

Effect of different plastic liners on the quality¹ of fresh-cut Jew's mallow leaves (*Corchorus olitorius* L.) during storage under different temperatures

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ABSTRACT

Jew's mallow (*Corchorus olitorius* L.) is an important crop worldwide known for its nutritional benefits. The postharvest quality responses of Jew's mallow leaves in two different types plastic liners, normal sealed low density polyethylene and modified atmosphere package, and under two different temperatures (4°C and 10°C), were investigated. 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 4°C than at 10°C. Modified atmosphere package liner showed a good result with respect to decay level. The shelf life was two weeks.

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 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]. Ahmed and Nizam (2008) reviewed the biochemical and microbiological of Jew's mallow. They recommended to use the modern molecular technology to improve the quality and reduce losses [4]. Öztürk and Favaroğlu (2011) studied Jew's mallow infusion and extracts with different polarities, and for their polyphenolic contents and antioxidant activities. They found that higher antioxidant activity was seen in the samples with higher phenolic content

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consumed

quality
or
composition

[5]. Maity et al. (2012) reviewed different characteristics of Jew's mallow, e.g. morphological, biochemical, and molecular analysis of genome along with pest management, retting procedures, and tissue culture [6].

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 [7]. The average cost of 1 kg of green Jew's mallow is about 1.5 dollars, and the average cost of 1 kg of frozen crushed Jew's mallow is about 6 dollars [8]. 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 causes a surplus and a decrease of the price during that period. On the other hand, there will be a shortage of production during other seasons, and the price will increase. This leads to think about the possibilities to store the product 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 ~~bad~~ storage system in tropical and subtropical areas. Moreover, sundried Jew's mallow is considered as a mean for numerous fungal pathogens ~~contaminations~~, and they must be bagged in safe and healthy manner [9]. 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, where they remain fresh only for a short time. As fresh-cut Jew's mallow leaves are sold at 4 times higher prices than ordinary attached leaves to their stalks, 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 storage at two different levels of temperature, 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. MATERIAL 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 were cut from the long stalks of the crop, which was ready for consumption. The experiment was conducted in ~~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°C and 10°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.

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size of the bag? ratio free headspace/weight of the product?
the films are acting as a water vapour barrier?
what is the relative humidity inside the refrigerators?

postharvest storage films?

storage

independent?

more information about films? like thickness, permeability rates?

model?

They did not measure the composition of the atmosphere inside the bags???

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85 2.2 Quality and shelf life evaluation

86 Six quality ^{indices studied} parameters were studied including weight loss, chlorophyll content, decay level, dryness level, yellowing and chilling injury. Measurements were carried out as follows:

- 87 1. Weight loss: the difference of weight of the same treatment during storage period
88 2. Chlorophyll content (mg/g): a sample of 10 grams was taken from each treatment
89 (liner) to laboratory analysis. ^{which technique they used?}
90 ^{It is total chlorophyll}

91 The other four quality indicators were evaluated based on changes in appearance of
92 leaves and freshness as well as shelf life stability. Evaluation was done by following a
93 five-point freshness scale:

- 94 3. Decay level: 1, no decaying; 2, slight decaying; 3, moderate decaying; 4, severe
95 decaying; and 5, extremely decaying.
96 4. Dryness level: 1, extremely dry; 2, severe dry; 3, moderate dry; 4, slightly dry; 5,
97 green.
98 5. Yellowing level: 1: all leaves are yellow; 2: most leaves are yellow; 3: half the leaves
99 are yellow; 4: most leaves are green; 5: all leaves are green.

100 Chilling injury: was evaluated in terms of browning of the leaves and stems based on the
101 following scale: 1, no browning; 2, slight browning; 3, moderate browning; 4, severe
102 browning; and 5, extremely dark brown.

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104 2.3 Statistical analysis

105 The statistical analysis of the data was carried out using XLStat program (Adinosoft). Mean
106 separation tests were calculated after using ANOVA after Tukey's HSD test at $P < 0.05$.

108 3. RESULTS AND DISCUSSION

110 3.1 Weight loss

111 The weight loss is shown in Figure 1. It can be seen that the highest percentage weight loss
112 was in the case of using modified atmosphere package liners at temperature of 10°C
113 (Bag_{MAP T10}). While the lowest percentage weight loss was in the case of using polyethylene
114 (PE) liners at temperature of 4°C (Bag_{PE T4}). The highest percentage weight loss occurred
115 mainly during the first week of experiment, and then became slower during the next three
116 weeks. The standard deviation of the weight loss values was in the range of 0-0.46 (Table
117 1).
118

It doesn't make sense. MAP should diminish respiration and therefore transpiration. Also it is suppose to be a barrier to the oxygen and therefore also a barrier to water vapour. so why it ~~is there~~ loses more water than PE which is not usually considered barrier material?

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How do you explain that? It's there any similar results in the previous works?

Precision?
Do they weighed the whole bag?

who did the evaluation?

It should say if they were trained judges or consumers

how many people, etc. the samples were coded etc.

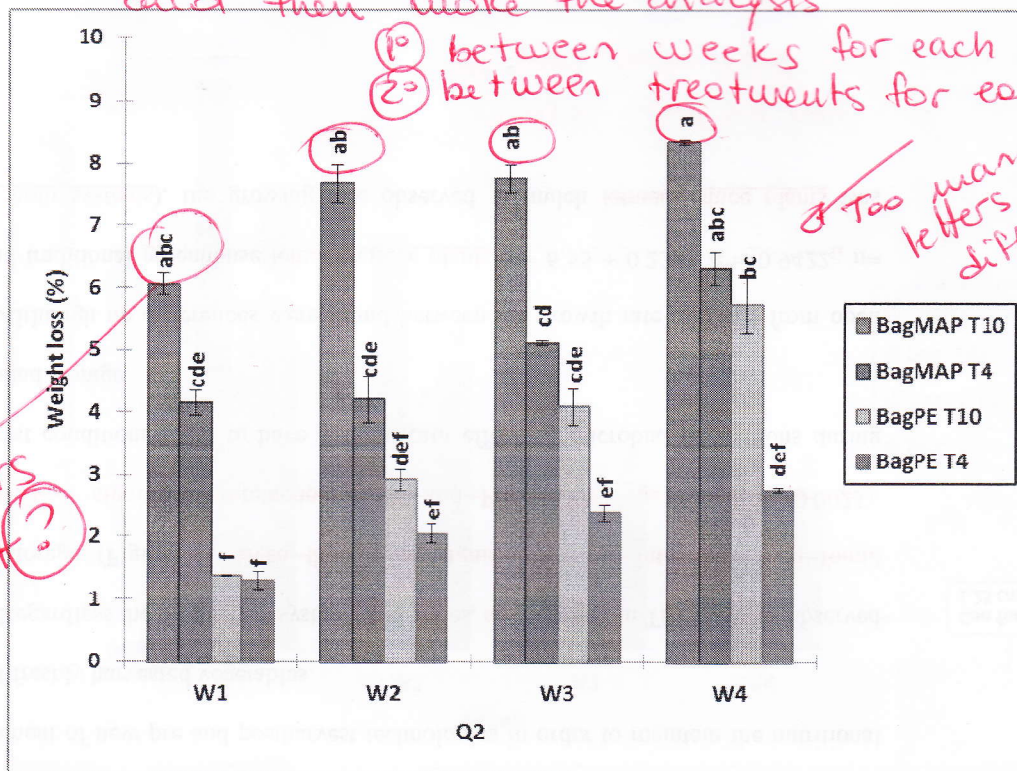
↑
Acceptance level?

Do they test for the assumptions of ANOVA?

Do they analyzed interaction temperature - time?

or they considered 4 different treatment?

Comparison between weeks and among treatments all together is wrong. they should test the interaction first (which appears to be significant) and then make the analysis



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

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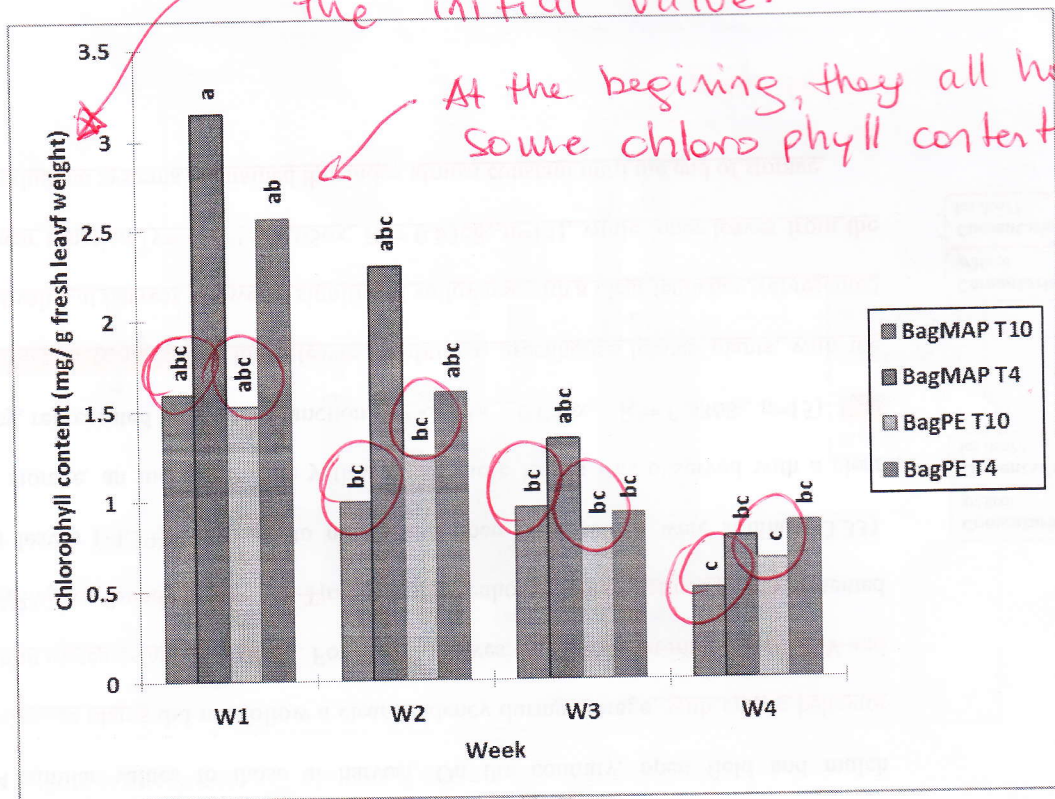
3.2 Chlorophyll content

The chlorophyll content (mg/g) is shown in Figure 2. The highest chlorophyll content was in the case of using MAP bags at 4°C temperature. However, there was a significant difference between chlorophyll content at 4°C when using MAP and PE bags. There was a decrease in chlorophyll content when storing at 10°C, in the case of both bags. This decrease was significantly during the first two weeks of storage. The standard deviation of the chlorophyll content values was in the range of 0.01-0.43 (Table 1).

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No discussion? Temperature seems to play an important role given that not differences or noted for PE or MAP at the same temperature.

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Figure 2: Chlorophyll content at different treatments during storage period.

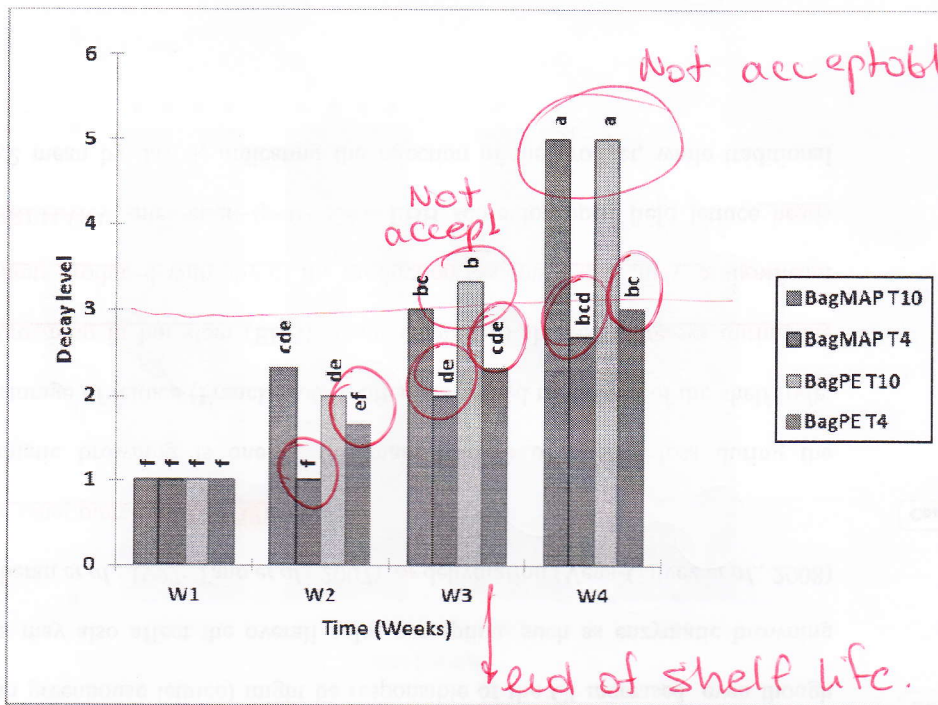
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3.3 Decay level

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The decay level is show in Figure 3. It can been seen that the highest decay level occurred when Jew's mallow leaves were stored at 10°C, 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 4°C. In this case, the decay level was almost zero during the experiment period. The standard deviation of the decay level values was in the range of 0-0.17 (Table 1).

Ageing: disution? Why is that?
~~Therefore~~ This sensorials analysis should provide the time for the end of the shelflife. For example at score = 3.



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173 Figure 3: Decay level average during the four weeks of experiment.

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175 **3.4 Dryness level**

176 Figure 4 shows the dryness level. During the first two weeks, the level is almost the same.
 177 Likewise, there was no significant difference between treatments. The standard deviation of
 178 the dryness level values was in the range of 0-0.17 (Table 1).

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to be able to obtain any conclusions
 we should ~~be aware~~ know the HR
 of the environment and inside the
 bags since its completely related to
 that.

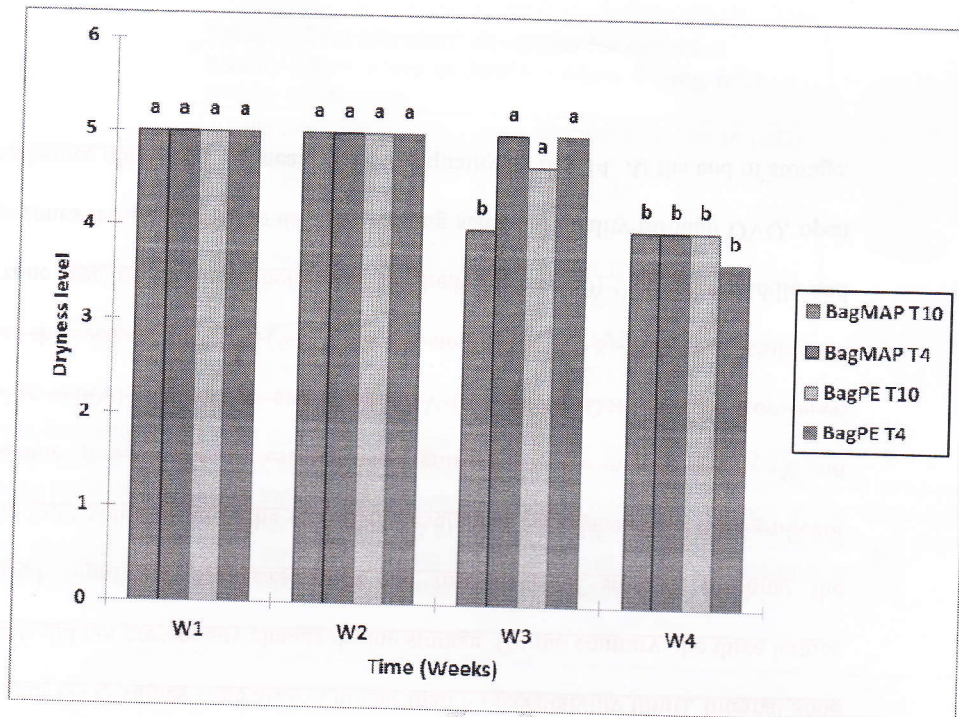


Figure 4: Dryness level average during the four weeks of experiment.

3.5 Yellowing level

Yellowing level is shown in Figure 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 (Table 1).

3.6 Chilling injury

As shown in Figure 6, it can be noticed that there was a high level of chilling injury at 4°C and MAP liners, especially at the last two weeks of experiment. The chilling injury level is the same at 10°C regardless the type of the liners. The standard deviation of the yellowing level values was in the range of 0-0.17 (Table 1).

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Table 1: The standard deviation for different quality parameters of Jew's mallow during four weeks of storage

Quality parameter	Standard deviation (SD)
Weight loss (%)	0-0.46
Chlorophyll content (mg/g)	0.01-0.43
Decay level	0-0.17
Dryness level	0-0.17
Yellowing level	0-0.17
Chilling injury	0-0.17

why is this important?

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From the results above, it can be seen that it was better to store fresh-cut Jew's mallow leaves at 4°C, since at this temperature there was 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 10°C. The modified atmosphere package (MAP) liner showed a very good result in keeping the decay level as low as possible at 4°C. However, this liner did not show any other privilege over the other liner.

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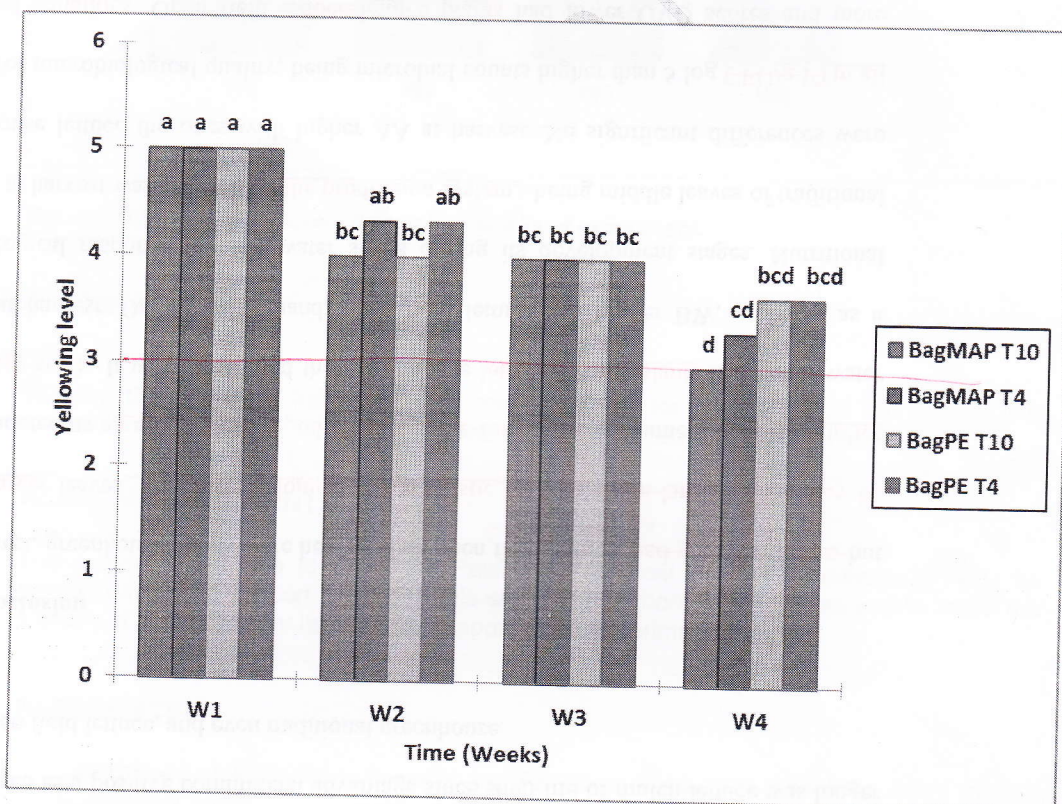
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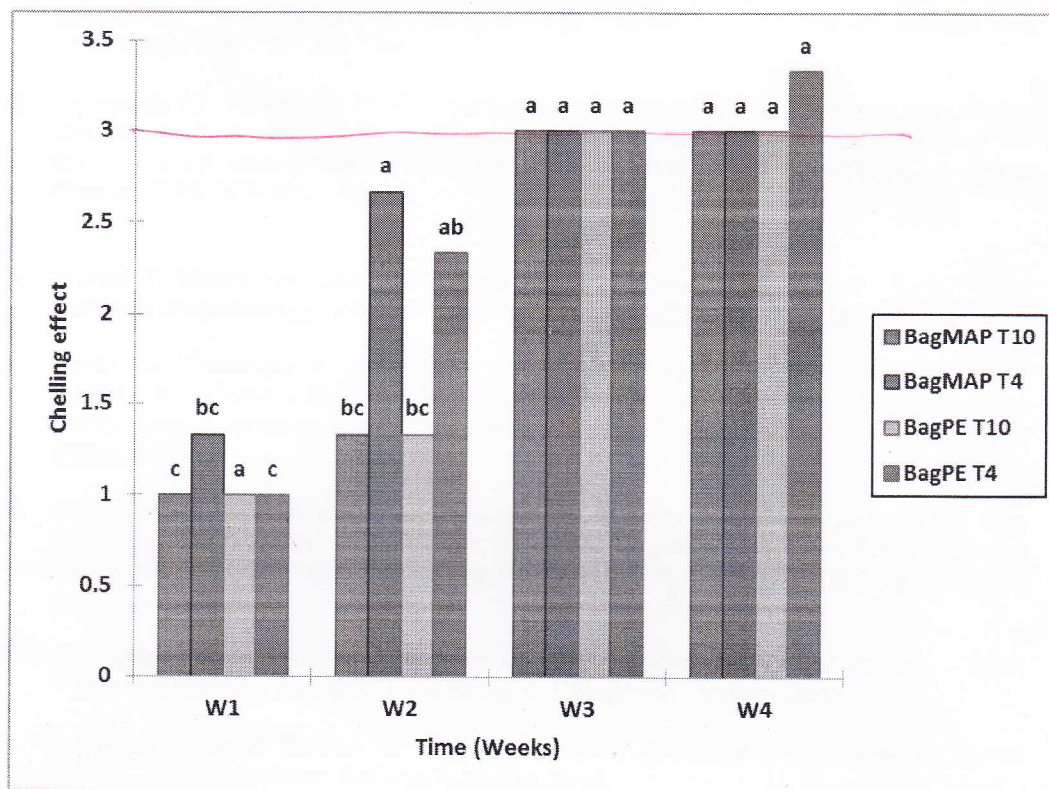
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Figure 5: Yellowing level average during the experiment period.

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235 Figure 6: Chilling injury levels during four weeks of experiment.

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4. CONCLUSION

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

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Why used MAP, which is more expensive if PE at 4°C obtained the same results? Here the most important factor is temperature (4°C) and not the film.