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The impact of some innocuous treatments (UV, Ozone, anise oil and acetic acid) on maintaining the quality attributes of "Swelling" peach fruit at cold storage

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Abstract : The present investigation was carried out to assess the effect of some safe treatments to maintain the quality attributes of "Swelling" peaches during cold storage at 0^oC and RH (90-95%) for four weeks two successive seasons 2015-2016. post-harvest treatments were applied by spraying the fruits with one of Anise oil concentration 0.5 %, 1.0 %, Ozone treatments 2ppm for 10min or 20min, irradiation with UV-C for 5min or 10min and evaporating with acetic acid vapor 4% or 8% for two min.

The attained results reveal that, all adopted treatments markedly decreased the percentages of both weight loss and decay. More pronounced effects were due to anise oil treatments in addition to its' evident effect on maintaining the considered quality attributes. The afore findings might be attributed to the antifungal effect of the anise oil in addition to forming a cat that resulted in changing the surrounding gaseous composition leading to a clear reduction in respiration rate and thereby delaying the deterioration stage occurrence.

Introduction

Peach (*Prunus persica* L.) belongs to family Rossaceae, widely grown in temperate region of the world. Peaches are extremely perishable fruits and do not lend themselves to prolonged storage. Swelling peach is one of the late season cultivars that suffer from accelerated- softened fruits, and therefore, the fruits exhibit short handling period which limits its commercial potential which is also limited by postharvest diseases as Brown Rot and Blue Mold the major postharvest diseases of this crop. Losses due to decay were estimated to be 5–10% when postharvest fungicides are used, without fungicide treatment losses may reach 50% or more Forster et al., [1].

These characteristics oblige growers to harvest fruits at an early ripening stage. Accordingly, there is a great need to slow the deterioration after harvest and to maintain fruit quality in order to prolong the handling season with acceptable yield El-Shazly, [2].

In recent years, there have been several attempts to manipulate inducible defense mechanisms of harvested fruits through pre-storage treatments with innocuous abiotic and biotic to control postharvest decay.

The reduction of postharvest decay of several harvested fruits by pre-storage treatment with UV-C light indicates that induction of defense responses in harvested crops is feasible and manageable on a variety of fruits (Ahmed El Ghaouth, *et al.*, [3]. Ultraviolet (UV) treatment of fresh produce is considered an alternative to chemical approaches that has great potential for controlling postharvest diseases (Cisneros L., [4]. Although UV light is generally harmful to living systems at high doses, at low doses it induces disease resistance in horticultural crops, slows ripening and maturation rate, and improves customary quality attributes. In specific cases, UV light also improves phytochemical content. This biological phenomenon is known as hormesis, where a low dose of a harmful physical or chemical agent stimulates beneficial responses in biological systems (Calabrese, et al.,[5]. The beneficial doses of the stressors are termed hormetic (Stevens C, *et al*., [6] or hormic (Arul J, *et al*., [7] doses. Pre-storage treatment of a variety of commodities including pome, stone, and citrus fruit with low dose of UV-C has been shown to reduce decay. This response has been attributed to the induction of antifungal secondary metabolites by UV-C rather than to its germicidal effect (Stevens, C., *et al.,* [8].

Acetic acid is a universal metabolic intermediary and occurs in plants and animals. The inhibitory effect of acetic acid on microorganisms is greater than that due to pH alone, and acetic acid can penetrate the microbial cell to exert its toxic effect (Banwart, [9] our goal was to determine if acetic acid as a vapor is toxic to fungal conidia and if it could be used to prevent postharvest decay of fruit. Liu, W.T., [10] found that vaporized acetic acid was extremely effective in inhibiting the spores of decay-causing fungi, by killing surface-borne conidia.

The effectiveness of ozone as a sanitizing agent lies in its ability to kill microorganisms by oxidation of cell membranes Sothornvit and Kiatchanapaibul, [11]. As an oxidizing agent, ozone is one and a half times more powerful than chlorine (Xu,[12]. Ozone has a number of features that make it ideally suited as a post-harvest treatment. It decays very rapidly into oxygen leaving no residues and has a half-life of 20 minutes in water a room temperature (Graham,[13]. Ozone can also destroy chemical residues on the fruit surface (Langlais *et al*, [14] and it has also been demonstrated to effectively reduce post-harvest losses during storage for several crops Ong et al.,[15]. In addition, ozone has also been demonstrated to induce defence responses within plant tissues Kangasjarvi *et al* [16].

The potential use of essential oil to control postharvest decay has been examined for fruits, vegetables and flowers. Recently, use of natural components such as natural extract or herbal oils is one of the healthiest and safest methods to control postharvest diseases, essential oils include extensive secondary metabolites, which in most cases have antimicrobial, fungicidal antioxidant and bio-regulating properties. Asghari *et al*., [17]. Recent experiments show that some essential oils are effective for reduce decay, quality maintenance and essential improvement post-harvest life of many fruits reported by Serrano *et al.,*[18].

The objective of this study was to investigate the effect of some safe treatments with low risk of chemical residues to enhancing quality of "Swelling" peach fruits under cold storage condition**.**

Materials and method

This investigation was carried out during the two seasons 2014 and 2015 on peach fruits (*Prunus persica* L. var. 'swelling**'**) obtained from a private orchard located at Cairo, Alex. Desert Road, Giza governorate. Peach fruits were picked at maturity stage(3rd week of June),103 days after full bloom according to Shaltout, [19]. uniform in size and free from visual symptoms of disease or mechanical damages were used for the experiment. Fruits were transported to the laboratory immediately after harvest; fruits were randomly selected for different groups, 3 replicates for each and were subjected to the following treatments:

1- **Control** (untreated) washed with water and left to dry

2- **UV-C irradiation treatments**: The UV-C irradiation treatment was applied using

un®ltered General Electric 15-watt G15 T8 lamps. Of the irradiance emitted by these lamps, 82% was in the UV-C (250±280 nm) region Erkan et al.,[20]. Groups of 20 peaches were placed on a wide mesh screen and irradiated with UV-C lamps on both upper and lower surface at a distance of 15 cm from the screen. **Irradiation treatment for 5 or 10 min**, fruits was rotated 180° to achieve complete irradiation.

3- **Essential oil treatments** were applied by spraying the fruits with **Anise essential oil** at **0.5% (**performed by dissolving **5** ml/L pure Anise oil in 20 ml of 0.05 % tween-80 and then mixing with 975 ml of water). Or **1.0% (**performed by dissolving **10** ml/L Anise oil in 20 ml of 0.05 % tween-80 and then mixing with 970 ml of water)**.** **.**

Anise oil was purchased from Cairo Company for oils and aromatic extractions CID, Egypt. This essential oil was stored in dark bottles at 4ºC until used in the experiments.

4- **Ozone treatments** Fruit were placed in a hermetic transparent glass chamber (50 x 30 x 30 cm) for ozone fumigation at 25 ºC. Fruits were fumigation when the ozone release reached the expected concentration (**2ppm**), the generator was switched off and the fruit were continued to keep in the chamber for **10 min** or **20 min**. Ozone was applied by the ozonizer - model B6ATP, Euro Entech Co., LTD - Thailand, with a capacity of 2,500 mg h^{-1}.

5- **Acetic acid treatments** were applied by evaporating fruits with acetic acid vapor **4% or 8%** for two min.

All treated fruits were packed in carton boxes (3Kg) in one layer and stored at 0oC, 85-95% relative humidity (RH) for 4 weeks. Samples were taken from three replicates for each treatment and examined intervals every 7 days.

The following properties were estimated.

1- Fruit physical characteristics:

1-1- **Weight loss percentage**: Fruits were periodically weighed and the percentage of weight loss was calculated by the difference between the initial weight and that recorded on sampling date.

1-2- **Decay percentage**: Was determined for each treatment according to McCormack and Brown [21]

1-3- **Fruit firmness (lb/inch^2)**: was measured by a hand Magness and Taylor pressure tester equipped with 5 mm tip plunger

2- Fruit chemical characteristics:

2-1- **Total soluble solids percentage:** Abbe refractometer was used to determine the percentage of total soluble solids in fruit juice (A.O.A.C., [22]

2-2- **Titratable acidity percentage**: It was determined as malic acid and calculated as percentage according to A.O.A.C., [22].

2-3- **Respiration rate (ml CO_2 /kg/h)**: Individual fruits for each treatment were Weighed and placed in 2-liter jars at room temperature (25°C ±1). The jars were sealed for 3 h with a cap and a rubber septum. Air samples of the headspace were removed from the septum with a syringe and injected into Servomex Inst. Model 1450C (Food Pack Gas Analyzer) to measure oxygen content and carbon dioxide production. Respiration rate was evaluated at harvest day and during cold storage period. Respiration rate was calculated as ml CO2 /kg/h (Lurie and Pesis,[23].

2-4- **Anthocyanin content (mg./100 g. Fresh weight):** Anthocyanin content was

Determined in skin of fruit according to the method described by (Yilids and Diken,[24].

3- Statistical analysis:

The complete randomized block design was used. Data was statistically analyzed according to Snedecor and Cochran, [25]. The comparisons among means were done by the Least Significant Difference (LSD) at $P \leq 0.05$.

Results and Discussion

1- Fruit physical characteristics:

1-1 Weight loss percentage:

It is evident from, (Table 1) that weight loss percentage increased significantly by elongating the storage period to reach its' peak after 4 weeks storage at 0^{o}C. The average magnitudes for treatments showed that control fruits attained significantly the highest losses. Whereas, significantly the lowest loss percentage was due to both anise oil treatments. Differences between them were significant in the first season only where the 1% recorded a lower percentage significantly. Interaction data were significant. On the last sampling date data clarify a similar trend as that of the illustrated average results. The attained results are in agreement with Marie, T.C. and Joseph, A., [26] found that a low dose of UV-C induced various classes of phytoalexins in several postharvest commodities. Studies presented solid evidence of a positive correlation between phytoalexin accumulation and the observed enhanced characters and disease resistance.

The weight loss occurs during the fruit storage due to its respiration process, the transference of humidity and some processes of oxidation Ayranci and Tunc,[27]. Water losses are as a result of transpiration from the surface of fruits wu, [28] or fruit respiration. Also, mechanical and decay damage leading to loss of water and ultimately fruit weight loss. Thus, the reducing of water and weight loss by essential oils can be attributed to controlling decay and damages or by decreasing the respiration rates by forming of a thin film of oil surrounding the fruit peel Samra et al.,[29].

A significant effect of postharvest applied aqueous ozone and UV-C on weight loss might be due to suppressing respiration and ethylene production Gustavo et al.,[30].

Table (1) Effect of some safe physical and chemical treatments on weight loss percentage of peach fruit under cold storage at 0±1^{o}C and RH 90%

Treatments (A)	Storage periods (Week) (B)											
	1St Season						2nd Season					
	0	1	2	3	4	Mean	0	1	2	3	4	Mean
Control	0.00	2.48	3.06	3.81	4.24	2.72	0.00	2.28	3.06	3.90	4.33	2.71
UV 5min	0.00	1.11	1.60	2.17	2.45	1.46	0.00	1.19	1.36	1.74	1.96	1.24
UV 10min	0.00	1.71	2.09	2.54	2.87	1.84	0.00	1.26	1.81	2.12	2.64	1.57
Anise oil 0.5	0.00	0.79	1.29	1.59	2.04	1.14	0.00	0.93	1.07	1.09	1.75	0.97
Anise oil 1.0	0.00	0.61	0.87	1.24	1.82	0.91	0.00	0.79	1.01	1.20	1.55	0.91
ozone 10min	0.00	1.48	1.81	1.90	2.25	1.49	0.00	1.10	1.49	1.79	2.06	1.29
ozone 20min	0.00	1.38	1.78	2.10	2.43	1.54	0.00	1.26	1.66	1.92	2.00	1.34
Acetic acid 4%	0.00	1.19	1.92	2.29	2.76	1.63	0.00	1.13	1.61	1.91	2.10	1.35
Acetic acid 8%	0.00	1.49	2.01	2.62	2.97	1.82	0.00	1.39	1.79	2.17	2.48	1.56
Mean	0.00	1.36	1.83	2.25	2.65		0.00	1.26	1.65	1.98	2.31	
LSD / A= 0.079 B=0.059 A*B=0.177							**LSD / A=0.117 B=0.0872 A*B=0.261**					

1-2- Decay percentage

As shown in (**Table 2**) the decay percentage increased significantly starting from the second week as storage period elapsed in both seasons. The presented data also reveal that, control fruits on the average attained the highest significant decay percentage in comparison with all treatments which all resulted in a significant positive reducing effect with various degrees of significance. Anise oil at both used concentrations recorded the lowest significant decay average percentage. Interaction results showed that all the adopted treatments resulted in significantly lower decay percentage anise oil at 1% in the first season resulted in significantly the lowest percentage. In the second season however, the results of anise at both concentrations were statistically equal with insignificant differences from both UV and ozone at 5 minutes exposure

The results showed that the used essential oils had positive effects on storage life and reduce decay percentages. Essential oils are mainly conjugated with phenolic compounds that accumulate in some plants cells and show useful effect for pathogen control Plotto *et al.*,[31]. Anethole found in anise oil is the main active constituent and these compounds have a strong fungicidal effect Takayuki *et al.*,[32].

UV-C light treatment induces resistance to infection in several crops including some harvested commodities, and the onset of the resistance has often been correlated with the accumulation of phytoalexins (Rodov, V. et al.,[33]; Mercier, J. *et al.,*[34] and Chalutz, E.,[35]). The effectiveness of UV-C irradiation on controlling decay of peaches, even at the lowest dose (3min), may be correlated with the induction of polyamines although the induction of defense mechanisms by UV-C in peaches were not in specific studied. Resistance induced by UV-C against fungal decay could also be associated with other defensive compounds. It has been observed that resistance against decay induced in oranges by UV-C treatment is related to increases of phytoalexins, scoparone and scopoletin. Droby *et al.*,[36] reported a marked inhibition of sporulation on fungi in grapefruit as well as significant increase in phenylalanine ammonia lyase (PAL) and peroxidase in the peel. UV-C treatments for 3 and 5 min can be used to reduce chilling injury symptoms, deterioration and prolong the shelf-life of peaches during storage at 5°C Gustavo et al.,[30].

Ozone can be effective in stimulating the production of phytoalexins, which increase resistance to decadence accordingly and have a high antioxidant role(Sarig, *et al.*,[37]. The inhibition of fungal growth resulting from O3 treatment also leads to the inhibition of the production of patulin. Patulin is a secondary metabolite, so its biosynthesis is not necessarily correlated with fungal growth. Schmidt Heydt *et al.,*[38].

Acetic acid is more potent as a fumigant and it can also be used to prevent postharvest decay caused by important plant pathogens such as *B. cinerea* and *P. expansum*. There are several advantages in using acetic acid fumigation to control postharvest diseases. It is a natural compound found throughout the biosphere, posing little or no residual hazard at the low levels required to kill fungal spores, it is a generally-regarded-as-safe compound and inexpensive compared to other fumigants (Tarabih, et al.,[39]).

Table (2) Effect of some safe physical and chemical treatments on decay percentage of peach fruit under cold storage at 0±1°C and RH 90%

Treatments (A)	Storage periods (Week) (B)											
	1St Season						2nd Season					
	0	1	2	3	4	Mean	0	1	2	3	4	Mean
Control	0.00	0.49	1.48	3.41	7.83	2.64	0.00	0.59	1.98	4.81	8.14	3.10
UV 5min	0.00	0.00	0.00	0.90	2.47	0.67	0.00	0.00	0.69	1.20	1.65	0.70
UV 10min	0.00	0.00	0.27	0.96	1.87	0.62	0.00	0.00	0.45	1.03	1.87	0.67
Anise oil 0.5	0.00	0.00	0.19	1.22	1.55	0.59	0.00	0.00	0.00	1.21	1.65	0.57
Anise oil 1.0	0.00	0.00	0.50	0.85	1.24	0.52	0.00	0.00	0.40	1.04	1.61	0.61
ozone 10min	0.00	0.00	0.00	1.29	2.06	0.67	0.00	0.00	0.00	1.57	1.99	0.71
ozone 20min	0.00	0.00	0.00	1.38	1.79	0.63	0.00	0.00	0.32	1.39	1.75	0.69
Acetic acid 4%	0.00	0.00	1.00	2.51	3.14	1.93	0.00	0.00	0.00	1.71	3.54	1.05
Acetic acid 8%	0.00	0.00	1.10	2.50	2.75	1.27	0.00	0.00	0.00	1.01	2.86	0.77
Mean	0.00	0.05	0.50	1.66	2.74		0.00	0.06	0.42	1.66	2.78	
LSD / A=0.100 B=0.074 A*B=0.223							**LSD / A=0.105 B=0.078 A*B=0.235**					

1-3- Fruit firmness (lb/inch^2)

Data in (**Table 3**) show that fruit firmness was significantly reduced with storage time elapse. All treatments used significantly maintained fruit firmness than control except UV-C treatment for 10min and the 8% acetic acid treatment where both had statistically equal effects as control. The highest significant average value of firmness recorded the anise oil treatments without significant differences between the two concentrations used. At the end of storage the anise oil 1% maintained significantly the highest firmness. Insignificant differences were attained by all treatments except acetic acid at 8% and UV at 10 min and control where all maintained firmness at statistically lower magnitudes.

Firmness is a very important quality factor for postharvest fruits. Nevertheless, tissue softening occurs for most fruits towards the end of storage to impart desirable palatability. The faster reduction in firmness in control fruit might also be due to the normally occurring ripening process during storage periods which mainly occurs by degradation of the middle lamella of the cell wall. Some essential oils as anise oil have significant efficacy on firmness by decreasing the respiration rates (Samra, *et al.*,[29]).

The UV-C irradiation appears to slow down the softening rate of several fleshy fruits. Higher firmness indices were reported for a short exposure to UV-treated peach fruits Lukumbo, *et al.*, [40] and Lu JY, *et al.*, [41]. In UV-treatment, the activity of polygalacturonase, an enzyme associated with fruit softening during ripening is reduced Stevens, *et al.*, [42]. The activity of other cell-wall-degrading enzymes was also found to be reduced in UV-treated tomato Ait-Barka *et al.*,[43].

Stevens, *et al.*, [44] reported that prolonged exposure of fruits to UV-C radiation accelerated the ripening and senescence processes of tomato fruit.

Sharpe, *et al.*,[45] found that the firmness of apples, carrots and grapes were not significantly affected by ozone treatment at low and high concentrations.

Table (3) Effect of some safe physical and chemical treatments on firmness (lb/inch2) of peach fruit under cold storage at 0±1°C and RH 90%

Treatments (A)	Storage periods (Week) (B)											
	1St Season						2nd Season					
	0	1	2	3	4	Mean	0	1	2	3	4	Mean
Control	12.8	10.4	9.6	8.8	8.1	9.9	14.4	12.2	10.6	9.1	7.9	10.8
UV 5min	12.8	12.4	11.8	9.2	7.2	10.7	14.4	12.7	11.3	10.8	9.6	11.8
UV 10min	12.8	11.3	9.4	9.3	6.9	9.9	14.4	12.3	11.7	9.5	7.5	11.0
Anise oil 0.5	12.8	12.1	11.4	9.8	8.4	10.9	14.4	13.1	12.6	11.8	10.6	12.5
Anise oil 1.0	12.8	12.0	11.2	10.0	10.8	11.4	14.4	13.6	12.8	11.7	11.5	12.8
ozone 10min	12.8	11.8	11.0	10.1	8.5	10.9	14.4	12.2	13.0	12.3	10.5	12.5
ozone 20min	12.8	11.4	10.6	10.1	9.2	10.8	14.4	12.9	12.4	11.7	11.0	12.4
Acetic acid 4%	12.8	11.9	10.4	9.2	9.6	10.8	14.4	12.8	11.8	11.5	10.1	12.1
Acetic acid 8%	12.8	11.1	10.8	9.0	8.2	10.4	14.4	13.3	11.3	10.5	7.6	11.4
Mean	12.8	11.6	10.7	9.5	8.5		14.4	12.8	11.9	11.0	9.6	
LSD / A=0.757 B=0.564 A*B=1.693							LSD / A= 0.844 B=0.629 A*B=1.888					

2- Fruit chemical characteristics

2-1- Total soluble solids percentage (TSS%)

Data presented in (**Table 4**) that Juice TSS % increased slightly from period to another of storage. Compared with zero period i.e. at harvest only the percentages attained by the third and fourth period were significantly higher on the average. On the average all treatments resulted in statistically equal percentages to control. Also a similar trend was attained on the last sampling date.

The adopted treatment did not have a significant effect on altering the maintenance of the juice TSS% which was not in agreement with previous reports which showed that essential oils had significant effect on TSS of strawberry (Tian *et al.*, [46]).

Charles, *et al.*,[47] did not observe any significant difference in the evolution of Total soluble solids in UV-treated tomato during storage, nor did (Vicente, *et al.*, [48] in UV-treated pepper.

According to Tran, *et al.*,[49] no significant differences on TSS % of mango fruit was detected among ozone treatments compared with control. (Sahar, and Ismail, [50] found that the changes in TSS% of mandarin fruits content were more slow in acetic acid fumigated ones than in control and the same result were also achieved on peach fruits Tarabih, *et al.*, [39].

Table (4) Effect of some safe physical and chemical treatments on total soluble solids percentage of peach fruit under cold storage at 0±1°C and RH 90%

Treatments (A)	Storage periods (Week) (B)											
	1St Season						2nd Season					
	0	1	2	3	4	Mean	0	1	2	3	4	Mean
Control	12.9	13.5	13.8	14.0	14.2	13.7	12.6	12.9	13.4	13.8	14.2	13.5
UV 5min	12.9	13.2	13.4	13.6	13.7	13.3	12.6	13.1	13.3	13.6	13.8	13.3
UV 10min	12.9	13.3	13.5	13.8	14.3	13.6	12.6	13.4	13.5	13.6	13.8	13.4
Anise oil 0.5	12.9	12.9	13.1	13.3	13.4	13.2	12.6	12.8	13.0	13.4	13.7	13.1
Anise oil 1.0	12.9	13.1	13.2	13.3	13.4	13.1	12.6	12.8	13.0	13.1	13.2	12.9
ozone 10min	12.9	13.0	13.3	13.4	13.5	13.2	12.6	13.0	13.1	13.5	13.6	13.2
ozone 20min	12.9	13.0	13.3	13.5	13.7	13.3	12.6	13.0	13.1	13.4	14.0	13.2
Acetic acid 4%	12.9	13.0	13.6	13.7	13.8	13.4	12.6	13.1	13.6	13.7	13.8	13.3
Acetic acid 8%	12.9	13.6	13.8	13.8	13.9	13.6	12.6	13.2	13.5	13.7	13.9	13.4
Mean	12.9	13.1	13.4	13.6	13.7		12.6	12.9	13.2	13.5	13.7	
LSD / A=0.977 B=0.728 A*B=2.185							**LSD / A=0.735 B=0.735 A*B=2.206**					

2-2- Titratable acidity percentage (TA%)

Data presented in (**Table 5**) show that fruit acidity decreased as the storage period extended till the end of storage at 4 weeks. On the average all of the applied treatments maintained the acidity percentage at a level that was statistically equal to control except for both anise treatments and acetic acid at 8% in the first season only where they maintained acidity at a significantly higher level with insignificant differences between them. On the last sampling date it was evident that all adopted treatments maintained the titratable acidity at a percentages that were insignificantly different from control. However, the effect of anise at 1% was significantly higher than control in the first season only. Essential oils treatments delayed the decrease in concentrations of acidity, which was in agreement with previous reports were shown that essential oils vapors had significant effect on acidity ian *et al.*, [46].

In UV- C or ozone treatments the acidity was found to decrease at a slower rate, on strawberries fruit (Baka, [51], while on apple fruit no significantly effect was found on the acidity Perez, *et al.*,[52]. In contrast, Ali,[53] found that the changes of (TA %) in ozone treated papaya fruits was to a lower level than control fruit.

Table (5) Effect of some safe physical and chemical treatments on titratable acidity percentage of peach fruit under cold storage at 0±1°C and RH 90%

Treatments (A)	Storage periods (Week) (B)											
	1st Season						2nd Season					
	0	1	2	3	4	Mean	0	1	2	3	4	Mean
Control	0.23	0.20	0.17	0.17	0.15	0.19	0.25	0.22	0.20	0.19	0.16	0.20
UV 5min	0.23	0.23	0.20	0.20	0.17	0.21	0.25	0.24	0.23	0.23	0.22	0.23
UV 10min	0.23	0.21	0.21	0.19	0.19	0.21	0.25	0.23	0.23	0.21	0.20	0.22
Anise oil 0.5	0.23	0.22	0.22	0.21	0.20	0.22	0.25	0.25	0.24	0.23	0.23	0.23
Anise oil 1.0	0.23	0.23	0.22	0.22	0.21	0.22	0.25	0.24	0.24	0.24	0.24	0.23
ozone 10min	0.23	0.23	0.21	0.22	0.19	0.22	0.25	0.24	0.23	0.23	0.22	0.23
ozone 20min	0.23	0.22	0.21	0.19	0.19	0.21	0.25	0.24	0.23	0.22	0.22	0.23
Acetic acid 4%	0.23	0.23	0.22	0.21	0.19	0.21	0.25	0.24	0.24	0.24	0.22	0.23
Acetic acid 8%	0.23	0.23	0.22	0.22	0.19	0.22	0.25	0.25	0.25	0.24	0.23	0.24
Mean	0.23	0.22	0.21	0.20	0.18		0.25	0.24	0.23	0.22	0.21	
LSD / A=0.022 B=0.017 A*B=0.051							**LSD / A=0.064 B=0.030 A*B=0.145**					

2-3- Respiration rate (ml CO2 /kg/h)

Data presented in **Table (6)** show that there was a noticeable decrease in values of the respiration rate towards the end of the cold storage period. On the average all of the considered treatments resulted in significantly lower rates when compared with control. The results of acetic acid at 4% were insignificantly different from control. Significantly the lowest rates were due to anise and UV treatments with insignificant differences between them. The effect of UV in the second season was significantly lower than them. On the last sampling date, data reveal that all conducted treatments significantly reduced the respiration rate compared with control excepy acetic acid at 4% whose effect was statistically equal. Anise at both concentrations resulted in significantly the lowest respiration rates with insignificant difference from the uv 10 min in the first season only.

Fruit respiration is a major factor contributing for fruit senescence. It involves a series of oxidation–reduction reactions. It converts stored sugar to energy in the presence of an oxygen substrate, thus, enhancing senescence (Nourian *et al.*, [54]). Therefore, it is crucial to maintain the respiration rate at a minimum level, as far as possible, to prolong the storage life of fruit. The reduction in respiration rate by essential oils treated fruits during cold storage could be due that oils act as coating that serves as a barrier to O_2 and CO_2, modifying internal atmospheres and slowing down the respiration rate of fruit (Debeaufort *et al.*, [55]). The UV-C treatment would inhibit the respiratory activity in several steps of the tricarboxylic acid cycle and respiratory electron transport chain of mitochondria, to delay fruit senescence (Zhenfeng, et al., [56]).

The lower respiration rates of peaches treated with UV-C suggested that the fruit has lower physiological activity and moderate metabolic activity (Alique, *et al.*, [57], which was related to the delayed senescence process in UV-C-treated peaches. However, Gonzalez-Aguilar, *et al.,* [58] reported that UV-C treatment increased respiration rate of peaches after being stored for 14 and 21 days at 5°C. The inconsistent results regarding the effect of UV-C treatment on respiration rate in postharvest peaches are probably due to the different storage temperature.

Many research proved that the efficacy of ozone in inhibiting the respiration rate depends on the type of produce and the ozone concentration. Ozone treatment prolonged the shelf life in tomatoes due to a lower respiration rate (Jin, *et al.*, [59]).

Table (6) Effect of some safe physical and chemical treatments on Respiration rate (ml CO2 /kg/h) of peach fruit under cold storage at 0±1°C and RH 90%

Treatments (A)	Storage periods (Week) (B)							
	1St Season				2nd Season			
	0	2	4	Mean	0	2	4	Mean
control	2.01	1.80	1.92	1.90	1.82	1.77	1.75	1.77
UV 5min	2.01	1.08	0.95	1.35	1.82	1.24	1.06	1.38
UV 10min	2.01	0.98	0.81	1.27	1.82	1.02	0.98	1.27
Anise oil 0.5	2.01	0.97	0.82	1.26	1.82	1.01	0.80	1.21
Anise oil 1.0	2.01	0.94	0.76	1.24	1.82	0.72	0.68	1.08
ozone 10min	2.01	1.76	1.59	1.79	1.82	1.31	1.56	1.55
ozone 20min	2.01	1.28	1.02	1.44	1.82	1.52	1.31	1.54
Acetic acid 4%	2.01	1.99	1.69	1.90	1.82	1.75	1.73	1.76
Acetic acid 8%	2.01	1.62	1.35	1.65	1.82	1.60	1.36	1.59
Mean	2.01	1.39	1.20		1.82	1.31	1.25	
LSD / A=0.10 B=0.06 A*B=0.18					A= 0.09 B=0.05 A*B=0.15			

2-4- Anthocyanin content (mg./100 g. F.W.)

It is clear from **Table 7** that the total anthocyanin content of the skin of "Swelling" peach fruits gradually increased from harvest till the end of cold storage. This result was in agreement with obtained by Hen, *et al.*, [60]. The average effect of anise oil at 1% treatments was maintaining the lowest concentration of anthocyanin pigments compared with other treatments and control in the first season. In the second season however, also anise at 1% induced the lowest content with insignificant differences from all treatments except for the acetic acid treatments and control as they induced significantly higher contents.

The interaction between treatments and storage period were significant. Highest significant contents were due to control in both seasons, acetic acid at 4% in the first season and acetic acid at both concentrations in the second season only. All the remaining treatments were statistically equal

The essential oils treatments delayed fruits ripening and senescence which was indicated as decrease in color development and the fruits become less redness than that of untreated fruits became redder and darker along the storage time Sahar,[61]. A similar effect was observed for some essential oils which had significant efficacy on inducing the lowest values of anthocyanin content (Atress *et al.*, [62]).

Several reports indicated that UV-C exposures promoted anthocyanin synthesis in other fruits, including apples Dong, *et al.*, [63], sweet cherries (Kataoka *et al.*, [64], grapes (Kataoka, *et al.*, [65], and boysenberries Vicente, *et al.*, [66]. On the other hand, delay in accumulation of anthocyanin by UV-C illumination has also been reported in strawberry fruit by (Pan, *et al.*, [67]).

Table (7) Effect of some safe physical and chemical treatments on anthocyanin content (mg./100g. F. W.) of peach fruit under cold storage at 0±1oC and RH 90%

Treatments (A)	Storage periods (Week) (B)											
	1St Season						2nd Season					
	0	1	2	3	4	Mean	0	1	2	3	4	Mean
Control	12.3	13.0	13.5	13.8	14.9	13.5	11.6	12.2	12.8	13.5	14.0	12.8
UV 5min	12.3	12.6	12.7	13.1	13.3	12.8	11.6	11.9	12.0	12.3	12.6	12.1
UV 10min	12.3	12.5	12.7	12.8	13.0	12.7	11.6	12.0	12.1	12.1	12.4	12.1
Anise oil 0.5	12.3	12.5	12.5	12.7	13.0	12.6	11.6	11.7	11.8	12.2	12.6	12.0
Anise oil 1.0	12.3	12.3	12.6	12.9	13.2	12.3	11.6	11.7	11.8	12.0	12.0	11.9
ozone 10min	12.3	12.7	13.0	13.1	13.7	12.9	11.6	11.7	12.1	12.4	12.7	12.1
ozone 20min	12.3	12.5	12.8	13.0	13.6	12.8	11.6	11.8	12.0	12.3	12.7	12.1
Acetic acid 4%	12.3	13.0	13.0	13.8	14.3	13.3	11.6	12.0	12.4	13.0	13.5	12.5
Acetic acid 8%	12.3	12.5	12.8	13.0	13.6	12.9	11.6	12.1	13.1	13.3	13.7	12.4
Mean	12.3	12.7	12.9	13.0	13.7		11.6	11.9	12.2	12.4	12.9	
LSD / A=0.14 **B**=0.29 **A*B**=0.89							**LSD / A= 0.39** **B**=0.30 **A*B**=0.90					

Conclusion

The obtained results indicated that all treatments played a pivotal in diminishing both the weight loss and decay percentage. Anise oil showed a more prominent effect in addition to its' pronounced effect on maintaining the assessed keeping quality attributes. The attained effects of anise oil in my opinion might be attributed to the antifungal effect exhibited by it due to its' content of Anethole in addition to its' forming a thin coat that might have modified the composition percentage of the surrounding air which lead to a marked reduction in respiration rate that retarded deterioration and maintained the keeping quality attributes to a longer period.

References

1. Forster, H., Driever, G. F., Thompson, D.C. and Adaskaveg, J. E., 2007. Postharvest decay management for stone fruit crops in California using the reduced-risk fungicides fludioxonil and fenhexamid. Plant Dis., 91: 209-215.
2. El-Shazly, S. M., Eisa, A. M., Moatamed, A. M. and Kotb, H. R. M., 2013. Effect of Some Agro-Chemicals Preharvest Foliar Application on Yield and Fruit Quality of "Swelling" Peach Trees. Alex. J. Agric. Res. Vol. 58, No.3, pp.219-229
3. Ahmed El Ghaouth, Charles L. Wilson, and Ann Callahan, M., 2003. Induction of Chitinase, 1,3-Glucanase, and Phenylalanine Ammonia Lyase in Peach Fruit by UV-C Treatment. The American Phytopathological Society, Vol. 93, No. 3,
4. Cisneros-Zevallos L., 2003. The use of controlled postharvest abiotic stresses as a Tool for enhancing the nutraceutical content and adding-value of fresh fruits and vegetables. Journal of Food Science. 68:1560–1565.
5. Calabrese EJ, McCarthy ME and Kenyon E., 1987. The occurrence of chemically induced hormesis. Health Phys : 52:531–541.
6. Stevens C, Khan VA, Lu JY, Wilson CL, Pusey PL, Igwegbe ECK, Kabwe K, Mafolo Y, Liu J, Chalutz E and Droby S., 1997. Integration of Ultraviolet (UVC) light with yeast treatment for control of postharvest storage rots of fruits and vegetables. Biological Control. 10:98–103,picota cv 'Ambrunes'. Postharvest Biology and Technology, 35, 153–165.

7. Arul J, Mercier J, Charles MT, Baka M and Maharaj R., 2001. Photochemical treatment for the control of postharvest diseases in horticultural crops. In: Physical methods in plant protection. Vincent C, Panneton B, Fleurat- Lessard F (Editors). Berlin: Springer-Verlag: 146–161.
8. Stevens, C., Khan, V. A., Lu, J. Y., Wilson, C. L., Pusey, P. L., Kabwe, M. K., Igwegbe, E. C. K., Chalutz, E., and Droby, S., 1998. The germicidal and hormetic effects of UV-C light on reducing brown rot disease and yeast microflora of peaches. Crop Prot. 17:75-84.
9. Banwart, G.J, 1981. Basic food microbiology. AVI, Westport, Conn.
10. Liu, W.T.and Chu, C.L., 2002. Thymol and acetic acid vapors reduce postharvest brown rot of apricots and plums. HortScience 37 (1): 151-156.
11. Sothornvit, R., Kiatchanapaibul, P., 2009. Quality and shelf-life of washed fresh-cut asparagus in modified atmosphere packaging. LWT-Food Sci. Technol. 42, 1484–1490.
12. Xu, L., 1999. Use of ozone to improve the safety of fresh fruit and vegetable. Food Technology 53:58-62.
13. Graham, D.M. (1997). Use of ozone for food processing. Food Technology 51:72-75
14. Langlais, B., Reckhow, D.A., and Brink, D.R., 1991. Practical applications of ozone: Principle and case study. In: Ozone in Water Treatment, Lewis Publishers, Michigan.
15. Ong, M.K., Kazi, F.K., Forney, C.F., Ali, A., 2012. Effect of gaseous ozone on papayaanthracnose. Food Bioprocess Technol. 6, 2996–3005.
16. Kangasjarvi J, Talvinen J, Utriainen M, Karjalinen R., 1994. Plant defence systems induced by ozone. Plant Cell and Environment 17:783 – 794
17. Asghari, A., Mostufi,Y. S., Shoheibi,H., Moghomiv, M., 2009. Effect of basil essential on control decay gray mould and postharvest quality of strawberry cv. selvia. Journal. Medicinial Plants. A Quarterly med. Plants. 8(28) 131-139.
18. Serrano, M., D. Martinez-Romero, S. Castillo, F. Guillen, and D. Valero, 2005. The Use of the Natural Antifungal Com- pounds Improves the Beneficial Effect of MAP in Sweet Cherry Storage," Innovative Food Science and Emerging Technologies. 6(1):115-123.
19. Shaltout, A.D., 1995. Introduction and production of some low-medium chill peach and apple ciltivars in the sub-tropical climate of Egypt. Assiut J. Agric. Sci., 26: 195-206.
20. Erkan, M., Wang, C.Y., Krizek, D.T., 2001. UV-C radiation reduces microbial populations and deterioration in Cucurbita pepo fruit tissue. Environ.Exp. Bot. 45,1–9.
21. McCormack, A. A., Brown, C. F., 1973. Market diseases and blemishes of florida citrus fruits . Florida Department of citrus, Lake Alfred, State of Florida.
22. A.O.A.C., 1990. Official methods of analysis. Association of Official Analytical Chemists., Washington, DC., USA.
23. Lurie, S. and E. Pesis, 1992. Effect of acetaldehyde and anaerobiosis as post- harvest treatment on the quality of peaches and nectarines. Postharvest Biol. Technol., 1: 317-326.
24. Yilidz, F.A. and D.S. Diken, 1990. The extraction of anthocyanin from black grape skins Doga. Degisi, 14(1): 57-66. horticultural product quality. Journal of Food Science, Vol, 74.
25. Snedecor, G.W. and W.G. Cochran, 1980. Statistical Methods. 7th Edn. Iowa State Univ. Press Ames. Low USA.
26. Marie, T. C. and Joseph, A., 2007. UV treatment of fresh fruits and vegetables for improved quality a status report. Stewart Postharvest Review, 3: 6
27. Ayranci, E. and S.Tunc,. 2003. A method for the measurement of the oxygen permeability and the development of edible films to reduce the rate of oxidative reactions in fresh foods. Food Chem., 80: 423-431.
28. Wu, C. T., 2010. An overview of postharvest biology and technology of fruits and vegetables. Technology on Reducing Post-harvest Losses and Maintaining Quality of Fruits and Vegetables. Proceedings of 2010 AARDO Workshop. Held at Taiwan Agricultural Research Institute, Council of Agriculture, Taiwan, ROS. 3-9 October 2010. P, 2-11.
29. Samra, N. R., Mansour, A. M., Tourky, M. N., Tarabih, M. E., 2006. Pre and post-harvest treatments on peach fruit grown under desert conditions. J. Agric. Sci. Mansoura Univ., 31: 7835-7846.
30. Gustavo G.A., Chien Y Wang and George, J. B., 2004. UV-C irradiation reduces breakdown and chilling injury of peaches during cold storage. Journal of the Science of Food and Agriculture J Sci Food Agric 84:415–422
31. Plotto A, Roberts RG, and Roberts, D.D., 2003. Evaluation of plant essential oils as natural postharvest disease control of tomato (Lycopersicon esculentum). Acta Horticulture 628: 737-745.

32. Takayuki S, Mami S, Azizi M, and Yoshiharu F., 2007. Antifungal effects of volatile compounds from black zira (Bunium persicum) and other spices and herbs. Journal Chemistry Ecology 33:2123- 2132.
33. Rodov, V., Ben-Yehoshua, S., Albaglis, R., and Fang, D., 1994. Accumulation of phytoalexins scoparone and scopoletin in citrus fruits subjected to various postharvest treatments. Acta Hortic. 381:517
34. Mercier, J., Arul, J., Ponnampalam, R., and Boulet, M., 1993. Induction of 6-methoxymellein and resistance to storage pathogens in carrot slices by UV-C. J. Phytopathol. 137:44-55.
35. Chalutz, E., Droby, S., Wilson, C., and Wisniewski, M., 1992. UV-induced resistance to postharvest diseases of citrus fruit. J. Phytochem. Phytobiol. 15:367-374.
36. Droby S, Chalutz E, Horev B, Cohen L, Gaba V, Wilson CL and Wisniewski M.1993.Factors affecting UV-induced resistance in grapefruit against the green mould decay caused by Penicillium digitatum. Plant Pathology. 42:418–424.
37. Sarig P, Zahavi T, Zutkhi Y, Yannai S, Lisker N, BenArie R., 1996. Ozone for control of post-harvest decay of table grapes caused by Rhizopus stolonifer. Physiol Mol Plant Pathol 48(6):403–415.
38. Heydt, S. M., D. Stoll and R. Geisen, 2013. Fungicides effectively used for growth inhibition of several fungi could induce mycotoxin biosynthesis in toxigenic species. International Journal of Food Microbiology 166, 407–412.
39. Tarabih, M.E., EL-Eryan, E.E. and Tourky ,M.N., 2012. Effect of Fumigation with Some Volatile Substances on Peach Fruits During Cold Storage. Trends in Horticultural Research, 2: 14-27.
40. Lukumbo, SM., Lu JY, Stevens, C., Khan, VA., Wilson, CL., Pusey, PL. and Chalutz, E., 1993. Comparing the effects of low dose UV and gamma radiation on the storage ability of peaches. Tuskegee Horizons . 4:22.
41. Lu JY, Stevens C., Khan VA., Kabwe M. and Wilson CL., 1991. The effect of ultraviolet irradiation on shelf-life and ripening of peaches and apples. Journal of Food Quality . 14:299–305
42. Stevens, J.L., Khan, V.A., Lu, J.Y. et al., 1993. Applica- tion of ultraviolet-C light on storage rots and ripening of tomatoes. Journal of Food Protection, 56, 868-872.
43. Ait-Barka E., Kalantari S., Makhlouf J. and Arul J., 2000. Impact of UV-C irradiation on the cell wall-degrading enzymes during ripening of tomato (Lycopersicon esculentum L.) fruit. Journal of Agricultural and Food Chemistry. 48:667–671.
44. Stevens, C., Liu, J., Khan, VA., Lu JY, Kabwe, MK., Wilson, CL., Igwegbe, ECK., Chalutz, E. and Droby, S., 2004. The effects of low-dose ultraviolet light-C treatment on polygalacturonase activity, delay ripening and Rhizopus soft rot development of tomatoes. Crop Protection: 23:551–554.
45. Sharpe, D., Fan,L. K., McRae, B. Walker, R. Mackay, C. Doucette, 2009. Effects of ozone treatment on Botrytis cinerea and Sclerotinia sclerotiorum in relation to
46. Tian J, Ban X.Q, Zeng H, He J.S, Huang B, and Wang Y.W., 2011. Chemical composition and antifungal activity of essential oil from Cicuta virosa L. var. latisecta Celak. International Journal of Food Microbiology 145: 464-470.
47. Charles, MT., Kalantari, S., Corcuff, R. and Arul, J., 2005. Postharvest quality and sensory evaluation of UV-treated tomato fruit. Acta Horticulturae: 682:537–542.
48. Vicente, A.R., Repice, B., Martinez, G.A., Chaves, A.R., Civello, P.M., Zozzi, G.O., 2004. Maintenance of fresh boysenberry fruit quality with UV-C light and heat treatments combined with low storage temperature. J. Hortic. Sci. Biotechnol. 79, 246–251.
49. Tran,T.L., Aimla, S., Srilaong, V., Jitareerat, P., Wongs-Aree, C. and Uthairatanakij, A. 2013. Fumigation with Ozone to Extend the Storage Life of Mango Fruit CV.Nam Dok Mai No. 4. Agricultural Sci. J. 44(2) 663-672
50. Sahar. M. Abd Elwahab and Ismail A.S. Rashid, 2013. Effect of Acetic Acid Fumigation and Waxing on Decay, Storability and Marketability of Mandarin Fruits. Journal of Applied Sciences Research, 9(3): 2146-2155, 2013
51. Baka, M., 1997. Photochemical therapy in the preservation of fresh fruits and vegetables: phenomenological aspects of disease resistance and delayed senescence. PhD thesis. Laval University, Department of Food Sciences.
52. Perez, A.G., Sanz, C., Rios,J. Olias J. R. and olias, J.M., 1999. Effects of ozone treatment on postharvest strawberry quality, Journal of Agriculture and Food Chemistry, 47, pp: 1652-1656.
53. Ali, A., Ong, M.K. and Forney,C.F., 2014. Effect of ozone pre-conditioning on quality and antioxidant capacity of papaya fruit during ambient storage, Food Chemistry, 142, pp: 19-26.

54. Nourian, F., Ramaswamy, H. S., & Kushalappa, A. C., 2003. Kinetics of quality change associated with potatoes stored at different temperatures. LWT-Food Science and Technology, 36, 49–65.
55. Debeaufort, F.J., A. Quezada-Gallo, and A.Voilley, 1998. Edible films and coatings: tomorrow's packagings: a review. Crit. Rev. Food Sci.,38: 299-313
56. Zhenfeng Yang , Shifeng Cao, Xinguo Su, Yueming Jiang., 2014. Respiratory activity and mitochondrial membrane associated with fruit senescence in postharvest peaches in response to UV-C treatment. Food Chemistry 161 16–21
57. Alique, R., Zamorano, J. P., Martiınez, M. A., & Alonso, J., 2005. Effect of heat and cold treatments on respiratory metabolism and shelf-life of sweet cherry, type.
58. Gonzalez-Aguilar, G. A., Wang, C. Y., & Buta, G. J., 2004. UV-C irradiation reduces break-down and chilling injury of peaches during cold storage. Journal of the Science of Food and Agriculture, 84, 415–422.
59. Jin, L., Xiaoyu, W., Honglin, Y. Zongan, Y., Jiaxun, W.,Yaguang,L., 1989. Influence of discharge products on post-harvest physiology of fruit, In: Proceedings of the Sixth International Symposium on High Voltage Engineering, 28 August to 1 September, New Orleans, LA, p.4.
60. Hen, C., Y. Zhao, S.W. Leonard and M.G. Traber, 2004. Edible coatings to improve storability andenhance nutritional value of fresh and frozenstrawberries (Fragaria x ananassa) and raspberries (Rubus ideaus).
61. Sahar, M. Abd El wahab., 2015. Maintain Postharvest Quality of Nectarine Fruits by Using Some Essential Oils. Middle East Journal of Applied Volume : 05 855-868
62. Atress, A.H., El-Mogy ,M.M., Aboul-Anean ,H. E. and Alsanius, B.W., 2010. Improving Strawberry Fruit Storability by Edible Coating as a Carrier of Thymol or Calcium Chloride. Journal of Horticultural Science & Ornamental Plants. 2 (3): 88-97.
63. Dong, Y.H., Mitra, D., Kootstra, A., Lister, C., Lancaster, J., 1995. Postharvest stimulation of skin color in Royal Gala apples. J. Am. Soc. Hortic. Sci. 120, 95–100.
64. Kataoka, I., Beppu, K., Sugiyama, A., Taira, S., 1996. Enhancement of coloration of "Satohnishiki" sweet cherry fruit by postharvest irradiation with ultraviolet radiation. Environ. Control Biol. 34, 313–319.
65. Kataoka, I., Sugiyama, A., Beppu, K., 2003. Role of ultraviolet radiation in accumulation of anthocyanin in berries of 'Gros Colman' grapes (Vitis vinifera L.). J. Jpn. Soc. Hortic. Sci. 72, 1–6.
66. Vicente, AR., Pineda, C., Lemoine, L., Civello, PM., Martinez, GA and Chaves, AR., 2005. UV-C treatments reduce decay, retain quality and alleviate chilling injury in pepper. Postharvest Biology and Technology: 35: 69–78.
67. Pan, J., Vicente, A.R., Martinez, G.A., Chaves, A.R., Civello, P.M., 2004. Combined use of UV-C illumination and heat treatment to improve postharvest life of strawberry fruit. J. Sci. Food Agric. 84, 1831–1838.

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