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Effect of Different Plastic Liners on the Quality of Fresh-Cut Jew's Mallow Leaves (*Corchorus olitorius* L.) During Storage under Different Temperatures

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Authors' contributions

This work was carried out in collaboration between all authors. Authors NAK and MS performed the statistical analysis and wrote the manuscript. Authors MA, AH, NA, HS and JZ conducted the experimental work of the study. Authors MA and JH designed and wrote the protocol. Authors NAK and MS managed the literature searches and scientific information related to this article. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

The postharvest quality of Jew's mallow was tested using two types of plastic liners and two temperatures, 4ºC and 10ºC. The plastic liners were normally sealed low density polyethylene and modified atmosphere package. Six quality parameters (weight loss, chlorophyll content, decay level, dryness level, yellowing level and chilling injury) were studied. It was found that Jew's mallow leaves had a longer shelf life at 4ºC than at 10ºC. Modified atmosphere package liner showed a good result with respect to decay level. The shelf life was two weeks.

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Keywords: Jew's mallow; Corchorus olitorius L.; Palestine; weight loss; chlorophyll content; chilling injury; yellowing; dryness; decay.

1. INTRODUCTION

Jew's mallow (*Corchorus olitorius* L.) is an essential green, leafy edible vegetable, consumed in many countries. The origin of Jew's mallow is unknown, however it has been cultivated in Asia and Africa for centuries [1]. Leaves of Jew's mallow are used for human consumption. The leaves are highly nutritious rich in proteins, vitamins A, C and E, beta-carotene, iron, calcium, thiamin, riboflavin, niacin, folate, dietary fibre, and most essential amino acids [2,3]. The biochemical and microbiological composition of Jew's mallow were reviewed, and it was suggested to use the modern molecular technology to improve the quality and reduce losses [4]. Jew's mallow infusion and extracts with different polarities, and for their polyphenolic contents and antioxidant activities, were studied. It was concluded that higher antioxidant activity was seen in the samples with higher phenolic content [5]. Different characteristics of Jew's mallow, e.g. morphological, biochemical, and molecular analysis of genome along with pest management, retting procedures, and tissue culture, were reviewed [6]. The heavy metals presented in different vegetables were investigated in several areas, to check the level of these metals in the vegetables. Jew's mallow contained high levels of heavy metals in polluted areas, and this affect the residents' health [7,8].

Despite that Jew's mallow is a leading leafy vegetable cultivated and traded in many countries, few statistical data on the production and marketing tendency of the crop are available [1]. In Palestine, the total cultivated area of Jew's mallow in 2010 was 245.85 ha. Among them, 160.21 ha grown in open irrigated lands and 76.27 ha in plastic houses [9]. The average cost of 1 kg of green Jew's mallow is about 1.5 USD, and the average cost of 1 kg of frozen crushed Jew's mallow is about 6 USD [10]. The local demand of Jew's mallow is growing rapidly, due to its healthy and tasty aspects. The production of Jew's mallow in Palestine is concentrated in summer season. This cause a surplus and a decrease of the price during that period. On the other hand, there is a shortage of production during other seasons, and the price increases. This leads to consider the possibilities of storing the leaves and increase its shelf life. Jew's mallow can be stored in two ways, sundried or frozen. However, it was found that sundried Jew's mallow is handled in unhealthy conditions and stored in bad system in tropical and subtropical areas. Moreover, sundried Jew's mallow is considered as a mean for numerous fungal pathogens, and they must be bagged in a safe and healthy manner [11]. Recently, many retailers started presenting fresh-cut Jew's mallow leaves in the Palestinian local market. Thereafter, a growing demand for these fresh-cut leaves has been noticed. However, such leaves are usually presented in normal plastic liners (i.e. films, or bags), where they remain fresh only for a short time. As fresh-cut, Jew's mallow leaves are sold at 4 times higher prices than leaves attached to the stalk. It is obvious that much value can be added to this crop by extending the shelf life of its fresh-cut leaves.

Worldwide, there are few research studies concerning fresh-cut Jew's mallow leaves and its postharvest quality changes during storage. This study was conducted with the objective to assess fresh Jew's mallow quality parameters during postharvest storage at two temperatures and in two different types of plastic liners, and to find the optimum storage conditions in order to increase the shelf life of this crop.

2. MATERIALS AND METHODS

2.1 Materials

Jew's mallow was purchased from local market at Jenin city (Northern part of Palestine) in summer season. Fresh leaves, ready for consumption, were cut from the stalks of the crop. The experiment was conducted in triplicates with four treatments (500 g of leaves each). The treatments were assigned in a completely randomized block design. Two types of liners were used to store each treatment, normal low density polyethylene (PE) (i.e. Bag_{PE}) and Zoepac modified atmosphere package (MAP) (Zoepac postharvest solution Ltd., Israel) (i.e. Bag_{MAP}). Normal liners were sealed using heat sealing machine before putting in refrigerator. Zoepac liners had a special zip to close. The sealed liners were stored after sealing at $4^{o}C$ and $10^{o}C$. Measurements were carried out during one month (i.e. one measurement once a week for each parameter). The total number of liners was 48 liners. Two refrigerators were used for storage. An electrical scale was used to measure the weights.

2.2 Quality and Shelf Life Evaluation

Six quality parameters were studied including weight loss, chlorophyll content, decay level, dryness level, yellowing and chilling injury.

Measurements were carried out as follows:

1. Weight loss (%): the difference of weight of the same treatment during storage period (i.e.: (Original weight of treatment (500 g) – Weight of treatment at each week) / (Original weight of treatment (500 g)) * 100%)).
2. Chlorophyll content (mg/g): a sample of 10 g was taken from each treatment (liner) for a standard chlorophyll laboratory analysis. Total chlorophyll content was determined by using 80% acetone extracts of the plant material, according to the spectrophotometric method [12].

The other four quality indices were evaluated based on changes in appearance of leaves and freshness as well as shelf life stability. Methods for evaluating these indices based on the experience and training of the reviewers to evaluate the required quality parameter of the agricultural commodity depending on their appearance. These methods were used in different places [13-15]. In this work, the method of Tulio et al. [2] was adopted with some modifications as described below.

Evaluation was done by experienced trained staff from extension department at Palestinian Ministry of Agriculture, following a five-point freshness scale:

3. Decay level: 1, no decaying; 2, slight decaying; 3, moderate decaying; 4, severe decaying; and 5, extremely decaying.
4. Dryness level: 1, green; 2, slightly dry; 3, moderate dry; 4, severe dry; and 5, extremely dry.
5. Yellowing level: 1, all leaves are green; 2, most leaves are green; 3, half the leaves are yellow; 4, most leaves are yellow; and 5, all leaves are yellow.
6. Chilling injury: was evaluated in terms of browning of the leaves and stems based on the following scale: 1, no browning; 2, slight browning; 3, moderate browning; 4, severe browning; and 5, extremely dark brown.

2.3 Statistical Analysis

The statistical analysis of the data was carried out using XLStat program (Addinsoft Software, Germany). Mean separation tests were calculated after using ANOVA after Tukey's HSD test at P< 0.05.

3. RESULTS AND DISCUSSION

3.1 Weight Loss

The weight loss is shown in Fig. 1. It was found that the highest weight loss was in the case of using modified atmosphere package liners at 10ºC temperature ($Bag_{MAP}T_{10}$). While the lowest percentage weight loss was in the case of using polyethylene (PE) liners at 4ºC ($Bag_{PE}T_4$). The highest percentage weight loss occurred mainly during the first week of experiment, and then became slower during the next three weeks. The standard deviation of the weight loss values was in the range of 0-0.46.

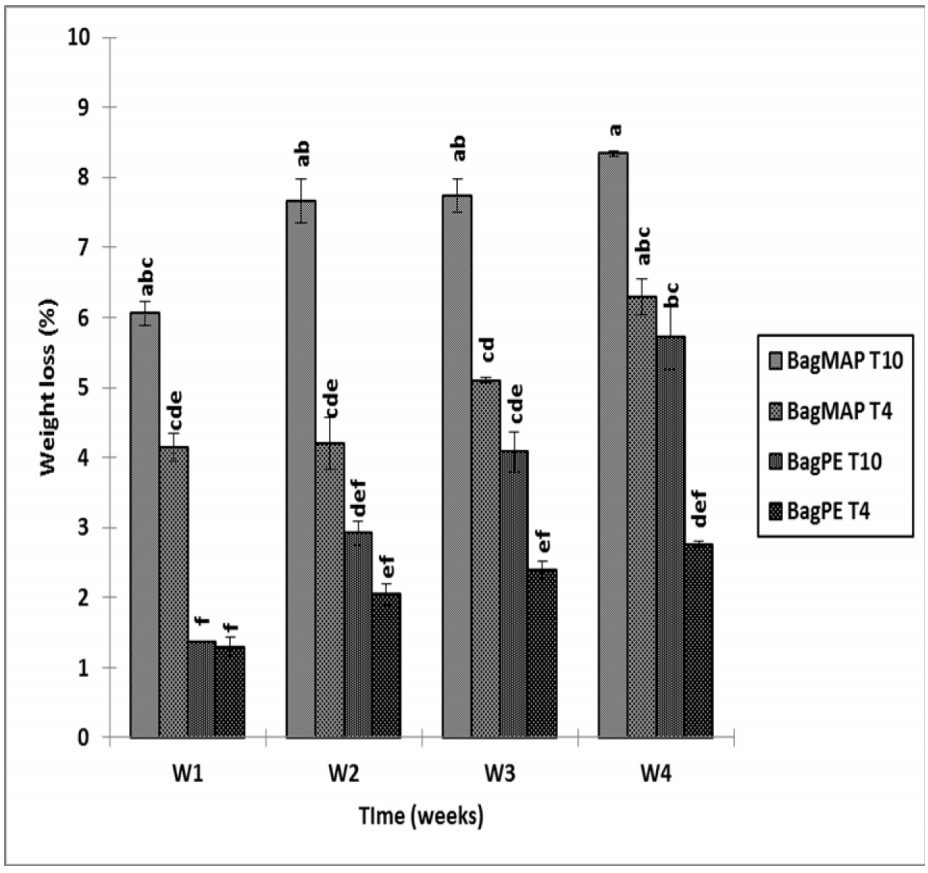

Fig. 1. Weight loss percentage during four weeks of experiment at different types of liners (modified atmospheric package (MAP) and polyethylene (PE)) and different temperature levels (10ºC (T10) and 4ºC (T4)). Data of different letters are significantly different after Tukeys HSD test using ANOVA at P < 0.05

3.2 Chlorophyll Content

The chlorophyll content (mg/g) is shown in Fig. 2. The highest chlorophyll content was in the case of using MAP bags at 4ºC. However, there was a significant difference between chlorophyll content at 4ºC when using MAP and PE bags. There was a decrease in chlorophyll content when storing at 10ºC, in the case of both bags. This decrease was significant during the first two weeks of storage. The standard deviation of the chlorophyll content values was in the range of 0.01-0.43.

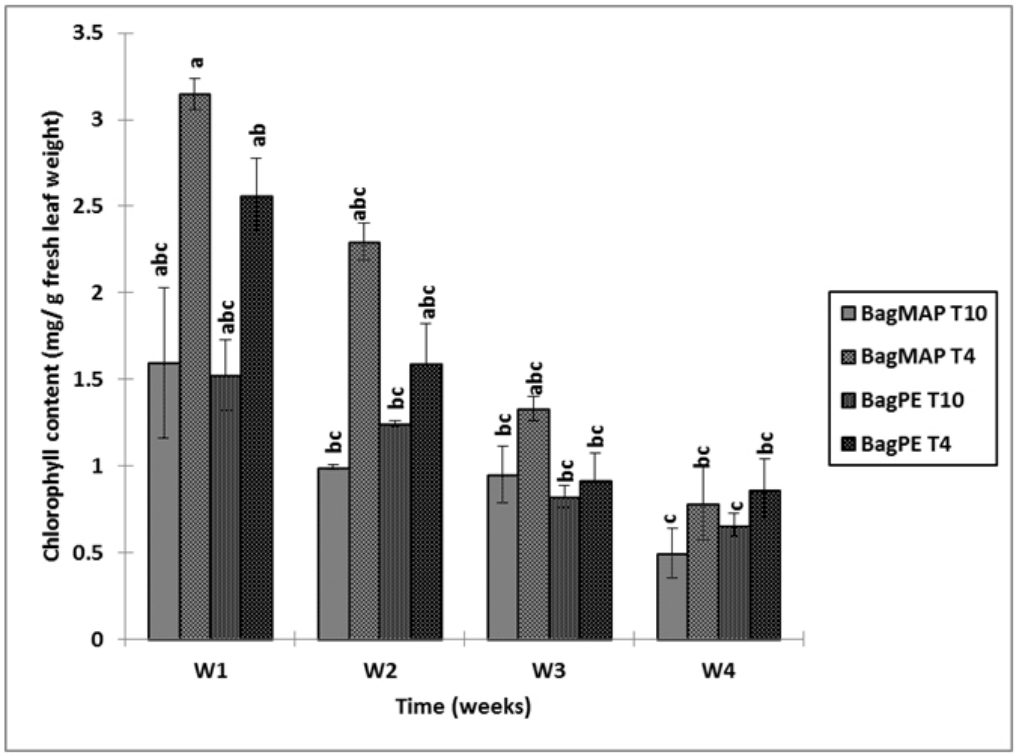

Fig. 2. Chlorophyll content at different treatments during storage period. Data of different letters are significantly different after Tukeys HSD test using ANOVA at P < 0.05

3.3 Decay Level

The decay level is show in Fig. 3. It can be seen that the highest decay level occurred when Jew's mallow leaves were stored at 10ºC, regardless the type of the liners. Jew's mallow leaves deteriorated markedly after nearly the third week. The lowest decay level was in the case of using MAP liners at 4ºC. The decay levels in this case were equal or less than the decay levels at any other cases.The standard deviation of the decay level values was in the range of 0-0.17.

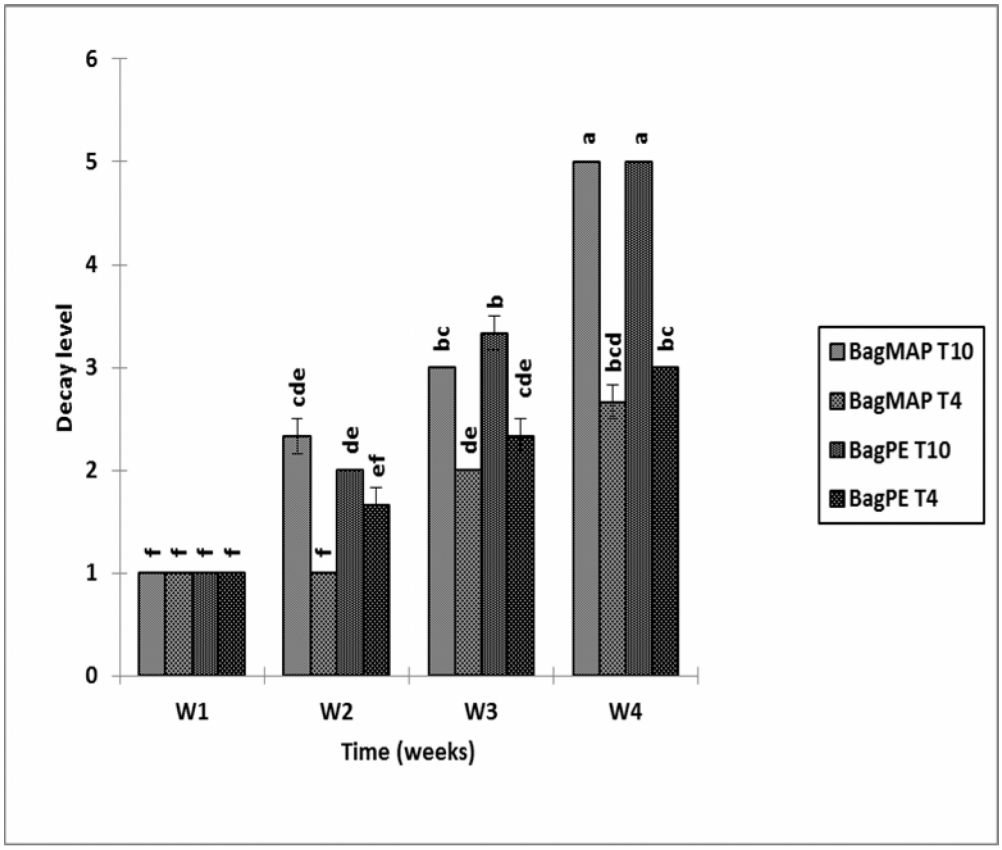

Fig. 3. Decay level average during four weeks of experiment. Data of different letters are significantly different after Tukeys HSD test using ANOVA at P < 0.05

3.4 Dryness Level

Fig. 4 shows the dryness level. During the first two weeks, the level is almost the same. Likewise, there was no significant difference between treatments. The standard deviation of the dryness level values was in the range of 0-0.17.

3.5 Yellowing Level

Yellowing level is show in Fig. 5. There was no significant difference between different treatments during the storage period. The standard deviation of the yellowing level values was in the range of 0-0.17.

3.6 Chilling Injury

As shown in Fig. 6, it can be noticed that there was a high level of chilling injury at $4^{o}C$ and MAP liners, especially at the last two weeks of experiment. The chilling injury level is the same at 10ºC regardless the type of the liners. The standard deviation of the chilling injury level values was in the range of 0-0.17.

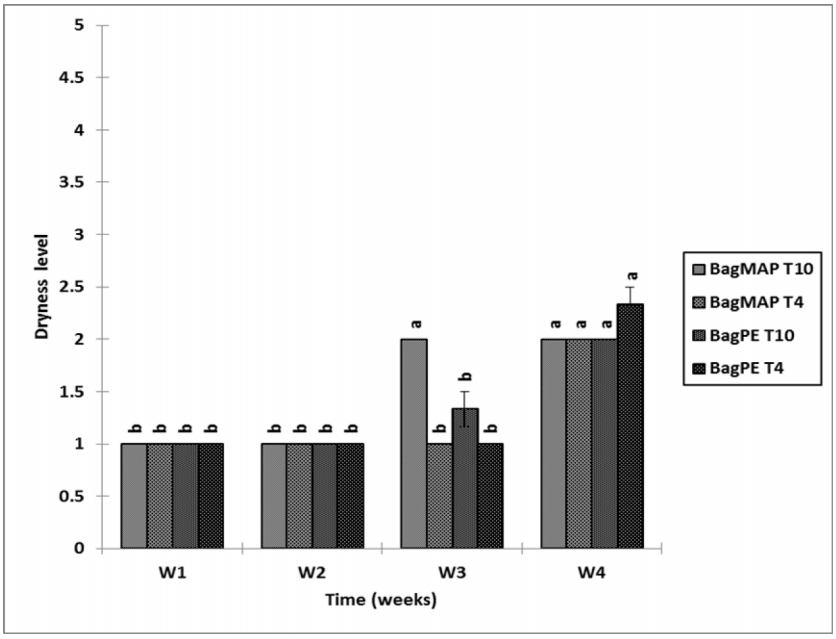

Fig. 4. Dryness level average during four weeks of experiment. Data of different letters are significantly different after Tukeys HSD test using ANOVA at P < 0.05

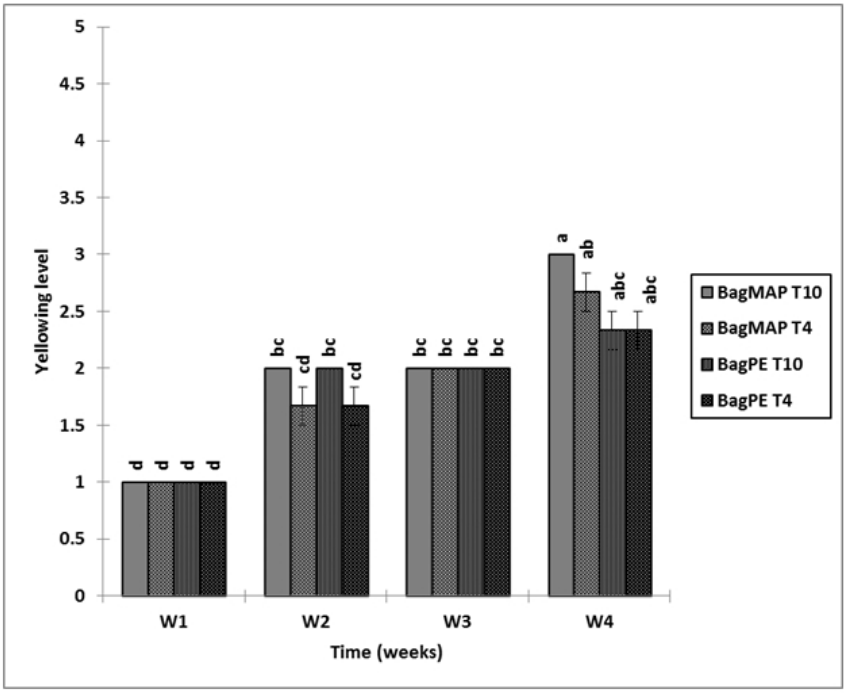

Fig. 5. Yellowing level average during experiment period. Data of different letters are significantly different after Tukeys HSD test using ANOVA at P < 0.05

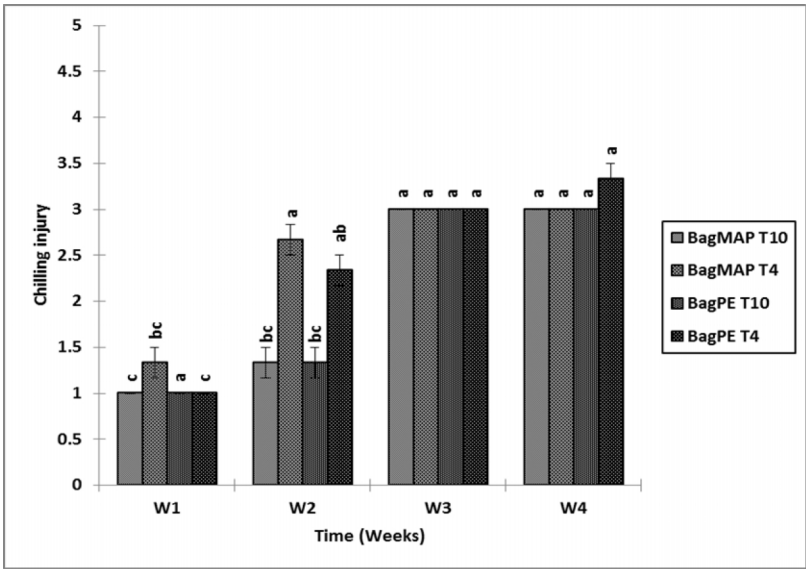

Fig. 6. Chilling injury levels during four weeks of experiment. Data of different letters are significantly different after Tukeys HSD test using ANOVA at P < 0.05

From the results above, it can be seen that it was better to store fresh-cut Jew's mallow leaves at 4ºC, since at this temperature there were higher chlorophyll content and lower decay level, especially in the first two weeks of storage period. However, at this temperature the chilling injury was higher than storing at 10ºC. The MAP liner showed a very good result in keeping the decay level as low as possible at 4ºC. However, this liner did not show any other advantages over the other liner. Despite that the MAP liner is a bit expensive than PE liner, storage at a lower temperature (i.e. 4ºC) for only two weeks has an economic implications for compensation of this cost, especially that the cost of electricity is rather high.

Further investigations are needed to study different storage conditions (e.g. temperatures and liners), and their effects on Jew's mallow postharvest quality.

4. CONCLUSION

To keep the quality of fresh-cut Jew's mallow leaves for a shelf life of two weeks, it is better to keep it at 4ºC, in modified atmosphere package (MAP) liner.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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