

Effect of Different Wrapping Films on Quality and Storability of Globe Artichoke during Cold Storage.

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Abstract

Artichoke heads of the cultivar "French Hyrious" were harvested at the suitable maturity stage of marketing with a dimension of (7-12 cm) on 14th and 16th of February in 2017 and 2018 seasons, respectively from Borg El-arab farm, Behera Governorate and shifted to the laboratory of Vegetable Handling Research Department, Horticultural Research Institute, Agricultural Research Center, Ministry of Agriculture, A.R.E. to evaluate the potential of wrapping films polypropylene, polyethylene and polyvinyl film in preserving the quality parameters and extend the shelf life of artichoke heads during cold storage. Wrapping artichoke heads in the different wrapping films slowed the rate of weight loss, had the highest compactness and gave the highest value of L value, resulted in lighter color comparatively to the highest ones obtained from unwrapped heads. Artichoke heads wrapped with polypropylene film or polyethylene film were perceived to have the highest intensities of freshness, greenness and compactness. Wrapping artichoke heads with polypropylene film produced an improvement in market quality; it would reduce weight loss percentage, color change and maintained ascorbic acid content and gave product with good appearance after 28 days of storage at 0 °C and 95 % RH.

Key words: Artichoke heads, Wrapping films, Artichoke storability and quality and cold storage.

Introduction

Globe artichoke (*Cynara scolymus* L.) is considered as one of the important vegetable crops for local consumption and export in Egypt. The nutraceutical properties of artichokes are mainly due to its high polyphenolic content (Azzini *et al.*, 2007), which can be up to 2% of the fresh weight (Mileo *et al.*, 2012), and the presence of fructan inulin that has been reported to have a prebiotic function that stimulates the growth of intestinal bifido bacteria (Salazar *et al.*, 2015 and Lavermicocca *et al.*, 2016).

However, artichoke is a highly perishable commodity, characterized by rapid rates of respiration and water loss (Kader, 1992). The main factors of artichoke heads quality degradation during prolonged storage are mostly due to decay development shriveling, associated with rapid water loss, poor external appearance, as well as reduced sensory quality. Therefore, optimum temperature (0 – 1° C) of storage was mainly the major factor for extending the storage ability of artichoke by minimizing both the physical, chemical and biochemical changes (Atala, 2006). In addition to refrigeration; wrapping film is one of the important supplemental tools to keep more good qualities for better marketing. Thus, it was found on globe artichoke that the stored heads at 4°C in polyethylene bags showed minimum loss in weight, unmarketable heads and maximum visual quality than the unpacked ones (Nobile *et al.*, 2009). The use of selective plastic film for prolonging the storability of artichoke heads was studied by many investigators, as the selection of proper packaging is of crucial importance to create conditions able to guarantee the maintenance of

product quality (Lucera *et al.*, 2011). Further study on globe artichoke indicated that the heads stored at 5°C in perforated polypropylene films kept comparatively the highest content of ascorbic acid than those stored in polyvinyl chloride, polyethylene or micro perforated polypropylene bags after 8 days of storage (Gil-Izquierdo *et al.*, 2002).

The objective of this work was to evaluate the potential of wrapping film in preserving the quality parameters and extend the shelf life of artichoke heads during cold storage.

Materials and Methods

Artichoke heads of the cultivar "French Hyrious" were harvested at the suitable maturity stage of marketing with a dimension of (7-12 cm) on 14th and 16th of February in 2017 and 2018 season respectively from Borg El-arab farm, Behera Governorate and shifted to the laboratory of Vegetable Handling Research Department, Horticultural Research Institute, Agricultural Research Center, Ministry of Agriculture, A.R.E.

Heads were cleaned with dry towels, graded and put in carton boxes with a dimension of (40×30×15 cm). Each box contained heads (three replicates, each replicate were three heads). Boxes were wrapped with polypropylene film (30µm thickness), polyethylene film (30µm thickness) and polyvinyl film (35µm thickness) beside unwrapped (control). Four boxes were prepared for each treatment. All wrapping materials were stored at 0° C and 95% RH for 28 days. The experimental design was completely randomized design with three replicates. Three replicate from each treatment were taken at

random and examined immediately after harvest and every 7 days at 0°C for the following properties.

Weight loss percentage calculated by the following equation: weight loss % = Loss in weight at the sampling date / the initial weight of the head X100. The general appearance: Score rating from 9 to 1 Where 9= excellent, 7= good, 5= fair, 3= poor and 1= inedible. The compactness: Score rating from 5 to 1, where 5= tight, 4= few basal bracts pointing a way from rather than toward tip of bud, 3= several whorls of bracts pointing a way from rather than toward tip of bud, 2= all or most outer bracts open, 1= all outer and more antrally located bracts open. External surface color was evaluated by a color meter (Minolta CR 200) to measure the lightness (L value) and hue angle (h°) value. Ascorbic acid content (as indicated for vit. C). It was determined (as fresh samples of heads) by titration method using 2,6-dichloro phenol indophenols as described in (Ranganna, 1979).

Statistical analysis

Data were statistically analyzed using the analysis of variance described by Snedecor and Cochran (1980). The method of Duncan multiple range tests were applied for than comparison between means according to Waller and Duncan (1969).

Results and Discussion

Weight loss percentage

Data in Table (1) showed that weight loss percentage of artichoke heads was increased considerably and consistently with the prolongation of storage period. These results were in agreement with those obtained by (Helaly *et al.*, 2016). The loss in weight may be attributed to respiration and other senescence related metabolic processes during storage (Wills *et al.*, 1981).

Concerning the effect of wrapping films, different wrapping films showed significant differences in their heads weight loss percentage. In this respect, wrapping artichoke heads in the different wrapping films slowed the rate of weight loss comparatively to the highest ones obtained from unwrapped heads. Artichoke heads wrapped with polypropylene film was the most effective treatment in reducing the weight loss percentage followed by polyethylene film with significant differences between them. Polyvinyl film was less effective in this concern. These results were achieved in the two seasons and were in agreement with (Nobile *et al.*, 2009), who found that lowest weight loss from artichoke heads wrapped in different wrapping films is due to the confinement of moisture around the produce. This increases the relative humidity and reduces vapor pressure deficit and transpiration. In addition, wrapping films creates a modified atmosphere with high concentration of CO₂ and reduced O₂ around the produce which slows down metabolic processes and transpiration (Thompson, 1996), which diminished the weight loss % during storage (Wang and Qi, 1997).

Table 1. Effect of different wrapping films on weight loss percentage of artichoke heads during storage in 2017 and 2018 seasons.

Treatments	Storage period in days					means
	Start	7	14	21	28	
2017 season						
Polypropylene film	0.00 K	1.47 J	2.43 HI	4.40 G	4.92 G	2.65 D
Polyethylene film	0.00 K	1.75 IJ	2.45 HI	5.09 G	5.95 EF	3.05 C
Polyvinyl film	0.00 K	2.87 H	5.15 FG	6.31 E	8.53 D	4.57 B
Control (unwrapped)	0.00 K	4.91 G	9.37 C	11.4 B	14.09 A	7.95 A
Means	2.75 D	4.85 C	6.80 B	8.37 A	0.15 E	
2018 season						
Polypropylene film	0.00 O	1.59 N	2.55 L	4.52 J	5.04 I	2.74 D
Polyethylene film	0.00 O	1.87 M	2.57 L	5.21 H	6.07 F	3.14 C
Polyvinyl film	0.00 O	3.13 K	5.41 G	6.57 E	8.79 D	4.78 B
Control (unwrapped)	0.00 O	5.17 H	9.63 C	11.66 B	14.35 A	8.16 A
Means	0.00 E	2.94 D	5.04 C	6.99 B	8.56 A	

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.

In general, the interaction between different wrapping films and storage period had significant effect on weight loss percentage. After 28 days of storage, the lowest value of weight loss was recorded from heads wrapped in polypropylene film while the highest ones were obtained from unwrapped film.

General appearance (GA)

Data in Table (2) revealed that there was significant reduction in GA with the prolongation of storage period. The decreases in GA of artichoke heads during storage might be due to shriveling with color change and decay (Nobile *et al.*, 2009).

Regarding the effect of wrapping films on general appearance, data showed that all wrapping films had higher score of GA when compared with unwrapped heads. Artichoke heads wrapped with polypropylene

film or polyethylene film were perceived to have the highest intensities of freshness, greenness and compactness with no significant differences between them, while unwrapped head was perceived to have low intensities of these attributes. These results were achieved in the two seasons and were in agreement with (Gil-Izquierdo *et al.*, 2002 and Nobile *et al.*, 2009).

The interaction between wrapping films and storage period revealed that artichoke heads wrapped with polypropylene film or polyethylene film gave good appearance after 28 days of storage at 0° C, while heads which wrapped with polyvinyl film rated good appearance after 21 days of storage. On the other hand, unwrapped heads rated below fair appearance after 28 days of storage.

Table 2. Effect of different wrapping films on general appearance (score) of artichoke heads during storage in 2017 and 2018 seasons.

Treatments	Storage period in days					means
	Start	7	14	21	28	
2017season						
Polypropylene film	9.00 A	9.00 A	9.00 A	8.33 AB	7.67 BC	8.60 A
Polyethylene film	9.00 A	9.00 A	9.00 A	7.67 BC	7.00 CD	8.33 AB
Polyvinyl film	9.00 A	9.00 A	8.33 AB	7.00 CD	6.33 D	7.93 B
Control (unwrapped)	9.00 A	9.00 A	7.00 CD	5.00 E	4.33 E	6.87 C
Means	9.00 A	9.00 A	8.33 B	7.00 C	6.33 D	
2018 season						
Polypropylene film	9.00 A	9.00 A	9.00 A	7.67 BC	7.00 C	8.33 A
Polyethylene film	9.00 A	9.00 A	8.33 AB	7.67 BC	7.00 C	8.20 A
Polyvinyl film	9.00 A	9.00 A	7.67 BC	7.00 C	5.00 D	7.53 B
Control (unwrapped)	9.00 A	9.00 A	7.00 C	5.00 D	3.67 E	6.73 C
Means	9.00 A	9.00 A	8.00 B	6.83 C	5.67 D	

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.

Compactness

Data in Table (3) showed that compactness (score) of artichoke heads was decreased with the prolongation of storage period. These results were in agreement with (Atala, 2006).

Concerning the effect of wrapping films, data revealed that there were significant differences between wrapping films and unwrapping (control). The highest score of head compactness were obtained by artichoke heads wrapped with polypropylene, polyethylene and polyvinyl films

with no significant differences between them, while the lowest values of head compactness score were recorded from unwrapped (control).

As for the interaction between wrapping films and storage period, after 28 days of storage, heads wrapped in polypropylene film or polyethylene film had the highest compactness score with no significant differences between them, while unwrapped (control) recorded the lowest compactness score in the same period. These results were in agreement with (Gil-Izquierdo *et al.*, 2002).

Table 3. Effect of different wrapping films on compactness (score) of artichoke heads during storage in 2017 and 2018 seasons.

Treatments	Storage period in days					means
	Start	7	14	21	28	
2017season						
Polypropylene film	5.00 A	5.00 A	5.00 A	5.00 A	5.00 A	5.00 A
Polyethylene film	5.00 A	5.00 A	5.00 A	5.00 A	4.67 AB	4.93 A
Polyvinyl film	5.00 A	5.00 A	5.00 A	5.00 A	4.33 BC	4.87 A
Control (unwrapped)	5.00 A	5.00 A	4.00 C	3.33 D	3.00 D	4.07 B
Means	5.00 A	5.00 A	4.75 B	4.58 B	4.25 C	
2018 season						
Polypropylene film	5.00 A	5.00 A	5.00 A	4.67 A	4.67 A	4.87 A
Polyethylene film	5.00 A	5.00 A	5.00 A	4.67 A	4.33 AB	4.80 A
Polyvinyl film	5.00 A	5.00 A	4.67 A	4.67 A	3.67 AC	4.60 A
Control (unwrapped)	5.00 A	5.00 A	3.67 A-C	3.00 BC	2.33 C	3.80 B
Means	5.00 A	5.00 A	4.58 AB	4.25 BC	3.75 C	

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.

Color

Data in Table (4) showed that the color of the homogenized sample (L value and hue angle) was

measured. The L value is measure of the highness of the artichoke heads while the hue angle represents a coordinate in a standardized color space. Lightness

of artichoke heads was affected by storage time. A decrease in L value was detected by prolonging the storage period indicated darker color.

Regarding the effect of wrapping films, data revealed that artichoke heads wrapped with polypropylene or polyethylene film gave the highest value of L value, resulted in lighter color with no significant differences between them in the first season, while unwrapped heads gave the lowest

value and resulted in darker color during storage. These results are in agreement with (Alexopoulos *et al.*, 2003 and Sergio *et al.*, 2016).

In general, the interaction between wrapping films and storage periods were significant, after 28 days of storage, the highest value of L (score) was recorded from heads wrapped in polypropylene film, while the lowest ones were obtained from unwrapped film.

Table 4. Effect of different wrapping films on color (L value) of artichoke heads during storage in 2017 and 2018 seasons.

Treatments	Storage period in days					means
	Start	7	14	21	28	
2017season						
Polypropylene film	50.81 A	40.33 CD	38.20 DE	45.03 B	33.29 FH	41.53 A
Polyethylene film	50.81 A	38.50 DE	35.40 EG	43.28 BC	30.10 HI	39.62 A
Polyvinyl film	50.81 A	37.46 DF	31.20 GH	41.82 BD	26.20 IJ	37.50 B
Control (unwrapped)	50.81 A	35.59 EG	29.40 HI	38.05 DE	23.20 J	35.41 C
Means	50.81 A	37.97 C	33.55 D	42.04 B	28.20 E	
2018 season						
Polypropylene film	48.60 A	38.23 E	36.10 F	42.93 B	31.19 K	39.41 A
Polyethylene film	48.60 A	33.40 H	33.30 H	41.18 C	28.00 M	36.90 B
Polyvinyl film	48.60 A	34.76 G	28.50 L	39.12 D	23.50 O	34.90 C
Control (unwrapped)	48.60 A	32.89 I	26.70 N	32.35 J	20.50 P	32.21 D
Means	48.60 A	34.82 C	31.15 D	38.90 B	25.80 E	

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.

Changes in hue angle values of artichoke heads are good indicator of senescence. As shown in Table (5) showed that the hue angle values of artichoke heads gradually decreased as the storage period extended indicating that artichoke heads turned to slight yellow as the storage period prolonged.

Concerning the effect of wrapping films on hue angle values, data revealed that artichoke heads wrapped with polypropylene film were more green

color of heads (higher value of hue angle) as compared to those wrapped with polyethylene or polyvinyl film during storage. On the other hand, unwrapped heads gave the lower value of hue angle as an important degreening or intense yellowing. These results were true in the two seasons and were in agreement with those obtained by (Alexopoulos *et al.*, 2003 and Sergio *et al.*, 2016).

Table 5. Effect of different wrapping films on color (hue angle h°) of artichoke heads during storage in 2017 and 2018 seasons.

Treatments	Storage period in days					means
	Start	7	14	21	28	
2017season						
Polypropylene film	88.48 A	86.21 B	84.32 D	81.22 H	80.13 J	84.07 A
Polyethylene film	88.48 A	85.11 C	83.41 E	80.21 I	78.25 K	83.09 B
Polyvinyl film	88.48 A	83.21 F	80.23 I	77.41 L	75.25 N	80.92 C
Control (unwrapped)	88.48 A	81.41 G	76.25 M	71.35 O	66.25 P	76.75 D
means	88.48 A	83.99 B	81.05 C	77.55 D	74.97 E	
2018 season						
Polypropylene film	91.26 A	90.42 B	88.23 C	86.24 E	84.25 F	88.08 A
Poly ethylene film	91.26 A	88.23 C	86.25 E	83.42 G	81.11 I	86.05 B
Polyvinyl film	91.26 A	86.32 D	84.21 F	80.52 J	78.24 L	84.11 C
Control (unwrapped)	91.26 A	83.25 H	80.11 K	77.23 M	73.17 N	81.00 D
means	91.26 A	87.06 B	84.70 C	81.85 D	79.19 E	

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.

Ascorbic acid content

Data in Table (6) showed that ascorbic acid content of heads was significantly decreased with the

prolongation of storage period. Similar results were obtained by (Atala, 2006). However, artichoke heads wrapped with different wrapping films hold more

ascorbic acid content than unwrapped heads during storage. Whereas, the highest ascorbic acid content were obtained from wrapped heads in polypropylene followed by polyethylene film with significant differences between them in the two seasons. While the lowest one was recorded in unwrapped heads.

The aforementioned results were in accordance with those obtained by (Gil-Izquierdo *et al.*, 2002) who reported that wrapping artichoke heads in polypropylene film kept comparatively the highest content of ascorbic acid than those stored in polyvinyl, polyethylene after 8 days of storage.

Table 6. Effect of different wrapping films on ascorbic acid content (mg/100gm f.w) of artichoke heads during storage in 2017 and 2018 seasons.

Treatments	Storage period in days					means
	Start	7	14	21	28	
2017season						
Polypropylene film	72.00 A	70.40 AB	65.00 AC	62.67 BD	54.67 DG	64.95 A
Polyethylene film	72.00 A	66.00 AC	58.33 CF	52.00 FH	46.67 GI	59.00 B
Polyvinyl film	72.00 A	61.60 BE	53.33 EH	46.67 GI	40.00 IJ	54.72 C
Control (unwrapped)	72.00 A	55.00 DG	45.00 HI	38.67 IJ	32.00 J	48.53 D
means	72.00 A	63.25 B	55.42 C	50.00 D	43.33 E	
2018 season						
Polypropylene film	70.20 A	68.20 A	62.80 B	57.14 CD	52.47 E	62.16 A
Polyethylene film	70.20 A	63.40 B	55.73 D	49.40 F	44.07 G	56.56 B
Polyvinyl film	70.20 A	59.40 C	51.13 EF	44.47 G	37.80 H	52.60 C
Control (unwrapped)	70.20 A	52.40 E	42.40 G	36.07 H	29.40 I	46.09 D
means	70.20 A	60.85 B	53.01 C	46.77 D	40.94 E	

Means in the same column having the same letter are not significantly different at 0.05 levels by Duncan's multiple rang test.

From the previous results, it can be concluded that wrapping artichoke heads with polypropylene film produced an improvement in market quality; it would reduce weight loss percentage, color change and maintained ascorbic acid content and gave product with good appearance after 28 days of storage at 0 °C and 95 % RH.

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تأثير التبطين بالاعلفة المختلفة على الجودة والقدرة التخزينية للخرشوف خلال التخزين المبرد.

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معهد بحوث البساتين - مركز البحوث الزراعية بالجيزة.

تم جمع نورات الخرشوف صنف French Hyrious في مرحلة القطف المناسبة للتسويق (قطر 7-12 سم) في 14، 16 فبراير سنة 2017 ، 2018 على التوالي من مزرعة برج العرب محافظة البحيرة ثم نقلت الى معمل بحوث تداول الخضار - معهد بحوث البساتين - مركز البحوث الزراعية - وزارة الزراعة و ذلك لدراسة تأثير استخدام انواع مختلفة من المغلفات (بولى بروبيلين و بولى ايتلين و بولى فينيل فيلم) على المحافظة على صفات الجودة و اطالة فترة حياة نورات الخرشوف اثناء التخزين المبرد.

أوضحت النتائج ان تبطين نورات الخرشوف بكل انواع المغلفات قد ادت الى تقليل معدل فقد الوزن ، اكثر اندماجا و اعطت اعلى قيمة من L value مقارنة بالنورات الغير مغلفة. نورات الخرشوف المغلفة بالبولى بروبيلين او البولى ايتلين كانت اكثر احتفاظا بالطزاجة و اللون الاخضر و الاندماج. ادى تغليف نورات الخرشوف بالبولى بروبيلين فيلم الى تحسين جودة التسويق حيث ادت الى تقليل نسبة فقد الوزن و التغير فى اللون مع المحافظة على محتوى حمض الاسكوربيك كما اعطت مظهر جيد بعد 28 يوم من التخزين على درجة صفر °م و رطوبة نسبية 95 %.