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QUALITY, STORABILITY, AND DECAY OF FRESH-CUT SLICES AND WHOLE PEACH FRUITS TREATED WITH ULTRAVIOLET (UV-B) IRRADIATION

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ABSTRACT

'EarliGrande' peach (*Prunus persica L.*) fruits were harvested at the firm ripe stage from a private farm in Ismailia Governorate. Fresh-cut slices and whole peach fruits were exposed to 0, 5, 10, 15, 20, and 25 min UV-B (310 nm) exposure time in two successive seasons (2000 and 2001). A 30 min UV exposure time was added to the treatments in the second season. Slices and whole fruits were stored at 2°C after backing.

The objectives were to determine the optimum UV exposure time for fresh-cut slices and whole peach fruits and its effect on quality, storability, and decay (%) of the slices and the whole fruits.

In both seasons, ultraviolate (UV-B) treatments (15 – 25 min) revealed a maintenance in peach fresh-cut slices 'L', 'a', and 'b' colour values relative to the control. This means that UV suppressed the onset of ripening process in respect to colour. However, during storage at 2°C, 'L' and 'a' colour values increased especially after 8-day of storage while 'b' value did not change in the first season and decreased in the second one.

For the whole fruits, 'L' and 'a' colour values were maintained as a result of the UV treatments relative to the control. However, 'b' value decreased by the 10 – 20 min treatments. During storage, 'L' (brightness indicator) value maintained similar to the control up to 30 days then decreased. However, 'a' and 'b' values of the whole peach fruits were decreased.

UV-B exposure time 15, 20, and 25 min resulted in the lowest decay percent. In addition, 10 – 25 min UV treatments revealed a reduction in the fresh-cut slices firmness while 5 min exposure time had no effect on the firmness. Also, no changes were observed in the whole fruit firmness as a result of the UV treatments. Both fresh-cut and whole fruit firmness was decreased during storage in both seasons.

Acidity in the juice of the fresh-cut peach slices and whole fruits did not change by the UV treatments relative to the control. Although SSC of the fresh-cut slices did not change by the treatments, SSC of the whole fruits increased relative to the control. Acidity and SSC increased during storage of the slices and the whole peach fruits. In addition to that, UV treatments resulted in an increase in weight loss of the whole peach fruits during storage in both seasons.

Sweetness and overall flavour of peach slices were improved by the treatments while crispness and astringency did not change significantly relative to the control. During storage, sweetness and overall flavour improved while crispness and astringency decreased.

INTRODUCTION

Studies are underway in several countries to find suitable methods to control human food-borne pathogens associated with fresh fruits and fresh-cut fruits.

Little information is available on how irradiation affects physiological and physical changes as well as its effect on decay control (Miller *et al.*, 1994). The purpose of most irradiation studies were to alter rates of ripening, control postharvest pathogens and disinfest (Thayer and Rajkowski, 1999).

Stevens *et al.* (1996) reported that low doses of ultraviolet (UV-C) light (254 nm) reduced postharvest decay of pome and stone fruits. Also, the UV-C irradiation delayed peach fruits ripening and suppressed ethylene production in addition to the reduction of fruits brown rot (Stevens *et al.*, 1998).

Ebel *et al.* (1999) found that UV-C light kills the fungus that causes brown rot in peaches. There was very little effect of UV light on firmness and soluble solids content (SSC). UV had little effect on ripening and peach fruit quality. Although Kalantari *et al.* (1999) reported similar results for controlling diseases of fruits by UV-C, their data revealed a delay in the onset of senescence.

Basiouny (2000) reported that UV-B for 24 hours under cold conditions had no beneficial effects on Blueberry fruits quality or storability. However, Fonseca *et al.* (2000) found that the overall quality of watermelon cubes exposed to UV light (250 nm for 1 – 5 min) was better than cubes received aqueous sanitizing treatment.

Many consumers do not buy peaches due to the fuzzy skin and seed stone and because out-of-season peaches do not possess optimum tree-ripe flavour (Beaulieu *et al.*, 1999).

Fresh-cut products offer retail consumers and food service operators convenience, portion control and labor savings. High-quality fresh-cut fruit products are more difficult to produce than fresh-cut vegetable products because of the easy contamination that occur few days after cutting and also many fruits must be ripened before they are processed (Gorny and Kader, 1996). Gorny *et al.* (1999) found that the shelf-life of slices from 13 peach fruit cultivars varied between 2 and 12 days at 0°C.

Fresh-cut products have grown rapidly during the paste decade, extending from the foodservice sector to the retail shelf. Although more expensive than bulk produce on a weight basis, successful fresh-cut products are often more cost-effective for the user due to reduced waste (Contwell and Suslow, 2002).

The main objectives of this study were to determine the optimum UV exposure time to fresh-cut and whole 'EarliGrande' peach fruits and its effect on quality and decay of the slices and whole fruits. Also, optimum storability of the fresh-cut slices and whole fruits was one of the aims of this work.

MATERIALS AND METHODS

Uniform size peach fruits of were hand harvested at the firm ripe stage referenced to peach colour chips #6 according to (Delwiche and Baumgardner, 1985) from a private farm (10-year old trees) at Abou-Sweer, Ismailia Governorate, Egypt, during 2000 and 2001one, respectively. Fruit firmness, acidity, and SSC at harvest were 85.79 N, 0.763 %, and 10% ,

respectively, in the first season and 96.23 N, 0.725%, and 11% , respectively, in the second season. The fruits were transferred to the lab (Horticulture Department, College of Agric., Suez Canal Univ., Ismailia) and sorted to eliminate defects. Fruits were washed with regular water and air dried.

Three hundred fruits were used for fresh-cut experiment. Each fruit was cut into eight slices (wedges) with a sharp stainless steel knife. All the slices of six fruits were put onto a foam plate. Fifty plates were used. Twenty four plates were used for six UV treatments in the first season and 28 were used for seven UV treatments in the second season. The rest of the plates were exposed to the same treatments in both seasons and were used for the sensory and decay evaluation. After the UV irradiation treatments all plates were lidded with perforated colourless polyethylene sheets.

Two hundred forty and 280 fruits for the first and second seasons, respectively, were used for the whole peach fruits experiment. After UV irradiation treatments, every forty fruits were put into perforated (7mm in diameter hole per 16 cm^2 of bag area) colourless polyethylene bag (30 x 40 cm).

Two fruits were used per replicate and three replicates were used per treatment per sampling time. Six bags were used in the first season and seven in the second one. All the fresh-cut plates and the bags were stored at 2°C and 80-85% relative humidity.

UV-B treatments. All fresh-cut peach slice plates and whole fruits were put in 60 x 120 x 70 cm chamber (before covering or bagging) under UV light (310 nm). The distance between the lamp and the slices or the whole fruits were 25 cm. The UV irradiation exposure time were 0, 5, 10, 15, 20, and 25 min and 0, 5, 10, 15, 20, 25, and 30 min in the first and second seasons, respectively. The process of turning the fruit and the slices during UV exposure was practiced.

Quality evaluations. At the start of the experiment and after 4, 8, 12, and 16 days for peach fruit slices and after 10, 20, 30, and 40 days of storage at 2°C for the whole fruits colour intensity, firmness, acidity, soluble solids content (SSC), sensory (for wedges only), and weight loss (for the whole fruits) were evaluated.

Colour intensity. Pulp colour evaluation was done using a Minolta CR 10 Chromameter (Minolta Crop, Japan) measuring CIE 'L', 'a', and 'b' coordinates (Francis, 1980). 'L' colour value (brightness; used as browning intensity, Kuczynski *et al.*, 1992 and Lee *et al.*, 1990), which measure relative white (100) to black (0) colour. 'a' colour value, which indicates the relative green (-) or red (+) colour and 'b' colour value, which measures relative yellow (+) to blue (-) colour.

Decay (%). The number of fresh-cut slices exhibited decay were calculated after 16 days of cold storage at 2°C. No decay was observed on the whole fruits.

Firmness. Penetration force for the wedges was determined by measuring the force required for a 7-mm probe to penetrate the cut surface (mid point between endocarp and skin) slice, held perpendicular to the probe to a depth of 1cm using Effegi penetrometer (McCormick, Yakima, Washington). Penetration force for the whole fruit was measured on two opposite sides of peach fruit replicate using the same firmness tester.

Acidity. Titratable acidity was determined by titrating 10g of filtered purees using 0.1N NaOH until pH 8.0 and expressed as citric acid percent.

SSC. Milton Roy (Japan) refractometer was used to determine SSC of peach purees.

Sensory evaluation. In both seasons, 3 fruits (24 slices) from each UV treatment were placed onto coded plates. A panel of 6 untrained judges rated fresh-cut peach sensory quality for sweetness, crispness, astringency and overall flavour at each sampling time. The sensory quality in each replicate (weighted average of individual fruit slices) was determined based on the following subjective (hedonic) scale: 1= poor (inedible); 3=fair; 5=good; 7=very good; 9=excellent for sweetness, crispness and overall flavour; and 1=low and 9=high for astringency.

Weight loss % For the whole fruit experiment, weight loss was calculated at each sampling time. The fruits were labeled at harvest and weighed. At each sampling time, the fruit were re-weighed and the weight loss was calculated by dividing the weight at each sampling period by the initial weight multiplied by 100.

Statistical analysis. It was done between treatments and storage periods. The experimental design was completely randomized with a factorial arrangement of UV treatments and storage periods (Steel and Torrie, 1980). Analysis of variance and means comparison (LSD, 5%) were performed using Statistix 4.1 (Analytical Software, Inc., Tallahassee, FL). The model used for analysis contained UV treatments and storage periods effects and their interactions.

For percent decay, Chi-square contingency tests were used to compare each pair of UV treatments in each season.

RESULTS AND DISCUSSION

Colour intensity. The interaction effects of storage periods (SP) x UV treatments (T) for fresh-cut peach slices 'L', 'a', and 'b' colour values were not significant in both seasons (Tables 1 and 2).

No major differences were noticed in 'L' (brightness) colour value as a result of UV treatments in both seasons. The only reduction in the brightness was in the first season after 5 and 10 min UV exposure time relative to the control. UV treatment (15 – 30 min) maintained tissue

brightness. During storage, and after 8, 12, and 16 days, 'L' colour value increased significantly (ripening processes were advanced 'L' colour value increased toward the brightness) in the first season. However, the increases were not significant in the second.

'a' colour value, which indicates the relative green (-) or red (+) colour increased significantly as a result of 10 and 25 min UV exposure time (slices advanced more toward ripening) in the first season and the increases were not significant as a result of the other treatments over the control. In the second season, no significant differences were obtained in 'a' colour value as a result of the UV treatments except for the 25 min exposure time where 'a' value decreased significantly. During storage, 'a' colour value of fresh-cut peach slices increased significantly at 12 days of storage and remained constant thereafter in the first season. In the second season, the increases in the 'a' colour value were significant at 10 days of storage and thereafter.

'b' colour value, which measures the relative yellow (+) to blue (-) colour did not change significantly by the treatments in both seasons. During storage, 'b' colour value did not change significantly in the first season. However, in the second one, 'b' value decreased significantly (some browning occurred).

In general, in both seasons, UV-B treatments (15 – 25 min) revealed a maintenance in peach fresh-cut slices 'L', 'a', and 'b' colour values relative to the control (except for a reduction in 'b' value in the second season, may be related to browning). This means that UV suppressed the onset of ripening process in respect to colour. These are in agreement with the data reported by Kalantari *et al.* (1999). However, during storage at 2°C, 'L' and 'a' colour values increased especially after 8-day of storage while 'b' value did not change in the first season and decreased in the second one.

For the whole peach fruits experiment, the interaction effects of SP x T for pulp 'L', 'a', and 'b' colour values were not significant in both seasons (Tables 3 & 4).

No significant differences were noticed in 'L' colour value as a result of the UV treatments over the control in both seasons. During storage, no significant differences were revealed in 'L' colour value in the first season and a significant reduction was noticed at 40 days of storage in the second one. UV treatments maintained the brightness of the fruit pulp for 30 days similar to the control.

No significant differences were noticed in 'a' colour value between the UV treated fruits and the control in both seasons. However, 'a' colour value increased significantly during storage in both seasons.

Significant reduction in 'b' colour value was obtained as a result of UV irradiation treatments for 10, 15 and 20 min in the first season while the decreases were not significant in the second one.

During storage of the peach whole fruits, 'b' colour value decreased significantly up to 30 days of storage and increased significantly thereafter, in the first season. However, in the second season, the 'b' colour value decreased significantly after 10 days of storage and remained constant thereafter.

For the whole fruits, 'L' and 'a' colour values were maintained as a result of the UV treatments relative to the control. However, 'b' value decreased by the 10 – 20 min treatments. During storage, 'L' (brightness indicator) value maintained similar to the control up to 30 days then decreased. However, 'a' and 'b' values of the whole peach fruits were decreased.

Decay (%). In the first season, the untreated and the 5 and 10 min exposed fresh-cut peach slices had significantly higher decay percentage the 15, 20 and 25 min exposed peach wedges (Table 1). The lowest decay percent were obtained from either 15, 20 or 25 min UV exposure time.

In the second season (Table 2), the highest decay percent was obtained from the untreated and 5 min treated slices followed by 10 and 15 min treated wedges. The lowest decay (%) was obtained from slices exposed to UV light for 30 min while no significant differences were noticed between the 20 and 25 min exposure time. Similar data were reported by Stevens *et al.* (1998) and Ebel *et al.* (1999). They found that UV irradiation reduced peach fruit brown rote.

Firmness. In the first season, the interaction effects of SP x T were not significant (Table 5).

UV treatments (10 – 25 min and 10 – 30 min in the first and second seasons, respectively) resulted in a reduction in the slices firmness (Tables 5 & 6). In addition, during storage, firmness decreased significantly in both seasons. A reduction in slices firmness was observed after 12 days of storage at 2°C in the second season relative to the other storage periods and it was more obvious with the 25 and 30 min UV exposure time.

The interaction effects of SP x T were not significant in both seasons for the whole UV treated peach fruits (Tables 7 and 8).

No significant differences in fruit firmness were obtained as a result of UV irradiation treatments over the control in both seasons.
Similar to the slices, fruit firmness decreased significantly during storage in both seasons.

Peach wedges firmness decreased (ripening was in progress) by the UV treatments while the treatments had no effect on the firmness of the whole fruits. The data reported herein are in agreement with the finding of Ebel *et al.* (1999). However, Kalantari *et al.* (1999) reported a delay of fruit senescence by UV treatments.

Acidity (%). The interaction effects of SP x T were not significant in both seasons (Tables 5 and 6).

No significant changes in acidity of peach slices were noticed as a result of UV different treatments in the first season. Similar trends were obtained in the second season. During storage, acidity increased significantly at 12 and 16 days of storage in the first season and at 4, 8, and 12 days of storage in the second season, then decreased.

The interaction effects of SP x T, for the whole fruits, were not significant in both seasons (Tables 7 and 8).

Table 1. Effect of UV treatments duration and storage periods on 'EarliGrande' peach fruit fresh-cut colour and decay in 2000 season.

Parameter	Storage Periods (SP)	UV Treatments (T, min)							LSD (5%)
	(days)	0 [X]	5	10	15	20	25	CESP[2]	SPxT
'L' [Z]	0 [Y]	69.73	69.73	69.73	69.73	69.73	69.73	69.73	
	4	72.30	69.27	69.70	69.57	71.20	72.27	70.72	
	8	77.27	75.87	77.50	76.77	79.30	75.50	77.04	NS
	12	77.50	73.93	75.87	74.23	74.90	75.60	75.34	
	16	75.93	74.07	71.67	76.67	73.70	75.97	74.67	
	CEUVT[1]	74.55	72.57	72.89	73.39	73.77	73.81		
LSD (5%)				1.32				1.20	
'a'	0	5.50	5.50	5.50	5.50	5.50	5.50	5.50	
	4	5.50	4.63	5.77	5.57	5.87	5.20	5.42	
	8	4.60	4.23	6.83	6.47	3.97	5.03	5.19	NS
	12	4.33	5.47	9.03	5.73	6.73	8.07	6.56	
	16	5.07	5.80	6.20	4.90	6.73	7.27	6.00	
	CEUVT	5.00	5.13	6.67	5.63	5.76	6.21		
LSD (5%)				1.13				1.03	
'b'	0	44.20	44.20	44.20	44.20	44.20	44.20	44.20	
	4	39.27	39.20	40.97	41.13	40.77	40.33	40.28	
	8	39.20	37.37	41.47	39.60	39.60	39.50	39.46	NS
	12	39.33	39.53	42.43	39.30	38.97	40.00	39.93	
	16	38.80	40.57	37.30	39.80	40.80	40.30	39.60	
	CEUVT	40.16	40.17	41.27	40.81	40.87	40.87		
LSD (5%)				1.78				1.63	
Decay (%)		64.29 a [W]	62.86 a	50.00 ac	28.57 bd	25.71 be	31.43 cde		

[Z] 'L' = Colour value; indicates the relative white (100) to black (0) colour.
'a' = Colour value; indicates the relative green (-) to red (+) colour.
'b' = Colour value; indicates the relative yellow (+) to blue (-) colour.

[Y] Harvest time. [X] No UV treatments.

[W] Treatments within row not followed by the same letter are different according to Chi-square contingency tests ($p \leq 0.05$).

[1] Composite effect of UV treatments. [2] Composite effect of storage periods (SP).

Table 2. Effect of UV treatments duration and storage periods on 'EarliGrande' peach fruit fresh-cut colour and decay in 2001 season.

Parameter	Storage Periods (SP)	UV Treatments (T, min)							LSD (5%)	
	(days)	0 [X]	5	10	15	20	25	30	CESP [2]	SPxT
'L' [Z]	0 [Y]	72.80	72.80	72.80	72.80	72.80	72.80	72.80	72.80	
	4	72.90	72.23	64.57	71.13	72.67	65.13	68.80	69.63	
	8	51.27	72.43	74.30	71.30	72.50	75.87	76.10	70.54	NS
	12	76.17	75.23	75.97	74.13	76.77	74.97	75.80	75.58	
	16	75.50	75.63	74.67	75.03	74.80	71.23	75.67	74.65	
	CEUVT [1]	69.73	73.66	72.46	72.88	73.91	72.00	73.83		
LSD (5%)					5.82				4.92	
'a'	0	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	
	4	5.57	6.00	4.53	7.03	4.57	3.87	7.67	5.61	
	8	7.10	7.80	7.80	9.90	9.67	4.77	4.83	7.41	NS
	12	6.47	5.33	6.50	7.53	7.87	4.67	4.60	6.14	
	16	6.60	6.53	5.67	6.33	6.20	4.54	7.70	6.22	
	CEUVT	6.10	6.08	5.85	7.11	6.62	4.52	5.91		
LSD (5%)					1.36				1.15	
'b'	0	60.67	60.67	60.67	60.67	60.67	60.67	60.67	60.67	
	4	43.43	43.87	41.20	44.73	46.00	40.90	44.50	43.52	
	8	44.07	42.67	41.53	43.73	43.53	42.13	43.30	42.99	NS
	12	37.33	41.40	39.73	41.07	39.73	37.37	41.70	39.76	
	16	40.87	39.77	40.03	41.60	42.07	37.67	41.07	40.44	
	CEUVT	45.27	45.68	44.63	46.36	46.40	43.75	46.25		
LSD (5%)					1.82				1.54	
Decay (%)		71.43 a [W]	68.57 a	45.71 b	34.29 bc	22.86 cd	28.57 c	11.43 d		

[Z] 'L' = Colour value; indicates the relative white (100) to black (0) colour.
'a' = Colour value; indicates the relative green (-) to red (+) colour.
'b' = Colour value; indicates the relative yellow (+) to blue (-) colour.

[Y] Harvest time. [X] No UV treatments.

[W] Treatments within row not followed by the same letter are different according to Chi-square contingency tests ($p \leq 0.05$).

[1] Composite effect of UV treatments. [2] Composite effect of storage periods (SP).

Table 3. Effect of UV treatments duration and storage periods on 'EarliGrande' peach whole fruit colour values in 2000 season.

Parameter	Storage Periods (SP)	UV Treatments (T, min)							LSD (5%)
	(days)	0 [X]	5	10	15	20	25	CESP[2]	SPxT
'L' [Z]	0 [Y]	69.73	69.73	69.73	69.73	69.73	69.73	69.73	
	10	71.40	65.90	73.47	68.90	69.80	67.53	69.50	
	20	69.07	66.97	69.10	67.50	68.57	68.80	68.34	NS
	30	66.69	68.16	69.03	68.79	69.29	68.89	68.48	
	40	68.77	68.63	67.53	67.17	67.17	66.90	67.70	
	CEUVT[1]	69.13	67.88	69.77	68.42	68.91	68.37		
LSD (5%)				2.42				2.21	
'a'	0	5.50	5.50	5.50	5.50	5.50	5.50	5.50	
	10	6.43	7.00	7.87	8.97	8.03	8.30	7.77	
	20	9.03	9.03	5.83	8.13	5.97	6.30	7.38	NS
	30	8.15	8.12	7.92	7.59	7.85	8.12	7.96	
	40	10.40	8.20	9.20	9.73	12.03	9.47	9.84	
	CEUVT	7.90	7.57	7.26	7.98	7.88	7.54		
LSD (5%)				1.59				1.45	
'b'	0	44.20	44.20	44.20	44.20	44.20	44.20	44.20	
	10	40.20	43.13	41.00	39.30	42.83	42.53	41.50	
	20	43.70	43.80	41.20	43.40	39.53	40.73	42.06	NS
	30	47.29	43.03	41.03	42.29	41.13	43.09	42.98	
	40	52.37	52.70	49.70	50.10	52.63	51.10	51.43	
	CEUVT	45.55	45.37	43.43	43.86	44.06	44.33		
LSD (5%)				1.95				1.78	

Z 'L' = Colour value; indicates the relative white (100) to black (0) colour.
'a' = Colour value; indicates the relative green (-) to red (+) colour.
'b' = Colour value; indicates the relative yellow (+) to blue (-) colour.

Y Harvest time.

X No UV treatments.

1 Composite effect of UV treatments.

2 Composite effect of storage periods (SP).

Table 4. Effect of UV treatments duration and storage periods on 'EarliGrande' peach whole fruit colour values in 2001season.

Parameter	Storage Periods (SP)	UV Treatments (T, min)							LSD (5%)	
	(days)	0[X]	5	10	15	20	25	30	CESP[2]	SPxT
'L'[Z]	0[Y]	72.80	72.80	72.80	72.80	72.80	72.80	72.80	72.80	
	4	71.67	74.10	70.00	73.40	73.87	74.20	72.60	72.83	
	8	71.53	71.00	70.03	71.90	73.47	70.40	71.67	71.43	NS
	12	71.60	70.30	73.73	72.40	72.57	74.93	69.70	72.18	
	16	69.20	69.83	67.90	67.07	69.57	69.43	69.17	68.88	
	CEUVT[1]	**71.36**	**71.61**	**70.89**	**71.51**	**72.46**	**72.35**	**71.19**		
	LSD (5%)				**1.93**				**1.63**	
'a'	0	4.77	4.77	4.77	4.77	4.77	4.77	4.77	4.77	
	4	8.37	8.53	8.20	7.60	6.40	6.47	5.50	7.30	
	8	7.47	9.87	10.10	11.50	8.47	8.57	10.63	9.52	NS
	12	12.20	8.77	12.23	11.93	10.97	8.60	10.27	10.71	
	16	14.47	13.77	15.53	14.73	14.13	13.50	12.73	14.12	
	CEUVT	**9.46**	**9.14**	**10.17**	**10.11**	**8.95**	**8.38**	**8.78**		
	LSD (5%)				**1.88**				**1.59**	
'b'	0	60.67	60.67	60.67	60.67	60.67	60.67	60.67	60.67	
	4	57.67	55.43	57.47	57.67	53.13	56.93	56.37	56.38	
	8	56.10	56.30	55.73	58.73	58.10	55.20	58.97	57.02	NS
	12	59.27	55.97	52.90	56.70	58.50	58.23	57.87	57.06	
	16	58.40	58.53	56.60	56.80	56.57	57.53	58.37	57.54	
	CEUVT	**58.42**	**57.38**	**56.67**	**58.11**	**57.39**	**57.71**	**58.45**		
	LSD (5%)				**1.91**				**1.61**	

Z 'L' = Colour value; indicates the relative white (100) to black (0) colour.
'a' = Colour value; indicates the relative green (-) to red (+) colour.
'b' = Colour value; indicates the relative yellow (+) to blue (-) colour.

Y Harvest time.

X No UV treatments.

1 Composite effect of UV treatments.

2 Composite effect of storage periods (SP).

Table 5. Effect of UV treatments duration and storage periods on 'EarliGrande' peach fruit fresh-cut parameters in 2000 season.

Parameter	Storage Periods (SP)	UV Treatments (T, min)							LSD (5%)
	(davs)	0 [Y]	5	10	15	20	25	CESP[2]	SPxT
Firmness (N)	0 [Z]	85.79	85.79	85.79	85.79	85.79	85.79	**85.79**	
	4	75.30	76.44	72.42	79.71	58.66	65.18	**71.29**	
	8	78.79	77.26	73.34	76.60	68.93	49.82	**70.79**	NS
	12	75.33	68.76	53.26	77.09	57.00	58.76	**65.03**	
	16	76.28	75.13	50.44	60.43	51.45	47.81	**60.26**	
	CEUVT[1]	**78.30**	**76.68**	**67.05**	**75.92**	**64.37**	**61.47**		
LSD (5%)				**6.84**				**6.24**	
Citric acid (%)	0	0.763	0.763	0.763	0.763	0.763	0.763	**0.763**	
	4	0.787	0.755	0.744	0.799	0.725	0.725	**0.756**	
	8	0.725	0.747	0.747	0.747	0.789	0.747	**0.750**	NS
	12	0.811	0.832	0.832	0.849	0.853	0.917	**0.849**	
	16	0.901	0.896	0.848	0.853	0.884	0.845	**0.871**	
	CEUVT	**0.797**	**0.800**	**0.787**	**0.802**	**0.803**	**0.799**		
LSD (5%)				**0.046**				**0.042**	
SSC (%)	0	10.00	10.00	10.00	10.00	10.00	10.00	**10.00**	
	4	11.67	12.92	10.33	10.17	11.42	10.50	**11.17**	
	8	11.17	10.17	10.67	10.00	10.50	10.00	**10.42**	1.27
	12	10.50	10.50	11.00	10.17	10.17	10.67	**10.50**	
	16	12.17	8.00	12.50	10.67	11.00	11.50	**10.97**	
	CEUVT	**11.10**	**10.32**	**10.90**	**10.20**	**10.62**	**10.53**		
LSD (5%)				**0.57**				**0.52**	

[Z] Harvest time. [Y] No UV treatments.
[1] Composite effect of UV treatments. [2] Composite effect of storage periods (SP).

Table 6. Effect of UV treatments duration and storage periods on 'EarliGrande' peach fruit fresh-cut parameters in 2001 season.

Parameter	Storage Periods (SP)	UV Treatments (T, min)								LSD (5%)
	(days)	0 [Y]	5	10	15	20	25	30	CESP [2]	SPxT
Firmness (N)	0 [Z]	96.23	96.23	96.23	96.23	96.23	96.23	96.23	96.23	
	4	79.69	77.10	63.68	71.93	78.35	69.98	74.17	73.56	
	8	76.93	69.13	58.90	65.17	65.93	53.03	68.68	65.40	9.77
	12	70.71	65.90	62.75	57.36	58.88	46.65	58.31	60.08	
	16	41.10	61.46	54.59	55.61	54.77	48.63	35.17	50.19	
	CEUVT [1]	72.93	73.96	67.23	69.26	70.83	62.90	66.51		
	LSD (5%)				4.37				3.69	
Citric acid (%)	0	0.725	0.725	0.725	0.725	0.725	0.725	0.725	0.725	
	4	0.864	0.811	0.864	0.960	0.853	0.795	0.875	0.860	
	8	0.800	0.768	0.832	0.821	0.779	0.796	0.811	0.801	NS
	12	0.821	0.853	0.768	0.811	0.821	0.843	0.789	0.815	
	16	0.661	0.811	0.693	0.681	0.715	0.774	0.789	0.732	
	CEUVT	0.774	0.794	0.776	0.800	0.779	0.787	0.798		
	LSD (5%)				0.044				0.038	
SSC (%)	0	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	
	4	14.33	11.67	11.67	11.50	11.83	12.33	12.67	12.29	
	8	10.67	11.67	10.00	12.17	12.33	12.50	12.57	11.70	1.48
	12	11.67	12.67	12.00	13.83	11.33	12.17	11.67	12.19	
	16	11.00	11.67	12.00	10.46	11.33	11.79	11.33	11.37	
	CEUVT	11.73	11.74	11.33	11.79	11.56	11.96	11.85		
	LSD (5%)				0.66				0.56	

[Z] Harvest time. [Y] No UV treatments.
[1] Composite effect of UV treatments. [2] Composite effect of storage periods (SP).

Table 7. Effect of UV treatment duration and storage periods on 'EarliGrande' peach whole fruit parameters in 2000 season.

Parameter	Storage Periods (SP)	UV Treatments (T, min)							LSD (5%)
	(days)	0 [Y]	5	10	15	20	25	CESP[2]	SPxT
Weight loss (%)	0 [Z]	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	
	10	3.55	4.41	4.01	4.49	3.77	4.82	**4.18**	
	20	5.05	6.37	6.55	8.30	8.79	8.98	**7.34**	NS
	30	10.55	8.10	10.12	9.69	7.28	10.64	**9.40**	
	40	14.96	13.98	15.69	17.29	15.63	16.96	**15.75**	
	CEUVT[1]	**6.82**	**6.57**	**7.27**	**7.95**	**7.09**	**8.28**		
LSD (5%)				**2.03**				**1.85**	
Firmness (N)	0	85.79	85.79	85.79	85.79	85.79	85.79	**85.79**	
	10	64.84	44.43	57.65	51.29	60.76	45.57	**54.09**	
	20	49.00	33.65	49.91	48.67	49.82	37.57	**44.77**	NS
	30	14.54	21.07	37.01	31.20	10.13	26.13	**23.35**	
	40	17.31	32.83	24.17	21.23	7.51	47.37	**25.07**	
	CEUVT	**46.30**	**43.55**	**50.91**	**47.64**	**42.80**	**48.49**		
LSD (5%)				**10.44**				**9.51**	
Citric acid (%)	0	0.763	0.763	0.763	0.763	0.763	0.763	**0.763**	
	10	0.820	0.787	0.732	0.775	0.756	0.787	**0.776**	
	20	0.807	0.815	0.857	0.811	0.811	0.800	**0.817**	NS
	30	0.848	0.841	0.823	0.842	0.855	0.823	**0.839**	
	40	0.897	0.961	0.889	0.862	0.874	0.887	**0.895**	
	CEUVT	**0.827**	**0.833**	**0.813**	**0.811**	**0.812**	**0.812**		
LSD (5%)				**0.048**				**0.044**	
SSC (%)	0	10.00	10.00	10.00	10.00	10.00	10.00	**10.00**	
	10	10.00	10.17	10.50	12.50	10.67	12.33	**11.03**	
	20	11.00	11.00	10.50	10.17	10.00	10.33	**10.50**	1.59
	30	8.67	10.33	9.50	10.50	11.50	11.17	**10.28**	
	40	11.17	12.33	11.17	11.17	12.17	11.17	**11.53**	
	CEUVT	**10.17**	**10.77**	**10.33**	**10.87**	**10.87**	**11.00**		
LSD (5%)				0.71				0.65	

Z Harvest time.
Y No UV treatments.
1 Composite effect of UV treatments.
2 Composite effect of storage periods (SP).

Table 8. Effect of UV treatments duration and storage periods on 'EarliGrande' peach whole fruit parameters in 2001 season.

Parameter	Storage Periods (SP)	UV Treatments (T, min)							LSD (5%)	
	(days)	0 [Y]	5	10	15	20	25	30	CESP [2]	SPxT
Weight loss (%)	0 [Z]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	10	5.13	5.79	6.69	5.15	3.31	6.89	5.76	5.53	
	20	7.83	7.63	7.83	9.68	9.82	9.87	8.80	8.78	NS
	30	9.82	7.86	12.13	12.62	14.40	12.37	12.04	11.61	
	40	12.99	11.67	16.16	14.78	14.89	15.59	15.50	14.51	
	CEUVT [1]		7.15	6.59	8.56	8.45	8.48	8.94	8.42	
LSD (5%)					1.31				1.11	
Firmness (N)	0	96.23	96.23	96.23	96.23	96.23	96.23	96.23	96.23	
	10	56.65	40.03	49.80	36.29	52.39	57.57	44.80	48.22	
	20	20.00	14.63	18.70	15.92	29.47	28.92	19.25	20.98	NS
	30	9.26	8.89	10.00	10.33	9.26	15.92	13.11	10.97	
	40	7.04	7.22	6.29	8.04	10.29	13.70	7.96	8.65	
	CEUVT	37.84	33.40	36.20	33.36	39.53	42.47	36.27		
LSD (5%)					6.33				5.35	
Citric acid (%)	0	0.725	0.725	0.725	0.725	0.725	0.725	0.725	0.725	
	10	0.725	0.757	0.811	0.757	0.768	0.683	0.715	0.745	
	20	0.725	0.779	0.747	0.704	0.725	0.789	0.800	0.753	NS
	30	0.875	0.926	0.789	0.768	0.875	0.811	0.960	0.858	
	40	0.907	0.821	0.672	0.715	0.757	0.821	0.949	0.806	
	CEUVT	0.791	0.802	0.749	0.734	0.778	0.766	0.838		
LSD (5%)					0.070				0.059	
SSC (%)	0	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	
	10	13.67	13.00	12.67	14.17	11.83	13.17	12.83	13.05	
	20	11.33	9.83	10.33	12.83	13.00	11.67	12.67	11.67	NS
	30	10.67	11.33	9.67	10.67	12.00	13.00	12.00	11.33	
	40	12.33	12.00	12.00	13.33	14.00	14.33	13.67	13.09	
	CEUVT	11.80	11.43	11.13	12.40	12.37	12.63	12.43		
LSD (5%)					1.06				0.89	

[Z] Harvest time. [Y] No UV treatments.

[1] Composite effect of UV treatments. [2] Composite effect of storage periods (SP).

No significant changes in acidity (%) were noticed between the UV treated fruits and the control in both seasons except for the 30 min exposed fruits in the second season where the acidity was higher than the acidity of 10 and 15 min treated fruits. Acidity maintained for 10 and 20 days for the first and second seasons, respectively, then increased significantly during storage. The increases in slices or whole fruit acidity might be related to the loss of moisture from the fruits during storage. No beneficial effects of UV-B treatments on blueberries quality or storability (Basiouny, 2000).

SSC (%). The interaction effects of SP x T were significant in both seasons (Tables 5 and 6).

In the first season, a slight reduction in SSC was noticed in peach slices as a result of UV treatments. No significant changes were noticed between the different UV treated peach slices in the second season. Similarly, Ebel *et al.* (1999) reported little effect of UV light on peach SSC. During storage, SSC increased starting at four days of storage in both seasons.

For the UV treated whole peach fruits, the interaction effects of SP x T for the SSC were not significant in the second season (Table 8).
In both seasons (Table 7 & 8), SSC of the whole fruits increased as a result of UV treatments over the control and the increases were more pronounced with the 15 – 25 and 15 – 30 min UV treatments in the first and second seasons, respectively. During storage, SSC increased in both seasons and the increases were the highest at 40 days of storage.

Weight loss (%). The interaction effects of SP x T for peach whole fruits weight loss were not significant in both seasons (Tables 7 and 8).

As a result of UV treatments, weight loss increased by 10 – 25 min exposure time over the control and the 5 min treatment but the results failed to show significant differences in the first season. However, in the second season, significant increments in weight loss were obtained by 10 – 30 min exposure time over the untreated fruits and the 5 min UV treated fruits. During storage, weight loss increased significantly in both seasons. The increases in weight loss at 40 days of storage were almost three-fold of that at 10-day of storage in both seasons.

Sweetness. The interaction effects of SP x T were significant in both seasons (Tables 9 and 10).

Sweetness score of the peach fruit slices increased significantly as a result of UV treatments in both seasons. In addition, sweetness increased significantly during storage for 16 days in both seasons.

Crispness. The interaction effects of SP x T were not significant in both seasons (Tables 9 and 10).

The higher the UV exposure time, the lower the crispness score, but data failed to show significant differences. Also, crispness decreased significantly after 8 days of storage and at 8 days of storage in the first and second seasons, respectively.

Table 9. Effect of UV treatments duration and storage periods on 'EarliGrande' peach fruit fresh-cut sensory evaluation parameters in 2000 season.

Parameter	Storage Periods (SP) (days)	UV Treatments (T, min) 0 [Y]	5	10	15	20	25	CESP[2]	LSD (5%) SPxT
Sweetness[1]	0 [Z]	3.67	3.67	3.67	3.67	3.67	3.67	3.67	
	4	3.00	5.67	2.33	5.67	7.00	7.67	5.22	
	8	1.67	3.67	5.67	4.33	6.33	6.33	4.67	2.14
	12	3.67	4.33	6.33	4.33	3.67	4.33	4.44	
	16	5.67	5.00	5.67	5.67	3.67	5.00	5.11	
	CEUVT[1]	3.54	4.47	4.73	4.73	4.87	5.40		
	LSD (5%)			0.96				0.88	
Crispness[1]	0	6.67	6.67	6.67	6.67	6.67	6.67	6.67	
	4	7.33	8.33	7.67	8.33	7.67	7.67	7.83	
	8	8.33	7.67	5.67	6.33	7.67	5.67	6.89	NS
	12	7.67	6.33	4.33	5.67	5.00	6.33	5.89	
	16	3.67	5.67	3.67	4.33	4.33	4.33	4.33	
	CEUVT	6.73	6.93	5.60	6.27	6.27	6.13		
	LSD (5%)			0.94				0.86	
Astringency[2]	0	8.00	8.00	8.00	8.00	8.00	8.00	8.00	
	4	3.33	5.67	3.67	6.33	6.33	8.33	5.61	
	8	7.00	7.67	4.67	5.67	5.00	3.67	5.61	2.34
	12	3.67	5.67	2.67	3.67	2.33	2.33	3.39	
	16	3.67	3.67	3.67	4.33	1.67	2.33	3.22	
	CEUVT	5.13	6.14	4.54	5.60	4.67	4.93		
	LSD (5%)			1.04				0.95	
Overall flavour[1]	0	4.33	4.33	4.33	4.33	4.33	4.33	4.33	
	4	3.67	8.33	3.67	7.67	8.33	8.33	6.67	
	8	3.00	4.33	4.33	5.67	6.33	6.33	5.00	2.31
	12	4.33	4.33	6.33	5.67	5.00	7.00	5.44	
	16	4.33	5.67	6.33	5.67	5.67	6.33	5.67	
	CEUVT	3.93	5.40	5.00	5.80	5.93	6.46		
	LSD (5%)			1.03				0.94	

[Z] Harvest time. [Y] No UV treatments.
[1] Composite effect of UV treatments. [2] Composite effect of storage periods (SP).
[1]: 1 = poor; 3 = fair; 5 = good; 7 = very good; 9 = excellent
[2]: 1 = low; 9 = high

Table 10. Effect of UV treat. periods and storage periods on 'EarliGrande' peach fruit fresh-cut sensory evaluation parameters in 2001season.

Parameter	Storage Periods (SP)	UV Treatments (T, min)							LSD (5%)	
	(days)	0 [Y]	5	10	15	20	25	30	CESP[2]	SPxT
Sweetness[1]	0 [Z]	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33	
	4	3.00	6.33	6.33	7.67	7.67	8.33	9.00	6.90	
	8	1.67	4.33	5.00	7.00	7.00	7.00	7.67	5.67	1.98
	12	4.33	5.00	5.67	5.67	5.67	5.67	7.00	5.57	
	16	6.33	3.67	6.33	4.33	4.33	4.33	4.33	4.81	
	CEUVT[1]	3.93	4.73	5.53	5.80	5.80	5.93	6.47		
	LSD (5%)				0.89				0.75	
Crispness[1]	0	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	
	4	6.67	7.00	7.67	8.33	6.33	7.00	7.00	7.14	
	8	7.67	6.33	7.00	7.67	7.00	5.67	6.33	6.81	NS
	12	7.00	5.67	6.33	5.67	5.67	5.00	5.00	5.76	
	16	5.67	5.00	4.33	3.67	3.67	5.00	4.33	4.52	
	CEUVT	6.94	6.33	6.60	6.60	6.07	6.07	6.07		
	LSD (5%)				0.93				0.79	
Astringency[2]	0	7.67	7.67	7.67	7.67	7.67	7.67	7.67	7.67	
	4	3.33	5.67	5.67	7.00	7.00	7.00	8.33	6.29	
	8	6.67	7.00	4.33	5.00	6.33	5.33	6.33	5.86	2.08
	12	4.33	5.00	3.67	3.67	4.33	4.33	3.00	4.05	
	16	2.67	4.33	3.00	2.33	2.33	2.33	1.67	2.67	
	CEUVT	4.93	5.93	4.87	5.13	5.53	5.33	5.40		
	LSD (5%)				0.93				0.79	
Overall[1] flavour	0	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	
	4	3.00	7.67	8.33	7.67	8.00	6.33	7.00	6.86	
	8	3.67	3.67	6.33	6.33	7.67	6.33	7.00	5.86	NS
	12	3.67	5.67	7.00	5.67	5.67	5.00	6.33	5.57	
	16	5.00	3.67	6.33	3.67	4.33	4.33	5.67	4.71	
	CEUVT	4.07	5.14	6.60	5.67	6.13	5.40	6.20		
	LSD (5%)				1.11				0.94	

[Z] Harvest time. [Y] No UV treatments.
[1] Composite effect of UV treatments. [2] Composite effect of storage periods (SP).
[1]: 1 = poor; 3 = fair; 5 = good; 7 = very good; 9 = excellent
[2]: 1 = low; 9 = high

Astringency. The interaction effects of SP x T were significant in both seasons (Tables 9 and 10).

In the first season, 5 min UV exposure time resulted in more astringent slices than the control and than 10, 15, 20 or 25 min exposure time. Similar trends were obtained in the second season. During storage, astringency of peach slices decreased significantly in both seasons.
The higher the UV exposure time and the longer the storage period, the lower the astringent taste of the slices.

Overall flavour. The interaction effects of SP x T were not significant in the second season (Table 10).

The overall flavour values of the peach fresh-cut slices improved as a result of the different UV irradiation time in both seasons (Tables 9 & 10). During storage, overall flavour improved up to 16 days of storage in the first season and up to 12 days in the second season.

The beneficial effects of UV-B light (15 – 25 min exposure time) on peach fresh-cut slices were in the reduction of the decay (%), maintaining pulp brightness, acidity, and SSC during storage relative to the control and the low UV exposure time.

It worth to mention that the peach slices storability based on eating quality was shown to be shorter than storability based on visual appearance. Although the colour values ('L' and 'a', brightness and redness, respectively) of the slices were high after 16 days of storage, sweetness, crispness, and overall flavour reached the maximum values after four days of storage.

Soft texture (less crispness and firmness) development during storage of peach slices is a serious issue which must be addressed to satisfy consumers and assure repeat purchases of fresh-cut peach products.

The UV treatments on peach whole fruits helped in maintaining fruit firmness and acidity, however, SSC and weight loss increased.

For storage periods, a recommendation would be in favor of 8-day for peach fresh-cut slices with 15 – 25 min UV-B exposure time. During this 8-day the slices kept most of their eating quality (brightness, firmness, acidity, SSC, sweetness, crispness, and overall flavour). Also, decay was not observed. Behind that time, browning and loss of quality (deterioration) progressed.

For whole fruits, 40-day of storage would be recommended with prestorage UV-B treatments (15 – 25 min). No major benefits were obtained from the 30 min over the 25 min UV exposure time relative to eating quality.

The conflicts between the data reported herein and some other literatures and also between the different literatures might be related to the UV irradiation used (A, B, or C), time of exposure, type of the fruits been used, and storage temperature.

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الجودة والقدرة التخزينية والعطب لشرائح الخوخ الطازجة وكذلك الثمار السليمة المعاملة بالأشعة الفوق بنفسجية (B)

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تم جمع ثمار الخوخ صنف ايرلى جراند في مرحلة النضج المتماسك من مزرعة خاصة في محافظة الإسماعيلية. تم تعريض شرائح الخوخ الطازج وكذلك الثمار السليمة للأشعة الفوق بنفسجية (B) بطول موجة ٣١٠ لمدة ٠، ٥، ١٠، ١٥، ٢٠، ٢٥ دقيقة في موسمين متتاليين (٢٠٠٠، ٢٠٠١). في الموسم الثاني تم إضافة وقت تعريض ٣٠ دقيقة أخري للمعاملات السابقة. تم تخزين شرائح الخوخ الطازج وكذلك الثمار السليمة علي درجة حرارة ٢ °م بعد التعبئة.

وقد كانت أهداف الدراسة معرفة أقصى فترة يمكن بها تعريض شرائح الخوخ الطازجة وكذلك الثمار السليمة للأشعة الفوق بنفسجية وتأثير ذلك علي الجودة والقدرة التخزينية وكذلك نسبة العطب.

أظهرت النتائج أن التعريض للأشعة الفوق بنفسجية (١٥ – ٢٥ دقيقة) أدى إلي المحافظة علي قيم اللون 'L'، 'a' ، 'b' بالنسبة لشرائح الخوخ الطازجة بدون تغيير عن الشرائح المقارنة فيما عدا انخفاض في قيمة اللون 'b' في الموسم الثاني والتي يمكن أعاذها إلي التلون باللون البني وقد اتضح أنة أثناء التخزين لمدة ١٦ يوما لشرائح الخوخ الطازجة فان قيمة اللون 'L'، 'a' زادت خاصة بعد ٨ أيام بينما لم تتغير قيمة اللون 'b' في الموسم الأول وحدث لها انخفاض في الموسم الثاني.

أما بالنسبة لثمار الخوخ السليمة فقد ساعدت المعاملة بالأشعة علي الحفاظ علي قيم اللون 'L'، 'a' بدون تغيير أيضا بالنسبة للثمار المقارنة. ولكن حدث انخفاض لقيمة اللون 'b' بسبب التعريض للأشعة لمدة ١٠ – ٢٠ دقيقة. وأثناء التخزين علي درجة حرارة ٢ °م فان ثمار الخوخ السليمة احتفظت بقيمة اللون 'L' بدون تغيير بالمقارنة بالثمار الكنترول وذلك لمدة ٣٠ يوما ثم حدث انخفاض بعد ذلك بينما حدث انخفاض لقيم اللون 'a' ، 'b' .

أدت المعاملة بالأشعة الفوق بنفسجية (١٥ – ٢٥ دقيقة) إلي الحصول علي أقل نسبة من العطب في شرائح الخوخ الطازج. وبالإضافة إلي ذلك فان المعاملة بالأشعة لنفس المدة أدت إلي انخفاض صلابة الشرائح الطازجة بينما المعاملة لمدة ٥ دقائق ساعدت علي الحفاظ علي صلابة الشرائح ولم يحدث تغيير ملحوظ في صلابة الثمار السليمة. وأثناء التخزين انخفضت صلابة الشرائح والثمار الطازجة في كلا الموسمين.

لم يحدث تغيير معنوي في حموضة شرائح الخوخ أو في الثمار السليمة نتيجة التعرض للأشعة وعلى الرغم من أن محتوى المواد الصلبة الذائبة في شرائح الخوخ لم تتغير معنويا بالتعرض للأشعة إلا أنها زادت في الثمار السليمة نتيجة المعاملة بالمقارنة بالكنترول. كذلك فقد حدث زيادة في محتوى المواد الصلبة الذائبة في كل من الشرائح وثمار الخوخ الكاملة أثناء التخزين. وقد زادت نسبة فقد الوزن من الثمار الكاملة نتيجة المعاملة بالأشعة (١٠ – ٢٥ دقيقة) بالمقارنة بالكنترول وبالمعاملة لمدة ٥ دقيقة كذلك زادت نسبة فقد الوزن من الثمار الكاملة أثناء التخزين لمدة ٤٠ يوما.

زادت درجة حلاوة شرائح الخوخ الطازجة وكذلك تحسنت النكهة الكلية بينما لم يتغير كل من درجة الطعم القابض والقرمشة بالمعاملة بالأشعة. وقد لوحظ أثناء التخزين لمدة ١٦ يوما أن درجة حلاوة شرائح الخوخ المقطعة وكذلك النكهة الكلية تحسنت بينما انخفضت درجة الطعم القابض وكذلك القرمشة.