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EFFECT OF SOME POST - HARVEST TREATMENTS AND PACKING TYPES ON PONKAN TANGERINE FRUIT QUALITY DURING AND AFTER COLD STORAGE

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ABSTRACT : Several bagging treatments were applied to Ponkan tangerine fruits during 1998 and 1999 seasons. The treatments were as follows : (1) dipping in water and then packed in netted plastic (T_1) , (2) dipping in water and then bagged in perforated (0.5%) polyethylene (PPE) (T_2) , (3) dipping in 1000 ppm Thiobendazole (TBZ) and then bagged in PPE (T_3) , (4) dipping in 1000 ppm TBZ and then packed in carton boxes (CB) tightly covered with sealed polyethylene (SPE) (T_4) , (5) as T_4 with the addition of CO_2 absorber Ca $(OH)_2$ (T_5) , (6) dipping in hot water (52°C for 3 min.) then dipping in 300 ppm GA_3 , 4% $CaCl_2$ and 1000 ppm TBZ and packed in CB covered with SPE after adding Ca $(OH)_2$. All dipping treatments were for 5 minutes. All treatments were stored at 8±1°C and 85-90% RH for 7 months . Packing in CB covered with SPE attained the maximum storage life (6 months) and shelf life. Using CO_2 absorber increased fruit decay percentage (FDP) , as well as peel and pulp firmness , while reduced FWL .Packing in plastic net increased FWL and FDP more than those bagged in PPE which indicated the highest carotenoids content in fruit peel . All CB packing treatments showed lower values of TSS (%) and higher acidity percentage .

For storing Ponkan tangerine fruits for relatively short periods, bagging in PPE was recommended , while for long storage period (more than three months) CB covered with SPE was superior .

INTRODUCTION

Ponkan tangerine (*Citrus reticulata* Blanco) which called in Egypt (chinese mandarin) is one of the new cultivars planted in the last fifteen years in Egypt . The trees are appreciated for high yield and good fruit quality particularly rich flavor and big fruit size with and late ripening date Feb. (Kinawi, 1995). Prolonging the marketing period of Ponkan tangerine through cold storage would improve its economic value taking into consideration that storing Ponkan tangerine fruits on trees resulted in deterioration of the eating quality other than Balady mandarine .

Prestorage hot dip treatments (52°C for 3 minutes) can be used to improve Fortune mandarin storing qualities (Schirra and Mulas 1995).

Modified atmosphere storage of Kinnow mandarin reduced weight loss (Jain and Chauchan, 1991). Weight loss of Fremont mandarin fruits was lower with polyethylene (PE) film package during either cold storage or shelf life (Piga *et al.* , 1996) . Firmness of Nova and Ora mandarin fruits was better maintained in the sealed and perforated packages after five week of cold storage at 5°C (Pereiz *et al.*, 1998).

Most of cold rooms in Egypt are not humidity controlled , therefore the suitable relative humidity percentage has to be attained through packing treatments . In addition , packing in PE bags prevent the recontamination of fruits in cold storage rooms, especially after the degradation of fungicides in long storage periods.

The present study aimed mainly to determine the effect of pagging Ponkan tangerine fruits in perforated and sealed PE after heat , TBZ , $CaCl_2$ and GA_3 treatments on fruit quality during and after cold storage period.

MATERIALS AND METHODS

This study has been carried out during the 1998 and 1999 seasons on Ponkan

tangerine (*Citrus reticulata* Blanco).

fruits were harvested from a private orchard at Menia El-Qamh district, Sharkia Governorate. The trees were 10-year-old, grafted on sour orange rootstock, grown in silty - clay soil at four meters apart and were irrigated with Nile water using the traditional basin irrigation system, the trees received the standard horticultural care during the two seasons

Harvesting took place early in the morning using a small clippers, and packed in plastic boxes. Fruits were directly taken to post- harvest laboratory in Horticulture Department , Faculty of Agriculture, Zagazig University .

The fruits were kept for one day at room temperature. All fruits were washed with water and soap and then rinsed with water to remove the residue of soap, followed by exposing the fruits to an air current till drying .

Defect - free fruits were selected and divided into six groups. Each group was randomly divided into three replicates, 165 uniform fruits were chosen at random for each replicate of Ponkan tangerine and correspond one of the following treatments.

1.Dipping in water for 5 minutes, air dried and then were packed in net .

2.Dipping in water for 5 min., air dried and then were bagged in perforated (0.5% of area) polyethylene (PPE).

3. Dipping in 1000 ppm TBZ for 5 min., air dried and then were bagged in PPE.

4.Dipping in 1000 ppm TBZ for 5 min., air dried and then were packed in carton boxes (CB) [3 liter / 1 kg fruits] covered tightly with sealed low density polyethylene (SPE) 30 μ thickness .

5. Dipping in 1000 ppm TBZ for 5 min., air dried and then were packed in CBs covered tightly with SPE bags 30 μ thickness after adding 15 gm wetted Ca

$(OH)_2$ in open small carton cylinder as CO_2 absorber.

6. Dipping in hot water at 52°C for 3 min., then in 300 ppm GA_3 for 5 min., then in 4% $CaCl_2$ for 5 min. and in 1000 ppm TBZ for 5 min. The fruit were then air dried and packed in CBs covered tightly with SPE bags 30μ thickness after adding 15 gm. wetted Ca $(OH)_2$.

Fruits of all treatments were stored for seven months at 8 ± 1°C .

Samples of each treatment were randomly taken at monthly intervals to evaluate storage period and treatments effects. Beginning with the fourth month, fruit characters were investigated after 7 days under conditions of 20°C and 60-70% RH in an incubator (the same as supermarket conditions) for detecting the effect of shelf life .

Pannel test was carried out at each sampling date and the treatments of unacceptable fruits were discarded.

Evaluation of cold storage period, treatments and shelf life effects on fruits were carried out through the following parameters:

1. Fruit decay percentage (FDP): The weight of decayed fruits due to fungus or any microorganisms infection was recorded periodically and calculated as a percentage from the total weight of fruits using the following equation :

$$FDP = \frac{\text{Weight of decayed fruit}}{\text{Total fruit weight}} \times 100$$

2. Fresh weight losses (FWL) (%): The fruits were weighed before cold storage to obtain the initial weights, then weighed after each period of cold storage and then after 7 days of the shelf life. Fruit weight was recorded and fruit weight losses were calculated as a percentage from the initial weight according to the following equation :

$$FWL\ \% = \frac{Wi - Ws}{Wi} \times 100.$$

Where W i = fruit weight at initial period .
Ws= fruit weight at sampling period.

3.Peel and pulp firmness: peel of fruits was removed , the firmness was determined for each of the peel and pulp separately using push-pull dynamometer McCormick (model FT 327) with plunger tip 5/16". Where rind oil rupture pressure (RORP) is the amount of pressure required to cause rupture of the oil cells on the rind surface. Readings were recorded on four different locations, on each of five fruits per replicate. The values were expressed as (L.b).

4.Rind total carotenoids content was numerically expressed through determination of carotenoids pigments in the peel according to Wettestein (1957) .

5.Juice percentage : juice was extracted from five fruits per replicate ..Juice content was expressed as percent of fruit weight (w/w).

6.Volume of juice : volume of juice obtained from 1kg fruits was determined.

7.Juice total soluble solids content (TSS %): was determined using a hand refractometer.

8.Juice total titratable acidity : was estimated by the direct titration method using (0.1 *N*) NaOH and expressed as grams of citric acid per 100 ml fruit juice using phenolphthalein as indicator according to A.O.A.C. (1960).

9.Juice active acidity (pH value) : was determined using a digital pH meter (Model No. 609).

10.Ascorbic acid (vitamin C) content : was determined by titration with 2,6 dichlorophenol- indophenol, using 2% oxalic acid solution as substrate. Ascorbic acid was calculated as milligram per 100 ml. of juice (Lucass, 1944).

11.Respiration rate : three fruits from each replicate were selected at random and placed in 3.8-l plastic

jars (respiratory chambers) mounted in groups of four. Three out of four were used for the respiration rate, while the fourth was used as the air blank. The air stream from each jar, metered through precision tube flow · meters was passed through two gas dispersion tubes connected in series (double trap) containing 0.1 *N* barium hydroxide and 0.2% barium chloride solution. CO_2 output was recorded by titration and respiration rate was calculated as mg CO_2 $kg^{-1}h^{-1}$ (Schirra, 1992). Respiration rate of fruits was determined under 20°C

Statistical analysis : the complete randomized block design with 3 replicates and with factorial arrangement was followed throughout the whole work (Snedecor and Cochran , 1980) . The means representing the effect of tested treatments, storage period and their interaction were compared using Duncan's multiple range test at 0.05.

RESULTS AND DISCUSSION

1.Fruit decay percentage (FDP) during cold storage period and after seven days shelf life

Decay percentages of Ponkan tangerine as affected by cold storage period and bagging treatments presented in Table 1 indicate the following data taking into consideration that 50% decay or above is not accepted, the obtained results give bases to consider that :

1. Packing in plastic net after dipping in water is acceptable up to three months of cold storage.
2. Bagging in PPE + water treatment is acceptable up to four months.
3. Bagging in PPE after dipping in 1000ppm thiabendazole (TBZ) treatment is acceptable up to five months of cold storage.
4. Packing in CBs covered with sealed low density polyethylene bags (CB) after dipping in TBZ treatment is acceptable up to six months of cold storage.
5. Packing in CB + TBZ + Ca $(OH)_2$ treatment is acceptable up to five months.

6.Packing in CB + hot water at 52°C for three minutes + 300 ppm GA_3 + 4% $CaCl_2$ +TBZ + Ca $(OH)_2$ treatment is acceptable up to five months.

Comparing the above mentioned findings, it is clear that TBZ treatment and packing in CB resulted in the maximum storage life (six or seven months) with acceptable FDP (38.11 and 26.78 %) after 6 months of cold storage in the two seasons, respectively. Meanwhile the common method used commercially until now (Packing in plastic net) was 93.49 and 90.95 after the same period. Adding Ca $(OH)_2$ to CBs as a CO_2 absorber resulted in increasing FDP after cold storage period compared with the treatment of CBs covered with sealed PE without CO_2 absorber and this may be due to the effect of CO_2 accumulation in sealed PE bags which covered carton boxes. High CO_2 concentration can be considered as a fungal stator its depressed the growth of mycelium . Decreasing O_2 concentration had no effect on controlling fruit decay . The treatment (TBZ + Ca $(OH)_2$ + CB) showed the same results like the treatment (TBZ + PPE).

Considering shelf life for one week after cold storage period , it is clear that TBZ treatment and packing in CB showed lower FDP during shelf life for one week after cold storage, since FDP ranged between O to 10.16% after storage four, five or six months, while much higher FDP values during shelf life for one week was recorded with water treatment and net packing which ranged between 40.03 - 44.57% .

Similar findings were mentioned by Chun *et al.*, (1990) who stated that using plastic film wrapping alone or with 1000 ppm TBZ treatment reduced decay of Minneola tangelos. Sealed packing of green lemon and grapefruit significantly reduced the incidence of decay (Ismail and El-Menshawy, 1997). Wrapping reduced

decay rates compared with control fruits of Baladi orange (El-Mughrabi, 1999).

2.Fresh weight losses (FWL)

Data in Table 2 show the FWL of Ponkan tangerine fruits as affected by cold storage period, the tested treatments and their interaction.

The main effect of cold storage period showed that FWL was markedly increased as cold storage period increased.

Thiabendazole treatment and CB packing resulted in the least significant FWL (1.91 and 2.70%) , while the highest one was belong to water and net packing (14.38 & 15.30%) in the first and second seasons, respectively. The treatment using perforated PE gave significantly lower values of FWL than net packing and higher values than sealed PE in both seasons.

The interaction between bagging and cold storage period was significant in both seasons. The treatment TBZ and CB packing recorded the least values of FWL along cold storage period and ranged between 2.63- 3.33% after 4 months storage.

Also, the lower FWL values were observed with TBZ +CB during shelf life for one week after 4 or 5 months of cold storage compared to other treatments .

In this regard Jawanda *et al.* (1978) found that waxed Kinnow mandarin fruits or unwrapped ones recorded high weight losses (24 and 48%, respectively) comparing with (6%) to perforated polyethylene bags treatment. Also, Miller and Risse (1998) found that film wrapping reduced moisture loss in grapefruits, lemons and oranges. So Tugwell, (1988) mentioned that wrapping Valencia oranges in plastic film reduced weight loss to nearly half of that which occurred when non-wrapped fruits were stored at 10°C.

3.Peel and pulp firmness (L.b)

Data in Tables 3 and 4 show peel and pulp firmness of Ponkan tangerine fruits as affected by cold storage

period, bagging treatments and their interaction.

Peel and pulp firmness was significantly decreased as cold storage period increased.

Bagging treatments resulted in the least peel and pulp firmness with water and net packing or water and PPE bagging , While the highest peel and pulp firmness was belong to TBZ and CB packing. The other treatments showed less firmness and mostly was not significantly differ than TBZ and CB packing.

The interaction between cold storage period and bagging treatments proved that the less firmness value of peel and pulp along cold storage period was belong to water and net packing or water and PPE bagging, although the firmness of peel and pulp was significantly decreased as cold storage period increased to four months. The TBZ and CB packing treatment, in addition to other applied treatments, recorded high peel and pulp firmness without significant differences between them along cold storage period. Moreover, the same trend still clear during shelf life for one week after cold storage period.

In this regard, Jawanda *et al.* (1978) found that kinnow mandarins kept in perforated polyethylene bags retained the best firmness and flavour comparing to that wrapped in newspaper . Also, Ben - Yehoshua and Shapiro (1979) on Shamouti and Valenci oranges, grapefruit or lemons found that sealed packed fruits individually in a film of high - density polyethylene remained firm for a much longer period than the non sealed ones. Moreover, Ahmed *et al.* (1991) mentioned that modified atmosphere packaging using low density polyethylene films of Clementine mandarin showed better retention of rind firmness. So, Pereiz *et al.* (1998) reported that sealed Nova and Ora mandarins fruits after four weeks storage at 5°C followed by one week at 20°C fruits. Firmness was best maintained in the sealed unperforated package. Perforated packages also had an

advantage in maintaining firmness in comparison with the control treatment.

4.Rind carotenoids content

Data in Table 5 show carotenoids content in the peel of Ponkan tangerine fruits as affected by cold storage period, bagging treatments and their interaction.

The main effect of cold storage period indicated significant increase in carotenoids content as cold storage period increased.

The main effect of bagging treatments shows that TBZ treatment and PPE bagging resulted in the highest carotenoids content descendingly followed by water and net backing or water and PPE pagging. The other applied treatments indicated lower values which obtained by TBZ and sealed PE bagging.

The interaction between bagging treatments and cold storage period was significant in the two tested seasons. The treatment TBZ and PPE bagging showed gradual significant increase in carotenoids content as cold storage period increased up to four months. This combination resulted in the uppermost values of carotenoids content (3.58 and 3.65 mg/100 gm fresh weight) . The values obtained by this treatment was not significantly differed than water and net packing or water and PPE bagging. The other applied combinations resulted in significantly lower values being the least with TBZ and CB packing .

The above mentioned trend was also noticed during shelf life.

The above mentioned findings are in harmony with those obtained by (Ben - Yehoshua and Shapiro 1979) who reported that the effect of sealing PE packing on fruit senescence was the considerable delay in the development of the advanced undesirable color in Marsh grapefruit and Eureaka lemons. Film wrapping of grapefruits, lemons and oranges, maintains characteristic freshness with reduced colour development during extended periods of storage and marketing (Miller and Risse, 1988). Lemons

yellowed more rapidly in non - sealed fruits and at higher temperatures (Cohen *et al.*, 1990) . Modified atmosphere packaging using low density polyethylene film on Clementine mandarin showed better retention of green and orange color (Ahmed *et al.*, 1991).

5.Juice percentage (w/w) and volume (ml/ kg fresh weight

Dada in Tables (6 and 7) show juice (%) and volume of Ponkan tangerine fruits as affected by cold storage period, bagging treatments and their interaction.

The main effect of cold storage period indicated significant reduction in juice (%) and volume as cold storage period increased .

The main effect of bagging treatments indicated that the least juice (%) and volume was recorded with water and net packing followed ascendingly by water and PPE bagging. This may be due to high loss of water content from the fruits (Table 2). On the other hand, TBZ other applied bagging treatments resulted in high percentage and volume of juice than water and net or PPE bagging treatments which may be due to less water loss .

The interaction between cold storage period and bagging treatments indicated significant reduction in juice (%) and volume with water treatment and net packing which being the least after four months of cold storage. On the other hand, TBZ treatment and other bagging treatments resulted in lower reductions in juice (%) and volume comparing to water and net packing or water and PPE bagging.

As for shelf life, TBZ and difference bagging treatments also recorded higher juice (%) and volume than water and packing treatments.

The results of this work indicated that water and net packing or water and PPE bagging enhanced the loss in juice percentage and volume than TBZ and PPE or sealed PE bagging. This may be due to less water loss or fresh weight losses due to bagging.

However, storing was found to decrease juice percentage in either sealed or non - sealed lemons fruits (Cohen *et al.*,1990) . On the other hand using ventilated polyethylene bags resulted in a greater decrease in juice content of Coorg mandarins (Angadi and Shantha, 1992).

6.Total soluble solids (TSS) percentage in juice

Data in Table 8 show that TSS% in juice of Ponkan tangerine fruits as affected by cold storage period, bagging treatments and their interaction.

The main effect of cold storage period pointed to significant increase in TSS as cold storage period increased.

The main effect of bagging treatments indicated that the treatments including (CB) covered with sealed PE, (TBZ +CB), [TBZ +$Ca(OH)_2$+ CB] and [H+GA_3 + $CaCl_2$ + TBZ + $Ca(OH)_2$ + CB] showed decreases in TSS(%) in both tested seasons, No significant differences can be observed between the treatments (water + PPE bagging) and (TBZ + PPE bagging). The highest values were obtained from the treatment (water + net packing).

The interaction between cold storage period and bagging treatments was significant in the two seasons and cleared the above mentioned trend along cold storage period.

As for shelf life, after 4 months cold storage water and net packing treatment revealed higher TSS (%) comparing with all other treatments in the first season and without significant differences in the second season.

These results can be related to the increase in fresh weight losses with treatment water and net packing (Table 2) which attained the highest TSS and this may be due to the rise in concentration after water loss.

In this regard D'Aquino *et al.* (1998) reported that wrapped Minneola tangelo fruits had the lowest TSS values than unwrapped. On the other hand Efiurwevwere and

Oyelade, (1991) found that the unperforated polyethylene packaged increased TSS in oranges fruits than perforated bags.

7.Total acidity percentage and activated acidity (pH value)

Data in Table 9 show that total acidity (%) in juice of Ponkan tangerine fruits as affected by cold storage period, bagging treatments and their interaction .

The data indicated significant reduction in total acidity (%) as cold storage period increased.

The main effect of bagging treatments indicated that water + net packing or water + PPE bags resulted in the highest acidity (%) comparing with TBZ + PPE or CB covered with sealed PE. The least acidity (%) was recorded with TBZ + $Ca(OH)_2$.

The interaction (period x treatments) indicated reduction in acidity (%) along cold storage period with similar magnitude in TBZ + CB + $Ca(OH)_2$ or in addition to hot water +GA_3 + $CaCl_2$. The later treatments had significantly less values than water + net packing .

As for shelf life, the above mentioned trend was also clear during shelf life.

In this respect, Kaushal and Thakur, (1996) mentioned that packed Kinnow mandarin fruits in sealed polyethylene bags exhibited a decrease in acidity than unsealed fruits . Also, Pereiz *et al.* (1998) reported that sealing treatment cause a reduction in acidity levels of Nova mandarin fruits after five weeks storage.

As for activated acidity (pH), data in Table 10 show that pH values of the juice showed opposite trend of that mentioned in acidity .

8.Ascorbic acid (vitamin C) (VC) content (mg/100 ml juice)

Data in Table 11 show VC content in juice of Ponkan tangerine fruits as affected by cold storage period, bagging treatments and their interaction.

The main effect of cold storage period showed significant reduction in VC content as cold storage period increased .

The main effect of bagging treatments indicated that water and net packing recorded less VC content than the other treatments in both seasons. This may be due to oxidation effect of the high O_2 concentration in net packing compared with lower O_2 concentration in bagged treatments .

The interaction between cold storage period and bagging treatments indicated that although all applied treatments showed reduction in VC along cold storage period, TBZ + Ca $(OH)_2$ + CB sealed PE bagging recorded less reduction than water + net packing or water + PPE bagging especially in the second season. The above mentioned trend took place during shelf life .

In this regard, Amarjit and Rajinder, (1996) mentioned that in either wrapping or storing in modified atmosphere of kinnow mandarin fruits , ascorbic acid was decreased as storage period advanced . Also, D'Aquino *et al.* (1998) reported that vitamin C content in juice of Minneola tangelo fruits decreased progressively from harvest to the end of the 30 - day- storage period in both wrapped with plastic film or unwrapped fruits. On the other hand, Kinnow and Thakur, (1996) found that sealed polyethylene packed Kinnow mandarins fruits exhibited a decrease in ascorbic acid content than non pagged fruits .

9.Respiration rate (mg CO_2/ kg fruits/h) after cold storage period

Data in Table 12 show respiration rate of Ponkan tangerine fruits as affected by cold storage period, bagging treatments and their interaction.

The main effect of cold storage period indicated significant increase in respiration rate as cold storage period increased.

The main effect of bag-

Table 1. Effect of bagging in sealed tightly and perforated polyethylene (PPE) on decay (%) of Ponkan tangerine fruits during cold storage period and shelf life (1998 and 1999 seasons).

Treatments soaking for 5 minutes	Fruit decay percentage (FDP)											
	Cold storage period (P) (months)								One week shelf life after cold storage			
	1	2	3	4	5	6	7	Treat. av.	4	5	6	7
	First season (1998)											
1-Water + net	0	19.36	37.46	53.42	82.12	93.49	100.00	55.12	44.57	-①	-	-
2-Water + PPE bags	0	7.31	28.12	31.51	64.62	82.56	92.52	43.80	22.90	-	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	0	0	0	13.88	26.21	63.28	76.86	25.74	7.65	9.66	-	-
4-TBZ + CB②	0	0	0	11.71	24.82	38.11	68.85	20.49	0	7.32	10.16	-
5-TBZ+Ca $(OH)_2$+CB②	0	0	0	14.13	28.24	64.46	79.33	26.59	3.96	8.87	-	-
6-H③+ 300 ppm GA_3 +4% $CaCl_2$+TBZ+ Ca $(OH)_2$ + CB②	0	0	0	15.37	27.61	65.78	78.35	26.73	5.13	9.11	-	-
P av.	0	4.44	10.93	23.33	42.27	67.94	82.65					
	Second season (1999)											
1-Water + net	0	16.32	33.92	49.88	79.58	90.95	100.00	52.95	40.03	-	-	-
2-Water + PPE bags	0	5.93	24.41	28.86	41.00	70.00	88.96	37.02	18.24	21.77	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	0	0	0	12.18	21.05	33.70	60.91	18.26	0	0	0	-
4-TBZ + CB②	0	0	0	11.37	20.16	26.78	40.15	14.06	0	0	0	0
5-TBZ+Ca $(OH)_2$+CB②	0	0	0	12.71	22.01	30.16	61.28	18.02	0	0	0	-
6-H③ + 300ppm GA_3+4% $CaCl_2$+TBZ+ Ca $(OH)_2$ +CB②	0	0	0	11.35	22.64	35.13	65.87	19.28	0	0	3.41	-
P av.	0	3.70	9.72	21.05	34.40	47.78	69.52					

- ① The treatment was terminated after the decay of 50% of fruits during shelf life .
- ② Carton boxes covered with sealed low density polyethylene bags.
- ③ Hot water at 52°C for 3 minutes.

Table 2. Effect of bagging in sealed tightly and perforated polyethylene (PPE) on fresh weight losses (%) of Ponkan tangerine fruits during cold storage period and shelf life (1998 and 1999 seasons).

Treatments soaking for 5 minutes	Fresh weight losses (FWL)											
	Cold storage period (P) (months)								One week shelf life after cold storage			
	1	2	3	4	Treat. av.	5	6	7	4	5	6	7
	First season (1998)											
1-Water + net	6.18 d	11.59c	14.80b	24.95a	14.38A	-①	-	-	6.73A	-	-	-
2-Water + PPE bags	1.34 l	2.97gh	4.91e	6.29d	3.88B	-	-	-	4.30BC	-	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	1.60 kl	2.50hij	3.73f	5.35e	3.29C	8.01A	-	-	4.13C	7.46A	-	-
4-TBZ + CB②	1.34 l	1.75kl	1.91jkl	2.63hij	1.91E	3.45D	4.48	-	4.57BC	7.62A	8.65	-
5-TBZ+Ca $(OH)_2$+CB②	1.54 kl	2.21ijk	2.87ghi	3.71f	2.58D	5.48B	-	-	4.67B	7.40A	-	-
6-H③+ 300 ppm GA_3 +4% $CaCl_2$+TBZ+ Ca $(OH)_2$ + CB②	1.30 l	2.10jk	2.60hij	3.54fg	2.38D	4.26C	-	-	4.60BC	7.63A	-	-
P av.	2.21 D	3.85C	5.13B	7.74A								
	Second season (1999)											
1-Water + net	7.72 d	12.44c	15.22b	25.80a	15.30A	-	-	-	7.42A	-	-	-
2-Water + PPE bags	2.98 hi	3.82g	5.34f	7.64d	4.94B	9.90A	-	-	5.02B	7.15A	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	2.24 jk	3.46gh	4.99f	6.68e	4.34C	9.10B	10.45A	-	4.43C	6.46C	7.12AB	-
4-TBZ + CB②	1.97 kl	2.56ij	2.93hi	3.33gh	2.70D	4.16D	5.49B	6.80	4.19C	6.16D	6.71C	7.34
5-TBZ+Ca $(OH)_2$+CB②	2.02 kl	2.70ij	2.93hi	3.56g	2.80D	4.29D	5.78B	-	4.24C	6.47C	7.02B	-
6-H③ + 300ppm GA_3+4% $CaCl_2$+TBZ+ Ca $(OH)_2$ +CB②	1.62 l	2.65ij	2.62ij	2.68g	2.64D	4.84C	5.70B	-	4.42C	6.60B	7.21A	-
P av.	3.09 D	4.60C	5.67B	8.45A								

- ① The treatment was terminated after the decay of 50% of fruits.
- ② Carton boxes covered with sealed low density polyethylene bags.
- ③ Hot water at 52°C for 3 minutes.

Values followed by the same alphabetical letters did not differ significantly according to Duncan's multiple range test.

Table 3. Effect of bagging in sealed tightly and perforated polyethylene (PPE) on fruit peel firmness (L.b) of Ponkan tangerine during cold storage period and shelf life (1998 and 1999 seasons).

Treatments soaking for 5 minutes	Peel firmness											
	Cold storage period (P) (months)								One week shelf life after cold storage			
	1	2	3	4	Treat. av.	5	6	7	4	5	6	7
	First season (1998)											
1-Water + net	7.05d-g	6.85hij	6.49k	6.20 l	6.65D	-①	-	-	5.90D	-	-	-
2-Water + PPE bags	7.26ab	7.11b-f	6.91ghi	6.71j	7.00C	-	-	-	6.51C	-	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	7.31a	7.16a-d	6.96fgh	6.81ij	7.06BC	6.66C	-	-	6.66B	6.46B	-	-
4-TBZ + CB②	7.31a	7.23abc	7.13b-e	7.08c-f	7.19A	7.05A	6.98	-	7.02A	6.97A	6.90	-
5-TBZ+Ca $(OH)_2$+CB②	7.26ab	7.16a-d	7.06def	7.00efg	7.12AB	6.95B	-	-	6.95A	6.86A	-	-
6-H③ + 300 ppm GA_3 +4% $CaCl_2$+TBZ+ Ca $(OH)_2$ + CB②	7.27ab	7.17a-d	7.07def	7.02d-g	7.13AB	6.96B	-	-	6.96A	6.87A	-	-
P av.	7.24A	7.11B	6.94C	6.80D								
	Second season (1999)											
1-Water + net	7.14de	6.95g	6.60i	6.32j	6.75D	-	-	-	6.04D	-	-	-
2-Water + PPE bags	7.35ab	7.19cde	7.00fg	6.80h	7.08C	6.65C	-	-	6.60C	6.47D	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	7.40a	7.25a-d	7.10ef	6.95h	7.17B	6.80B	6.65B	-	6.82B	6.62C	6.47B	-
4-TBZ + CB②	7.40a	7.30abc	7.22b-e	7.17cde	7.27A	7.12A	7.05A	6.99	7.11A	7.06A	6.99A	6.92
5-TBZ+Ca $(OH)_2$+CB②	7.36ab	7.27a-d	7.20cde	7.15de	7.24A	7.09A	7.03A	-	7.08A	7.02B	6.97A	-
6-H③ + 300ppm GA_3+4% $CaCl_2$+TBZ+ Ca $(OH)_2$ +CB②	7.35ab	7.26a-d	7.18cde	7.13def	7.23AB	7.08A	7.04A	-	7.06A	7.03B	6.98A	-
P av.	7.33A	7.20B	7.05C	6.92D								

- ① The treatment was terminated after the decay of 50% of fruits.
- ② Carton boxes covered with sealed low density polyethylene bags.
- ③ Hot water at 52°C for 3 minutes.

Values followed by the same alphabetical letters did not differ significantly according to Duncan's multiple range test.

Table 4. Effect of bagging in sealed tightly and perforated polyethylene (PPE) on fruit pulp firmness (L.b) of Ponkan tangerine during cold storage period and shelf life (1998 and 1999 seasons).

Treatments soaking for 5 minutes	Pulp firmness											
	Cold storage period (P) (months)								One week shelf life after cold storage			
	1	2	3	4	Treat. av.	5	6	7	4	5	6	7
	First season (1998)											
1-Water + net	2.62c-f	2.38ij	2.19k	2.02l	2.30D	-①	-	-	1.83D	-	-	-
2-Water + PPE bags	2.71a-d	2.49f-j	2.35j	2.23k	2.44C	-	-	-	2.16C	-	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	2.80ab	2.68b-e	2.49f-i	2.40hij	2.59B	2.28B	-	-	2.33B	2.21B	-	-
4-TBZ + CB②	2.81a	2.76ab	2.62c-f	2.56efg	2.69A	2.48A	2.39	-	2.49A	2.41A	2.33	-
5-TBZ+Ca $(OH)_2$+CB②	2.72abc	2.69a-e	2.50f-i	2.45g-j	2.59B	2.38AB	-	-	2.40AB	2.29AB	-	-
6-H③+ 300 ppm GA_3 +4% $CaCl_2$+TBZ+ Ca $(OH)_2$ + CB②	2.80ab	2.73abc	2.59def	2.52fgh	2.66A	2.44AB	-	-	2.46AB	2.36AB	-	-
P av.	2.74A	2.62B	2.46C	2.36D								
	Second season (1999)											
1-Water + net	2.54fgh	2.31 ij	2.16k	1.99 l	2.25D	-	-	-	1.90D	-	-	-
2-Water + PPE bags	2.65b-f	2.44h	2.32i	2.50jk	2.40C	2.09C	-	-	2.12C	2.05D	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	2.75ab	2.66b-e	2.57efg	2.49gh	2.62B	2.42B	2.36B	-	2.44B	2.38C	2.30B	-
4-TBZ + CB②	2.83a	2.76ab	2.68b-e	2.62c-f	2.72A	2.57A	2.51A	2.46	2.58A	2.52A	2.48A	2.41
5-TBZ+Ca $(OH)_2$+CB②	2.80a	2.72a-d	2.63c-f	2.62def	2.69A	2.53A	2.47A	-	2.49AB	2.49B	2.43AB	-
6-H③ + 300ppm GA_3+4% $CaCl_2$+TBZ+ Ca $(OH)_2$ +CB②	2.83a	2.74abc	2.65b-f	2.57efg	2.70A	2.52AB	2.49A	-	2.50AB	2.50AB	2.45A	-
P av.	2.73A	2.60B	2.50C	2.42D								

- ① The treatment was terminated after the decay of 50% of fruits.
- ② Carton boxes covered with sealed low density polyethylene bags.
- ③ Hot water at 52°C for 3 minutes.

Values followed by the same alphabetical letters did not differ significantly according to Duncan's multiple range test.

Table 5. Effect of bagging in sealed tightly and perforated polyethylene (PPE) on rind carotenoids content (mg/100gm fresh weight) of Ponkan tangerine fruit peel during cold storage period and shelf life (1998 and 1999 seasons).

Treatments soaking for 5 minutes	Rind carotenoids content											
	Cold storage period (P) (months)								One week shelf life after cold storage			
	1	2	3	4	Treat. av.	5	6	7	4	5	6	7
	First season (1998)											
1-Water + net	2.90jkl	3.11fgh	3.32cde	3.53ab	3.21B	- ①	-	-	3.65AB	-	-	-
2-Water + PPE bags	2.91jkl	3.09ghi	3.27de	3.45abc	3.18B	-	-	-	3.56AB	-	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	3.00hij	3.19efg	3.39bcd	3.58a	3.29A	3.77A	-	-	3.69A	7.87A	-	-
4-TBZ + CB②	2.77lm	2.95ijk	3.13fgh	3.31de	3.04C	3.49B	3.76	-	3.42B	3.70B	4.00	-
5-TBZ+Ca $(OH)_2$+CB②	2.82klm	3.09gh	3.30de	3.51ab	3.18B	3.72A	-	-	3.62AB	3.88A	-	-
6-H③ + 300 ppm GA_3 +4% $CaCl_2$+TBZ+ Ca $(OH)_2$ + CB②	2.73m	2.90jkl	3.01hij	3.24ef	2.97D	3.47B	-	-	3.44B	3.62B	-	-
P av.	2.85D	3.05C	3.24B	3.44A								
	Second season (1999)											
1-Water + net	2.89ij	3.14e-h	3.38bcd	3.65a	3.26AB	-	-	-	3.77A	-	-	-
2-Water + PPE bags	2.90ij	3.12e-h	3.34cd	3.57ab	3.23BC	3.79AB	-	-	3.68A	4.00A	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	3.04ghi	3.25c-f	3.44be	3.65a	3.35A	3.84A	4.12A	-	3.76A	3.95A	4.29A	-
4-TBZ + CB②	2.82j	2.98hij	3.14e-h	3.31cde	3.06D	3.47C	3.63B	3.79	3.44B	3.56B	3.72B	4.00
5-TBZ+Ca $(OH)_2$+CB②	2.87ij	3.04ghi	3.21d-g	3.38bcd	3.12D	3.55BC	3.76B	-	3.48B	3.64B	3.93B	-
6-H③ + 300ppm GA_3+4% $CaCl_2$+TBZ+ Ca $(OH)_2$ +CB②	2.90ij	3.06f-i	3.24def	3.40bcd	3.15CD	3.56BC	3.72B	-	3.48B	3.65B	3.82B	-
P av.	2.90D	3.09C	3.29B	3.49A								

- ① The treatment was terminated after the decay of 50% of fruits.
- ② Carton boxes covered with sealed low density polyethylene bags.
- ③ Hot water at 52°C for 3 minutes.

Values followed by the same alphabetical letters did not differ significantly according to Duncan's multiple range test.

Table 6. Effect of bagging in sealed tightly and perforated polyethylene (PPE) on juice percentage (juice weight/ fruit fresh weight) of Ponkan tangerine fruits during cold storage period and shelf life (1998 and 1999 seasons).

Treatments soaking for 5 minutes	Fruit juice percentage											
	Cold storage period (P) (months)								One week shelf life after cold storage			
	1	2	3	4	Treat. av.	5	6	7	4	5	6	7
	First season (1998)											
1-Water + net	35.39k	33.50 l	32.19m	30.38n	32.87E	- ①	-	-	28.59E	-	-	-
2-Water + PPE bags	41.59bc	40.61def	38.85ij	38.05j	39.77D	-	-	-	36.49D	-	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	41.84bc	40.96cde	39.69f-i	38.88ij	40.34C	37.97B	-	-	37.38C	35.59B	-	-
4-TBZ + CB②	42.38ab	41.68bc	39.83fgh	39.15hi	40.76BC	38.35B	37.57	-	38.03B	36.20B	35.98	-
5-TBZ+Ca $(OH)_2$+CB②	42.54ab	41.71bc	40.28efg	39.41ghi	40.98B	38.50B	-	-	38.37B	36.21B	-	-
6-H③ + 300 ppm GA_3 +4% $CaCl_2$+TBZ+ Ca $(OH)_2$ + CB②	43.01a	42.23ab	41.23cd	40.51def	41.74A	39.60A	-	-	39.44A	37.68A	-	-
P av.	41.12A	40.11B	38.68C	37.73D								
	Second season (1999)											
1-Water + net	43.21efg	41.77fg	40.87g	36.77h	40.65C	-	-	-	35.18D	-	-	-
2-Water + PPE bags	46.07a-e	45.04a-f	44.20c-g	43.50d-g	44.70B	42.24C	-	-	42.00C	41.01C	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	47.04a-d	46.16a-e	45.20a-f	44.40b-f	45.70AB	43.18B	42.24C	-	43.56B	42.12B	41.34B	-
4-TBZ + CB②	48.27a	47.57abc	46.76a-e	45.87a-e	47.12A	45.19A	44.54A	43.68	44.75A	43.90A	43.02A	42.48
5-TBZ+Ca $(OH)_2$+CB②	48.00ab	47.19a-d	46.29a-e	45.49a-e	46.74A	44.71A	43.87B	-	44.25AB	43.28A	42.33A	-
6-H③ + 300ppm GA_3+4% $CaCl_2$+TBZ+ Ca $(OH)_2$ +CB②	48.28a	47.57abc	46.58a-e	45.70a-e	47.03A	44.97A	44.08B	-	44.79A	43.49A	42.95A	-
P av.	46.81A	45.88AB	44.98B	43.62C								

- ① The treatment was terminated after the decay of 50% of fruits.
- ② Carton boxes covered with sealed low density polyethylene bags.
- ③ Hot water at 52°C for 3 minutes.

Values followed by the same alphabetical letters did not differ significantly according to Duncan's multiple range test.

Table 7. Effect of bagging in sealed tightly and perforated polyethylene (PPE) on volume of juice (ml/kg fresh weight) of Ponkan tangerine fruits during cold storage period and shelf life (1998 and 1999 seasons).

Treatments soaking for 5 minutes	Juice volume / kg fruits											
	Cold storage period (P) (months)								One week shelf life after cold storage			
	1	2	3	4	Treat. av.	5	6	7	4	5	6	7
	First season (1998)											
1-Water + net	338.90g	320.20gh	306.80h	322.20gh	322.00D	-①	-	-	337.60A	-	-	-
2-Water + PPE bags	403.80a-d	391.20a-e	373.50ef	365.30f	383.50C	-	-	-	349.80A	-	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	403.40a-d	394.60a-e	381.90def	373.80ef	388.50BC	364.70B	-	-	358.70A	740.80C	-	-
4-TBZ + CB②	408.70ab	401.70a-d	383.40c-f	376.60ef	392.60ABC	368.50B	360.74	-	365.30A	347.10B	344.79	-
5-TBZ+Ca $(OH)_2$+CB②	410.50ab	402.30a-d	387.70b-f	380.20def	395.20AB	370.00B	-	-	368.70A	347.20B	-	-
6-H③ + 300 ppm GA_3 +4% $CaCl_2$+TBZ+ Ca $(OH)_2$ + CB②	415.20a	407.30abc	397.30a-e	390.20b-e	402.50A	381.00A	-	-	379.40A	361.80A	-	-
P av.	396.80A	386.20B	371.80C	368.00C								
	Second season (1999)											
1-Water + net	383.90m	369.50n	360.40o	352.70p	366.60E	-	-	-	336.90E	-	-	-
2-Water + PPE bags	445.70fg	435.30j	427.80k	420.20l	432.30D	407.40D	-	-	405.20D	395.30D	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	455.50c	446.60efg	437.30ij	429.10k	442.10C	416.30C	408.30B	-	420.50C	405.30C	398.50C	-
4-TBZ + CB②	467.60a	460.60b	452.60cd	443.70fgh	456.20A	436.90A	430.40A	421.86	432.50A	424.30A	415.30A	409.81
5-TBZ+Ca $(OH)_2$+CB②	456.10a	456.90bc	447.90ef	439.90hi	452.50B	432.20B	423.70A	-	427.50B	417.90B	408.40B	-
6-H① + 300ppm GA_3+4% $CaCl_2$+TBZ+ Ca $(OH)_2$+CB②	467.90a	460.70b	450.80de	442.10gh	455.40A	434.70AB	425.80A	-	432.90A	419.90B	414.40A	-
P av.	447.60A	438.30B	429.50C	421.30D								

- ① The treatment was terminated after the decay of 50% of fruits.
- ② Carton boxes covered with sealed low density polyethylene bags.
- ③ Hot water at 52°C for 3 minutes.

Values followed by the same alphabetical letters did not differ significantly according to Duncan's multiple range test.

Table 8. Effect of bagging in sealed tightly and perforated polyethylene (PPE) on TSS (%) in juice of Ponkan tangerine fruits during cold storage period and shelf life (1998 and 1999 seasons).

Treatments soaking for 5 minutes	Total soluble solids (TSS)											
	Cold storage period (P) (months)								One week shelf life after cold storage			
	1	2	3	4	Treat. av.	5	6	7	4	5	6	7
	First season (1998)											
1-Water + net	12.00def	12.67a-d	13.17ab	13.25a	12.77A	-①	-	-	13.00A	-	-	-
2-Water + PPE bags	12.00def	12.33cde	12.77abc	13.00abc	12.52AB	-	-	-	12.33B	-	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	11.83ef	12.00def	12.50b-e	12.67a-d	12.25BC	12.83A	-	-	11.67C	12.33A	-	-
4-TBZ + CB②	11.33fg	12.50b-e	12.67a-d	12.83abc	12.33B	13.00A	13.53	-	11.67C	12.83A	13.73	-
5-TBZ+Ca $(OH)_2$+CB②	11.10g	12.00def	12.33cde	12.50b-e	11.98C	12.63A	-	-	11.67C	12.50A	-	-
6-H③ + 300 ppm GA_3 +4% $CaCl_2$+TBZ+ Ca $(OH)_2$ + CB②	11.17g	11.83ef	12.33cde	12.50b-e	11.96C	13.00A	-	-	12.33B	12.83A	-	-
P av.	11.57C	12.22B	12.63A	12.79A								
	Second season (1999)											
1-Water + net	11.82abc	11.90abc	12.00ab	12.03ab	11.94A	-	-		11.90A	-	-	-
2-Water + PPE bags	11.77abc	11.83abc	11.93abc	11.97ab	11.88AB	12.00A	-		11.85A	12.00A	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	11.50cde	11.67a-d	11.97ab	12.00ab	11.78ABC	12.23A	12.53AB	-	11.83A	12.00A	12.50AB	-
4-TBZ + CB②	11.17e	11.67a-d	11.70abc	11.83abc	11.59C	12.07A	12.33B	12.76	11.83A	12.00A	12.27B	12.56
5-TBZ+Ca $(OH)_2$+CB②	11.17e	11.60bcd	11.67a-d	11.93abc	11.59C	12.27A	12.43B	-	11.83A	12.07A	12.33B	-
6-H③ + 300ppm GA_3+4% $CaCl_2$+TBZ+ Ca $(OH)_2$ +CB②	11.27de	11.67a-d	11.83abc	12.07a	11.71BC	12.40A	12.93A	-	12.03A	12.40A	12.83A	-
P av.	11.45C	11.72B	11.85AB	11.97A								

- ① The treatment was terminated after the decay of 50% of fruits.
- ② Carton boxes covered with sealed low density polyethylene bags.
- ③ Hot water at 52°C for 3 minutes.

Values followed by the same alphabetical letters did not differ significantly according to Duncan's multiple range test.

Table 9. Effect of bagging in sealed tightly and perforated polyethylene (PPE) on acidity (%) in juice of Ponkan tangerine fruits during cold storage period and shelf life (1998 and 1999 seasons).

Treatments soaking for 5 minutes	Total acidity											
	Cold storage period (P) (months)								One week shelf life after cold storage			
	1	2	3	4	Treat. av.	5	6	7	4	5	6	7
	First season (1998)											
1-Water + net	1.20a	1.01cd	0.83f	0.70hi	0.93A	-①	-	-	0.63A	-	-	-
2-Water + PPE bags	1.19a	0.99d	0.77g	0.64jkl	0.89B	-	-	-	0.56B	-	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	1.17a	0.94e	0.69hij	0.58m	0.84C	0.51A	-	-	0.53B	0.50A	-	-
4-TBZ + CB②	1.15a	0.93e	0.74gh	0.63klm	0.86C	0.51A	0.43	-	0.56B	0.48A	0.43	-
5-TBZ+Ca $(OH)_2$+CB②	1.09b	0.89e	0.68ijk	0.57m	0.81D	0.50A	-	-	0.52B	0.47A	-	-
6-H③ + 300 ppm GA_3+4% $CaCl_2$+TBZ+ Ca $(OH)_2$ + CB②	1.06bc	0.83f	0.71hi	0.59lm	0.80D	0.52A	-	-	0.53B	0.51A	-	-
P av.	1.14A	0.93B	0.73C	0.62D								
	Second season (1999)											
1-Water + net	1.08a	0.79d	0.75def	0.68f-j	0.82A	-	-	-	0.62A	-	-	-
2-Water + PPE bags	1.06ab	0.77de	0.71d-h	0.63h-k	0.79AB	0.52A	-	-	0.56B	0.48A	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	0.98bc	0.74d-g	0.68fi	0.62ijk	0.75B	0.51A	0.45A	-	0.50B	0.44BC	0.42A	-
4-TBZ + CB②	1.12a	0.73d-g	0.63h-k	0.57k	0.76B	0.50A	0.44AB	0.41	0.50B	0.45B	0.41A	0.39
5-TBZ+Ca $(OH)_2$+CB②	1.12a	0.74d-g	0.66g-j	0.59jk	0.78B	0.50A	0.42B	-	0.54B	0.44BC	0.39A	-
6-H③ + 300ppm GA_3+4% $CaCl_2$+TBZ+ Ca $(OH)_2$+CB②	0.95c	0.70e-i	0.62ijk	0.56k	0.70C	0.46A	0.43AB	-	0.53B	0.43C	0.41A	-
P av.	1.05A	0.74B	0.67C	0.61D								

- ① The treatment was terminated after the decay of 50% of fruits.
- ② Carton boxes covered with sealed low density polyethylene bags.
- ③ Hot water at 52°C for 3 minutes.

Values followed by the same alphabetical letters did not differ significantly according to Duncan's multiple range test.

Table 10. Effect of bagging in sealed tightly and perforated polyethylene (PPE) on pH value in juice of Ponkan tangerine fruits during cold storage period and shelf life (1998 and 1999 seasons).

Treatments soaking for 5 minutes	Activated acidity (pH)											
	Cold storage period (P) (months)								One week shelf life after cold storage			
	1	2	3	4	Treat. av.	5	6	7	4	5	6	7
	First season (1998)											
1-Water + net	3.65i	3.77h	4.05f	4.46b	3.98C	-①	-	-	4.62C	-	-	-
2-Water + PPE bags	3.61i	3.82gh	4.28de	4.64a	4.09B	-	-	-	4.68AB	-	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	3.79h	3.82gh	4.23e	4.59a	4.11B	4.81A	-	-	4.73A	4.89AB	-	-
4-TBZ + CB②	3.64i	3.90g	4.35cd	4.61a	4.13B	4.80AB	5.03	-	4.61C	4.95A	5.07	-
5-TBZ+Ca $(OH)_2$+CB②	3.58i	3.81gh	4.41bc	4.69a	4.12B	4.83A	-	-	4.70AB	4.86AB	-	-
6-H③ + 300 ppm GA_3+4% $CaCl_2$+TBZ+ Ca $(OH)_2$ + CB②	3.77h	3.90g	4.49b	4.63a	4.20A	4.75B	-	-	4.65BC	4.78B	-	-
P av.	3.67D	3.84C	4.30B	4.60A								
	Second season (1999)											
1-Water + net	3.96f	4.32e	4.37de	4.62bc	4.32B	-	-	-	4.89D	-	-	-
2-Water + PPE bags	3.92f	4.37de	4.60bc	4.87a	4.44A	5.27A	-	-	5.16A	5.46B	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	3.97f	4.37de	4.62bc	4.88a	4.46A	5.36A	5.70A	-	5.09AB	5.55A	5.71B	-
4-TBZ + CB②	3.87f	4.23e	4.58cd	4.81ab	4.37AB	5.32A	5.67A	5.70	5.07AB	5.40B	5.69B	5.73
5-TBZ+Ca $(OH)_2$+CB②	4.22e	4.27e	4.54cd	4.84a	4.47A	5.29A	5.57B	-	4.95CD	5.38B	5.70B	-
6-H③ + 300ppm GA_3+4% $CaCl_2$+TBZ+ Ca $(OH)_2$+CB②	3.99f	4.32e	4.60bc	4.86a	4.44A	5.28A	5.54B	-	5.02BC	5.45B	5.78A	-
P av.	3.99D	4.31C	4.55B	4.81A								

- ① The treatment was terminated after the decay of 50% of fruits.
- ② Carton boxes covered with sealed low density polyethylene bags.
- ③ Hot water at 52°C for 3 minutes.

Values followed by the same alphabetical letters did not differ significantly according to Duncan's multiple range test.

Table 11. Effect of bagging in sealed tightly and perforated polyethylene (PPE) on VC content (mg/100 ml juice) of Ponkan tangerine fruits during cold storage period and shelf life (1998 and 1999

Treatments soaking for 5 minutes	Ascorbic acid content (VC)											
	Cold storage period (P) (months)								One week shelf life after cold storage			
	1	2	3	4	Treat. av.	5	6	7	4	5	6	7
	First season (1998)											
1-Water + net	31.27cd	30.85cd	29.00fg	28.13g	29.81BC	-①	-	-	27.88A	-	-	-
2-Water + PPE bags	33.27a	32.72ab	30.33def	29.22efg	31.39A	-	-	-	29.09A	-	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	31.18cd	30.47de	28.67g	28.40g	29.68C	26.64A	-	-	28.19A	26.47AB	-	-
4-TBZ + CB②	31.64bcd	31.13cd	29.50efg	29.12efg	30.35B	27.70A	26.72	-	29.08A	27.33A	26.49	-
5-TBZ+Ca $(OH)_2$+CB②	32.08abc	31.60bcd	29.50efg	28.49g	30.42B	26.63A	-	-	28.27A	26.43AB	-	-
6-H③+ 300 ppm GA_3+4% $CaCl_2$+TBZ+ Ca $(OH)_2$ + CB②	31.23cd	30.93cd	29.40efg	28.70g	30.07BC	26.37A	-	-	28.56A	26.11B	-	-
P av.	31.78A	31.29B	29.40C	28.68D								
	Second season (1999)											
1-Water + net	32.67b-f	31.40f-i	29.62j	27.66k	30.34D	-	-	-	27.45C	-	-	-
2-Water + PPE bags	34.76a	33.40b	31.52e-h	29.44j	32.28AB	27.14C	-	-	29.22B	26.86C	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	34.76a	33.33bc	31.55e-h	30.22ij	32.47A	28.28B	27.23B	-	30.11AB	28.04BC	27.00B	-
4-TBZ + CB②	32.72b-e	32.22b-g	31.66d-h	30.44hig	31.76BC	29.52A	28.41A	26.33	30.37AB	29.34AB	28.19A	26.26
5-TBZ+Ca $(OH)_2$+CB②	34.57a	33.22bc	32.22b-g	31.01ghi	32.75A	30.44A	29.20A	-	30.89A	30.22A	28.90A	-
6-H③ + 300ppm GA_3+4% $CaCl_2$+TBZ+ Ca $(OH)_2$+CB②	32.96bcd	32.04c-g	31.29ghi	29.65j	31.48C	28.42B	27.26B	-	29.21B	28.23BC	26.93B	-
P av.	33.74A	32.60B	31.31C	29.74D								

- ① The treatment was terminated after the decay of 50% of fruits.
- ② Carton boxes covered with sealed low density polyethylene bags.
- ③ Hot water at 52°C for 3 minutes.

Values followed by the same alphabetical letters did not differ significantly according to Duncan's multiple range test.

Table 12. Effect of bagging in sealed tightly and perforated polyethylene (PPE) on respiration rate (mg/CO_2/kg fruits/h) of Ponkan tangerine fruits after cold storage period (1998 and 1999 seasons).

Treatments soaking for 5 minutes	Respiration rate							
	After cold storage period (P) (months)							
	1	2	3	4	Treat. av.	5	6	7
	First season (1998)							
1-Water + net	22.78 i	23.67h	25.00cd	26.37a	24.45C	- ①	-	-
2-Water + PPE bags	23.04 i	24.31efg	25.36bc	26.67a	24.85B	-	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	20.64k	21.96j	23.01i	24.13fgh	22.44D	26.15B	-	-
4-TBZ + CB②	23.96gh	24.58def	25.43bc	26.65a	25.16A	28.42A	30.52	-
5-TBZ+Ca $(OH)_2$+CB②	22.72 i	23.91gh	24.77de	26.33a	24.43C	28.17A	-	-
6-H③ + 300 ppm GA_3 +4% $CaCl_2$+TBZ+ Ca $(OH)_2$ + CB②	23.10 i	24.33efg	25.64 b	26.44a	24.88B	28.41A	-	-
P av.	22.71D	23.79C	24.87B	26.10A				
	Second season (1999)							
1-Water + net	17.84j	19.11g	20.91cde	22.81a	20.17C	-	-	-
2-Water + PPE bags	18.11ij	19.76f	21.27cd	23.11a	20.56B	25.41AB	-	-
3-1000ppm thiabendazole (TBZ)+PPE bags	17.14k	18.71ghi	20.17f	22.04b	19.51D	24.73C	27.23B	-
4-TBZ + CB②	18.81gh	20.33ef	21.36cd	23.07a	20.89A	25.74A	28.23A	30.73
5-TBZ+Ca $(OH)_2$+CB②	18.13ij	19.81f	20.83de	22.70a	20.37BC	25.04BC	27.55B	-
6-H③ + 300ppm GA_3+4% $CaCl_2$+TBZ+ Ca $(OH)_2$ +CB②	18.41hij	19.87f	21.51bc	22.89a	20.67AB	25.60AB	28.14A	-
P av.	18.07D	19.60C	21.01B	22.77A				

- ① The treatment was terminated after the decay of 50% of fruits.
- ② Carton boxes covered with sealed low density polyethylene bags.
- ③ Hot water at 52°C for 3 minutes.

Values followed by the same alphabetical letters did not differ significantly according to Duncan's multiple range test.

ging treatments indicated that the higher respiration rates were obtained by TBZ + sealed PE treatment comparing with all other treatments in both seasons. While, treatments with modified atmosphere with CO_2 absorber [Ca $(OH)_2$] showed lower value of respiration rate. The increase in respiration rate may be due to the accumulation of CO_2 in modified atmosphere, the least respiration rate was belong to TBZ and PPE bagging in both seasons and can be due to the fruit tranformation to anaerobic respiration which produce high CO_2 .

The results of the interaction between cold storage period and bagging treatments indicated that although respiration rate increased progressively as cold storage period increased with any treatment, TBZ and PPE bagging recorded the least respiration rate comparing with the other treatments .

In this regard Cohen *et al.* (1990) mentioned that after three months storage lemons fruits at 13°C showed increase in respiration rate in sealed fruit than non - sealed. So, D'Aquino *et al.* (1998) found that Minneola tangelo fruits wrapped with plastic film or unwrapped and stored at 20°C showed increase in respiration rate from harvest to the end of storage .

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تأثير بعض طرز التعبئة على صفات ثمار اليوسفى بونكان أثناء وبعد التخزين المبرد

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أجريت عدة معاملات تخزينية على ثمار اليوسفى البونكان (الصينى) خلال موسمى ١٩٩٨، ١٩٩٩ وكانت كالتالى : ١ - غمس الثمار فى الماء لمدة خمس دقائق ثم توضع فى شبك بلاستيك (T1)، ٢- غمس الثمار فى الماء لمدة خمس دقائق ثم توضع فى أكياس بولى إيثيلين مثقبة ٥ر٪ (T2) ، ٣- غمس الثمار فى محلول TBZ بتركيز ١٠٠٠ جزء فى المليون لمدة خمس دقائق ثم توضع فى أكياس بولى إيثيلين مثقبة ٥ر٪ (T3)، ٤- غمس الثمار فى محلول TBZ ١٠٠٠ جزء فى المليون ثم توضع فى صناديق كرتون ثم تغطيتها بأحكام بالبولى إيثيلين (T4)، ٥- مثل المعاملة السابقة (T4) مع إضافة أيدروكسيد كالسيوم المندى لامتصاص ثانى أكسيد الكربون (T5)، ٦- غمس الثمار فى ماء ساخن ٥٢°م لمدة ٣ دقائق ثم الغمس فى محلول حمض جبريليك ٣٠٠ جزء فى مليون ثم الغمس فى ٤٪ كلوريد كالسيوم ثم الغمس فى ١٠٠٠ جزء فى مليون TBZ لمدة ٥ دقائق ثم وضعت فى صناديق كرتون ثم تغطيتها بإحكام بالبولى إيثيلين بعد إضافة أيدروكسيد الكالسيوم المندى داخل الصناديق (T6)، خزنت ثمار جميع المعاملات على درجة ٨± ١°م ورطوبة نسبية ٨٥-٩٠٪ لمدة سبعة أشهر.

حققت معاملة التعبئة فى صناديق الكرتون المغلف بالبولى إيثيلين أعلى عمر تخزينى (٦ أشهر) ، وكذا أطول مدة عرض وأقل فقد فى الوزن الطازج ، وأعلى صلابة لقشرة ولب الثمار، كما حققت معاملة تعبئة الثمار فى الشبك البلاستيك أعلى نقص فى الوزن الطازج ، وأعلى نسبة تلف عن تلك المعبأة فى البولى إيثيلين المثقب والتى أظهرت أعلى محتوى من الكاروتينات.

أعطت جميع معاملات التعبئة فى صناديق الكرتون المغلفة بالبولى إيثيلين أقل قيمة من المواد الصلبة الذائبة (TSS) وأعلى نسبة لحموضة العصير.

لذا فإنه يفضل عند الرغبة فى تخزين ثمار اليوسفى البونكان لفترات قصيرة أن تعبأ فى أكياس بولى إيثيلين مثقبة وعند تخزينها لفترات أطول يفضل تعبأتها فى صناديق كرتون مغلفة بالبولى إيثيلين المحكم مع تخزينها على درجة ٨ ± ١°م ، ٨٥-٩٠٪ رطوبة نسبية.