IMPACT OF PACKAGING AND HEAT TREATMENT ON MAINTAINING GREEN ONION POST HARVEST QUALITY

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Abstract

Packaging film and heat treatments were tested as means to maintain quality and extend the shelf life of green onion plants (*Allium cepa*) cv. Giza 20. Packaging in nonperforated polyethylene bags maintained the visual quality appearance, chlorophyll content of the green leaves and reduced weight loss percentage when stored at 0°C followed by 2 days at 20°C simulated retail period.

Total soluble solids did not affect by packaging type. However, hot water treatment 55°C for 6 min controlled leaf growth and reduced curvature. Also, stored the plants vertically reduced subsequent green onion geotropic curvature but did not affect the extension leaf growth.

INTRODUCTION

Minimal or fresh-cut processing of green onion provides convenience to food service and retail customers but may result in limited postcutting shelf life because of undesirable physiological changes (Cantwell *et al.,* 2001). Minimal processing of green onion includes removal senescent and damaged outer leaves, the cutting of roots, trimming of the leaves to give plants of 30 cm length. This preparation usually results in cutting damage, discoloration, dehydration and decay which are common defects of the cut surface (Hong *et al.*, 2000).

Extention growth of the white inner leaf bases (Cantwell *et al.,* 2001) and leaf curvature due to negative geotropism which occurs when the product is placed horizontally (Hong *et al.*, 2000) causes a rapid loss in the overall market quality of the product. Thus, for this reason, this work was undertaken to study the potential benefit of packaging film, hot water treatment and plant position inside the package on the maintenance of quality, reducing extension growth and geotropic curvature of green onion during cold storage and shelf life conditions.

Packaging film has been used with low temperature storage to maintain green onion fresh appearance (Atta-Aly, 1998), reduced weight loss (Jacxsens *et al.,* 2002) and slowed down the loss of color (Hruschka, 1974). Packaging green onion in polypropylene bag is very important to protect the marketability of the plant (Emam, 1999).

Heat treatment have been demonstrated to be effective as a non chemical means for quality retention of fresh horticultural products. Hot water dip was more effective in reducing extension growth of green onion (Hong *et al.*, 2000, Cantwell *et al.,* 2001) and controlled geotropic curvature in green onion (Hong *et al.*, 2000).

Packaging and shipping of asparagus spear vertically can be considered as useful tool to reduce geotropic bending (Paull and Chen., 1999).

MATERIALS AND METHODS

Green onion (Allium cepa, L.) seeds cv. Giza 20, were sown on 19th of October of both 2005 and 2006 seasons, at Kaha Experimental Farm, Qalubia Governorate using standard production practices.

After 3 months from planting, the plants were harvested on January 22nd and 24th of 2006 and 2007 seasons respectively. Plants were transferred directly to the laboratory of Post harvest and Handling Research Department at Giza Governorate under cooling. Plants were trimmed (leaf tips and root cut) and sorted in uniform size (10-17 mm bulb diameter and 25 cm length). Defect free plants were bunched (10 plants/bunch) and tied using rubber bands. The bunches were divided into two groups for the following experiments:

The first experiment:

Effect of packaging type

Green onion plants were packed in the following procedures:

1- Packing every two bunches in non perforated polyethylene bags 30 micron thickness and 30×15 cm in size.
2- Packing every two bunches in perforated polypropylene bags 0.09 micron thickness and 30×15 cm in size.
3- Packing the plants with gel ice.
4- Unpackaged plants (control).

The second experiment

Effect of hot water treatment and plant position

Green onion plants were dipped in hot water from the lower 5 cm of the white stem base as follows

1 - 55°C for 6 min. -2- 47°C for 4 min.

After the heat treatment, the plants were cooled by immersion in cool water.

3 - Plants were placed vertically inside carton box

4 - Plants were placed horizontally inside carton box (control)

Experiments were arranged in completely randomized design. Fourteen punches were put in carton box as one replicate. Twelve replicates for each treatment were stored at 0°C and 90-95 RH for 16 days. Three replicates were removed every 4 days intervals and placed at 20°C for 2 subsequent days to simulate retail market, and examined for quality measurements.

Quality evaluations

a- Physical determinations

1- Overall visual quality was scored on a 9-1 scale, with reference points of 9 excellent, 7 good, 5 fair, 3 poor and 1 unusable. The visual quality included symptoms and rate of deterioration (leaf tip dryness, leaf witting, yellowing and curvature defects (Hong *et al.*, 2000).
2- Percentage of weight loss was determined as :

$$= \frac{\text{Weight of sample at the beginning of storage - its weight after storage}}{\text{weight of sample at the beginning of storage}} \times 100$$

3- Inner leaf extension was measured with a vernier caliper, considering the growth of leaves from the 25 cm initial plant length to the upper leaflet and expressed in mm.
4- Curvature score of 1-5 was used where 1= none, 2 curvature of stem or leaf up to 15° from the horizontal position, 3, 15-30°, 4, 30-45° and 5,>45° (Hong *et al.*, 2000).

Chemical determinations:

1- Total soluble solids% was determined by using hand rafractometer (A.O.A.O, 1990).
2- Dry matter% was determined by weigh 100 gm of fresh weight and dried at 70°C until a constant weight was reached.
3- Titratable acidity was quantified by titrating against 0.01 N NaOH with phenol phethalin as an indicator and expressed as mg/100gm fresh weight (A.O.A.C, 1990).
4- Total chlorophyll was measured using Minolta chlorophyll meter spad.

All the data were subjected to the statistical analysis according to the method described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

3.1 Effect of packaging type

3.1.1: Effect of packaging type

Packaging of green onion plants resulted in a significantly higher visual quality score as compared to unpacked control (Table 1). Green onion plants packed in unperforated poly ethylene (P.E) bags had the superior score followed by perforated polypropylene bags in the two seasons. Unpackaged onion plants had the lower visual quality score. It seems that the higher relative humidity created within packages film reduces moisture loss and maintaining the fresh appearance of green onion plant (Atta-Aly, 1998, In and Man, 2004 on green onion).

The results in Table (1) demonstrate that the unpackaged green onion plants control resulted significant higher weight loss (11.23%) when compared with the other packaging types whereas the least loss in weight obtained from non perforated polyethylene and perforated polypropylene bags respectively in the two seasons. These results confirming the previous reports about packing film effects on reducing water loss in green onion (Atta-Aly, 1998, Emam, 1999).

Packaging type had non significant effect on dry matter content after cold storage at 0^{o}C and holding at 20^{o}C simulated retail period in the first season while significant effect was noticed in the second season pointing that, un packaged control and non-perforated polyethylene bag had the higher dry matter content (Table 1).

No significant differences in total soluble solids content among packaging type and those unpackaged were detected in the both seasons of study (Table 1).

Table 1. Effect of packaging type on the physical and chemical properties of green onion plants during storage in 2005-2006 and 2006-2007 seasons.

Packaging type	Visual quality (score)	Weight loss (%)	Dry matter (%)	Total soluble solids (%)	Chlorophyll (spad)	Titratable acidity (mg/100g.f.w)
2005-2006						
Non perforated poly ethylene bag	8.19	0.44	13.52	9.12	47.72	0.24
Perforated polyproplene bag	7.79	0.91	13.35	8.84	45.77	0.23
Packaging with gel ice	7.66	6.51	13.44	9.13	46.35	0.23
Unpackaged plant control	6.33	11.23	13.73	9.03	43.56	0.22
L.S.D at 5%	0.57	0.59	N.S	N.S	2.39	0.000233
2006-2007						
Non perforated poly ethylene bag	7.79	0.51	12.77	8.49	50.58	0.25
Perforated polyproplene bag	7.26	0.99	12.58	8.35	49.26	0.25
Packaging with gel ice	7.04	6.44	12.59	8.50	49.21	0.25
Unpackaged plant control	6.46	11.69	13.09	8.50	45.97	0.23
L.S.D at 5%	0.63	1.18	0.48	N.S	2.63	0.000233

Packaging types induced higher chlorophyll content in the green leaves after cold storage and simulated retail market as compared with the unpackaged control (Table, 1). This results confirmed with those obtained by Atta-Aly, 1998 and Emam,1999 on green onion.

Packaging green onion plants in non perforated polyethylene bags resulted in significant higher titratable acidity as compared to the un-packaged control. These findings were similar to those found by Atta-Aly,1998, and Emam, 1999.

3.1.2 Effect of storage period:

Visual quality decreased significantly during storage. After 8 days in cold storage plus 2 days at 20°C visual quality score was (7.46) while after 16 days in cold storage plus additional 2 days at 20°C, visual quality score reached (5.92) in the first season (Table, 2) and similar results was found in the second season.

Table 2. Effect of storage period on the physical and chemical properties of green onion plants during storage in 2005-2006 and 2006-2007 seasons

Character / Storage period (days)	Visual quality (score)	Weight loss (%)	Dry matter (%)	Total soluble solids (%)	Chlorophyll (spad)	Titratable acidity (mg/100g.f.w)
2005-2006						
At harvest	9.00	0.00	13.63	9.33	51.40	0.26
4 d at 0°C + 2 d at 20°C	8.50	2.63	13.81	9.39	48.55	0.24
8 d at 0°C + 2 d at 20°C	7.46	3.95	13.71	9.19	45.85	0.23
12 d at 0°C + 2 d at 20°C	6.62	5.51	13.41	8.85	43.16	0.22
16 d at 0°C + 2 d at 20°C	5.92	6.99	13.01	8.39	40.28	0.20
L.S.D at 5%	0.63	0.59	0.45	0.38	2.67	0.000261
2006-2007						
At harvest	9.00	0.00	12.89	8.67	54.67	0.27
4 d at 0°C + 2 d at 20°C	8.25	2.76	13.06	8.67	51.40	0.26
8 d at 0°C + 2 d at 20°C	7.38	4.53	12.95	8.59	49.20	0.25
12 d at 0°C + 2 d at 20°C	6.25	5.57	12.62	8.29	45.85	0.23
16 d at 0°C + 2 d at 20°C	4.83	6.75	12.28	8.11	42.67	0.21
L.S.D at 5%	0.70	1.18	0.54	0.36	2.94	0.000261

Stored green onion plants showed significant weight loss as the storage period extended. After 16 days in cold storage and 2-subsequent days at 20°C, weight loss reached (6.99%). in the first season and similar trend was found in the second one. This continuous loss in weight during storage and shelf life resulted from the loss of water by transpiration and dry matter by respiration (Atta-Aly, 1998 on green onion).

Holding green onion plant in cold storage for 16 days plus 2 additional days at 20°C resulted in significant continuously loss in dry matter except after 4 days which gave slight increase as a result of more water loss and less consumption of dry matter content (carbohydrates) as compared to that at harvest time in the two seasons. (Table, 2).

A significant decrease in total soluble solids content was noticed with the advancement of the storage period in both seasons. T.S.S. followed the same trend in dry matter which increased after the 4th day of cold storage and then started to decrease due to the effects of the previous reasons mentioned before. The changes in T.S.S at the various storage periods is the resultant of movement of water and soluble solids to and from the plant, the inversion of insoluble solids compound to simpler soluble solids forms and the use of these chemicals during respiration. The prevalence of one or more of these factors during plant growth may accumulate or lessen these contents (Hulme, 1970).

Storing green onion plant for 16 days at 0°C plus 2 subsequent days at 20°C resulted in significant loss in chlorophyll content compared to that found at harvest time found in the two seasons (Table, 2). The reduction in chlorophyll content with the elapse of the storage period may be due to the destruction of the chlorophyll and transformation of chloroplasts to chromoplasts by chlorophyllase activity (Hulme,1970).

A general trend of decrease in titratable acidity took place till the last storage period (Table, 2) The progressive consumption of organic reserves of harvested plant induced a loss of quality and a reduction of their shelf life. Aerobic respiration involves oxidation of organic compounds by enzymatic reaction with production of CO_2 and water vapor and release of free energy. Consequently respiration is one of the most important factors for keeping quality of vegetables. In fact, decreased respiration activity is usually a good index to the increased shelf life (Artes, 2002).

3.1.3: Effect of interaction between packaging type x storage period.

Green onion plants from all packaging types significantly lost visual quality score after cold storage and retail market simulation, after 16 days of cold storage and 2 subsequent days at 2o°C (Table, 3). However, in spite of, the continuous visual quality loss, green onion plants still good after 8 days at 0°C +2days at 20°C when packed in the sealed P.E.B and perforated poly propylene bags or with gel ice while unpacked plants had the least score, especially at the end of storage in the two seasons. Interaction effects between packaging types and storage period appeared significant in both seasons for dry matter and total soluble solids contents (Table, 3). However, after 16 days of cold storage plus 2-subsequent days at 20°C, non perforated polyethylene bag had higher values of chlorophyll and titratable acidity than the other packaging types (Table, 3).

From the previous results, it could be concluded that packaging green onion plants in non perforated poly ethylene bags was the most effective in reducing weight loss and maintain the green colour of the leaves during storage beside induced good visual quality after 16 days of cold storage at 0°C plus 2 days at 20°C.

Table 3. Effect of interaction between packaging type and storage period on the physical and chemical properties of green onion plants during storage in 2005-2006 and 2006-2007 seasons

Packaging type	Storage period (days)	Visual quality (score)	Weight loss (%)	Dry matter (%)	Total soluble solids (%)	Chlorophyll (spad)	Titratable acidity (mg/100g.f.w)	Visual quality (score)	Weight loss (%)	Dry matter (%)	Total soluble solids (%)	Chlorophyll (spad)	Titratable acidity (mg/100g.f.w)
		2005-2006						2006-2007					
	At harvest	9.00	0.00	13.63	9.33	51.40	0.26	9.00	0.00	12.89	8.67	54.67	0.27
Non perforated polyethylene bag	4 d at 0°C + 2 d at 20°C	9.00	0.28	13.76	9.20	50.80	0.25	9.00	0.34	13.01	8.60	53.80	0.27
	8 d at 0°C + 2 d at 20°C	8.33	0.34	13.62	9.23	48.40	0.24	8.33	0.41	12.87	8.66	51.20	0.26
	12 d at 0°C + 2 d at 20°C	7.66	0.48	13.43	9.03	45.40	0.23	7.00	0.59	12.66	8.33	48.20	0.24
	16 d at 0°C + 2 d at 20°C	7.00	0.65	13.16	8.80	42.60	0.22	5.66	0.70	12.43	8.20	45.03	0.23
	At harvest	9.00	0.00	13.63	9.33	51.40	0.26	9.00	0.00	12.89	8.67	54.67	0.27
perforated polyproplene bag	4 d at 0°C + 2 d at 20°C	9.00	0.38	13.70	9.33	48.20	0.24	8.33	0.52	12.94	8.52	51.30	0.26
	8 d at 0°C + 2 d at 20°C	7.66	0.64	13.43	8.86	45.30	0.23	7.66	0.90	12.81	8.20	50.80	0.25
	12 d at 0°C + 2 d at 20°C	7.00	1.09	13.17	8.56	43.43	0.22	6.33	1.10	12.31	8.25	46.50	0.23
	16 d at 0°C + 2 d at 20°C	6.33	1.52	12.84	8.13	40.50	0.20	5.00	1.42	11.95	8.13	43.03	0.22
	At harvest	9.00	0.00	13.63	9.33	51.40	0.26	9.00	0.00	12.89	8.67	54.67	0.27
packaging with gel ice	4 d at 0°C + 2 d at 20°C	9.00	3.06	13.81	9.50	48.50	0.24	8.00	3.21	13.00	8.80	51.80	0.26
	8 d at 0°C + 2 d at 20°C	7.50	5.11	13.57	9.45	46.10	0.23	7.20	5.70	12.73	8.66	49.60	0.25
	12 d at 0°C + 2 d at 20°C	6.80	7.69	13.28	8.89	44.30	0.22	6.00	7.13	12.33	8.26	46.40	0.23
	16 d at 0°C + 2 d at 20°C	6.00	10.19	12.91	8.50	41.43	0.21	5.00	9.70	12.00	8.13	43.60	0.22
	At harvest	9.00	0.00	13.63	9.33	51.40	0.26	9.00	0.00	12.89	8.67	54.67	0.27
un packaged	4 d at 0°C + 2 d at 20°C	7.00	6.80	13.97	9.53	46.70	0.24	7.66	7.00	13.27	8.75	48.70	0.24
	8 d at 0°C + 2 d at 20°C	6.33	9.71	14.20	9.23	43.60	0.22	6.33	11.10	13.40	8.81	45.20	0.23
	12 d at 0°C + 2 d at 20°C	5.00	12.80	13.73	8.92	39.50	0.198	5.66	13.46	13.15	8.32	42.30	0.21
	16 d at 0°C + 2 d at 20°C	4.33	15.60	13.11	8.13	36.60	0.183	3.66	15.20	12.72	7.95	39.00	0.19
L.S.D at 5%		1.27	1.19	0.90	0.77	5.35	0.000522	1.41	2.37	1.09	0.73	5.89	0.000522

3.2. Effect of heat treatment and plants position

3.2.1. Effect of heat treatment and plant position

Pre-storage heat treatment and packaging the plant´vertically had higher visual quality as compared with untreated control in the first season. While no significant difference was detected in the second season (Table, 4). Four minutes dip at 47°C was partially effective in controlling extension growth but, the 6-min dip in water at 55°C were much more effective. At the same time the re-growth of trimmed leaves was highly variable in untreated control. Similar results were reported by Cantwell *et al.,* (2001) on green onion plants.

The heat treatment at (47°C for 4 min reduced the rate of curvature of the green onion, whereas, those plants dipped into 55°C for 6 min or a vertically position in carton box effectively controlled subsequent green onion leaf curvature as compared with the un treated plants in the two seasons. Various metabolic reactions and growth phenomena can be controlled by short heat shock treatments (Hong *et al,* 2000 on green onion and Cantwell *et al.,* 2003 on garlic).

It was demonstrated that curvature in green asparagus spear can be prevented by dipping the spears in 47°C for 2.5 min. hot water or packaging the spear vertically Paull and Chen (1999). Untreated control and a- vertically position showed higher dry matter content in both seasons (Table, 4).

Table 4. Effect of heat treatment and plant position on physical and chemical properties of green onion plants during storage in 2005-2006 and 2006-2007 seasons.

Treatment	Visual quality (score)	Leaf extention (mm)	Curvature (score)	Dry matter (%)	Chlorophyll (spad)	Titratable acidity (mg/100g.f.w)
2005-2006						
55°C / 6 min	7.39	0.34	1.40	12.82	43.19	0.22
47°C / 4 min	7.13	0.84	1.73	12.92	44.56	0.22
A-Vertically position	6.86	1.58	1.07	13.34	43.17	0.22
Un-treated (control)	6.46	1.82	2.67	13.15	42.80	0.21
L.S.D at 5%	0.66	0.25	0.23	0.44	N.S	0.000233
2006-2007						
55° C / 6 min	7.19	0.12	1.53	12.26	46.72	0.23
47° C / 4 min	6.86	1.06	2.20	12.44	47.39	0.24
A-Vertically position	6.86	1.43	1.27	13.20	45.64	0.23
Un-treated (control)	6.59	1.71	2.93	12.81	44.81	0.22
L.S.D at 5%	N.S	0.49	0.23	0.40	N.S	N.S

Pre-storage heat treatment and a- vertically position did not have any significant differences in their effects on the chlorophyll content in both seasons. Untreated control had lower values of titratable acidity as compared with the other treatments in the first season (Table, 4) but no significant difference was found in the second season.

3.2.2: Effect of storage period.

Green onion plant could be stored for 8 days at 0°C plus 2-subsequent days at 20°C without serious loss of quality. Significant loss of quality was observed when the period of storage was extended.

Storage green onion at 0°C for 8 days plus subsequence 2- days at 20°C results in 0.83 mm leaf extension of the cut end,. Moreover, a continuous increases in leaf extension were evident where storage period was extended to 16 days at 0°C plus 2- subsequence days at 20°C, and leaf growth reached 2.81 mm in the first season (Table, 5). Such an increase in leaf extension, negatively affected the market quality (Hong *et al*, 2000). It was noticed that temperature over 0°C favored leaf growth of asparagus spears in addition storage under conventional had influences since the apex cells were kept in a state of active division and consequently inner petioles continued to grow and elongate (Paull and Chen 1999).

The leaf curvature started to be shown after 8 days of cold storage plus 2-subsequent days at 20°C, extending the period of storage up to 16 days at 0°C plus 2 days at 20°C resulted in a significant higher leaf curvature score (Table 5).

Table 5. Effect of storage period on physical and chemical properties of green onion plants during storage in 2005-2006 and 2006-2007 seasons.

Character / Storage period (days)	Visual quality (score)	Leaf extention (mm)	Curvature (score)	Dry matter (%)	Chlorophyll (spad)	Titratable acidity (mg/100g.f.w)
2005-2006						
At harvest	9.00	0.00	1.00	13.63	51.40	0.26
4 d at 0°C + 2 d at 20°C	7.66	0.37	1.00	13.57	46.55	0.23
8 d at 0°C + 2 d at 20°C	7.00	0.83	1.66	13.13	43.43	0.22
12 d at 0°C + 2 d at 20°C	6.00	1.72	2.08	12.71	39.55	0.20
16 d at 0°C + 2 d at 20°C	5.16	2.81	2.84	12.24	36.22	0.18
L.S.D at 5%	0.73	0.28	0.26	0.49	3.351	0.000261
2006-2007						
At harvest	9.00	0.00	1.00	12.89	54.70	0.27
4 d at 0°C + 2 d at 20°C	7.75	0.40	1.08	13.08	48.75	0.24
8 d at 0°C + 2 d at 20°C	7.33	0.89	1.83	12.86	45.77	0.23
12 d at 0°C + 2 d at 20°C	5.99	1.52	2.66	12.47	41.93	0.21
16 d at 0°C + 2 d at 20°C	4.33	2.59	3.33	12.09	39.55	0.20
L.S.D at 5%	0.70	0.55	0.26	0.45	3.35	0.026

A significant loss of dry matter, chlorophyll and titratable acidity were detected with the extended of the storage period and reached the lowest values by the end of 16 days at 0°C plus 2- subsequent days at 20°C (Table, 5).

3.2.3 Effect of interaction among heat treatment, plant position and storage period.

Interaction effect among heat treatment, plant position x storage period appeared significant for the physical and chemical quality attributes, (Table, 6). The obtained results showed that, after 16 days at 0°C plus 2- days at 20°C, the interaction among all the studied factors were found significant for visual quality, dry matter, chlorophyll and titratable acidity,. However, hot water dips at 55°C for 6 min. gave the lowest leaf growth (1.20) mm after 16 days of cold storage plus 2- days at 20°C, whereas, untreated control and a-vertically position had the highest values of leaf growth over the same period in the two season.

After 16 days of cold storage followed by 2- days at 20°C a-vertically position had lower curvature score, whereas untreated control showed the higher values over the same period in the two seasons (Table, 6), From the previous results, it could be suggested that dipping the white leaf bases of green onion in hot water at 55ºC for 6 min., effectively controlled leaf growth of the green onion, reduced geotropic curvature and gave good appearance after 12 days at 0ºC plus 2-days at 20ºC.

Table 6. Effect of interaction between heat treatment, plant position and storage period on physical and chemical properties of green onion plants during storage in 2005-2006 and 2006-2007 seasons.

Treatment	storage period (days)	Visual quality (score)	Leaf extension (mm)	Curvature (score)	Dry matter (%)	Chlorophyll (spad)	Titratable acidity (mg/100g.f.w)	Visual quality (score)	Leaf extension (mm)	Curvature (score)	Dry matter (%)	Chlorophyll (spad)	Titratable acidity (mg/100g.f.w)
		2005-2006						2006-2007					
55° c / 6 min	At harvest	9.00	0.00	1.00	13.63	51.40	0.26	9.00	0.00	1.00	12.89	54.70	0.27
	4 d at 0°C + 2 d at 20°C	8.33	0.00	1.00	13.21	45.50	0.23	8.00	0.00	1.00	12.67	49.00	0.25
	8 d at 0°C + 2 d at 20°C	7.66	0.00	1.00	12.86	43.60	0.22	7.66	0.00	1.00	12.31	46.20	0.23
	12 d at 0°C + 2 d at 20°C	6.33	0.51	1.66	12.45	39.40	0.20	6.33	0.00	2.00	11.91	42.90	0.22
	16 d at 0°C + 2 d at 20°C	5.66	1.20	2.33	11.94	36.03	0.18	5.00	0.59	2.66	11.53	40.80	0.21
47° c / 4 min	At harvest	9.00	0.00	1.00	13.63	51.40	0.26	9.00	0.00	1.00	12.89	54.70	0.27
	4 d at 0°C + 2 d at 20°C	7.66	0.00	1.00	13.36	48.20	0.24	7.66	0.33	1.00	12.90	50.80	0.25
	8 d at 0°C + 2 d at 20°C	7.00	0.00	1.66	12.92	44.80	0.22	7.66	0.62	2.00	12.50	47.43	0.24
	12 d at 0°C + 2 d at 20°C	6.33	1.67	2.00	12.54	41.20	0.21	5.66	1.66	3.33	12.12	42.40	0.21
	16 d at 0°C + 2 d at 20°C	5.66	2.53	3.00	12.13	37.20	0.19	4.33	2.69	3.66	11.81	41.60	0.21
Vertically	At harvest	9.00	0.00	1.00	13.63	51.40	0.26	9.00	0.00	1.00	12.89	54.70	0.27
	4 d at 0°C + 2 d at 20°C	7.66	0.71	1.00	13.96	46.30	0.23	7.66	0.59	1.00	13.42	47.80	0.24
	8 d at 0°C + 2 d at 20°C	7.00	1.50	1.00	13.46	42.50	0.21	7.00	1.33	1.00	13.63	45.40	0.23
	12 d at 0°C + 2 d at 20°C	5.66	2.10	1.00	13.06	39.30	0.20	6.33	2.10	1.33	13.23	41.70	0.21
	16 d at 0°C + 2 d at 20°C	5.00	3.60	1.33	12.58	36.33	0.18	4.33	3.11	2.00	12.83	38.60	0.19
Un-treated (control)	At harvest	9.00	0.00	1.00	13.63	51.40	0.26	9.00	0.00	1.00	12.89	54.70	0.27
	4 d at 0°C + 2 d at 20°C	7.00	0.77	1.00	13.75	46.20	0.23	7.66	0.66	1.33	13.33	47.40	0.24
	8 d at 0°C + 2 d at 20°C	6.33	1.80	3.00	13.28	42.80	0.21	7.00	1.60	3.33	13.00	44.03	0.22
	12 d at 0°C + 2 d at 20°C	5.66	2.61	3.66	12.78	38.30	0.19	5.66	2.33	4.00	12.63	40.70	0.20
	16 d at 0°C + 2 d at 20°C	4.33	3.90	4.70	12.31	35.30	0.18	3.66	3.96	5.00	12.21	37.20	0.19
L.S.D at 5%		1.47	0.57	0.52	0.98	6.70	0.000522	1.41	1.10	0.52	0.91	7.71	0.05

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تأثير إستخدام المغلفات والمعاملة الحرارية فى الحفاظ على جودة البصل الاخضر

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قسم بحوث تداول الخضر – معهد بحوث البساتين – مركز البحوث الزراعية – جيزة

اختبرت المغلفات والمعاملة الحرارية كطرق للحفاظ على جودة البصل الاخضر ولإطالة فترة العرض بالسوق للصنف جيزة ٢٠. وجد أن التعبئة فى اكياس بولى ايثيلين مغلقة قد حافظت على المظهر العام للنباتات ومحتوى الاوراق من الكلوروفيل وقللت الفقد فى الوزن عندما خزنت على درجة حرارة صفر درجة مئوية يتبعها يومين على درجة حرارة ٢٠ درجة مئوية (كفترة عرض بالاسواق) ولكنها لم تؤثر على المواد الصلبة الذائبة الكلية كما ظهر أن المعاملة الحرارية ٥٥ درجة مئوية لمدة ٦ دقائق قد ثبطت من استطالة الأوراق وقللت الانحناء ووضح أن وضع النباتات رأسياً داخل الكرتونة يقلل من انحناء النباتات لكنة لم يؤثر على الاستطالة.