EFFECTS OF MODIFIED ATMOSPHERE PACKAGING ON RIPENING OF ‘DOURADÃO’ PEACH RELATED TO PECTOLYTIC ENZYMES ACTIVITIES AND CHILLING INJURY SYMPTOMS

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ABSTRACT - The present study evaluated the effects of modified atmosphere packaging on inhibition of the development of chilling injury symptoms in ‘Douradão’ peach after cold storage and the possible involvement of cell wall enzymes. Fruits were harvested at the middle stadium of ripening, packed in polypropylene trays and placed inside low density polyethylene (LDPE) bags (30, 50, 60 and 75 µm of thickness) with active modified atmosphere (10 kPa CO₂ + 1.5 kPa O₂, balance N₂). The following treatments were tested: Control: peaches held in nonwrapped trays; MA30: LDPE film - 30 µm; MA50: LDPE film - 50 µm; MA60: LDPE film - 60 µm and MA75: LDPE film - 75 µm. Fruits were kept at 1±1°C and 90±5% relative humidity (RH) for 28 days. After 14, 21 and 28 days, samples were withdrawn from MAP and kept in air at 25±1°C and 90±5% RH for ripening. On the day of removal and after 4 days, peaches were evaluated for woolliness incidence, pectolytic enzymes activities. The respiratory rate and ethylene synthesis were monitored during 6 days of ripening. The results showed that MA50 and MA60 treatments had positive effect on the inhibition of the development of woolly texture and reduced pectin methylesterase activity on the ripe fruits, keeping good quality of ‘Douradão’ peach during 28 days of cold storage. The treatments Control, MA30 and MA75 showed higher woolliness incidence and did not present marketable conditions after 14 days of cold storage.

Index terms: Prunus persica, LDPE, woolliness, ethylene synthesis.
INTRODUCTION

Peaches ‘Douradão’ stored at low temperatures for prolonged periods can show a form of chilling injury called woolliness (mealiness), characterized by a lack of juiciness and a mealy texture (SANTANA et al., 2010). It is not possible to detect mealiness from the exterior of the fruit, since woolly fruit weigh is the same and they have a similar firmness to the fingers. However, when biting the fruit the lack of juice results in an absence of flavour and a dryness which make it inedible, and leads to consumer dissatisfaction. The woolliness in peach is caused by storage of fruit in the 2–8°C range for a period of at least 2 weeks (BEN-ARIE; LAVEE, 1971), and is of commercial importance due to the need to ship and store fruit prior to sale.

Numerous studies of the biochemical basis for woolliness have identified factors which may be important in the development of the symptoms, although considerable discrepancy exists between studies. Compared with juicy fruit, woolliness has been found to be associated with a reduction in pectin methylesterase (PME) activity (BUESCHER; FURMANSKI, 1978), or with an increase (BEN-ARIE; SONEGO, 1980), or with unchanged levels (OBENLAND; CARROLL, 2000; ZHOU et al., 2000b). Similarly, exo-polygalacturonase (exo-PG) activity was reduced in mealy fruit in some studies (ZHOU et al., 2000b), or showed no correlation with mealiness in others (ARTÈS et al., 1996). A reduction in endo-PG activity during cold storage has commonly been observed (BUESCHER; FURMANSKI, 1978; BEN-ARIE; SONEGO, 1980; ARTÈS et al., 1996; ZHOU et al., 2000b), although mealiness develops not in cold storage but during the subsequent ripening period at warm temperatures (BUESCHER; FURMANSKI, 1978). If the cold period exceeds a certain critical length (of approximately 2 weeks), or the ripening period is short, no increase in endo-PG activity occurs during ripening and, instead of juiciness, the fruit develop woolliness (BEN-ARIE; SONEGO, 1980; VON MOLLENDORFF; DE VILLIERS, 1988b). During the ripening period fruit may develop mealiness properties with low extractable juice, but upon extended ripening become juicy (VON MOLLENDORFF; DE VILLIERS, 1988b; VON MOLLENDORFF et al., 1989, 1993). However, this apparent restoration of free juice may be due to tissue breakdown and senescence processes. It has been suggested that changes to pectin metabolism cause mealiness either by cell fluids forming calciumpectate gel complexes with high molecular weight pectin in the middle lamella (BEN-ARIE; LAVEE, 1971), or that the decreased intercellular adhesion in mealy fruit reduces cell rupture during biting and chewing, preventing the release of cellular contents (KING et al., 1989).

The development of woolliness symptoms is accompanied by reduced rates of respiration, very low ethylene evolution (VON MOLLENDORFF; DE VILLIERS, 1988A; ZHOU et al., 2001). These findings indicate that the normal metabolism associated with ripening is partially suspended. The synthesis of many cell-wall-modifying enzymes, including endo-PG and endo-1,4-β-glucanase, is regulated by ethylene, although the accumulation of others such as PME may be controlled by different factors (BRUMMELL; HARPSTER, 2001). Brummell et al. (2004b) studied the cell wall metabolism during the development of chilling injury in cold storage peach fruit, but this capacity is impaired in mealy fruit. After subsequent ripening, juicy fruit accumulated high levels of all enzymes examined, except for PME. The increase was greater after 1 week of storage for some enzymes, and after 2 weeks of storage for others. Since some enzymes increase during ripening and others increase then decrease (BRUMMELL et al., 2004a), the ‘normal’ activity of a particular enzyme is dependent on developmental stage. Juicy fruit thus retain the ability to synthesize or activate numerous enzymes both during cold storage and upon ripening, but this capacity is impaired in mealy fruit. Mealy fruit possessed low levels of all activities examined except exo-PG, but high levels of PME. The lack of correlation of exo-PG activity with maliness (ARTÈS et al., 1996) and the decline then rise in PME activity with increasing cold storage (BEN-ARIE; LAVEE, 1971) are consistent with previous studies. The advanced stage of mealiness was correlated with low levels of endo-PG and high levels of PME activity (BEN-ARIE; LAVEE, 1971; BUESCHER; FURMANSKI, 1978; BEN-ARIE; SONEGO, 1980; VON MOLLENDORFF; DE VILLIERS, 1988b; ARTÈS et al., 1996), but also with reduced activities of endo-1,4-β-glucanase, endo-1,4-β-mannanase, β-galactosidase and α-arabinosidase. These observations suggest that cold storage causes a reduction in ethylene-regulated enzymes, including endo-PG, which are required for normal ripening in some peach varieties.

Reports have related that the use of modified
atmosphere packaging (MAP) with elevated CO$_2$ and reduced O$_2$ concentrations delay or prevent the onset of these chilling symptoms and the storage life of peaches can be extended (LURIE; CRISOSTO, 2005; SANTANA et al. 2010). The aim of the present work was to study the responses of the 'Douradão' peach to low temperature storage and modified atmosphere packaging treatments in relation to cell wall modifying enzyme activities, the respiratory rate and ethylene synthesis. The effects of MAP in inhibition of the development of woolly texture in 'Douradão' peach and the possible involvement of cell wall enzymes were examined.

**MATERIALS AND METHODS**

Peaches (*Prunus persica* L.) ‘Douradão’ were harvested from a commercial orchard in Jarinu, São Paulo, located in the southeast of Brazil under a subtropical climate, pre-selected and transported about 80 km to the Postharvest Laboratory. Then, the fruits were selected according to size and skin background color (green-yellow) at commercial maturity and immediately pre-cooled to 5°C. Before pre-cooling, 72 peaches were randomly sampled and placed in 6 nonwrapped polypropylene (PP) trays (United Plastic Corporation S.A.), containing 12 peaches each, which were held in air at 25±1°C and 90±5% RH during 4 days for ripening. On the same day of harvest (3 trays, each tray constituted a replicate) and on the 4th day of ripening (3 trays), the peaches were evaluated for woolliness incidence, pectolytic enzymes activities: exo-polygalacturonase (exo-PG), endo-polygalacturonase (endo-PG) and pectin methyl-esterase (PME); the respiratory rate and ethylene synthesis were monitored during 6 days of ripening.

The experiment was carried out in an entirely randomized design where fruits to be cold stored were randomly distributed into five lots, one was held in non-wrapped PP trays (control) kept in air and the others were placed in similar PP trays, inserted in bags of low density polyethylene (LDPE) film (Al-taplast Ltda, Brazil), where gas mixture of 10 kPa CO$_2$ + 1.5 kPa O$_2$ (balance N$_2$) was injected and the packages were sealed, using a Selovac 200B machine (Selovac Ltda, Brazil). After sealing, the package area for gas exchange was equivalent to 0.21 m$^2$ kg$^{-1}$ of fruit. The following treatments were tested: Control: non-wrapped PP trays; **MA30**: LDPE film of 30 µm thickness, with CO$_2$ permeability rate at standard temperature and pressure (CO$_2$ PR) of 22.021 mL m$^{-2}$ d$^{-1}$ and O$_2$ permeability rate at standard temperature and pressure (O$_2$ PR) of 6.012 mL m$^{-2}$ d$^{-1}$, the water vapor permeability rate (WVPR) at 38 °C and 90% RH was 14.1 g water m$^{-2}$ d$^{-1}$; **MA50**: LDPE film of 50 µm thickness, with CO$_2$ PR of 11.562 mL m$^{-2}$ d$^{-1}$ and O$_2$ PR of 2.986 mL m$^{-2}$ d$^{-1}$, the WVPR was 6.6 g water m$^{-2}$ d$^{-1}$; **MA60**: LDPE film of 60 µm thickness, with CO$_2$ PR of 9.577 mL m$^{-2}$ d$^{-1}$ and O$_2$ PR of 2.872 mL m$^{-2}$ d$^{-1}$, the WVPR was 5.9 g water m$^{-2}$ d$^{-1}$; **MA75**: LDPE film of 75 µm thickness, with CO$_2$ PR of 7.425 mL m$^{-2}$ d$^{-1}$ and O$_2$ PR of 1.705 mL m$^{-2}$ d$^{-1}$ the WVPR was 4.1 g water m$^{-2}$ d$^{-1}$. All treatments were stored during 28 days at 1 ± 1 °C and 90±5% RH. After 14, 21 and 28 days, fruits were taken from cold storage, the LDPE films removed and subsequently the trays were held in air at 25±1°C and 90±5% RH during 4 days for ripening. On the same day of removal and on the 4th day of ripening, peaches were evaluated as mentioned to the fruits at harvest. Three replicates per treatment were obtained to each assayed period (each tray with 12 peaches constituted a replicate).

At the same time of the ripening process, after harvest and after each cold storage period (14, 21 and 28 days), measurements of CO$_2$ and C$_2$H$_4$ were carried out at 25±1°C and 90±5% RH for 6 days. Three replicates of five fruits from each treatment were held in 2.5 L gastight jars, using a continuous humidified air flow of 2-3 L h$^{-1}$ that passed through the jars (KADER, 2002; WATADA et al., 1996). The respiratory rate and ethylene emission were measured every day by taking 1 mL gas samples from the headspace and injecting in a gas chromatograph (Varian CG 3400, Varian Instruments, Walnut Creek, CA., USA). For CO$_2$ determinations, the CG was equipped with a thermal conductivity detector (200°C) and with a Molecular Sieve column (2.0 m length and 3.2 mm diameter, Norwalk, USA). Column and injector temperatures were 60°C and 70°C, respectively. For ethylene, the CG was fitted with a flame ionization detector (270°C) and with a Porapak N column (4.0 m length and 3.2 mm diameter, Norwalk, USA), operating at 60°C. Helium was used as carrier gas at 80 psi and a flow rate of 30 mL min$^{-1}$. Flame was obtained mixing hydrogen at 40 psi and synthetic air at 60 psi, with flow rate of 70 and 300 mL min$^{-1}$, respectively. Calibration of carbon dioxide, oxygen and ethylene was done with known standards (Air Liquide S.A., São Paulo, Brazil).

On each day of evaluation, ten fruits were randomly removed from three trays to determination of woolliness incidence (WI). The fruits were cut into two halves and the WI was determined visually in both sides (adapted from FERNÁNDEZ-TRUEJILLO et al., 1998) and rated as very slight (1% < area ≤ 10%), slight (10% < area ≤ 25%), moderate (25% <
area ≤ 50%) or severe (area > 50%). Healthy fruits were those showing no signs of internal breakdown. The WI was calculated as follow: WI = (number of healthy fruit x 0) + (number of fruits with very slight decay x 1) + (number of fruits with slight decay x 2) + (number of fruits with moderate decay x 3) + (number of fruits with severe decay x 4), divided by 4 x N (N= total number of fruits).

For the pectolytic enzymes activities assays, the peach flesh was macerated in a blender. The enzymes were extracted by homogenizing 100g of peach flesh in 100mL of cold aqueous solution containing polyethylene glycol 12% (PEG 4000, Merck, Darmstadt, Germany) and 0.2% sodium bisulfite, during 2 min. The homogenates were centrifuged (Beckman Centrifuge, Model J2-21, Beckman Instruments Inc., Palo Alto, CA., USA) at 10,000 x g for 15 min, the pellet was collected and separated into two parts for extraction of enzymes. For polygalacturonase (PG, EC 3.2.1.15) extraction, the pellet was incubated on a shaker (Marconi, Dubnoff mod. 145, Brazil) at 4 ºC during 2 h in 80 mL of cold 50 mM Na acetate buffer (Merck, Brazil) pH 5.0 and 0.5 M NaCl; after centrifugation as above, the supernatant was used as crude extract. For determination of the exo-PG activity, 1 mL extract was mixed with an equal volume of 2% polygalacturonic acid in 50 mM Na acetate buffer pH 4.4 and incubated at 30°C for 18 h. Reducing sugars released were determined with the Somogyi method (NELSON, 1944). Galacturonic acid was used as standard, and controls of boiled extract were run. One activity unit was defined as 1 µg galacturonic acid released per g of fresh sample per h. The determination of the endo-PG activity was measured in a Cannon-Fenske viscosimeter (Model N.100, USA) by mixing 3 mL enzyme extract with 4.5 mL 2% polygalacturonic acid (Sigma Chemical Company, G-2125, USA) in 50 mM Na acetate pH 4.4. Initial viscosity was measured and after a further 18 h incubation at 30°C (ZHO et al., 2000a). One activity unit was defined as the change in viscosity (s) per g of fresh sample per h.

During ripening after harvest, it was observed an increase in the ethylene synthesis and respiration rate of the peaches (Figure 1). Accentuated ethylene production from the 3rd to 5th day was concomitant with fruit ripening that showed typical behavior of climacteric fruit, and in this phase were initiated changes in color, aroma, texture, flavor and others biochemical and physiological attributes (SANTANA et al., 2010). After cold storage, changes in respiration rates and ethylene synthesis of peaches are showed in Figure 2 for all treatments during ripening at 25±1°C. It was observed that the ethylene production and the respiration rate increased with the ripening. The Control and MA30 treatments showed a tendency of higher respiration rates while lower respiration rates were observed in fruits from MA50, MA60 and MA75 treatments. The respiration rate was around 95 mg CO₂ kg⁻¹ h⁻¹ at the beginning of the ripening process and increased to 120-130 mg CO₂ kg⁻¹ h⁻¹ during ripening, for the Control and MA30 treatments, while the others treatments reached respiration rates around to 100-110 mg CO₂ kg⁻¹ h⁻¹ during ripening process. Similar tendencies were obtained with nectarines ‘Fantasia’ and ‘Fairlane’ and peaches ‘Flavorcrest’ and ‘Red Top’, where higher respiration rates during shelf-life were verified in the control treatment and lower respiration rates were obtained in polyethylene packages treatments (ZOFO et al., 1998; AK-BUDAK; ERIS, 2004). Large increases in ethylene production were observed in Control and MA30 treatments. The ethylene emission was around 20 µL C₂H₄ kg⁻¹ h⁻¹ at the beginning of the ripening process and increased to 50-70 µL C₂H₄ kg⁻¹ h⁻¹ until the 4th ripening day, for the Control and MA30 treatments. This positive feed-back loop was interrupted and at 5th and 6th days began the senescence phase. The lowest ethylene production was observed in fruit from MA75 treatment, which produced about 7-10 µL C₂H₄ kg⁻¹ h⁻¹ at the beginning of the ripening and reaching only 20-25 µL C₂H₄ kg⁻¹ h⁻¹ on the 4th ripening day; physiological
alterations (fermented fruit) and senescence were verified in this treatment. Fruits from MA50 and MA60 produced around 12-15 µL C<sub>2</sub>H<sub>4</sub>·h<sup>-1</sup> at the beginning of the ripening and an increased to 40-45 µL C<sub>2</sub>H<sub>4</sub>·h<sup>-1</sup> until the 6<sup>th</sup> ripening day was observed, remaining stable and keeping good quality of the fruits. Some reports (FERNANDEZ-TRUJILLO et al., 1999; GIRARDI et al., 2005) associated the higher incidence of woolliness with a sharp decrease in ethylene production rather than with a high respiratory rate during post-storage ripening. In this study, such behavior might be associated with the reduced occurrence of woolliness in MA50 and MA60 treatments and higher incidence of mealy texture in Control and MA30 treatments.

Figure 3 shows that woolliness incidence of ‘Douradão’ peach was affected by the MAP treatments. The Control, MA30 and MA75 treatments presented higher woolliness incidence after cold storage and post-storage ripening, independently of the period. Several studies about woolliness in peaches and nectarines reported that this condition became apparent by the time the fruits were removed from cold storage and kept at 20-25°C (CRISOSTO et al., 1999; ZHOU et al., 2000b; ROMBALDI et al., 2001). The use of MAP reduced the occurrence of woolliness, fruits from MA50 and MA60 treatments were little affected, reaching lower woolliness incidence after 28 days of cold storage.

In the fruit evaluated immediately after harvest, it was observed a gradual increase in the endo-PG and exo-PG activities during ripening, while the PME activity showed accentuated decrease during ripening (Figures 4, 5 and 6). In cold storage fruits were not found significant difference in the exo-PG activity among the treatments, independently of the storage period. With post-storage ripening was observed increase in exo-PG activity for all treatments, and were not found significant difference among the treatments, although these values had been always lower than the fruit evaluated after harvest (Figure 4). The association of exo-PG activity in the development of woolliness symptoms has showed many discrepancies. By some authors (ZHOU et al., 2000b; GIRARDI et al., 2005) the exo-PG activity was mentioned like reduced activity in woolly fruit, by others authors (VON MOLLENDORFF; DE VILLIERS, 1988b) peaches that developed woolliness during ripening showed increase on exo-PG activity and others studies related that there was no relation with woolliness symptoms (ARTÉS et al., 1996; BRUMMELL et al., 2004b). The endo-PG activity during 28 days of cold storage showed no significant difference among treatments (Figure 5). After additional 4 days ripening, was detected increase in endo-PG activity for all treatments, Control and the fruits from MA30 and MA75 treatments showed slight increase and no difference among each other was verified. The most significant increase was observed in fruits from MA50 and MA60 treatments, and these values were similar to that fruits evaluated after harvest. In these fruits the increase in ethylene production after 4<sup>th</sup> day of ripening was followed by a concomitant increase in endo-PG activity, while the decline in ethylene production in Control was followed by a little increase in endo-PG activity. The PME activity from Control, MA30 and MA75 treatments were higher than the PME activity from MA50 and MA60 treatments, after cold storage and ripening post-storage. The PME activity of MA50 and MA60 treatments did not differ from fruits evaluated after harvest (Figure 6). It was observed that woolliness in ‘Douradão’ peaches is related to the low endo-PG and high PME activities. Previous reports (BENARIE; SONEGO, 1980; VON MOLLENDORFF; DE VILLIERS, 1988b; ZHOU et al., 2000b; Girardi et al., 2005) associated the incidence of woolliness in peaches with an imbalance between the PG and PME activities.

In this study, the rate between PG and PME activities (exo-PG/PME and endo-PG/PME) were calculated to found values that could explain the imbalance between the PG and PME in the woolly fruits. Fruits from MA50 and MA60 treatments showed higher rate between exo-PG/PME and endo-PG/PME after ripening at 25°C, while Control, MA30 and MA75 treatments showed lower rate between exo-PG/PME and endo-PG/PME (Table 1). Higher rate PG/PME implied lower woolliness incidence in the fruits. When occur woolliness incidence, the polygalacturonic acid (main component of pectin) shows reduced methylation (due to higher PME activity), without subsequently degradation of pectin (due to lower PG activity), resulting large pectin molecules with reduced methylation that gelling and can cause more free water to be bound into gel, leading to less juice content and causing woolly texture (LURIE; CRISOSTO, 2005). Similar results were reported by ZHOU et al. (2000b), in their studies with ‘Flavortop’ nectarines cold stored under controlled atmosphere (10% CO<sub>2</sub> and 3% O<sub>2</sub>) during 4 and 6 weeks. The authors also found lower rate between endo and exo-PG/PME to the Control fruit after 5 days at 20°C, and higher rate between endo and exo-PG/PME to the fruits from CA storage. About the imbalance, they mentioned that there was no difference in the RNAm expression of the PG and PME enzymes, among Control fruit and those cold stored fruit under AC. The authors concluded that CA repress enzymes activities (mainly PG), but maintain the ability for recuperation of this repression, when the fruit are exposed on warmer temperatures.
FIGURE 1 – Respiration rate and ethylene synthesis of ‘Douradão’ peaches during ripening at 25±1°C for 6 days, immediately after harvest. Standard deviation represented by the vertical bar (n=3).

TABLE 1 – Rate between exo-PG and PME (exo-PG/PME) activities and endo-PG and PME (endo-PG/PME) activities of ‘Douradão’ peaches cold storage (CS) at 1±1°C under MAP after 14, 21 and 28 days, plus 4 days ripening in air at 25±1°C.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Cold Storage Period (1°C)</th>
<th>14 days After CS + 4 days ripening</th>
<th>21 days After CS + 4 days ripening</th>
<th>28 days After CS + 4 days ripening</th>
</tr>
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<tbody>
<tr>
<td>Control</td>
<td>Exo-PG/PMEx &lt;sup&gt;1&lt;/sup&gt;</td>
<td>488.63</td>
<td>589.18</td>
<td>349.47</td>
</tr>
<tr>
<td>MA30</td>
<td>Exo-PG/PMEx &lt;sup&gt;1&lt;/sup&gt;</td>
<td>505.64</td>
<td>651.92</td>
<td>349.82</td>
</tr>
<tr>
<td>MA50</td>
<td>Exo-PG/PMEx &lt;sup&gt;1&lt;/sup&gt;</td>
<td>479.11</td>
<td>1130.13</td>
<td>472.74</td>
</tr>
<tr>
<td>MA60</td>
<td>Exo-PG/PMEx &lt;sup&gt;1&lt;/sup&gt;</td>
<td>430.51</td>
<td>1026.11</td>
<td>429.17</td>
</tr>
<tr>
<td>MA75</td>
<td>Exo-PG/PMEx &lt;sup&gt;1&lt;/sup&gt;</td>
<td>403.79</td>
<td>580.24</td>
<td>380.21</td>
</tr>
<tr>
<td></td>
<td>Endo-PG/PMEx &lt;sup&gt;1&lt;/sup&gt;</td>
<td>1.78</td>
<td>2.21</td>
<td>1.09</td>
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<tr>
<td></td>
<td>Endo-PG/PMEx &lt;sup&gt;2&lt;/sup&gt;</td>
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<td>Endo-PG/PMEx &lt;sup&gt;2&lt;/sup&gt;</td>
<td>1.83</td>
<td>5.94</td>
<td>1.92</td>
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<tr>
<td></td>
<td>Endo-PG/PMEx &lt;sup&gt;2&lt;/sup&gt;</td>
<td>1.81</td>
<td>5.82</td>
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<tr>
<td></td>
<td>Endo-PG/PMEx &lt;sup&gt;2&lt;/sup&gt;</td>
<td>1.48</td>
<td>2.85</td>
<td>1.39</td>
</tr>
</tbody>
</table>

<sup>1</sup> One unit of Exo-PG was defined as 1 μg galacturonic acid g<sup>-1</sup> sample h<sup>-1</sup>.
<sup>2</sup> One unit of Endo-PG was defined as change in viscosity (s) g<sup>-1</sup> sample h<sup>-1</sup>.
<sup>3</sup> One unit of PME was defined as 1 μM NaOH g<sup>-1</sup> sample h<sup>-1</sup>.
FIGURE 2 – Respiratory rate (A, C, E) and ethylene synthesis (B, D, F) of ‘Douradão’ peaches after 14, 21 and 28 days of cold storage under modified atmosphere (MAP) and ripening at 25±1°C for 6 days. Standard deviation represented by the vertical bar (n=3).
FIGURE 3 – Wooliness incidence of ‘Douradão’ peaches cold storage at 1±1°C under MAP after 14, 21 and 28 days, plus 4 days ripening in air at 25±1°C.

FIGURE 4 – Exo-Polygalacturonase activity of ‘Douradão’ peaches cold storage at 1±1°C under MAP after 14, 21 and 28 days, plus 4 days ripening in air at 25±1°C.

FIGURE 5 – Endo-Polygalacturonase activity of ‘Douradão’ peaches cold storage at 1±1°C under MAP after 14, 21 and 28 days, plus 4 days ripening in air at 25±1°C.
FIGURE 6—Pectin methylesterase activity of ‘Douradão’ peaches cold storage at 1±1°C under MAP after 14, 21 and 28 days, plus 4 days ripening in air at 25±1°C.

CONCLUSIONS

1-Higher respiratory rate and ethylene production were verified in Control treatment and lower respiratory rate and ethylene production were obtained in MAP treatments.

2-Higher rate PG/PME implied lower woolliness incidence in the ripe fruits.

3-The MA50 and MA60 treatments had positive effect on the inhibition of the development of woolly texture, on the reduction the pectin methylesterase activity on the ripe fruits, keeping good quality of ‘Douradão’ peach during 28 days of cold storage.

4-The treatments Control, MA30 and MA75 showed higher woolliness incidence and did not present marketable conditions after 14 days of cold storage.

REFERENCES


