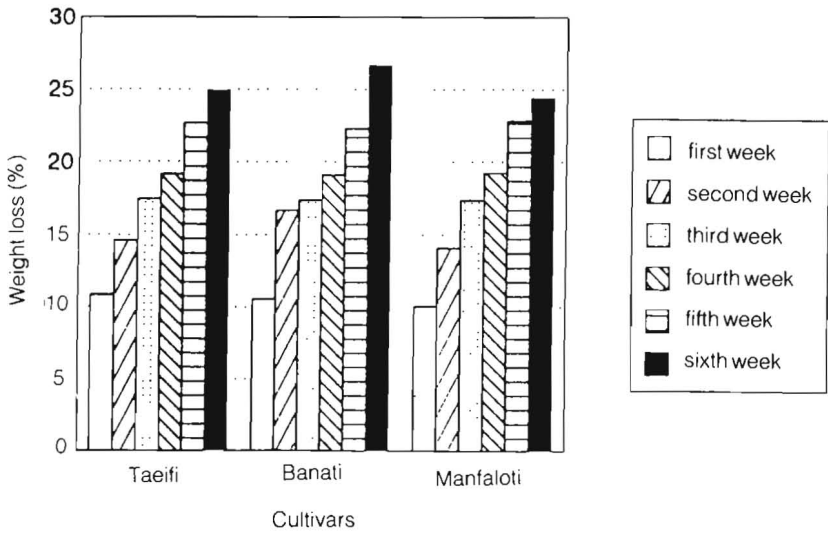


Fig. 4. Percent weight loss of three Pomegranate cultivars during six weeks of storage (Season 1989)

Table 1. Effect of storage temperature on some physical properties of pomegranate fruits in 1988 season.

| Treatments | Fruit weight (g) | | | Fruit diameter (cm) | | | Fruit length (cm) | | |
|--------------|------------------|-------|--------|---------------------|-------|-------|-------------------|-------|-------|
| | 0 | 4 | 8 | 0 | 4 | 8 | 0 | 4 | 8 |
| Temperature: | | | | | | | | | |
| 5°C | 254 a | 207 a | 184 a | 7.5 a | 7.2 a | 7.2 a | 7.1 a | 6.5 a | 6.4 a |
| 10°C | 224 a | 205 a | 175 a | 7.2 a | 7.3 a | 6.8 a | 6.8 a | 6.6 a | 6.3 a |
| R. T. | 237 a | 178 b | --- | 7.4 a | 7.2 a | --- | 6.9 a | 6.5 a | --- |
| Cultivars: | | | | | | | | | |
| Taeifi | 194 b | 171 b | 155 c | 6.9 c | 6.9 a | 6.7 a | 6.6 b | 6.4 a | 6.2 a |
| Banati | 256 a | 205 a | 198 a | 7.4 ab | 7.4 a | 7.3 a | 7.1 a | 6.6 a | 6.5 a |
| Manfaloti | 265 a | 214 a | 186 ab | 7.8 a | 7.5 a | 6.9 a | 7.2 a | 6.6 a | 6.4 a |

Means with the same letter are not significantly different.

(0, 4 and 8 : weeks in storage).

(R. T. : Room temperature).

Table 1. continued

| | Fruit rind weight (g) | | | Fruit pulp weight (g) | | | Fruit juice quantity (cc) | | |
|--------|-----------------------|------|-------|-----------------------|-------|------|---------------------------|------|---|
| | 0 | 4 | 8 | 0 | 4 | 8 | 0 | 4 | 8 |
| 125 a | 64 a | 71 a | 129 a | 144 a | 113 a | 73 a | 84 a | 68 a | |
| 109 a | 61 ab | 71 a | 116 a | 140 a | 104 a | 68 a | 84 a | 63 a | |
| 113 a | 49 c | -- | 124 a | 129 a | -- | 74 a | 76 a | -- | |
| 82 a | 46 c | 55 b | 109 a | 125 a | 100 a | 64 a | 76 a | 62 a | |
| 139 a | 60 ab | 83 a | 119 a | 143 a | 114 a | 58 a | 84 a | 65 a | |
| 125 ab | 68 a | 75 a | 140 a | 145 a | 111 a | 82 a | 84 a | 70 a | |

In the second season (1989), data (Table 2) showed that most of the physical properties of the fruits did not statistically differ among the three storage treatments with a few exceptions. After four weeks, fruit weight and fruit rind were significantly lower in fruits stored at room temperature than those stored at both 5°C and 10°C temperatures. Besides, fruit diameter was significantly lower in fruits stored at room temperature than that stored at 5°C. After eight weeks, fruit weight, length and juice content were significantly lower in fruits stored at 10°C than those in fruits stored at 5°C (Table 2).

Concerning the changes in these parameters during storage, similar trend of results was also obtained as found in the first season. The differences among the three cultivars showed that Manfaloti cultivar had always higher values of the physical properties than the other two cultivars on all sampling dates. These differences were statistically significant in most cases, especially between Manfaloti and Taeifi cultivars (Table 2).

Table 2. Effect of storage temperature on some physical properties of pomegranate fruits in 1989 season

| Treatments | Fruit weight (g) | | | Fruit diameter (cm) | | | Fruit length (cm) | | |
|--------------|------------------|-------|--------|---------------------|-------|-------|-------------------|-------|-------|
| | 0 | 4 | 8 | 0 | 4 | 8 | 0 | 4 | 8 |
| Temperature: | | | | | | | | | |
| 5°C | 279 a | 244 a | 237 a | 8.0 a | 7.8 a | 7.4 a | 7.5 a | 7.0 a | 6.4 a |
| 10°C | 224 a | 205 a | 175 a | 7.2 a | 7.3 a | 6.8 a | 6.8 a | 6.6 a | 6.3 a |
| R. T. | 237 a | 178 b | --- | 7.4 a | 7.2 a | --- | 6.9 a | 6.5 a | --- |
| Cultivars: | | | | | | | | | |
| Taeifi | 194 b | 171 b | 155 c | 6.9 c | 6.9 a | 6.7 a | 6.6 b | 6.4 a | 6.2 a |
| Banati | 256 a | 205 a | 198 a | 7.4 ab | 7.4 a | 7.3 a | 7.1 a | 6.6 a | 6.5 a |
| Manfaloti | 265 a | 214 a | 186 ab | 7.8 a | 7.5 a | 6.9 a | 7.2 a | 6.6 a | 6.4 a |

Means with the same letter are not significantly different.

(0, 4 and 8 : weeks in storage).

(R. T. : Room Temperature).

The obtained results are in line with those presented by Al-Mughraby and Bacha [4] working on some pomegranate cultivars.

Fruits of the three pomegranate cultivars showed noticeable shriveling and were discarded after four weeks of storage at room temperature.

2) Chemical properties

a) TSS %: The results showed that after four weeks of storage TSS % was significantly lower in fruits stored at both 5°C and 10°C treatments compared to fruits stored at room temperature in both seasons (Tables 3 and 4). However, there were no significant differences among the two storage treatments (5 and 10°C) after 8 weeks from storage. It was also noticed that TSS % was gradually increased with increasing storage period in all treatments in both seasons.

Regarding the differences among the three cultivars, TSS % did not significantly differ except after 8 weeks, in 1988 season when Banati cultivar had higher values of TSS % than the other two cultivars (Table 3).

These results are not in line with those reported by Kader *et al.*, [3] and Al-Mughrabi and Bacha [4] who found that TSS % was decreased during storage of pomegranate fruits. Heikal *et al.*, [2] found insignificant changes in TSS content in pomegranate fruits during cold storage. However, the results of the present study were similar to those obtained by Khattab and Stino [8] on Le Conte pear fruits and Ewaida and Bacha [9] on prickly pear fruits.

Table 3. Effect of storage temperature on some physical properties of pomegranate fruits in 1988 season

| Treatments | TSS % | | | Acidity % | | | Vitamin C mg/100ml juice | | |
|--------------|----------|--------|--------|--------------|--------|--------|-----------------------------|-------|-------|
| | 0 | 4 | 8 | 0 | 4 | 8 | 0 | 4 | 8 |
| Temperature: | | | | | | | | | |
| 5°C | 16.4 a | 16.9 b | 19.2 a | 0.78 a | 0.89 a | 0.83 a | 6.2 a | 2.9 a | 2.6 a |
| 10°C | 15.8 a | 16.6 b | 18.2 a | 0.83 a | 0.90 a | 0.84 a | 6.2 a | 2.5 a | 2.4 a |
| R. T. | 16.5 a | 18.0 a | -- | 0.83 a | 0.95 a | -- | 6.8 a | 3.0 a | -- |
| Cultivars: | | | | | | | | | |
| Taeifi | 16.5 a | 17.2 a | 17.6 b | 0.41 b | 0.44 b | 0.41 b | 5.2 a | 0.8 b | 0.7 b |
| Banati | 15.8 a | 17.1 a | 20.0 a | 0.96 a | 1.16 a | 1.07 a | 6.9 a | 3.9 a | 3.3 a |
| Manfaloti | 15.5 a | 17.2 a | 18.6 b | 1.07 a | 1.14 a | 1.04 a | 7.0 a | 3.6 a | 3.6 a |

Means with the same letter are not significantly different.

(0, 4 and 8 : weeks in storage).

(R. T. : Room temperature)

Table 4. Effect of storage temperature on the chemical properties of the pomegranate fruits in 1989 season

| Treatments | TSS % | | | Acidity % | | | Vitamin C mg/100ml juice | | |
|--------------|----------|--------|--------|--------------|--------|--------|-----------------------------|---------|--------|
| | 0 | 4 | 8 | 0 | 4 | 8 | 0 | 4 | 8 |
| Temperature: | | | | | | | | | |
| 5°C | 16.8 a | 17.0 b | 17.9 a | 0.83 a | 0.86 a | 0.79 a | 8.87 a | 8.96 a | 5.61 a |
| 10°C | 16.8 a | 17.3 b | 17.4 a | 0.85 a | 0.77 a | 0.75 a | 9.64 a | 8.89 a | 4.93 a |
| R. T. | 16.8 a | 18.7 a | -- | 0.80 a | 0.90 a | -- | 8.87 a | 7.55 a | -- |
| Cultivars: | | | | | | | | | |
| Taeifi | 16.6 a | 17.7 a | 17.8 a | 0.40 b | 0.43 b | 0.41 b | 4.47 b | 4.04 b | 1.34 c |
| Banati | 16.9 a | 17.6 a | 17.9 a | 1.07 a | 1.06 a | 0.90 a | 10.53 a | 9.97 a | 4.61 b |
| Manfaloti | 17.2 a | 17.2 a | 17.3 a | 1.00 a | 1.04 a | 0.99 a | 12.38 a | 11.49 a | 9.86 a |

Means with the same letter are not significantly different.

(0, 4 and 8 : weeks in storage).

(R. T. : Room temperature)

b) Acidity: Data in Tables 3 and 4 showed that storage treatments did not significantly affect acidity content of the pomegranate fruits during storage in both seasons. In addition, acidity % did not show a consistent trend during storage period in all treatments.

Regarding the differences among the three cultivars, data showed that Taeifi cultivar had significantly lower acidity values as compared with the other two cul-

tivars on all sampling dates in both seasons (Tables 3 and 4).

Kader *et al.*, [3] stated that acidity decreased during cold storage, while Al-Mughrabi and Bacha [4] reported that acidity increased during the storage period in pomegranate fruits.

c) Vitamin C: Data of the present study showed that storage treatments did not affect vitamin C content of pomegranate fruits in both seasons. Furthermore, vitamin C content was gradually decreased in all treatments during the storage period in both seasons (Tables 3 and 4).

Concerning the differences among the three cultivars, data showed that manfaloti cultivar had almost higher vitamin C content than the other two cultivars in both seasons (Tables 3 and 4).

These results are in agreement with those of Ewaida and Bacha [9] on prickly fruits, Khalil *et al.*, [10] and Ishak *et al.*, [11] on lime fruits.

From the foregoing data, it could be concluded that fruits of Taeifi, Banati and Manfaloti pomegranate cultivars could be stored safely without shriveling and with a minimum decrease in fruit quality at 5°C up to 8 weeks.

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تأثير درجات الحرارة وفترة التخزين على الصفات الثمرية لثلاثة أصناف من الرمان

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ملخص البحث. أجري هذا البحث خلال موسمي ١٩٨٨ و١٩٨٩م لدراسة تأثير درجات حرارة التخزين (٢٥°م و١٠°م ودرجة حرارة الغرفة ٢٢ - ٢٤°م)، على الفقد في الوزن وبعض الصفات الطبيعية والكيميائية لثمار ثلاثة أصناف من الرمان هي: الطائفي، البناتي والمنفلوطي.

وقد أوضحت النتائج أن الفقد في الوزن (%) يزداد تدريجياً مع طول فترة التخزين وكان أعلى بصورة مؤكدة إحصائياً في الثمار المخزنة على درجة حرارة الغرفة مقارنة بالثمار المخزنة على درجات حرارة ٥°م و١٠°م. ولم تكن هناك فروق مؤكدة إحصائياً بين الأصناف الثلاثة في كلا الموسمين.

وقد تأثرت بعض الصفات الطبيعية للثمار بدرجات حرارة التخزين وبطول الفترة. كما وجدت اختلافات مؤكدة إحصائياً في هذه الصفات بين الأصناف الثلاثة في معظم الحالات. أما بالنسبة للصفات الكيميائية فقد وجد أن المواد الصلبة الذائبة الكلية (% TSS) كانت أعلى بفروق مؤكدة إحصائياً في الثمار المخزنة على درجة حرارة الغرفة مقارنة بالثمار المخزنة على درجات حرارة ٥°م أو ١٠°م، في حين لم تكن هناك فروق مؤكدة إحصائياً في محتوى الثمار من الحموضة أو فيتامين (ج). وقد وجد أن محتوى الثمار من المواد الصلبة الذائبة الكلية قد ازداد مع طول فترة التخزين وعلى العكس من ذلك انخفض محتوى الثمار من فيتامين (ج)، في حين لم يظهر اتجاه محدد للتغيرات في الحموضة.

وتوضح نتائج هذا البحث أنه يمكن تخزين ثمار أصناف الرمان الثلاثة بأمان وبدون حدوث تكرمش وبأقل نقص في الجودة على درجة حرارة ٥°م لمدة ٨ أسابيع.