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HEAT TREATMENTS AND DIFFERENT PACKAGING MATERIALS FOR THE MODIFIED ATMOSPHERE STORAGE OF POMEGRANATE FRUITS

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Abstract

Different thermal (for one hour at 40° C and 50° C) and packaging applications (with 50ì and 100ì LDPE-Low Density Polyethylene and 15ì PP-Polypropylene) were conducted to prolong the storage period and to decrease decay in pomegranate fruits.

Physical and chemical factors related to quality (weight loss, taste, mold, soluble solids, titratable acid, pH and ascorbic acid) were investigated. Storage conditions were 2-3° C and 90-93% RH.

As the result of the study, all packaging applications with 50ì LDPE gave promising results. Besides, the best result was obtained from both applications, which were under 50° C and packaged with 50ì LDPE.

1. INTRODUCTION

The native types of the pomegranates can be found in the Middle East, Iran, Pakistan and India. Today, it seems that the fruit of the pomegranate (*Punica granatum*) is mainly growing in subtropical areas of Mediterranean countries, South Africa, Pakistan, India and USA, especially in California. Turkey is among the major pomegranate producing countries (with 53 000 tons in 1991) and has a great potential towards enhancement of pomegranate production. In recent years, the exportation of pomegranates from Turkey showed an important increase (Anonymous 1993).

There are not enough publications about post-harvest treatment, transportation and storage of pomegranates. However, few studies were conducted constituting the fundamental principles for pomegranate storage. The growers keep and market the fruits for a few months under natural conditions. Nevertheless, this kind of application causes a high rate of water loss, which in turn also causes decay in fruits (Köksal 1988, Onur et al. 1992).

It has been reported that among tropical and subtropical fruits, the pomegranate is perhaps the only fruit having a long storage life (Salunkhe and Desai 1984). The determination of storage temperature of pomegranate is a concept which is very important and which could not be completely established so far. The researchers reported different results on this subject. However, the studies in recent years concentrated on storage temperatures.

Some of the literature recommended storage temperatures of 0 to 1.7° C and relative humidity of 85 to 90% for storing pomegranates for 11 weeks (Özbek 1959; Dokuzoguz 1968; Salunkhe and Desai, 1984). Although, according to Ryall and Pentzer (1982), pomegranates are well adapted to cold storage conditions. At a temperature of 0° C with 90% RH, sound fruits can remain in marketable condition for at least 8 to 9 weeks (Salunkhe and Desai 1984). On the other hand, the same researchers explained that pomegranates were kept more well in storage at 5° C and were subjected to relatively few post-harvest troubles (Ryall and Pentzer 1982).

Elyatem and Kader (1984), Kader (1984) and Yilmaz (1988) also reported that the fruits were, generally, kept well in storage at 5° C, compared to temperatures below 5° C. Storage at 5° C or lower resulted in chilling injury and the severity of the symptoms increased with time and temperature decrease below 5° C.

Some other researchers also explained different storage temperatures as usable, depending on cultivars. For instance, Treglazova and Fataliev (1989) stored different pomegranates at 2-4° C and 85-90% RH for 110 days. Köksal (1989) reported the least weight loss after 4 months storage occurred in fruits treated with an antitranspirant and stored at 1° C. The storage temperatures 2, 6 and 10° C were examined by Onur et al. (1992) for 5 months. As result, the storage at 2° C showed minimum weight loss but slight chilling injury, especially after long-term storage.

As it seems, one of the factors affecting quality in pomegranate storage is the suitability of cultivar to storage. Onur (1989) explained the sour pomegranates, which mature late, constitute the most suitable cultivar for storage in Turkey.

Beside the storage temperature, to gain more success during storage of pomegranates, some other applications were also used. For instance, in a study in Turkey with pomegranates under conventional storage conditions, a weight loss of 27.37% was determined (Onur and Ari 1986). In another study, a group of pomegranates was put into plastic bags before storage and these were compared with the group, which was put directly into storage. The weight loss in the fruit, covered with plastic bags, was 0.88% whereas in control this ratio was 10.78% (Onur 1989).

In another study (Ben-Arie and Or, 1986), a superficial browning disorder (scald) was observed on fruits during storage. For this purpose, the effects of delaying the harvest time, reducing the storage temperature, dipping the fruits in boiling water (for 2 minutes) and in anti-oxidant solutions, storing the fruit in a low O_2 atmosphere were investigated. The most effective control of husk scald was obtained by storing late-harvested fruits in 2% O_2 at 2° C. However, this treatment resulted in accumulation of ethanol, which caused off-flavour development. When the fruits were transferred to air at 20° C, ethanol and off-flavours dissipated.

The effect of $CaCl_2$ applications on pomegranate fruits during storage was determined by Treglazova and Fataliev (1989). They immersed the fruits in $CaCl_2$ solution for 3 minutes after five days of harvest. The application of 4% $CaCl_2$ gave the best result in cultivars in aspect of low storage loss and good fruit composition after 110 days of storage at 2-4° C.

In this study, it was attempted to decrease the mold load on the outer surface of the fruits. On the other hand, these pomegranates, which were subjected to thermal process, were covered in this way. It was aimed to inhibit the water loss from outer skin and to maintain the vitality of skin.

The other important aim of the study was to constitute an internal atmosphere different from the external environment with the help of CO_2 produced by the respiration of product due to covering with plastic films (Polypropylene 15ì-PP, Low Density Polyethylene 50ì and 100ì-LDPE), which have different thicknesses and permeabilities. As well as this second aim, it was objected to determine the most suitable plastic film (cover) for pomegranate storage.

2. MATERIALS AND METHODS

Pomegranate fruits were picked from the orchard in the Anamur county of Mersin, which is in South of Turkey, and packaged suitably and transported on the same day to the Department of Horticulture, in Uludag University.

Later on, the fruits were separated into three groups. One of the groups was subjected to thermal application at 40° C, and the second one, at 50° C for one hour, whereas no thermal application was conducted on the third group. After that, the fruits were placed into cardboard packages as groups of four. The cardboard packages were covered with plastic materials whose thicknesses and permeabilities were known (PP 15ì, LDPE 50ì and 100ì). The cardboard packages were wrapped with plastic and then sealed with hot sealer to prevent air penetration.

Having completed these procedures, the fruits were taken into storage at 2-3° C and 90-93% RH. Respiration rate, water soluble solids, pH, titratable acidity, weight loss, ascorbic acid, soluble solids and sensory analysis were conducted in the fruit samples and at certain intervals during storage period.

3. RESULTS

At the end of storage, after different applications, the quality changes in pomegranate fruits are shown in figures 1-7.

Weight loss in pomegranate fruits increased during storage period. With the thermal applications and covering materials the weight loss were decreased. The highest weight loss was observed in control fruits, whereas the lowest was observed in the fruits which were covered with LDPE-50ì and LDPE-100ì. The lowest weight loss was obtained from the fruits kept at 40° C for 1 hour (Figure 1).

Water soluble solids showed a reduction during storage, however this reduction was not found to be related to the covering materials or thermal application. A similar reduction was also observed in control fruits (Figure 2). Similarly, titratable acid content of the fruits decreased during storage period in all samples of applications. However, between the samples which were covered with different materials and treated with heat were not found any significant difference (Figure 3). Also, an increase in pH was observed in pomegranate fruits, in parallel to the reduction in acidity (Figure 4).

Ascorbic acid content in fruits increased slightly during storage in some samples. However, ascorbic acid content of fruits, which covered with PP-15ì, significantly decreased during storage. The highest ascorbic acid level was obtained from the combination of LDPE-50ì and 50°C, whereas the lowest from the PP-15ì and 40° C combination (Figure 5).

Sensory analyses were also conducted during storage. The best score was obtained from LDPE-50ì / 50° C combination; whereas the lowest from PP-15ì / control combination with 4.6 after 160 days of storage. While the results of sensory analyses were not affected by thermal application, the covering materials were found effective (Figure 6).

When the mold ratio was considered, an increase was observed, during the days 105 and 160. After 160 days of storage mold ratio was very high in all samples especially. However both thermal application and covering materials were found to be negatively effective on mold development. At the end of the storage period, the best result and the lowest mold ratio (5%) was obtained from LDPE-50ì / 50° C combination (Figure 7).

4. DISCUSSION

Pomegranate fruit do not ripen off the tree and should be picked when fully ripe to ensure their best flavour. According to some researches, pomegranates are susceptible to chilling injury if stored longer than one month at temperatures between their freezing point (-3° C) and 5° C (Kader *et al.*, 1984). On the other hand, in some other works it was also determined that the storage temperatures of pomegranates depend especially on cultivars (Özbek, 1959; Dokuzoguz, 1968; Salunkhe and Desai, 1984; Treglazova and Fataliev 1989; Köksal, 1989; Onur, 1989). In this study, it was determined that the storage temperature of 2-3° C was suitable for pomegranates cv. Hicaz, especially for 105 days storage. After 105 days storage at this temperature the chilling injury has been determined. During 105 days storage at this temperature all of the quality criteria were not affected negatively, especially in heat treated and packaged material. A slight reductions in some quality criteria, such as water soluble solids and acidity, appeared as a consequence of the non-climacteric characteristic of pomegranates.

High rates of water loss in pomegranate fruits, especially in control, resulted in skin thinning and discoloration on the surface of fruits. The weight loss in the fruits, which covered with plastic bags, decreased compared with the non-covered fruits. These results were in parallel to those of Onur (1989).

The highest increase in ascorbic acid took place with LDPE-50ì. The covering materials were effective on the increase in ascorbic acid. The reasons of the further reductions might be the chilling injury and internal break-down especially after 105 days of storage. Another probable reason is different atmospheric combinations in the package, likely to affect the chemical changes in the product due to the covering materials at different permeabilities. This opinion is supported by the fact that the ascorbic acid level was determined as the lowest with the PP-15ì material having very limited permeability. The Modified Atmosphere -formed inside- were also effective on mold development. The lowest mold development at the end of the storage was observed in LDPE-50ì with good permeability. Mold development was more pronounced than control. This indicates that the anaerobic activity in the packages, made from PP-15ì, increased as a result of the increasing CO_2 and the decreasing O_2 levels towards the end of the storage period. Another effective factor on mold development is the thermal application. There was less mold development in the fruits, which were under 40° C or 50° C for one hour compared with control. Similarly, Ben-Arie and Or (1986) controlled husk scald with some applications such as dipping the fruits in boiling water, storing the fruits in a low O_2 atmosphere.

According to the results explained above, pomegranates (depending on cultivars) would be stored longer than 3 months if their weight loss and mold ratio could be controlled.

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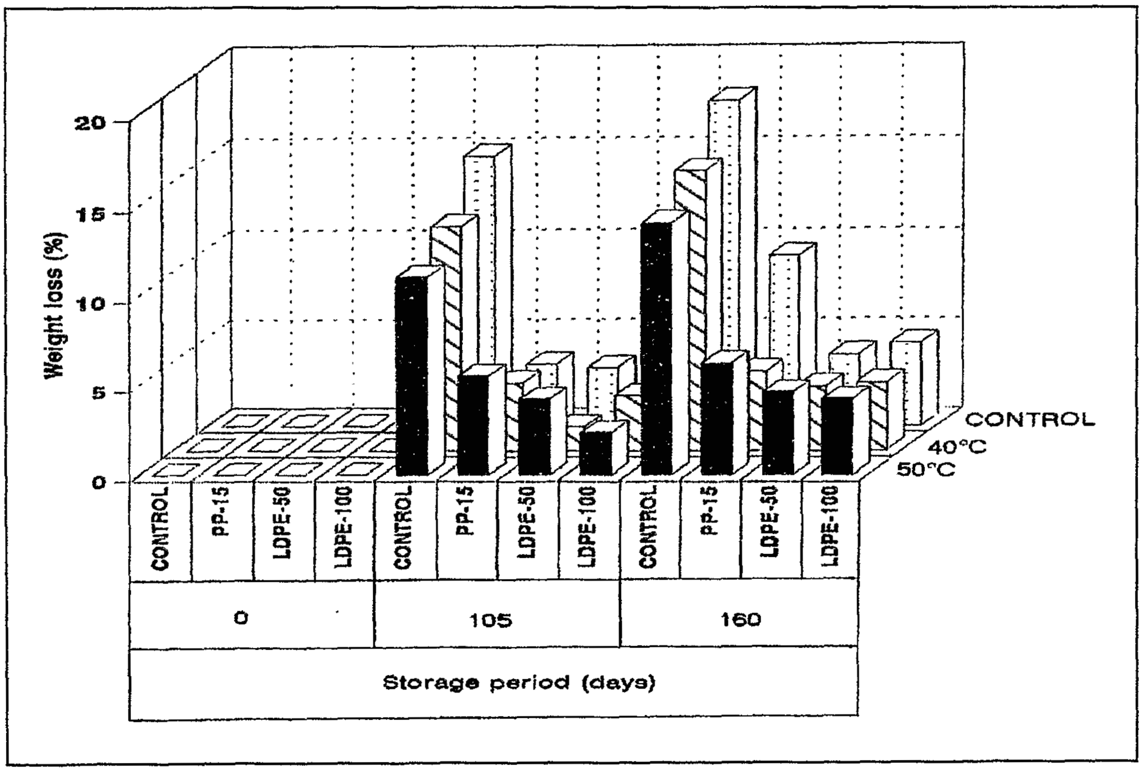

Fig 1. The effects of different covering materials and heat treatments on changes of weight loss in pomegranates during storage.

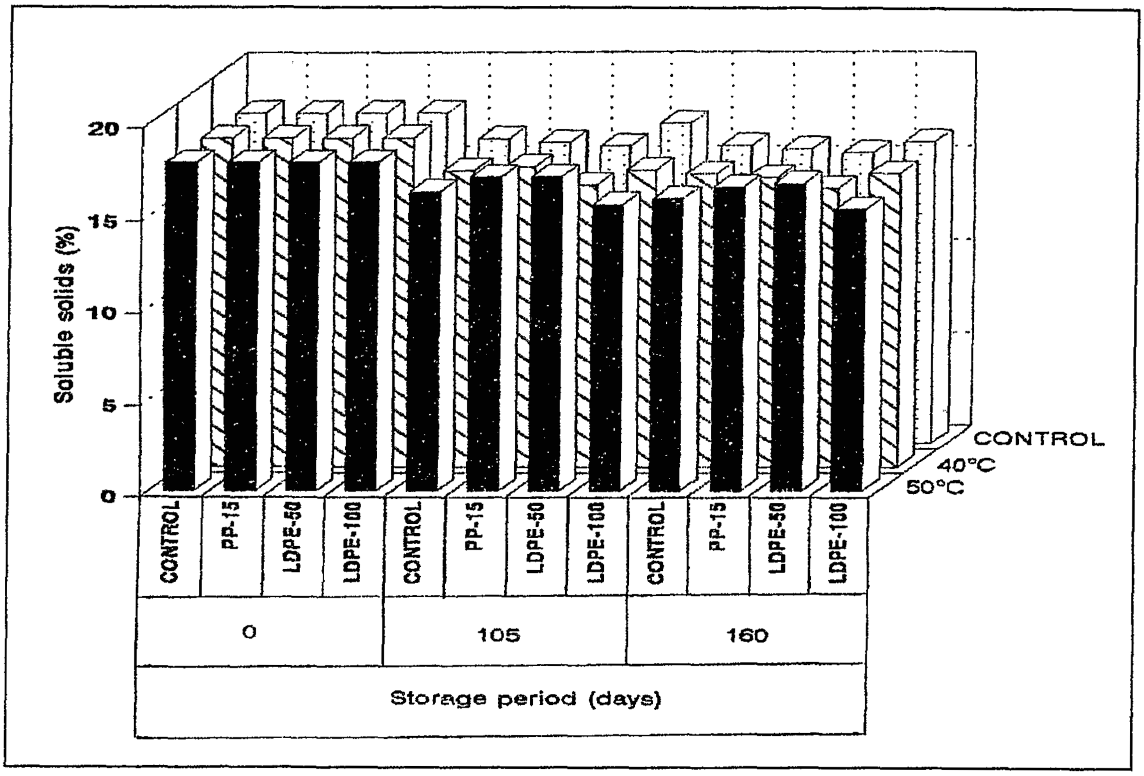

Fig 2. The effects of different covering materials and heat treatments on changes of soluble solids in pomegranates during storage.

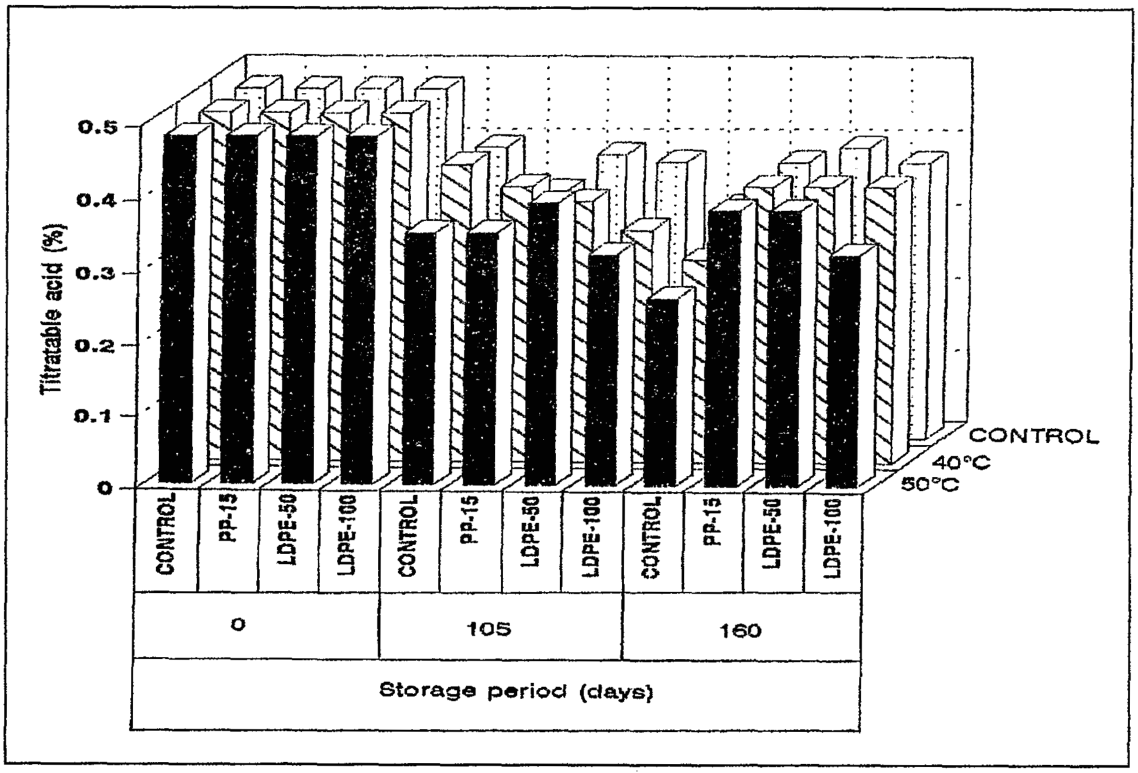

Fig 3. The effects of different covering materials and heat treatments on changes of titratable acid in pomegranates during storage.

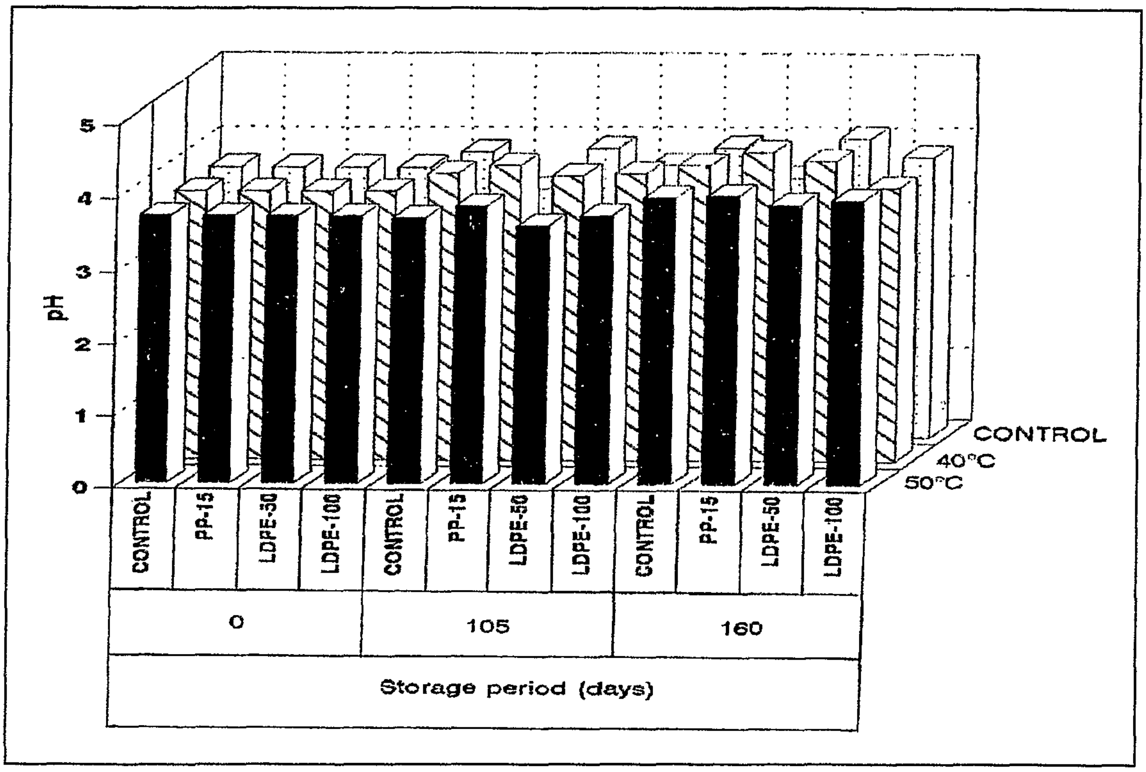

Fig 4. The effects of different covering materials and heat treatments on changes of pH in pomegranates during storage.

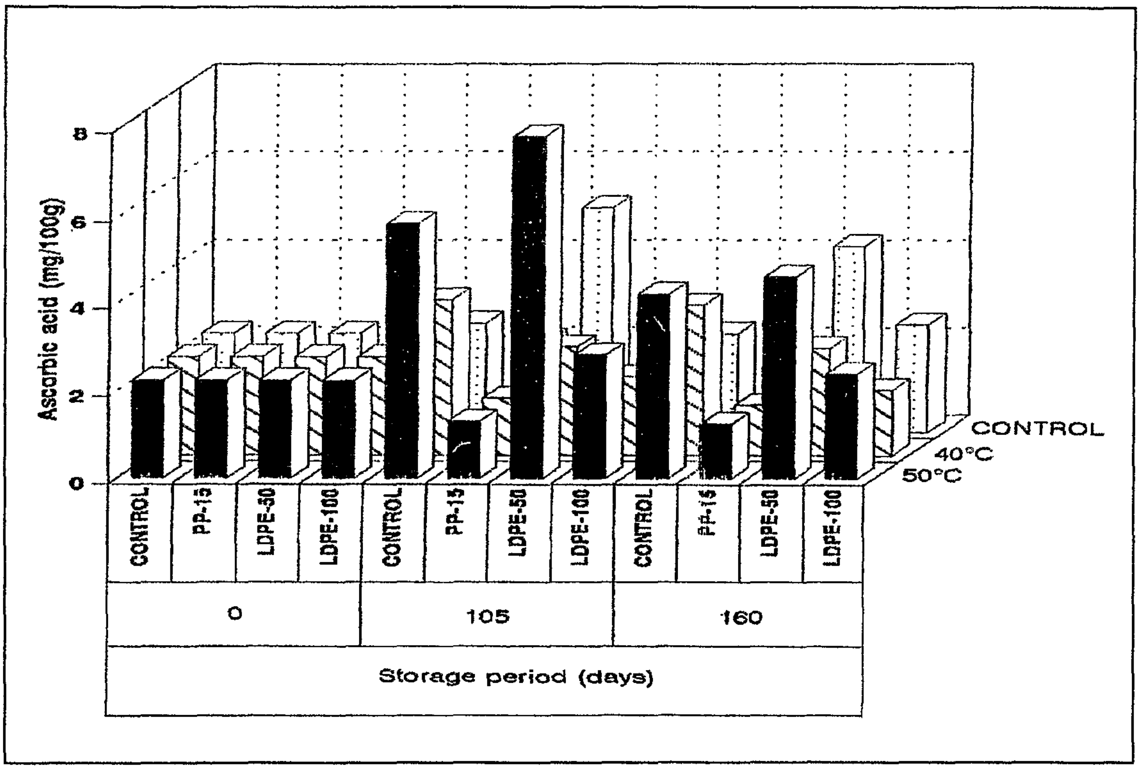

Fig 5. The effects of different covering materials and heat treatments on changes of ascorbic acids in pomegranates during storage.

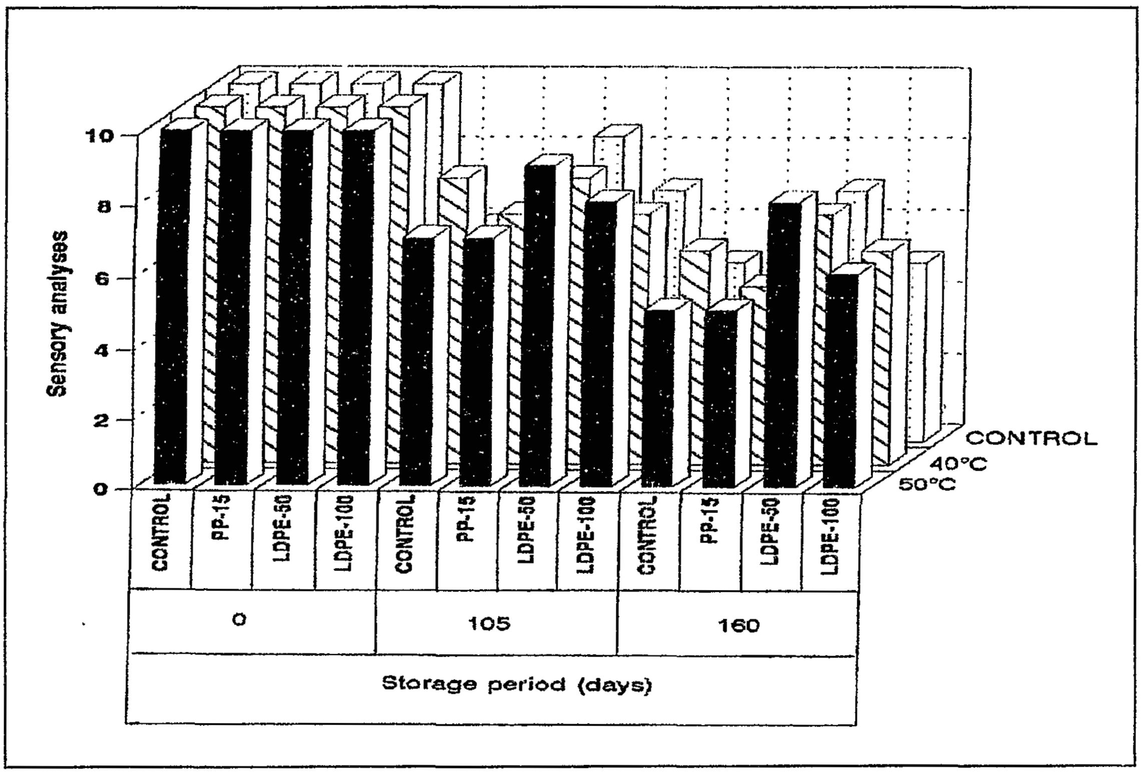

Fig 6. The effects of different covering materials and heat treatments on changes of sensory analyses in pomegranates during storage.

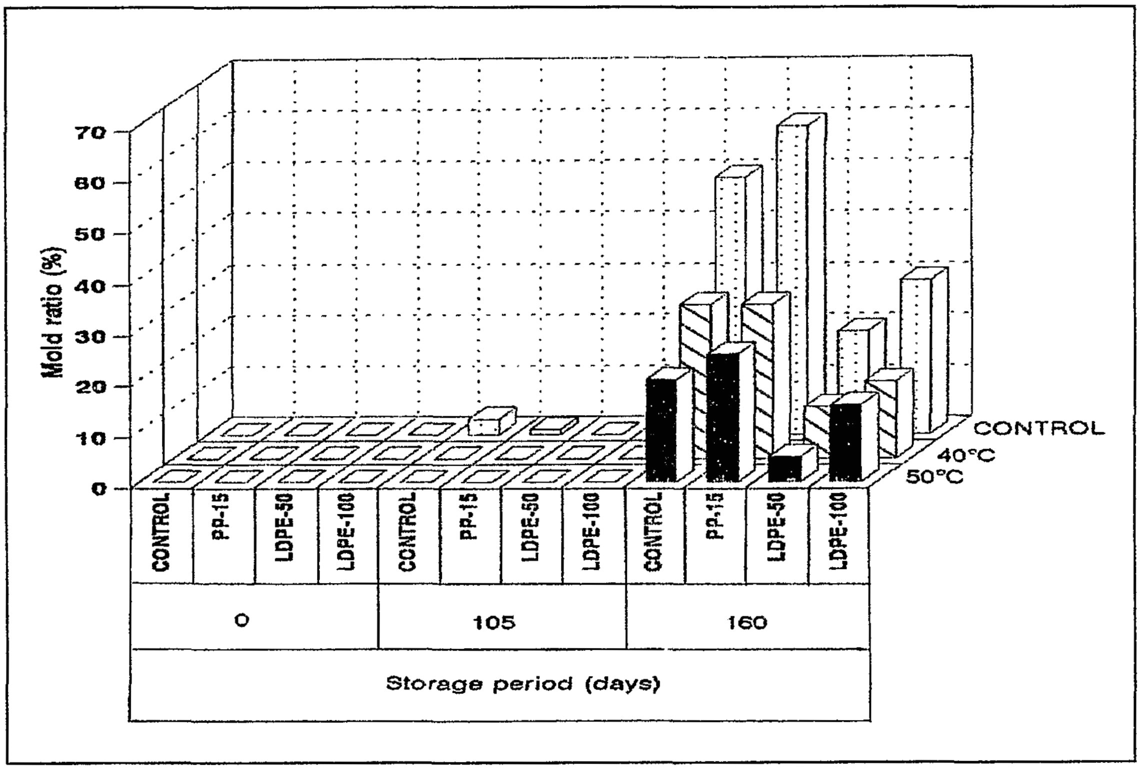

Fig 7. The effects of different covering materials and heat treatments on changes of mold ratio in pomegranates during storage.