SHELF- LIFE OF BROCCOLI HEADS AS AFFECTED BY PACKAGING MATERIAL

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Abstract

This study was carried out for evaluating the effect of some different packages on the keeping quality of broccoli heads, *Brassica oleracea* var. *italica* cv. Tokyo Dome F_1 hybrid during storage. Two types of packages were examined, namely: cardboard carton boxes of three different sizes (30×20×10, 40×30×9 and 45×30×14 cm), and non perforated and perforated polyethylene bags at the size of 45x30 cm, where the ventilation holes percentage of perforated bags were 0.15, 0.30 and 0.45%. The evaluation of the various packages proved that large boxes (45 × 30 ×14 cm) and non-perforated polyethylene bags were the promising ones in minimizing the heads loss in weight and the unmarketable percentage. Moreover, all packages retained more T.S.S., ascorbic acid, total chlorophyll and total sugars as compared to the control treatment.

INTRODUCTION

The successful marketability of broccoli heads depend on maintaining high quality after harvesting. Packaging is one of the most important tools in this concern. Thus, packing broccoli heads in cardboard carton boxes was found promising in minimizing the loss in weight during storage (Esmail, 1997) and the same was true also for polyvinyl chloride (PVC) film (Rij. & Ross, 1987 and Forney and Rij, 1991). From another point of view using non-perforated polyethylene bags for backing broccoli heads proved without doubt that the decay percentage was lesser than that of perforated ones (Emond *et al.,* 1995).

The sequence of experiments carried out on fruits stored in various packages showed that the chemical constituents were changed during storage in different consequences. Thus, it was found that T.S.S. were kept higher in the fruits of cantaloupe (Esmail, 1992) stored in fiberboard carton boxes than those of unpacked ones.

Amore objective approach to follow ascorbic acid content in the fruits of cantaloupe (Esmail, 1992) during storage revealed that packing these fruits in fiberboard carton boxes retained high quantity of this vitamin as compared with the control ones. On the other hand, using polyethylene bags in storing broccoli heads elevated CO_2 inside the bags that led to reduce the loss of ascorbic acid content as

compared with the unpacked ones (Platenius and Jones, 1994 and Paradis *et al.* 1995).

Some published reports on the behavior of chlorophyll in fruits during storage showed that packing these fruits in polyethylene bags like broccoli (James, 1990; Zhuang *et al.*, 1994 and Gillies and Toivonen, 1995) kept more chlorophyll content during the various storage periods due to the modified atmosphere.

Considerable attention has been paid to the changes occurred in fruit total sugars content during storage after packing. However, using fiberboard carton boxes in storring cantaloupe (Esmail 1992) retained more sugars than the unpacked ones. The same was true also when polyethylene bags were used for storing broccoli (Yamashita *et al.*, 1993).

This study, however, was designed to investigate the effect of postharvest treatments by the various fiberboard boxes and polyethylene bags on the keeping quality of broccoli during storage.

MATERIALS AND METHODS

This work was carried out on broccoli (*Brassica oleracea* var. *italica* plenk) cv. Tokyo DOME F1 hybrid. Seeds were sown in seedbed on September 15th and transplants were shifted to the field on October 25 th in the two successive winter seasons of 2001-2002 and 2002 –2003 in El-Bosaily Protected Cultivation Unit, El-Beheara Governorate. The used spacing was 70 cm apart in the row and 50 cm between plants. When the buds begin to form heads, Labels were hanged after which heads were picked 20 days later and stored under room temperature conditions at Dokki site under temperature of 20 ± 2C°and relative humidity (RH) of 58±2%. The following packages were examined:

1- **Cardboard carton boxes**: Three different sizes of boxes were evaluated. They were 30×20×10, 40×30×9 and 45×30×14×cm.

2- **Polyethylene bags:** Two types of the bags of the same size of 30 × 45 cm were checked. They were non-perforated and vented ones. The vented polyethylene bags had ventilation holes of 0.15,0.30 and 0.45%. However, unwrapped heads represented the control ones. All the stored broccoli heads in the different packages were represented in three replicates and devoted to the physical and chemical analysis every two days during the whole storage periods. The examined characteristics were:

a- Physical changes:

1- loss in weight %=

$$\frac{\text{Loss in weight at the sampling dates} \times 100}{\text{The initial weight of heads}}$$

2- Unmarketable heads % =

$$\frac{\text{Total number of unmarketable heads at the sampling date} \times 100}{\text{The initial weight of heads}}$$

b- Chemical chagnes:

1- **T.S.S** % were determined by Abbe refractometer according to A.O.A.C, 1980.

2- **Ascorbic acid** was determined by using the dye 2,6 dichlorophenol-indophenol method as reported in A.O.A.C. 1980. The results were calculated as mg/100g fresh weight.

3- **Total chlorophyll** was determined as mg/100g fresh weight after Robbelen method (1957).

4- **Total sugars** were determined adopting the clorometric method for the determination of sugar related substances according to Dubois *et al.*(1956). The results were calculated as g/100g dry weight.

RESULTS AND DISCUSSION

Physical changes:

It is obvious from the results in Table (1) that all the packed or unpacked heads showed a continuous loss in weight with the extension of storage periods. However, the big size package (45 × 30 × 14 cm) proved to be the most effective one in reducing the losses after two days of storage as compared with the medium (40 ×30× 9 cm) and small (30×20×10 cm) ones. On the other hand, the non- perforated polyethylene bags surpassed all the other types of bags in minimizing these losses. On the whole, the non-perorated polyethylene bags were the most obvious ones in reducing this character over all the used packages.

Concerning unmarketable heads, it is evident from Table (2) that in both packed and unpacked heads a gradual increase in the unmarketable percentage occurred till the end of storage periods. Evidences from the results showed that similar figures in this characteristic were obtained from using all the fiberboard carton boxes. Concerning the polyethylene bags, it was clear that the non-perforated ones were the most effective in minimizing the unmarketable percentage in the whole storage periods.

Chemical changes:

The results in Tables 3, 4, 5 and 6 show the effect of various packages on the head T.S.S, ascorbic acid, total chlorophyll and total sugars contents during the storage periods. It was clear that there was a decline trend in these contents in all the stored heads during storage. However, the biggest fiberboard carton boxes (45 ×30 ×14 cm) kept more contents than the other boxes during storage. On the other hand,

heads packed in non-perorated polyethylene bags hold greater contents than those kept in the other different bags in the various storage periods. Chemically speaking the non-perforated polyethylene bags were the most obvious one in retaining these components in comparison with the other packages.

It is evident from the results that there was an increase trend in the loss in weight with every extend of the storage periods. However, the continuous loss in weight during storage may be attributed, to both loss of humidity throughout transpiration and dry matter by respiration. The big box (45× 30×14 cm) and the non–perforated polyethylene bag surpassed all the other types of boxes or bags in minimizing this loss with the priority of the non perforated polyethylene bags in reducing the weight loss may be due to the role of these bags in hindering the water loss from the head which in turn reduced this percentage (Rij and Ross, 1987).

Concerning the unmarketable heads, it is clear that this character increased gradually either in boxes or bags by the elapse of storage periods. However, this feature may be attributed to the continuous chemical and biochemical changes happened in the heads during storage which led to moisture condensation and transformation of complex compounds to simple forms of more liability of fungus infection, such as the change from the solid protopectin to the soluble pectin. However, the non-perforated polyethylene bags proved to be the most effective ones in minimizing this characteristic during storage. Non ventilated film bags often maintained fruits in good appearance longer than in ventilated ones. This may be due to the initiated modified atmosphere which are characterized with low O_2 and more CO_2. Hence modified atmosphere storage reduced respiration rates as long as O_2 and CO_2 levels are maintained within levels suitable for the commodity. Reduced respiration rates were combined with lowering of C_2H_4 production which induced for expample better retention of chlorophyll (Green color) and texture (less softening and lignification) (Kader *et al.*, 1989). In other words, elevated CO_2 atmosphere has been shown to be a comparative inhibitor of the biological action and synthesis of Ethylene. So, the non–perforated polyethylene bags showed the least loss in weight and unmarketable heads beside it kept comparatively the highest TSS, ascorbic acid, total chlorophyll and total sugars.

CONCLUSION

It may be concluded from the results of this investigation that the large fiberboard carton box (45×30×14 cm) and non-perforated polyethylene bags were the most obvious packages in reducing the physical disorders of broccoli heads during storage

and keeping relatively their chemical contents with the superiority of perforated polyethylene bags.

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Table 1. Effect of different packages on head loss in weight percentage during storing in 2001-2002 and 2002-2003 seasons.

Storage periods (in days) / Packaging	Head loss in weight percentage											
	2001 – 2002 season						2002 –2003 season					
	2	4	6	8	10	12	2	4	6	8	10	12
Fiber board carton boxes												1.40
30 x 20 x 10 cm	7.42	13.13	19.23	-	-	-	8.51	16.20	20.40	-	-	-
40 x 30 x 9 cm	6.91	11.72	15.95	-	-	-	6.85	12.80	16.36	-	-	-
45 x 30 x 14 cm	3.49	8.67	10.44	-	-	-	4.22	8.52	12.41	-	-	-
Perforated polyethylene bags												
0.015%	0.80	1.49	2.63	3.09	-	-	0.81	1.50	2.40	3.16	-	-
0.030%	1.33	2.61	3.50	-	-	-	1.41	2.82	4.20	-	-	-
0.045%	1.87	3.98	5.44	-	-	-	2.10	4.20	6.15	-	-	-
Non perforated polyethylene bags	0.14	0.32	0.52	0.79	1.20	1.42	0.15	0.37	0.50	0.80	1.25	1.40
Control	9.04	18.61	-	-	-	-	9.90	19.20	-	-	-	-

Table 2. Effect of different packages on head unmarketable percentage during storage in 2001- 2002 and 2002 –2003 seasons.

Storage periods (in days) / *Packaging*	Head unmarketable percentage												
	2001 – 2002 season							2002 –2003 season					
	2	4	6	8	10	12	14	2	4	6	8	10	12
Fiber board carton boxes													
30 x 20 x 10 cm	0.00	25.00	50.00	100.00	-	-	-	25.00	50.00	100.00	-	-	-
40 x 30 x 9 cm	0.00	25.00	50.00	100.00	-	-	-	25.00	50.00	100.00	-	-	-
45 x 30 x 14 cm	0.00	25.00	50.00	100.00	-	-	-	25.00	50.00	100.00	-	-	-
Perforated polyethylene bags													
0.015%	0.00	05.00	25.00	50.00	100.00			0.00	25.00	50.00	100.00	-	-
0.030%	0.00	25.00	50.00	100.00	-	-	-	25.00	50.00	100.00	-	-	-
0.045%	0.00	25.00	50.00	100.00	-	-	-	25.00	50.00	100.00	-	-	-
Non perforated polyethylene bags	0.00	0.00	0.00	25.00	50.00	75.00	100.00	0.00	0.00	25.00	50.00	75.00	100.00
Control	0.00	50.00	100.00	-	-	-	-	50.00	100.00	-	-	-	-

Table 3.Effect of different packages on head total soluble solids percentage during storage in 2001- 2002 and 2002 –2003 seasons.

Storage periods (in days) / *Packaging*	Head total soluble solids percentage													
	2001 – 2002 season							2002 –2003 season						
	0	2	4	6	8	10	12	0	2	4	6	8	10	12
Fiber board carton boxes								10.50	8.40	6.70	4.50	-	-	-
30 x 20 x 10 cm	10.20	8.00	6.40	4.00	-	-	-	10.50	8.50	6.90	4.40	-	-	-
40 x 30 x 9 cm	10.20	8.10	6.50	4.20	-	-	-	10.50	8.70	6.90	4.50	-	-	-
45 x 30 x 14 cm	10.20	8.20	6.80	4.40	-	-	-							
Perforated polyethylene bags														
0.015%	10.20	8.70	7.20	5.60	4.80	-	-	10.50	8.90	7.50	5.80	4.90	-	-
0.030%	10.20	8.50	7.00	4.50	-	-	-	10.50	8.60	7.30	4.60	-	-	-
0.045%	10.20	8.60	6.80	4.30	-	-	-	10.50	8.70	7.40	4.70	-	-	-
Non perforated polyethylene bags	10.20	9.20	8.30	7.00	6.00	5.40	4.10	10.50	9.60	8.70	7.30	6.20	5.00	4.00
Control	10.20	7.60	4.10	-	-	-	-	10.50	7.50	4.00	-	-	-	-

Table 4. Effect o different packages on head ascorbic acid (mg/100g f.w) during storage in 2001- 2002 and 2002 –2003 seasons.

Storage period (in days) / *Packaging*	Head ascorbic acid (mg/100g f.w)													
	2001 – 2002 season							2002 –2003 season						
	0	2	4	6	8	10	12	0	2	4	6	8	10	12
Fiber board carton boxes														
30 x 20 x 10 cm	105.50	88.10	74.20	59.30	-	-	-	112.60	62.40	78.10	60.30	-	-	-
40 x 30 x 9 cm	105.50	88.60	74.80	60.50	-	-	-	112.60	63.90	79.90	62.1	-	-	-
45 x 30 x 14 cm	105.50	89.00	75.30	59.50	-	-	-	112.60	94.10	80.20	63.20	-	-	-
Perforated polyethylene bag														
0.015%	105.50	92.30	80.20	65.10	51.80	-	-	112.60	96.30	84.60	66.10	52.90	-	-
0.030%	105.50	89.10	78.20	63.50	-	-	-	112.60	93.80	80.20	64.2	-	-	-
0.045%	105.50	88.80	78.20	61.60	-	-	-	112.60	91.60	78.90	61.4	-	-	-
Non perforated polyethylene bags	105.50	98.80	90.50	85.10	79.00	65.50	54.30	112.60	100.00	94.20	85.60	80.30	66.40	55.10
Control	105.50	80.1	60.40	-	-	-	-	112.60	83.1	61.60	-	-	-	-

Table 5. Effect of different packages on head total chlorophyll (mg/100g f.w) during storage in 2001- 2002 and 2002 –2003 seasons.

Storage periods (in days) / *Packaging*	Head total chlorophyll (mg/100g f.w)													
	2001 – 2002 season							2002 –2003 season						
	0	2	4	6	8	10	12	0	2	4	6	8	10	12
Fiber board carton boxes														
30 x 20 x 10 cm	52.80	35.00	19.60	3.60	-	-	-	55.00	37.00	20.00	3.50	-	-	-
40 x 30 x 9 cm	52.80	35.60	20.00	3.50	-	-	-	55.00	38.00	21.00	3.30	-	-	-
45 x 30 x 14 cm	52.80	36.00	20.40	3.70	-	-	-	55.00	39.00	23.00	3.60	-	-	-
Perforated polyethylene bags														
0.015%	52.80	52.80	39.00	23.00	12.40	-	-	55.00	41.00	27.00	12.00	3.40	-	-
0.030%	52.80	35.30	20.40	3.20	-	-	-	55.00	33.00	23.00	10.00	-	-	-
0.045%	52.80	32.00	18.50	3.00	-	-	-	55.00	33.00	19.00	8.00	-	-	-
Non perforated polyethylene bags	52.80	51.60	50.40	48.10	45.00	40.00	35.30	55.00	53.00	51.00	49.00	46.00	43.00	39.00
Control	52.80	21.00	2.10	-	-	-	-	55.00	20.60	2.20		-	-	-

Table 6. Effect of different packages on head total sugars (g/100g d.w) during storage in 2001- 2002 and 2002 –2003 seasons.

Storage periods (in days) / *Packaging*	Head total sugars (g/100g d.w)													
	2001 – 2002 season							2002 –2003 season						
	0	2	4	6	8	10	12	0	2	4	6	8	10	12
Fiber board carton boxes														
30 x 20 x 10 cm	51.40	47.20	43.90	31.50	-	-	-	49.00	44.00	39.60	27.30	-	-	-
40 x 30 x 9 cm	51.40	47.40	44.00	31.20	-	-	-	49.00	44.10	40.00	27.40	-	-	-
45 x 30 x 14 cm	51.40	47.90	44.60	31.80	-	-	-	49.00	44.30	40.20	27.50	-	-	-
Perforated polyethylene bags														
0.015%	51.40	48.90	45.80	40.20	34.80	-	-	49.00	46.20	41.60	38.10	30.60		
0.030%	51.40	48.80	45.40	35.10	-	-	-	49.00	44.20	39.80	30.20			
0.045%	51.40	48.60	45.10	33.30	-	-	-	49.00	42.10	35.00	27.00			
Non perforated polyethylene bags	51.40	50.50	47.80	45.10	40.30	33.70	30.60	49.00	47.20	44.00	40.30	35.30	28.60	25.70
Control	51.40	32.00	20.10	-	-	-	-	49.00	29.00	16.00	-	-	-	-

تأثير مواد التعبئة على تخزين رؤوس البروكولى

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المعمل المركزى للمناخ الزراعى – مركز البحوث الزراعية وزارة الزراعة

أجريت هذه الدراسة لمعرفة تأثير بعض أنواع العبوات على إطالة فترة تخزين رؤوس البروكولى صنف طوكيو دوم هجين، حيث تم تعبئة الرؤوس في عبوات كرتون مختلفة الأحجام كانت أبعادها ٣٠×٢٠×١٠، ٤٠×٣٠×٩، ٤٥×٣٠× ١٤سم وكذلك فى أكياس بولي إيثيلين مقاس ٤٥×٣٠ سم سمك ٨٠ ميكرون مثقبة ذات نسب تهوية مختلفة هي ٠,١٥، ٠,٣٠، ٠,٤٥٪ بالإضافة إلى أكياس غير مثقبة، وقد تم تخزين العبوات في جو الغرفة العادية على درجة حرارة ٢٠°م + ٢°م ورطوبة نسبية ٥٨٪ ± ٢٪. وقد دلت النتائج أن العبوات المختلفة قللت من نسبة الفقد في الوزن وكان أفضلها صناديق الكرتون ذات الأبعاد ٤٥×٣٠×١٤ سم، هذا بجانب أكياس البولي إيثيلين غير المثقبة. أما بالنسبة للرؤوس غير الصالحة للتسويق فإن عبوات صناديق الكرتون لم يكن لها تأثيراً واضحاً على تلك النسبة في حين تفوقت عبوات البولي إيثيلين غير المثقبة على الأنواع الأخرى في تقليلها. ومن جهة أخرى احتفظت الرؤوس المعبأة في صناديق الكرتون وعبوات البولي إيثيلين المختلفة بمحتوى أعلى من المواد الصلبة الذائبة وحمض الأسكوربيك والكلوروفيلات والسكريات عن تلك غير المعبأة. وقد وضح أن أفضل العبوات كانت عبوات البولي إيثيلين غير المثقبة، حيث أطالت فترة تخزين الرؤوس إلى ستة أيام بحالة جيدة وبدون تلف في حين أطالت عبوات البولي إيثيلين المثقبة ٠,١٥٪ العمر التخزينى للرؤوس بحالة جيدة لمدة أربعة أيام ومن ناحية أخرى وجد أن المعاملات الأخرى لم تستمر بها الرؤوس بحالة جيدة خلال فترة زمنية لا تتعدى يومين مما يدل على تفوق التعبئة فى عبوات البولي إيثيلين غير المثقبة.