

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

Nawaf Abu-Khalaf¹, Mohammed Almasri², Ahmed Hajja², Naser Abbadi²,
Hakam Salah², Jawad Zakarne², Jamil Harb³ and Mazen Salman^{1*}

¹Palestine Technical University – Kadoorie, Tulkarm, Palestine

²Palestinian Ministry of Agriculture, Ramallah, Palestine

³Birzeit University, Ramallah, Palestine

ABSTRACT

The postharvest quality of Jew's mallow was tested using two types of plastic liners and two temperatures, 4°C and 10°C. 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 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, 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

* Tel.: +970-(0)9-267-7923 / Ext. 520; fax: +970-(0)9-267-7922.

E-mail salman_mazen@daad-alumni.de

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 fozen 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. 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, 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°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.

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 grams 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. 2002 [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.

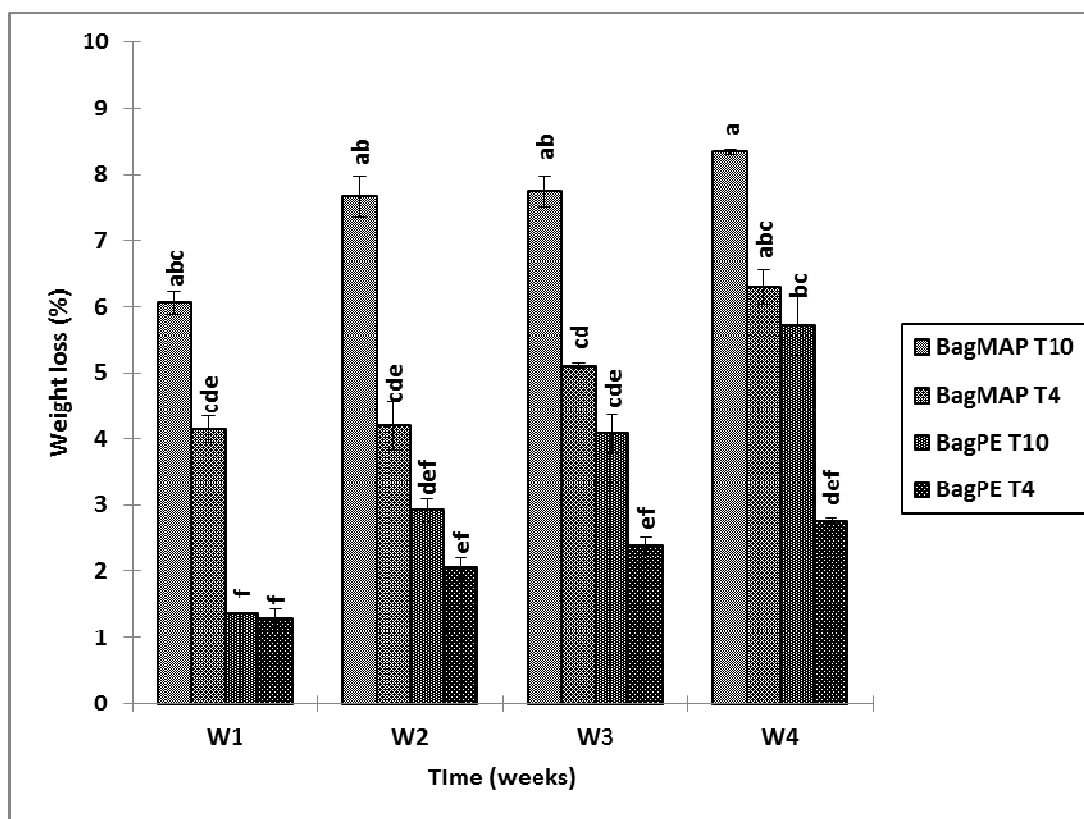
2.3 Statistical analysis

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 Figure 1. It was found that the highest weight loss was in the case of using modified atmosphere package liners at temperature at 10°C (Bag_{MAP T10}). While the lowest percentage weight loss was in the case of using polyethylene (PE) liners at 4°C (Bag_{PE T4}). 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.



127

128 Figure 1: Weight loss percentage during four weeks of experiment at different types of liners
 129 (modified atmospheric package (MAP) and polyethylene (PE)) and different temperature levels
 130 (10°C (T10) and 4°C (T4)). Data of different letters are significantly different after Tukeys HSD
 131 test using ANOVA at $P < 0.05$.
 132

133 3.2 Chlorophyll content

134 The chlorophyll content (mg/g) is shown in Figure 2. The highest chlorophyll content was in
 135 the case of using MAP bags at 4°C. However, there was a significant difference between
 136 chlorophyll content at 4°C when using MAP and PE bags. There was a decrease in
 137 chlorophyll content when storing at 10°C, in the case of both bags. This decrease was
 138 significant during the first two weeks of storage. The standard deviation of the chlorophyll
 139 content values was in the range of 0.01-0.43.
 140

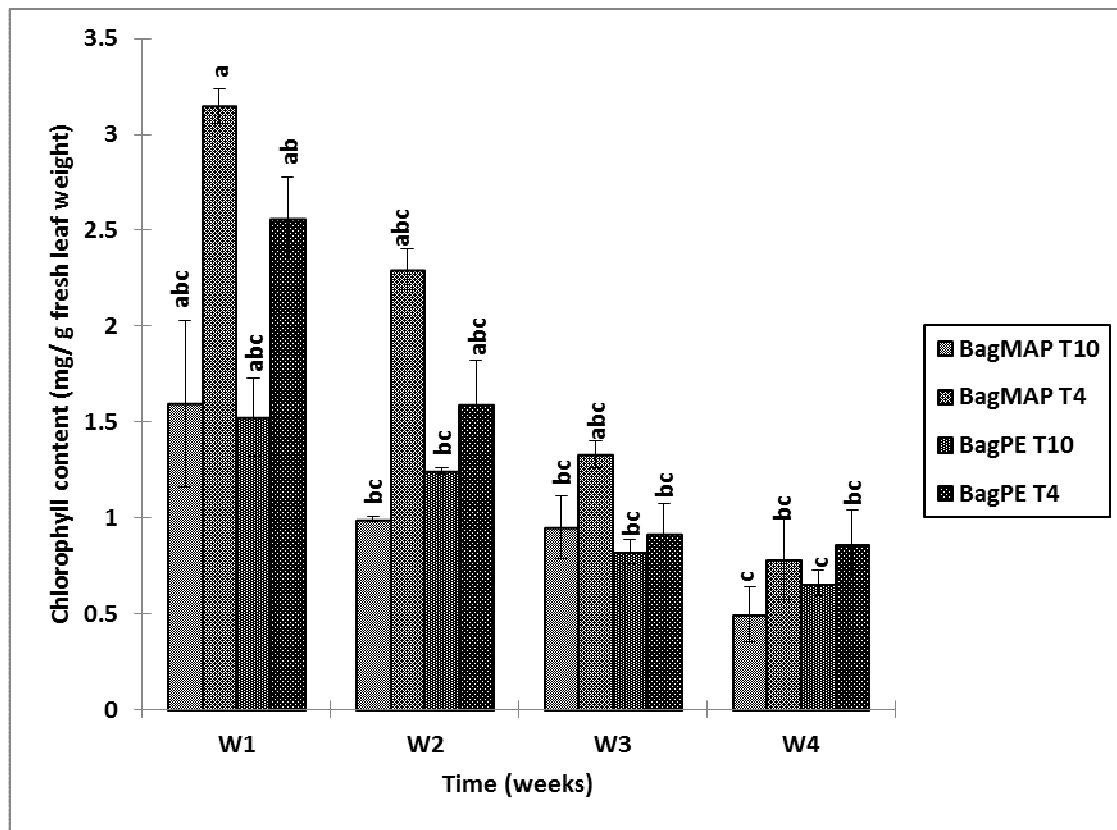
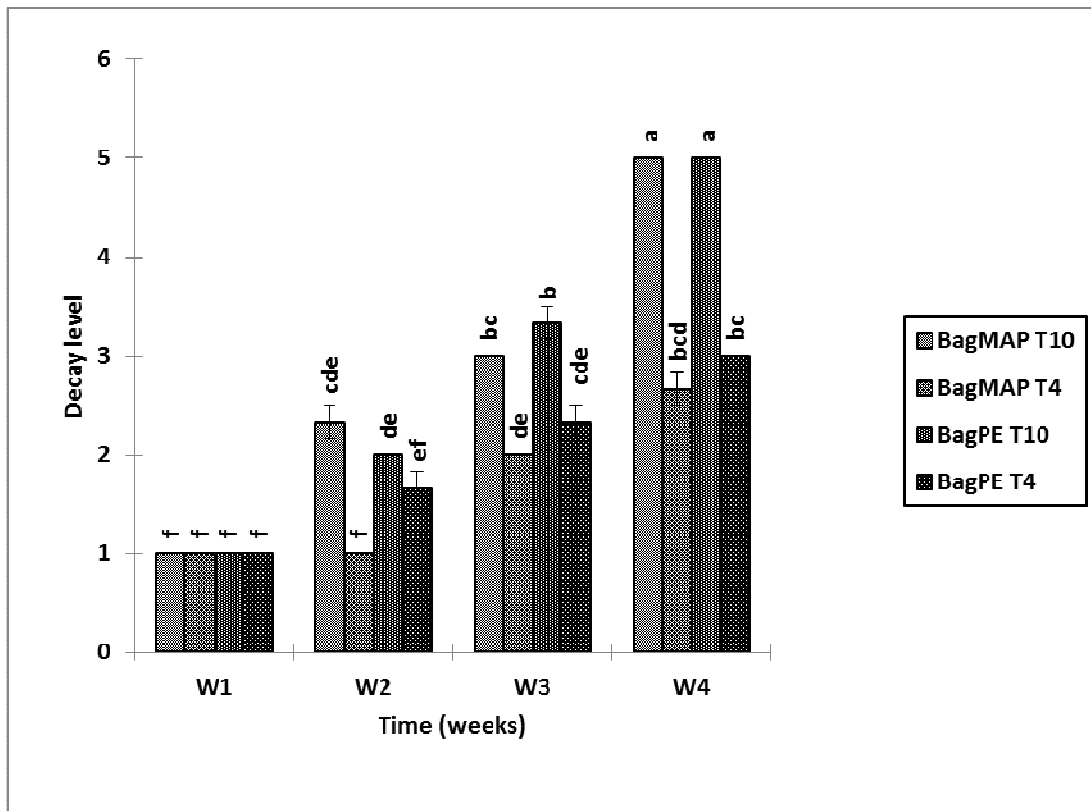


Figure 2: Chlorophyll content at different treatments during storage period. Data of different letters are significantly different after Tukeys HSD test using ANOVA at $P < 0.05$.

3.3 Decay level

The decay level is show in 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 . 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.



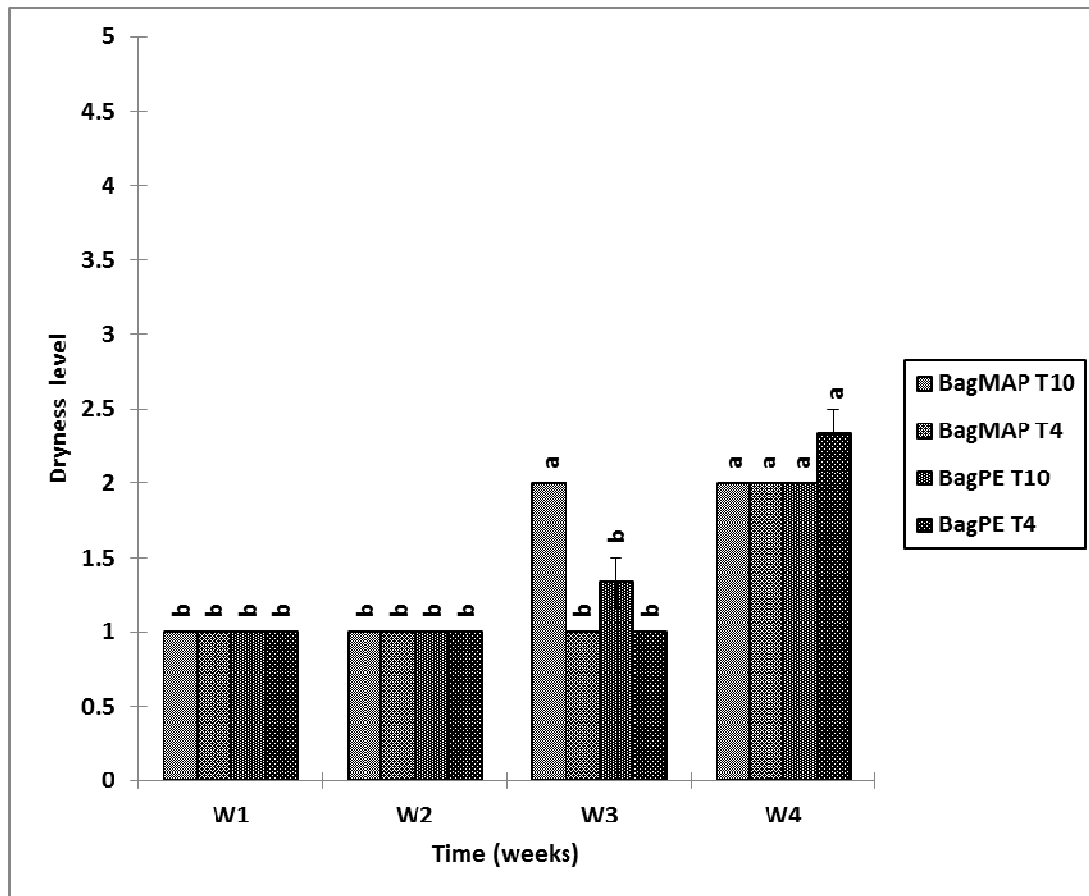
154

155 **Figure 3: Decay level average during four weeks of experiment. Data of different letters are**
 156 **significantly different after Tukeys HSD test using ANOVA at $P < 0.05$.**
 157

158 3.4 Dryness level

159 Figure 4 shows the dryness level. During the first two weeks, the level is almost the same.
 160 Likewise, there was no significant difference between treatments. The standard deviation of
 161 the dryness level values was in the range of 0-0.17.
 162

163



164

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

167

168 3.5 Yellowing level

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

172

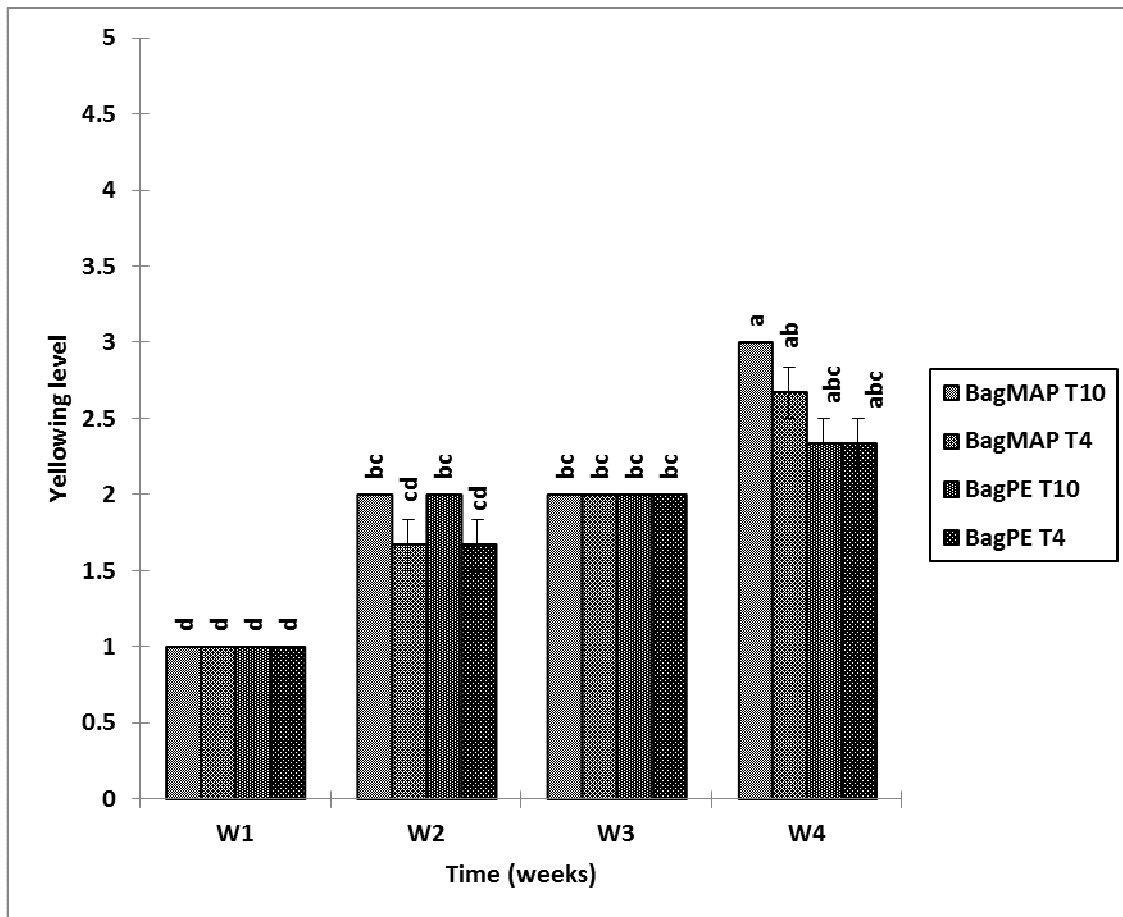
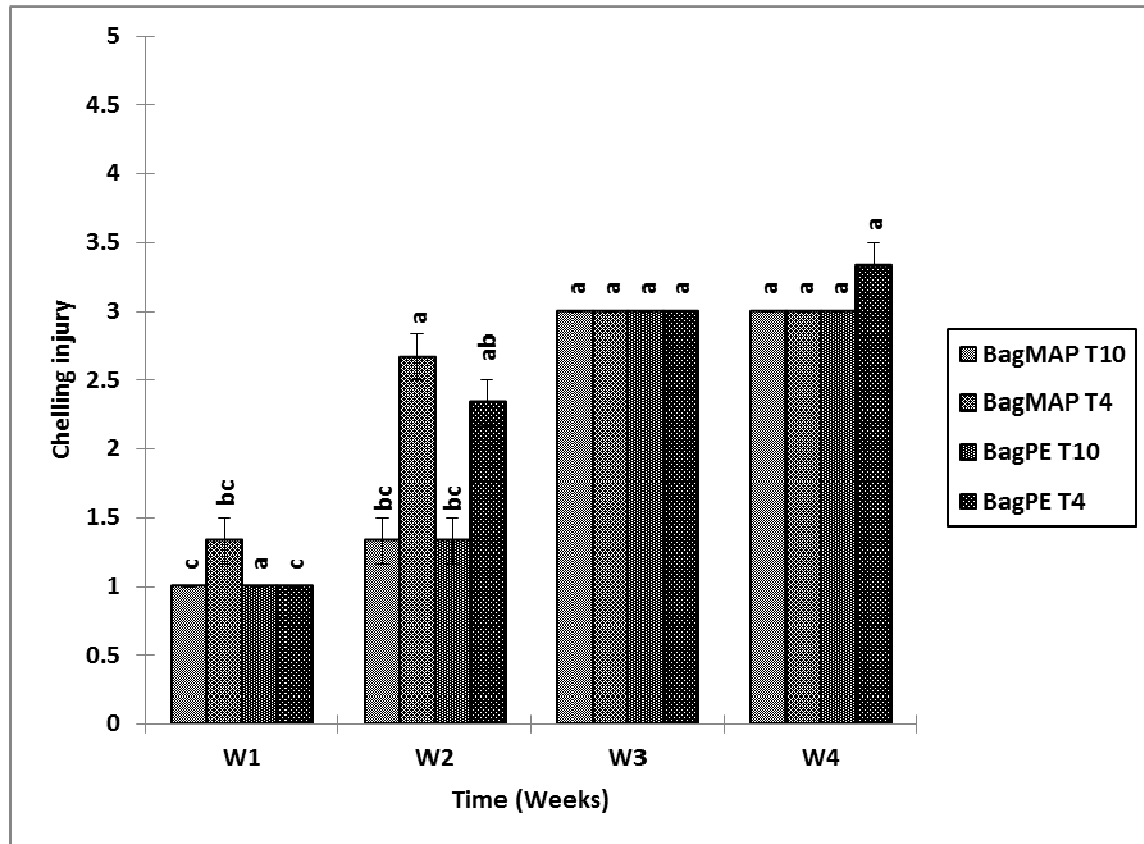


Figure 5: Yellowing level average during experiment period. Data of different letters are significantly different after Tukeys HSD test using ANOVA at $P < 0.05$.

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.



183 **Figure 6: Chilling injury levels during four weeks of experiment. Data of different letters are**
 184 **significantly different after Tukeys HSD test using ANOVA at $P < 0.05$.**

185

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

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

196

197 4. CONCLUSION

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

200
201
202
203
204
205
206
207
208

ACKNOWLEDGEMENTS

The authors would like to thank the Palestine Technical University-Kadoorie (PTUK) for providing financial support to publish this work. The authors would like as well to thank the Palestinian Ministry of Agriculture for its financial support of the experimental work.

REFERENCES

209 1. Department of Agriculture, Forestry and Fisheries. Production guidelines Jew's mallow
210 (Corchorus olitorius L.). Issued on February 2012, Agriculture, Forestry and Fisheries,
211 Republic of South Africa. <http://www.daff.gov.za/docs/Brochures/JewMallowPG.pdf>.

212 2. Tulio AZ, Ose K, Chachin K, Ueda, Y. Effects of storage temperatures on the
213 postharvest quality of jute leaves (Corchorus olitorius L.). Postharvest Biology and
214 Technology. 2002; 26: 329–338.

215 3. Ogunrinde AT, Fasinmirin JT. Soil moisture distribution pattern and yield of Jute mallow
216 (corchorus olitorius) under three different soil fertility management. Proceedings of the
217 Environmental Management Conference, Federal University of Agriculture, Abeokuta,
218 Nigeria. 2011; 373-381.

219 4. Ahmed Z, Nizam SA. Jute - microbiological and biochemical research. Plant Tissue
220 Culture & Biotechnology. 2008; 18: 197-220. DOI. 10.3329/ptcb.v18i2.3651.

221 5. Öztürk N, Favaroğlu F. Antioxidant activities of Molokhia (Corchorus olitorius L.)
222 extracts. In: Gökçekus H, Türker U, LaMoreaux JW, editors. Survival and Sustainability,
223 Environmental concerns in the 21st Century. 2011; 535-543. DOI: 10.1007/978-3-540-
224 95991-5_48.

225 6. Maity S, Chowdhury S, Datta, AK. Jute biology, diversity, cultivation , pest control, fiber
226 production and genetics. In: Lichtfouse, E, editors. Organic Fertilisation, Soil Quality and
227 Human Health, Sustainable Agriculture Reviews. 2012; 9: 227-262. DOI: 10.1007/978-
228 94-007-4113-3_9.

229 7. Ali, MH, Al-Qahtani, KM. Assessment of some heavy metals in vegetables, cereals and
230 fruits in Saudi Arabian markets. The Egyptian Journal of Aquatic Research. 2012; 38(1):
231 31–37.

232 8. Doherty, VF, Sogbanmu, TO, Kanife, UC, Wright, O. Heavy metals in vegetables
233 collected from selected farm and market sites in Lagos, Nigeria. Journal of
234 Environmental Science and Toxicology. 2012; 1(6): 137-142.

235 9. Palestinian Central Bureau of Statistics (PCBS), Statistics Agricultural Census – 2010,
236 Palestinian National Authority, Final Results - Palestinian Territory. 2011.

237 10. Palestinian Central Bureau Of Statistics (PCBS), Prices and price indices, annual
238 bulletin, 2010, Palestinian National Authority. 2011.

239 11. Youssef MS. Studies on mycological status of sundried Jew's-mallow leaves and okra
240 fruits in Egypt. Research Journal of Microbiology. 2008; 3: 375-385.

- 241 12. Lichtenthaler, HK. Chlorophylls and carotenoids: pigments of photosynthetic
242 membranes. *Methods in Enzymology*. 1987; 148: 350–382.
- 243 13. Kristina, G. Consumer perceptions of fresh meat quality: cross-national comparison.
244 *British Food Journal*. 2000; 102: 177-194.
- 245 14. Peneau, S, Hoehn, E, Roth, HR, Escher, F, Nuessli, J. Importance and consumer
246 perception of freshness of apples. *Food Quality and Preference*. 2006; 17(1): 9-19.
- 247 15. Prabhu, S, Barrett, DM. Effects of storage condition and domestic cooking on the quality
248 and nutrient content of African leafy vegetables (*Cassia tora* and *Corchorus tridens*).
249 *Journal of the Science of Food and Agriculture*. 2009; 89(10): 1709-1721.