Article

Extending the Shelf-Life of White Peach Fruit with 1-Methylcyclopropene and *Aloe arborescens* Edible Coating

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Abstract: The maintenance of high quality standards for prolonging shelf life of fruit and maintaining sensory and nutritional quality is a priority the horticultural products. The aim of this work was to test the effectiveness of a single treatment of edible coating based on *Aloe arborescens* and a combined treatment of 1-Methylcycyclopropene and edible coating to prolong the shelf-life of "Settembrina" white flesh peach fruit. White flesh peach fruit were harvested at the commercial ripening stage and treated with edible coating (EC) or 1-MCP +EC and stored for 28 days at 1°C. After 7, 14, 21 and 28 days fruits were removed from cold storage, transferred at 20°C and then analyzed immediately (cold out) and after 6 days (shelf life) to evaluate the combined effect of cold storage and room temperature. Weight loss, physical, chemical and sensory parameters were measured. Fruit treated with EC and 1-MCP +EC kept their marketing values better than CTR after 14 days of storage and 6 days of simulated shelf life, in terms of flesh firmness, total soluble solids and titratable acidity as well as sensory parameters. After 21 days of storage, all treatments showed a deterioration of the quality parameters. The single and combined application of Aloe-based coating (with 1-MCP) slowed down the maturation processes of the fruit, limited the weight loss and preserved its organoleptic characteristics.

Keywords: *Prunus persica*; edible coating; 1-Methylcycyclopropene; *Aloe* spp; post-harvest quality;

1. Introduction

Peach is a climacteric fruit that dramatically increases ethylene production during ripening **[1]**. White flesh melting peaches rapidly soften after commercial maturity, are highly sensitive to chilling injuries, and can be easily damaged during shelf life **[2]**.. The development of new technologies in controlling the fruit ripening process, makes it possible to prolong its shelf life, reducing distribution loss and supplying high quality fruit for consumers. Among the numerous factors involved, the use of cyclopropenes (1-MCP), which is a volatile and active compound at very low concentrations **[3, 4]** has shown an inhibitory effect by occupying the ethylene receptors and entering into the physiological processes in which the hormone is involved **[5].** Widespread use of 1-MCP has been found in climacteric fruits **[6]**. Several studies show that the application of 1-MCP had a high effect on respiratory rate, total soluble solid and titratable acid content at harvest and during storage **[7]** depending on the fruit ripening stage at harvest and the time of application **[5]**. Several studies have implemented 1-MCP to preserve fruit quality during its storage and shelf life of yellow-flesh peach genotypes but little has been done for white-flesh ones We know that it is able to delay the progression of important maturation and senescence processes, e.g. softening, aroma evolution, color development, **[8]** but the effect is limited to the first 2 -3 days of ripening after harvest **[9]**. In addition to the use of 1-MCP there are other techniques to maintain the quality

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of the harvested fruit during cold storage and shelf life e.g. the edible coatings (EC). Edible coating is made of a thin layer of edible material which is laid on the surface of the fruit **[10, 11]**. A further advantage of this methodology is the possibility to add substances that act as carriers of antimicrobial agents and slow release substances **[12, 13]**. Recent studies have been carried out on the post-harvest application of Aloe gel to preserve the quality characteristics of fruits **[14]**. However, detailed information on the influence of EC on quality and post-harvest behavior of white flesh melting peaches is not yet available. Indeed, in Italy, the marketability of white flesh melting peaches, with a remarkable organoleptic value **[15, 16, 17, 18, 19]** is hindered by their high susceptibility to post-harvest injuries. This study was carried out in order to widening the marketability of white flesh melting peaches, based on the hypothesis that implementing 1-MCP with EC might help in a better regulation the ripening process. We evaluated the interaction between the antioxidant and antimicrobial properties of the *Aloe arborescens* gel EC **[20]** and the 1-MCP **[21]**, which delays the ripening of the fruit, testing the storage at low temperatures (1±0.5°C) and then the shelf life at 20 °C for 6 days.

2. Material and Methods

2.1. Plant material and treatments

The trial was carried out in a commercial orchard located in Bivona (AG) (37°37′ N, 13°26′ E, 503 m a.s.l.) made of 15-years-old trees of the local white, melting flesh peach (*Prunus persica* Batsch) cultivar *Settembrina* **[16, 15]**, grafted on GF677 rootstock (*P. persica x P. amygdalus*) and trained to a vase. Two hundred and twenty fruits were hand-picked, from six trees, using the flesh firmness (60.5±8.2 N) as maturity index.to determine the ripening stage of the whole sample.

Aloe arborescens gel **[14]** was prepared from 1 kg of leaves taken from 10-years-old plants. The leaves were cleaned externally with a knife, removing the margin and then were cut lengthwise. The parenchyma (from which the gel is obtained) was separated from the epidermis. The gelatinous parenchyma was homogenized with Ultra-Turrax (Ultra-Turax T25, Janke and Kunkle, IKa Labortechnik, Breisgau, Germany) for 5 minutes at 24.500 rpm, thus obtaining a mucilaginous gel, subsequently filtered to eliminate the fibrous portion. A gelling agent (Gellan 0.56% w/v) and glycerol 0.89% w/v were added to improve the viscosity and plasticity of the film. After, following further homogenization, a 90°C/40 minutes heat treatment was applied to stabilize the solution from a microbiological point of view. Finally, a solution containing ascorbic acid 1% w/v was added to prevent further darkening **[22]** and citric acid 1% w/v to maintain the pH value below 3.

2.2. Experimental design

To understand the effect of 1-MCP and the edible coating, the experiment was designed according to a full randomized block design with 3 main treatments: 1-MCP + edible coating (1-MCP + EC); edible coating (EC); control (CTR); 5 storage times: 0, 7, 14, 21, 28 d. each one followed by 6 days at 20°C and 70% RH to simulate domestic shelf life. 210 fruits were sampled and used as follows: $15_{\text{single fruit replicates}}$ x $3_{\text{treatments}}$ x $4_{\text{times of storage}}$ + $10_{\text{single fruit replicates}}$ x $3_{\text{treatments}}$ analyzed before storage. At each storage time 5 single fruit replicates were either analyzed immediately after cold storage (cold out- 0 days) or after 6 days of simulated domestic shelf life and, at this stage, utilised for the sensory analysis.

Fruit were washed with distilled water (5°C) and a solution of hydrogen peroxide and peroxyacetic acid (OXVIRIN 0.5% w/v for 3 minutes) was added. Subsequently, they was treated with 1-Methylcyclopropene (1-MCP) (SmartFresh®, Italy), within a bag of HDPE, with a capacity of 5 L, for 21 h, at a temperature of 2°C. A test tube containing the fruits was placed inside the bag, with 1 μl l^{-1} of 0.14% 1-MCP, and distilled water at 40 °C was added to the test tube (5 mL) just before treatment. The test tube was immediately closed, shaken and placed in the bag with the fruit;

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the bag was sealed and the test tubes opened inside the bags **[23]**. At the end of the treatment with 1-MCP, fruit were submitted to the dipping treatment with edible coating based on *Aloe arborescens* (1-MCP+EC). A second group of 70 fruit was treated only with the dipping treatment with edible coating (EC) based on *Aloe arborescens.* A third group (CTR) of 70 fruit was treated with a dipping in distilled water.

All fruit were stored in a 25 m^2 cold-storage chamber (21 kPa O_2/0.03 kPa CO_2) at 1°C RH 95% for 28 days. A sample of 15 fruits for each treatment was removed from cold storage after each of 7, 14, 21 and 28 days and transferred at 20°C to be analyzed immediately (cold out - 0 day) or after 6 days (shelf life - 6 days) to evaluate the effect of cold storage and room temperature. Five fruit per treatment at each storage time were subjected to sensory analysis after shelf life.

2.3. Physic-chemical analysis

Fruit fresh weight loss, firmness (FF), total soluble solids content (TSSC), titratable acidity (TA), peel color (PC) were analyzed. The loss of fresh weight was measured at each storage time using a digital scale (model BP4100; Sartorius Inc., Edgewood, NY, USA), reporting the results as a cumulative percentage of weight loss during storage (7, 14, 21, 28 days at 1 °C, 95% RH). Fruit firmness (N) was measured with a digital penetrometer (53205, TR Turoni, Forlì, Italia) on the two sides of the fruit. Juice was extracted with a centrifuge and TSSC (Brix°) was measured by digital refractometer Atago Palette PR–32 (Atago Co., Ltd, Tokyo, Japan) and TA (g/L of citric acid) using a Crison compact tritator (Crison Instruments, SA, Barcelona, Spain); moreover, solids content/titratable acidity ratio (TSSC/TA) was calculated. Peel color was evaluated on the two opposite sides of each fruit. Two readings per fruit were taken using a Minolta colorimeter model CR-400 (Minolta Co., Ramsey, NJ, USA) to obtain variables of lightness (L^*), $a*$ and $b*$. Data from $a*$ and $b*$ were processed to calculate the hue angle or tone, $h = \arctan (b*/a*)$, and also the chromaticity or saturation values of the color $[(a^2+ b^2) 1/2]$.

2.4. Sensory analysis

Sensory analysis was performed on a sample of 5 fruit, a) immediately after treatment, before storage and b) after 7, 14, 21, 28 of cold storage + 6 d of simulated, domestic shelf life. The sensory analysis was conducted at postharvest laboratory of the University of Palermo in September 2016. The sensory evaluation test was performed by an evaluation team consisting of 11 panelists (six men and five women, 25-60 years old) with a good background and knowledge of the details of this evaluation. All panelists were trained and had a broad expertise in sensory evaluation of fruits **[24]**. During the evaluation, all 11 panelists completed a short questionnaire covering the quality indicators independently **[25]**. The evaluation was carried out from 10.00 to 12.00 a.m. in a special room with individual booths under white lights. Samples were presented in a white plastic plate and tasted 1 h after they were taken out of the cold room **[26]**. Each panelist received in a random order a sample made of 3 anonymous slices per treatment labeled with numbers.

During preliminary meetings, 15 descriptors were selected for the definition of the sensory profile, generated on the basis of the citation frequency (> 60%) and listed below: External color uniformity (ECU); compactness (COM); Pulp color intensity (PCI); Peach smell (PS); Herbaceous smell (HS); Floral odor (FO); Pasty (PA); Sweet (S); Acid (A); Bitter (B); Juicy (JU); Peach Flavor (FIF); Herbaceous Flavor (HF); Floral Flavor (FF) and Comprehensive Evaluation (CE). The samples were evaluated using several attributes (Table 2). The judges evaluated the intensity of each descriptor by assigning categorical scores of 1 (absence of sensation), 2 (just recognizable), 3 (very weak), 4 (weak), 5 (slight), 6 (moderate), 7 (intense), 8 (very intense) and 9 (extremely intense). **[27]**. The sample order for each panelist was randomized and water was provided for rinsing between samples.

2.5. Statistical analysis

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The study was planned with randomized sampling design. Statistical differences with P-values under ≤0.05 were considered significant. The Tukey test was used for comparing the averages of measured values. Data for the physical, chemical, and sensory parameters were subjected to analysis of variance. Sources of variation were time of storage and treatments. Mean comparisons were performed using the Tukey HSD test to examine if differences between treatments and storage time were significant at $P < 0.05$. All analyses were performed with XLStat® software version 9.0 (Addinsoft, Paris, France).

3. Results and Discussion

3.1. Cold out (0 day)

Treatments had a significant effect on flesh firmness which decreased linearly in the untreated fruit during the cold storage period, consistent with what is generally reported in peach fruit after harvest **[28]**. Flesh softening is related to the action of cell wall degrading enzymes, which hydrolyze starch to soluble sugars and protopectin to water-soluble pectin. Furthermore, microbial contamination plays a significant role in the loss of fruit firmness . Therefore, 1-MCP combined with Aloe coating could have positively influenced the firmness of peach fruits by reducing cell wall degradation through the inhibition of microbial propagation and delaying fruit senescence. Indeed, no significant reduction in flesh firmness occurred in EC and 1MCP+EC treated fruit, with no significant difference between the two treatments (Fig. 1). Differences between treated and untreated fruit occurred from the second week after storage and increased during the whole storage period. Total soluble solid content (TSS) increased significantly during the storage period in all treatments, though with a different rate pattern (Fig. 2). As fruit firmness decreased linearly in CTR fruit so TSS increased in a similar way. EC+1MCP treated fruit showed significant lower TSSC values than CTR fruit, from 7 to 28 days after storage; a significant increase in TSS values occurred in EC+1MCP fruit only during the last two weeks of storage (Fig. 2). TSS values in EC treated fruit were always intermediate between CTR and 1-MCP+EC treated fruit, with a sudden increase just after storage and a marginal increase from 7 to 21 d after storage, followed by a further increase at the end of the storage period. In other word, while the decrease in fruit firmness in CTR fruit was paralleled by the increase of TSSC, this was not the case of EC and 1-MCP+EC fruit in which the increase of TSSC content, from 0 to 28 days of storage was lower than for CTR fruit and occurred without any reduction of flesh firmness. The ripening process is, normally characterized by an increase in sugars and a reduction in organic acids (TTA). Indeed, all treated and untreated fruit showed a sharp reduction of TTA, during the first two weeks of storage, when 1-MCP+EC fruit showed the highest values and CTR fruit the lowest ones. EC treated fruit and CTR ones showed a significant increase of TTA during the last two weeks of storage, while 1-MCP+EC fruit showed a significant increase only at the end of the storage period. At this stage, no differences occurred among treatments and TTA values were close to those measured at the beginning of the storage period (stage 0). (Fig. 3). Overall, treated fruit retained a higher firmness than treated ones, with a slower increase in TSSC and slower decrease in TTA, indicating a different ripening rate pattern (Fig. 3).

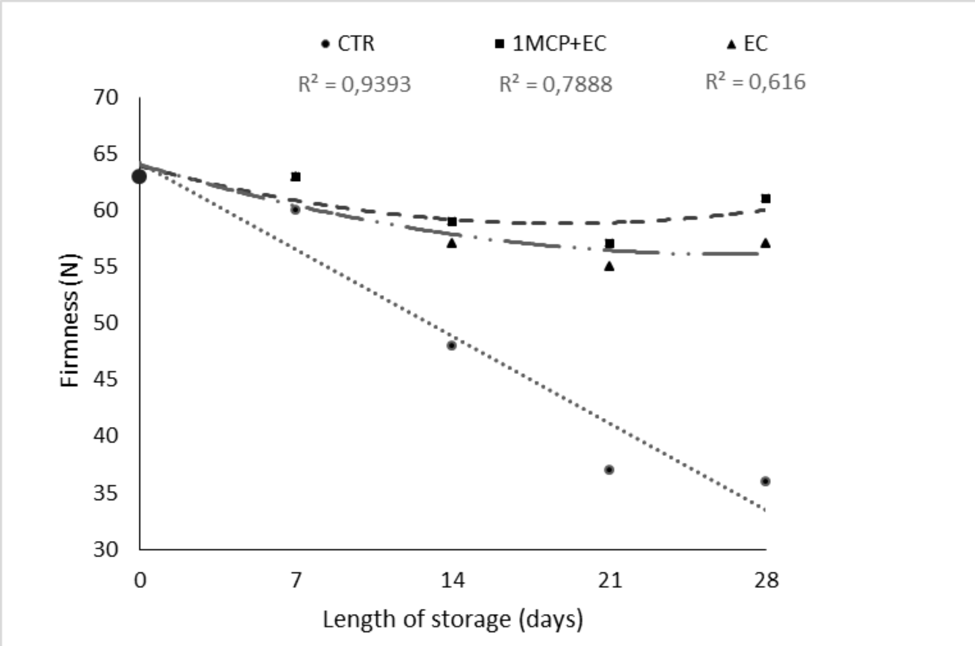

Figure 1. Evolution of fruit firmness (N) in white flesh melting peaches (*P. persica*) cv *Settembrina* treated with the edible coating (EC) and 1MCP+EC, untreated (CTR) stored at 1 °C for 7, 14, 21 28 days. (n=15 for each stage and treatment).

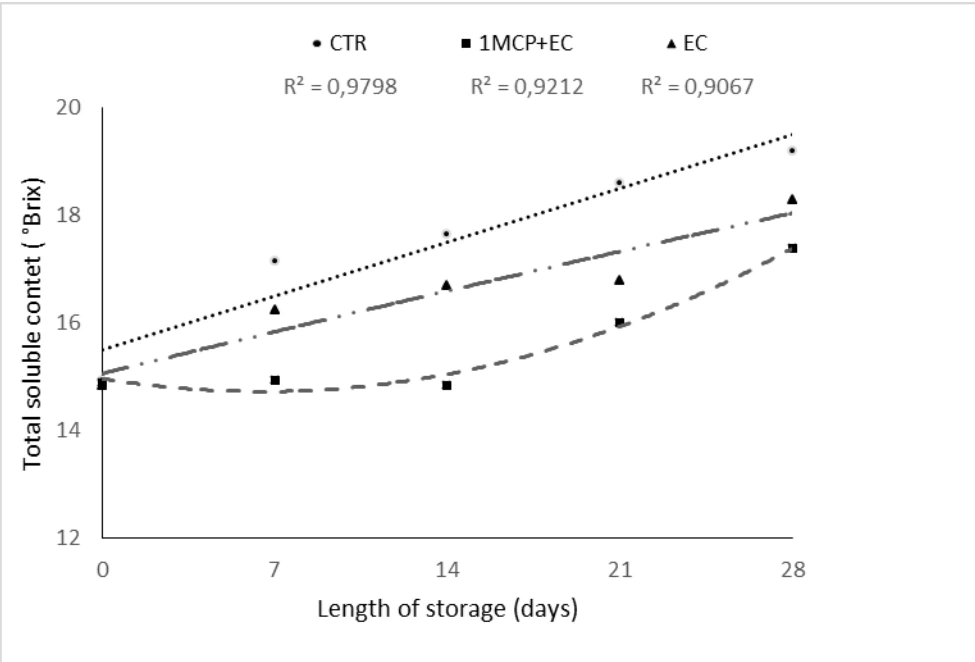

Figure 2. Evolution of fruit total soluble solids (°Brix) in white flesh melting peaches (P. persica) cv Settembrina treated with the edible coating (EC) and 1MCP+EC, untreated (CTR) stored at 1 °C for 7, 14, 21 28 days. (n=15 for each stage and treatment).

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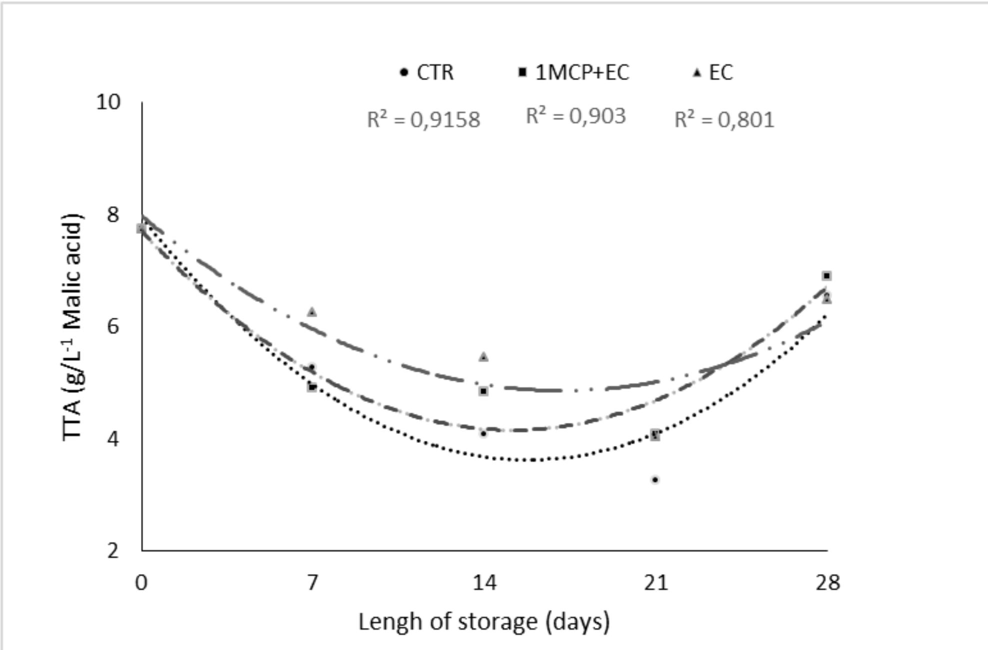

Figure 3. Evolution of fruit titratable acidity (g L^{-1}) in white flesh melting peaches (P. persica) cv Settembrina treated with the edible coating (EC) and 1MCP+EC, untreated (CTR) stored at 1 °C for 7, 14, 21 28 days. (n=15 for each stage and treatment).

The loss of fresh weight originated from transpiration was, on average much lower after simulated shelf life (2.1±0.3 %) than after cold storage (3.9 ±1.4%) and increased with storage period with no significant effect of treatments. CTR fruits had the highest weight loss both after storage and after shelf life, regardless the storage period, while at the end of the whole storage + shelf life period, EC treated fruit showed a significant higher weight loss than 1MCP+EC fruit after all the storage periods, indicating an effect od 1-MCP in reducing weight loss (Table 1).

Table 1. Evolution of firmness (N), total soluble solid content (TSS) and total tritatable acidity (TTA), in white flesh melting peaches, cv *Settembrina*, measured immediately after harvest and after 7, 14, 21 and 28 days of storage at 1 ° C (SL0) followed by 6 days of simulated shelf life at 20°C (SL6).

Treatment	Cold storage (d) + 6 d at 20 °C		Firmness (N)	TSS (°Brix)	TA (g L^{-1})	Weight loss (%)
CTR	**7**	**SL$_6$**	50.2±0.5 **aA**	18.1±0.14 **cB**	4.3±0.4 **aB**	6.1±0.6**cA**
	14	**SL$_6$**	31.6±1.1 **cC**	18.6±0.14 **bB**	4.0±0.6 **aB**	8.4±0.7**bA**
	21	**SL$_6$**	19.1±0.8 **dD**	19.2±0.64 **aA**	3.0±0.3 **bC**	9.5±0.9**aA**
	28	**SL$_6$**	41.4±0.3 **bB**	19.5±0.5 **aA**	3.1±0.2 **bC**	10.6±1.1**aA**
1MCP + EC	**7**	**SL$_6$**	50.8±1 **aA**	14.6±0.21 **bD**	6.0±0.2 **aA**	2.1±0.5**dC**
	14	**SL$_6$**	50.3±1 **aA**	15.0±0.7 **bD**	5.5±0.1 **bB**	3.3±0.2**cC**
	21	**SL$_6$**	20.3±0.3 **cD**	16.8±0.4 **aC**	3.5±0.9 **cC**	4.1±0.3**bC**
	28	**SL$_6$**	40.3±0.5 **bB**	17.0±0.2 **aC**	3.3±0.1 **cC**	6.1±0.9**aC**
EC	**7**	**SL$_6$**	50.7±0.9	16.9±0.1 **cC**	5.0±0.4 **aB**	3.3±0.4**cB**

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		aA			
14	**SL_6**	50.4±2.3 **aA**	16.0 ±0.4 **bD**	4.5±0.4 **aB**	4.7±0.6**bB**
21	**SL_6**	20.1±1.1 **cD**	18.7±0.3 **aA**	3.0±0.3 **bC**	5.0±0.7**bB**
28	**SL_6**	40.8±2.2 **bB**	19.3±0.7 **aA**	3.1±0.4 **bC**	7.8±1.23**aB**

Lowercase letters indicate significant differences within each treatment at different cold storage times; capital letters indicate significant differences between treatment (CTR, 1-MCP+EC and EC) for each sampling date, according to Tukey's test ($P \leq 0.05$).

Neither Chroma nor Hueangle values were significantly affected by the time of storage (Table 2). EC treated fruit showed a significant lower Chroma value than CTR ones, but after the first week of storage (Table 2). This disagree with previous finding **[29]**. Finally, skin color change unevenly, as shown by the ΔE values and by the visual analysis (Fig. 4).

Table 2. Color change (chroma, Hueangle and Δ E %) of 'peach' fruit, cv. 'Settembrina' coated with edible coating made of *Aloe arborescens* pure mucilage (EC), 1MCP+coating, treated (CTR) and stored for 7, 14, 21 and 28 days at 1 °C. Data are means (n= 15) ± SE. Different letters indicate significant differences at $p \leq 0.05$.

Treatments	storage period days	shelf life	Chroma		Hueangle		Δ E (%)
CTR	0	At harvest	34.45±2.67		1.05±0.09		
	7	SL_0	31.90±5.96	ns	0.08±1.30	ns	7.73
		SL_6	33.41±4.93	ns	1.14±0.44	ns	5.83
	14	SL_0	35.99±3.29	a	0.50±1.06	ns	2.20
		SL_6	33.41±4.93	a	1.14±0.44	ns	5.83
	21	SL_0	34.98±2.82	a	0.60±1.08	ns	4.24
		SL_6	35.68±3.27	a	0.71±1.12	ns	7.07
	28	SL_0	35.88±5.26	a	1.12±0.38	ns	3.53
		SL_6	34.70±3.27	a	1.11±0.37	ns	8.36
1MCP+EC	0	At harvest	**34.45±2.67**		**1.05±0.09**		
	7	SL_0	31.52±1.12	ns	1.17±0.34	ns	7.55
		SL_6	27.39±4.87	ns	1.17±0.40	ns	10.16
	14	SL_0	32.03±2.06	ab	0.61±1.07	ns	5.40
		SL_6	27.39±4.87	ab	1.17±0.40	ns	10.16
	21	SL_0	28.68±8.17	ab	0.22±1.35	ns	12.09
		SL_6	30.18±3.99	ab	1.41±0.22	ns	15.57
	28	SL_0	36.00±3.11	ab	1.14±0.21	ns	5.30
		SL_6	30.18±3.99	ab	1.41±0.22	ns	12.08
EC	0	At harvest	**34.45±2.67**		**1.05±0.09**		
	7	SL_0	29.06±2.82	ns	0.26±1.38	ns	13.95
		SL_6	26.64±4.27	ns	1.16±0.37	ns	11.14
	14	SL_0	26.84±6.63	b	1.04±0.42	ns	9.57
		SL_6	26.64±4.27	b	1.16±0.37	ns	11.10
	21	SL_0	27.28±7.38	b	0.67±1.10	ns	10.91
		SL_6	28.03±5.46	b	1.27±0.25	ns	11.42
	28	SL_0	25.57±4.64	b	1.04±0.22	ns	9.48
		SL_6	28.56±3.89	b	1.17±0.33	ns	8.36

Letters indicate significant differences within each treatment (CTR, 1-MCP+EC and EC) for each sampling date, according to Tukey's test ($P \leq 0.05$).

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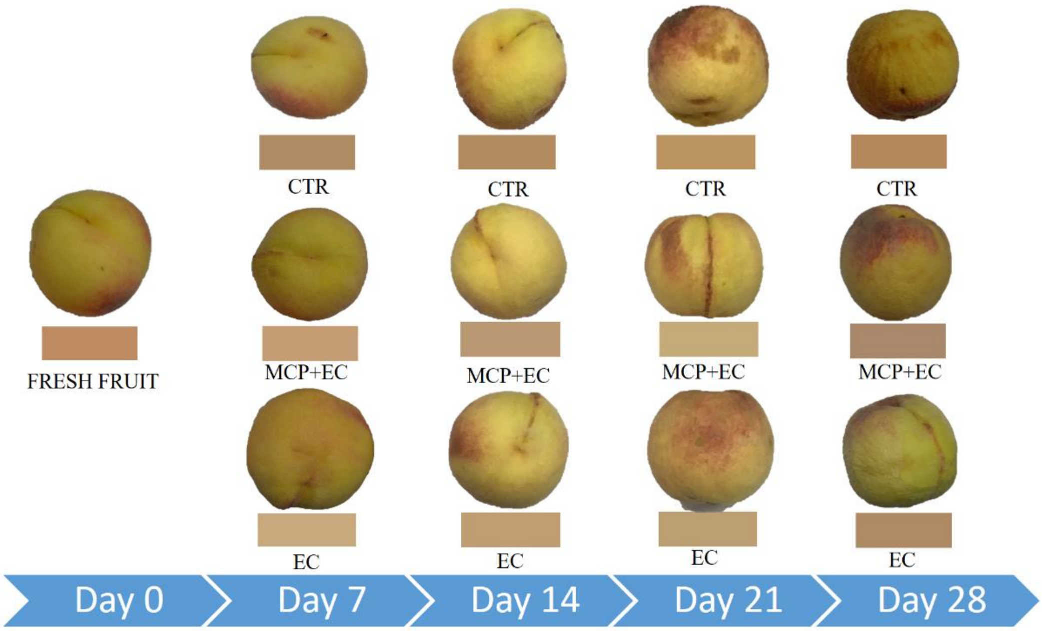

Figure 4. Conversion of the chromatic parameters L * a * b * in RGB using "e-paint.co.uk Convert Lab" software and subsequent comparison with photos of the examined fruits.

3.2. The sensory profile

The sensory profile of the *Settembrina* peaches changed with time of storage and treatment. Indeed, the effect of 1MCP+ EC and EC treatment clearly appeared, for most of descriptors (external color uniformity (ECU), compactness (COM), pulp color intensity (PCI), peach smell (PS)) and the comprehensive evaluation (CE), 14 d after storage. At this stage those descriptors measured in 1-MCP+EC and EC fruit kept the same values of the fresh fruit, will in CTR ones they were significantly lower. The relatively low values of herbaceous smell (HS and herbaceous flavor (HF indicate that the fruit were harvested at a proper stage of ripeness. No significant differences between treatments occurred 7 d, 14 d and 28 d after storage. Indeed, 7 d after storage fruit of all treatments retained the same sensory values measured at T_0, while 28 d after storage, the sensory profile was very much reduced regardless the treatment, since all fruit were almost overripe (Fig. 5). Values of all descriptors were significantly reduced 21 and 28 d after storage, with a single score never higher than 5.

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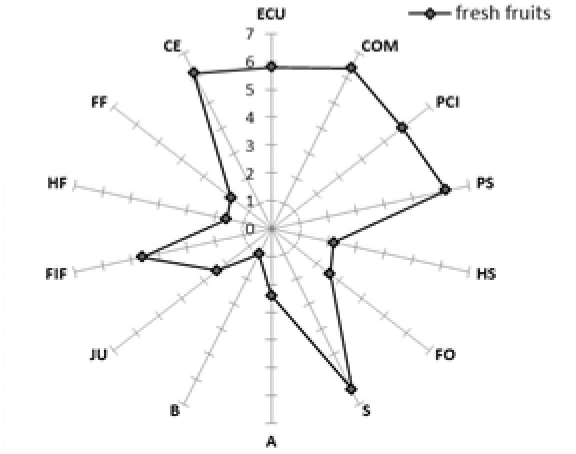
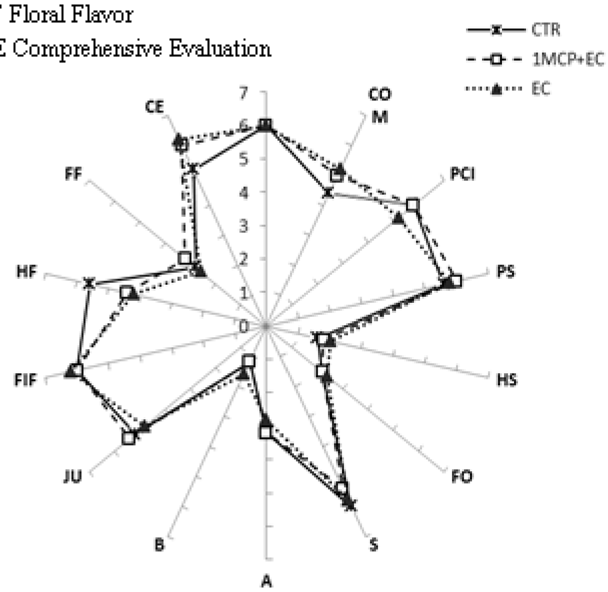
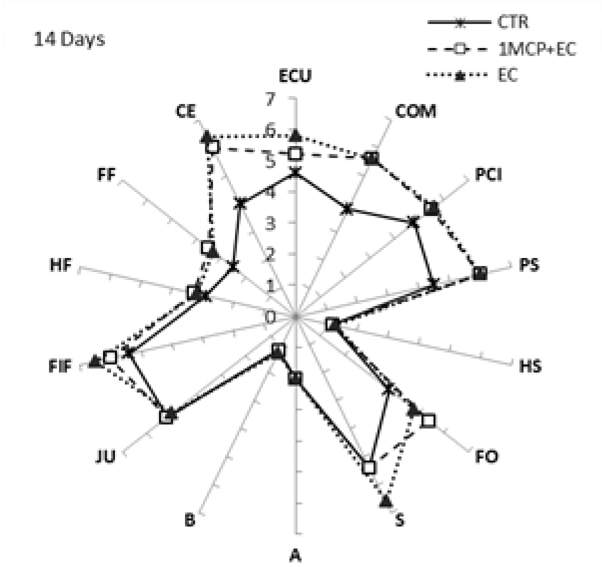
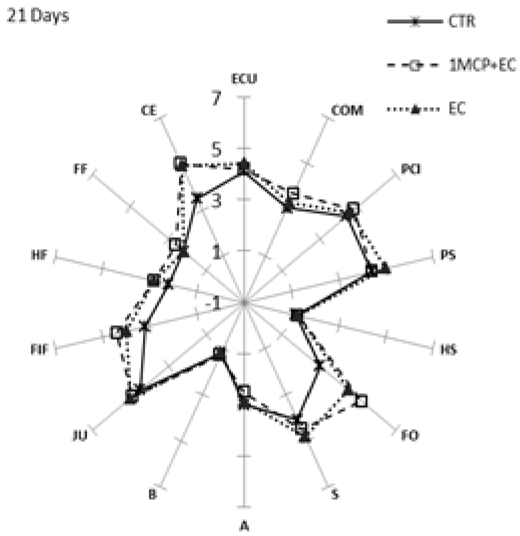


ECU External color uniformity
COM compactness
PCI Pulp color intensity
PS Peach smell
HS Herbaceous smell
FO Floral odor
S Sweet
A Acid
B Bitter
JU Juicy
FIF Peach Flavor
HF Herbaceous Flavor
FF Floral Flavor
CE Comprehensive Evaluation







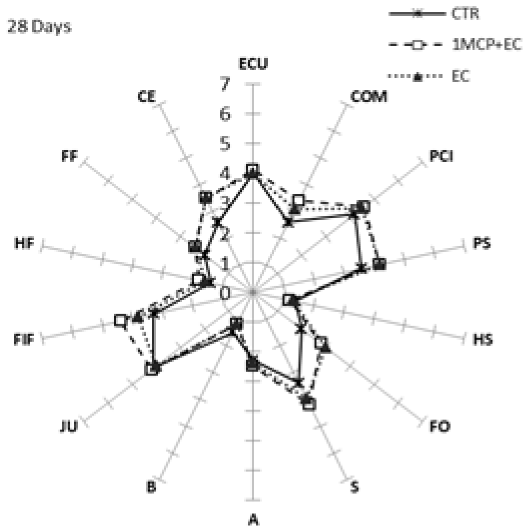


Figure 5. Evolution of Scores for the sensory analysis in white flesh melting peaches (*P. persica*) cv *Settembrina* treated with the edible coating (EC) and 1MCP+EC, untreated (CTR) stored at 1 °C for 7, 14, 21 28 days. (n=15 for each stage and treatment).

3.3. Shelf life

The effect of simulated shelf life changed with the length of the storage period and with treatments. Fruit firmness significantly decreased in all treatments regardless the length of the storage period. However, CTR fruit showed a continuous decrease related to the length of the previous storage period (7 to 21 of storage), while 1MCP+EC and EC showed a significant decrease only 21 d after storage, followed by 6 d of simulated shelf life. (Table 1). Fruit firmness apparently increased in all fruit stored 28 d and after 6 d of simulated shelf life. This could be attributed to the leatheriness following prolonged periods of refrigeration **[2, 30]**, due to a reduction in polygalacturonase (PG) resulting in a high level of pectins that are not hydrolysed.

At this stage CTR, EC and 1-MCP+EC fruit showed the lowest TTA values, while 1MCP+EC fruit still retained a higher TSS content than CTR and EC ones. On the whole, CTR fruit were almost overripe after 14 d of storage followed by 6 d of simulated shelf life, in terms of lack of firmness, low TTA and very high TSS content. Eventually, 1MCP+EC and EC fruit retained marketable firmness, TSS and TTA values until 14 d of storage followed by 6 d of simulated shelf life, even though, at this stage, EC fruit showed lower TTA and higher TTS values than 1MCP+EC fruit.

4. Conclusion

Both the application of the Aloe-based coating and of the combined Aloe coating with 1-MCP, resulted in a significant slowdown of the ripening processes of *Settembrina* white and melting flesh peaches. Indeed, fruit treated with with EC and MCP+EC kept, after 28 days of cold storage, values of flesh firmness higher than 60 N, which is an excellent result for commercial purposes, particularly if it occurs together with optimal values of total soluble solids and titratable acidity content. However, treated fruit kept their quality when stored no longer than 14 d associated with 6 d of simulated shelf life (6 d). At this stage treated and untreated fruit differ also in term of sensory descriptors. Fruit treated with 1-MCP+EC had the lowest weight loss and TSS content and these are the only significant differences between EC and 1-MCP+EC treated fruit. Indeed, coatings make a layer on the surface of the fruit and operate as a protective barrier that decrease respiration and transpiration through the fruit surface **[31]**. This effect has also been characterized in fig **[11]**, sweet cherries **[32]**, pomegranate **[31]**, litchi **[33, 34]**. and papaya **[35]**, kiwi **[36]**. Eventually, the present study indicates that combined treatment with Aloe coating and 1-MCP significantly delays ripening of melting-flesh. This opens perspectives of potential diffusion and future research activity.

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