PRESERVATION OF MINIMALLY PROCESSED 'AURORA-1' PEACHES USING ADDITIVES[1]

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ABSTRACT - 'Aurora-1' peaches establishes an interesting alternative as a minimally processed product, due to its characteristics like flavor, color, smell, and also because of its handling resistance. However, it has a short shelf life after a fresh-cut due to enzymatic browning and stone cavity collapse. The main purpose of this research was to test the additive with antioxidant effect to prevent browning in minimally processed 'Aurora-1' peaches. The minimal processing consists of washing, sanitizing, peelings and fruit stone extraction. After that, longitudinal cuts were made to obtain eight segments per fruit. The slices were immersed into the following treatment solutions: control (immersion in 2% ascorbic acid); 2% ascorbic acid + 2% calcium chloride; 1% sodium isoascorbate; 1% citric acid; 1% L-cysteine hydrochloride. The products were placed into rigid polystyrene trays branded MEIWA M-54, covered with 14 µm PVC film (Omnifilm™) and kept in cold storage at 3ºC ± 2ºC and 65% RH for twelve days, and evaluated each three days. Appraised variables were appearance, soluble solids, titratable acidity, soluble carbohydrates and reducing sugars, total and soluble pectin, ascorbic acid, and peroxidase and polyphenol oxidase enzyme activity. L-cysteine gave to the minimally processed products a shelf life of twelve days, limmited by off-flavor. The treatment with ascorbic acid was efficient to maintainthe ascorbic acid content, with a shelf-life of nine days, limited by enzymatic browning.
Index terms: ascorbic acid, calcium chloride, cysteine, citric acid, isoascorbate.

USO DE ADITIVOS PARA CONSEVARÇÃO DE PÊSSEGOS 'AURORA-1' MINIMAMENTE PROCESSADOS

RESUMO- O pêssego 'Aurora 1' constitui interessante alternativa como produto minimamente processado, devido principalmente às suas características de sabor, coloração, aroma e também por ser uma fruta resistente ao manuseio. No entanto, possui curta vida de útil após o processamento mínimo devido ao escurecimento enzimático e ao colapso da cavidade do caroço. Objetivou-se, neste trabalho, a avaliação de aditivos com efeito antioxidante na prevenção do escurecimento de pêssegos 'Aurora-1', minimamente processados. O processamento mínimo consistiu de lavagem, sanificação, descasque e retirada do caroço das frutas. Em seguida, realizaram-se cortes longitudinais para obtenção de oito segmentos por fruto. As fatias obtidas foram imersas nas soluções, compondo os tratamentos: testemunha (imersão em ácido ascórbico a 2%); ácido ascórbico a 2% + cloreto de cálcio a 2%; isoascorbato de sódio a 1%; ácido cítrico a 1%; cloridrato de L-cisteína a 1%. Foram acondicionadas em bandejas de poliestireno, rígidas, marca MEIWA M-54, revestidas com filme de PVC esticável de 14µm (Omnifilm®), armazenados em câmara fria a 3ºC ± 2°C e 65% UR por 12 dias e avaliados a cada três dias. As variáveis avaliadas foram aparência, sólidos solúveis, acidez titulável, relação sólidos/acidez, açúcares solúveis e redutores, pectina total e solúvel, ácido ascórbico, atividade das enzimas peroxidase e polifenoloxidase. A L-cisteína proporcionou aos produtos minimamente processados vida útil de 12 dias, sendo limitada pelo odor não característico do produto. O ácido ascórbico mostrou-se eficiente na manutenção do ácido ascórbico, com vida útil de nove dias, sendo limitado pelo escurecimento enzimático.
Termos para indexação: ácido ascórbico, cloreto de cálcio, cisteína, ácido cítrico, isoascorbato.

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INTRODUCTION

Among all fruit from temperate climate, peach (*Prunus persica* L. Batsh) is one of the most produced in the world and one of the most consumed 'fresh'. 'Aurora-1' cultivar presents sweet pulp and low acidity, what is responsible for its great success "in natura" market and, due to its pulp firmness, it is resistant to handling and conservation (PEREIRA et al., 2002).

The commercialization of minimally processed peaches has been limited because of immediate physiological responses to damaged tissues like browning, stone cavity collapse and firmness loss (Gorny et al., 1998). According to Beaulieu and Gorny (2004), the use of antioxidants and some chelating agents is an interesting alternative to maintain quality of these products.

Ascorbic acid use in minimally processed products to stop browning has been reported in works with pears (GORNY et al., 2002), melon (LAMIKANRA; WATSON, 2006) and bananas (VILAS BOAs, 2004).

Citric acid is the principal organic acid found naturally in plants, acts as a chelator and acts synergistically with ascorbic acid and erythorbic and their neutral salts. It features dual inhibitory effect on PPOs not only by lower the pH, but also with the copper complexing of the active center of the enzyme (PINELLI, 2004)..

Cystein is an aminoacid that contains a tiol group with reducing action. (RICHARD-FORGET et al., 1992). Several studies have demonstrated their efficiency in the inhibition of polyphenol oxidase (PPO) in palm (ROBERT et al., 1996) and Red Delicious apple cultivar (EISSA et al., 2006).

The calcium chloride has been applied effectively in the prevention of the softening of fresh-cut fruits (VILAS BOAS; KADER, 2001), even so can contribute, in set with antirust agents, for the browning control (MELO;VILAS BOAS, 2006).

This research have the objective of testing the effect of antioxidants to prevent browning of minimally processed 'Aurora-1'peaches.

MATERIAL AND METHODS

'Aurora-1' peaches were purchased between October and November, 2008, in a trade orchard located in Taiúva, SP, far away 30 kilometers from Jaboticabal, SP. The experiment was conducted in the Agricultural Products Technology Laboratory at FCAV-UNESP, Jaboticabal Campus.

Fruits were harvested manually in the morning and selected according to uniformity, damage absence and maturation. After that, the fruits were packed in plastic boxes coated with bubble plastic to protect them against mechanical damage. Immediately after harvest, the fruits were transported to the laboratory, where they were again selected by color uniformity, size, mechanical and physiological damage absence. After being selected, the fruits were washed with neutral detergent and immerged in chlorinated water at 200 mg L^{-1} of sodium hypochlorite for 15 minutes for superficial disinfection. They were left to dry at 25ºC on a previously sanitised surface covered with paper. Then the fruits were taken to cold storage at 12ºC ± 2ºC previously sanitised, where they were kept for twelve hours before processing.

Walls, floors, ceilings and benches, as well as cut tools were previously washed and rinsed with chlorinated water at 200 mg L^{-1}. After hygienisation, the room were kept closed and refrigerated at 12ºC.

Processing consisted of peeling the fruits using stainless steal sharp knives. A longitudinal cut was made, and, with an appropriate spoon, the stone was removed. After that, new longitudinal cuts were made to get eight segments per fruit. The slices were immersed for 3 minutes in the following treatment solutions: control (immersion in 2% ascorbic acid); 2% ascorbic acid + 2% calcium chloride; 1% sodium isoascorbate; 1% citric acid; 1% L-cysteine hydrochloride. The slices were put to rest to drain off any excess liquid and, after that, the products were placed into rigid polystyrene trays branded MEIWA M-54, covered with 14 µm PVC film (Omnifilm™) and kept in cold storage at 3ºC ± 2ºC and 65% RH for twelve days. Each packaging contained about 200g of product.

During storage period, appearance evaluations were made every three days through a scale from 4 to 1, where 4 (great) = fresh aspect and browning absence; 3 (good) = fresh aspect but light browning; 2 (regular) = low fresh aspect and ligh browning; 1 (bad) = no fresh aspect and high browning. Since 3 was the acceptance limit for commercial quality. Soluble solids (SS) was assessed with a Digital Handheld "Pocket" Refractometer PR 101 and expressed in ºBrix (AOAC, 1997). Titatrable acidity was determined by titration of peaches juice with 0.1M NaOH solution to pH 8.1 (using a pH meter), according to the AOAC, 1997. The titratable acidity was expressed as % of citric acid. Soluble carbohydrates extraction was made according to Faleiros (1978) technique, determined according to Dubois et al. (1956), and results were expressed as % of glucose. Reducing sugars content was determined using 3.5 dinitrosalicylic (DNS) technique, proposed by Miller (1959), and results were expressed as % of glucose. Total and soluble pectins were extracted according to McCready and McComb (1952) technique, determined colorimetrically according to Bitter and Muir (1962), and the results were expressed as % of fresh weight. Ascorbic acid content was determined according to AOAC (1997), and the results were expressed in mg 100 g^{-1} of fresh weight. Peroxidase and enzyme activity was determined by supernatant of homogenized samples in potassium phosphate buffer (0.2 M, pH 6.7, and centrifuged at 10,000 rpm for 10 minutes, at 4℃). Peroxidase activity was determined by the Allain et al. (1974) method, with a reading in 505 nm and expressed in µmol of consumed H_2O_2 min^{-1} g^{-1}. Polyphenol oxydase was determined by the same method using phenol, and a reading in 420 nm, being expressed in µmol of consumed phenol min^{-1} g^{-1}.

The experiment was conducted following a casual design in a 5x5 factorial scheme: five additives and five sampling dates (0, 3, 6, 9 and 12 days). Three repetitions per treatment were made.

The data obtained were submitted to analysis of variance (ANOVA) and the means were compared by the Tukey test at a significant level of 0.05.

RESULTS AND DISCUSSION

L-cystein treatment provided a better conservation of external appearance to minimally processed peaches (Figure 1), where products submitted to L-cystein treatment, kept good quality (score of 4) during the whole storage period. It was noticed that with other treatments, there was quality loss. It was also noticed that AA + $CaCl_2$ treatment got the lowest note to the peaches appearance. During the analysis period, it was also observed that fruits treated with L-cystein presented a non-characteristic smell. This result probably due to the releasing in the cysteine molecule, causing unusual smell of the product.

Soluble solids contents in minimally processed peaches remained constant during storage time (Figure 2A), while acidity contents were reduced (Figure 2B), increasing ratio (Figure 2C). The behavior for sugars was different from that observed by Vilas Boas et al. (2004), working with application of chemical additives in minimally processed ‘Tommy Atkins’ mangoes, when it was verified reduction in soluble solid contents. Possibly the result obtained in this experiment is due to decreased metabolism in the application of additives, and consequent consumption of soluble solids as substrates for respiration, because the physical actions of minimal processing induces an increase in breathing, which quickly use the substrates.

There was a significative interaction between treatments and storage time for titratable acidity (Figure 2B), and the treatment with L-cystein addition provided a better maintenance of peach acidity, and, probably, a lower utilization of organic acids in respiratory process. It was also noticed a progressive reduction of the contents of that variable through storage time (Figure 2B). Similar result was observed by Botelho et al. (2010), working with fresh cut pupunha palm. Chitarra and Chitarra (2005) say organic acids contents tend to decrease along maturation due to respiratory activity and convertion of those acids in sugar.

Soluble carbohydrate and reducing sugar contents varied significatively among treatments and during evaluation days (Figure 3), increasing sugar contents during storage time. It was observed that treatment with L-cysteine led to lower values of soluble sugars.

L-cystein and citric acid treatments were ones that better kept the reducing sugars contents during storage time (Figure 3). Similar results were observed by Melo and Vilas Boas (2006), when treating minimally processed ‘Maçã’ bananas with L-cystein. Vilas Boas et al. (2004), also verifyed that citric acid treatment in ‘Tommy Atkins’ mango kept the soluble carbohydrate contents.

It is noticed, in Figure 3, an increased in reducing sugar contents. L-cystein and citric acid showed the highest average values for this variable. Wills et al. (1983) and Chitarra and Chitarra (2005) cite that increased levels of reducing sugars in fruit climacteric occurs due to water loss and hydrolysis of polysaccharides, hemicellulose and pectic cell wall, common in the ripening process after harvest and during storage.

There was a significative interaction between additives and stotage time to the ascorbic acid variable (Figure 4). It was verified that ascorbic acid contents were higher in control products and those treated with ascorbic acid associated with calcium chloride. It was noticed that, although both treatments were immersed in ascorbic acid, the highest maintenance of this acid was verified in ascorbic acid treatment associated with calcium chloride (AA + $CaCl_2$). It could be verified in Figure 4 that products treated with L-cystein presented high contents of ascorbic acid during the storage period, if compared with those treated with citric acid and isoascorbate, indicating that L-cystein treatment was more efficient to avoid degradation of ascorbic acid, and reduced evolution of peach senescence. Biale and Young (1981) reported that changes, occurred during maturation in fruit, led to oxidation, and consequently inactivation of ascorbic acid in 2.3-dicetogulonic acid.

Total and soluble pectin contents and their solubilization were influenced by the storage time, used additives, and the interaction among them (Figure 5). It was noticed an expressive reduction of total pectin contents in all treatments, as from the 3rd day of cold storage (Figure 5A), and that AA + $CaCl_2$ treatment provided a lower solubilization of pectins, indicated by low soluble pectin contents. Xisto et al. (2004), studying 'Pedro Sato' guavas, also noticed that guavas treated with calcium chloride showed the same behavior. Heppler and Wayne (1985) said that calcium increases the insolubility of pectic material due to formation of calcium pectate.

The treatment effect in POD and PPO activity during storage can be verified in Figure 6. It was observed an increase in enzymatic activity during storage time of peach slices treated with AA + $CaCl_2$. These results are different from those got by Souza et al. (1999) in mechanically damaged peaches. They observed that 1% calcium application reduced oxidizing actions catalysed for POD, but they were consistent with Aguila et al. (2008), who observed that calcium chloride did not avoid browning in lychee fruits. Antoniolli (2003) observed that calcium application in fresh cut pineapple had negative effect on pulp showing more browning. Results of the application of calcium to fruits and its effects on POD activity have been inconsistent, sometimes showing an increase (HIWALES; SING, 2003)..

L-cystein treatment showed a lower enzymatic activity, followed by isoascorbato treatment. Use of reducing compounds, like cystein, are very effective to control enzymatic browning, reducing quinones to o-diphenols, that are lighter compounds; either by combination with products of enzymatic reaction forming lighter colored compounds or by PPO irreversible inactivation (CRUMIÉRE, 2000; ENDO et al., 2006).

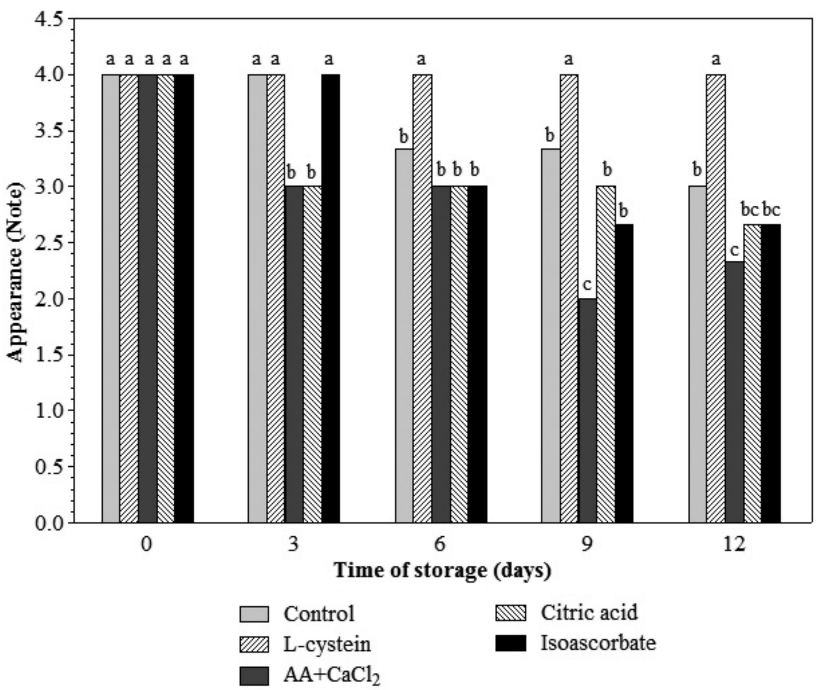


FIGURE 1-The appearance of 'Aurora-1' peaches submitted to minimal processing and additive application, stored at 3ºC and 65% RH. Scale: 4 = great; 3 = good; 2 = regular; 1 = bad. AA = ascorbic acid. $CaCl_2$ = calcium chloride.

Different letters in the same day indicate significant differences among treatments according to Tukey's test with a *P* value of 0.05.

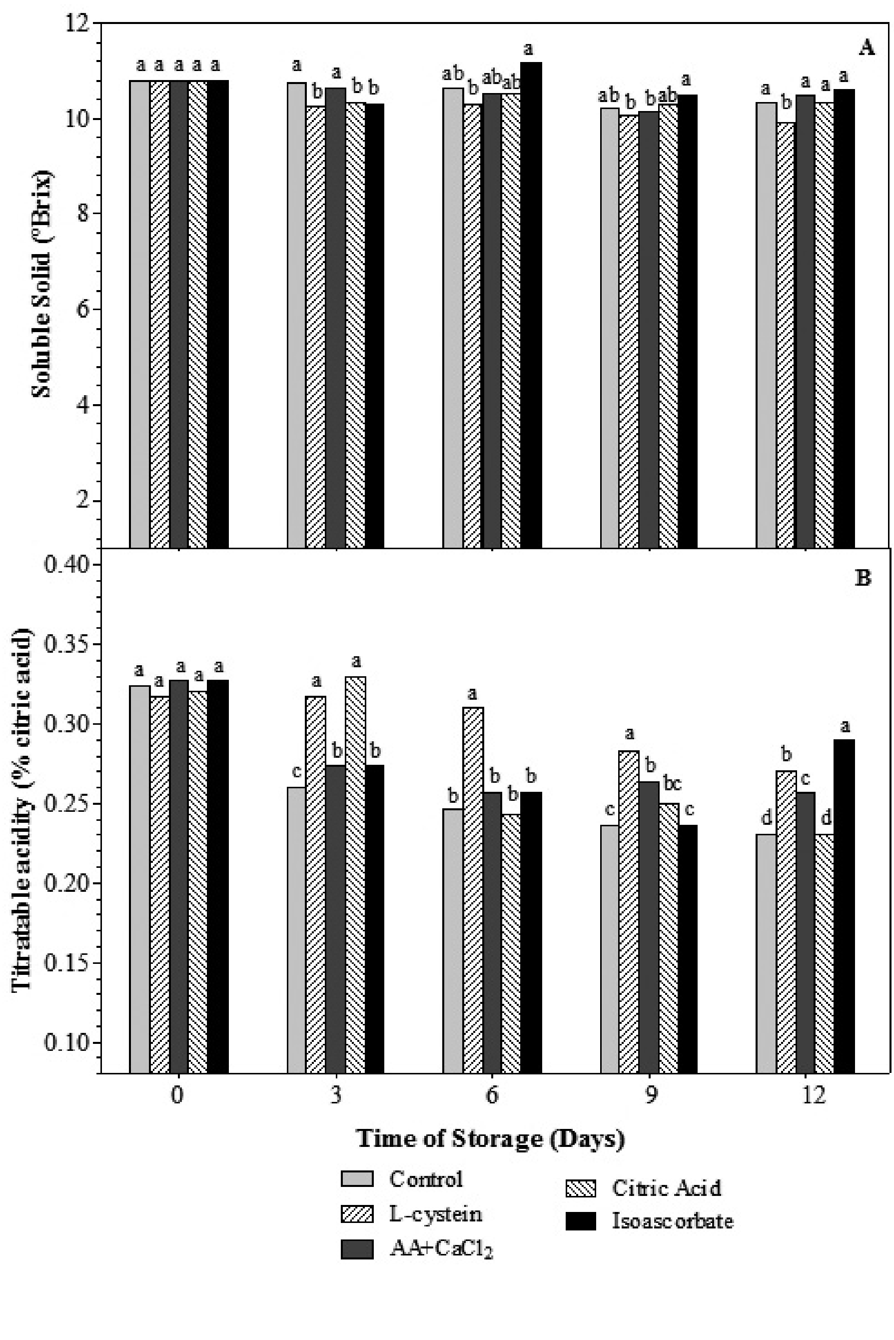


FIGURE 2 - Content of soluble solids (A) and titratable acidity (B) of 'Aurora-1' peaches submitted to minimal processing and additive application, stored at 3ºC and 65% RH. AA = ascorbic acid. $CaCl_2$ = calcium chloride.

Different letters in the same day indicate significant differences among treatments according to Tukey's test with a *P* value of 0.05.

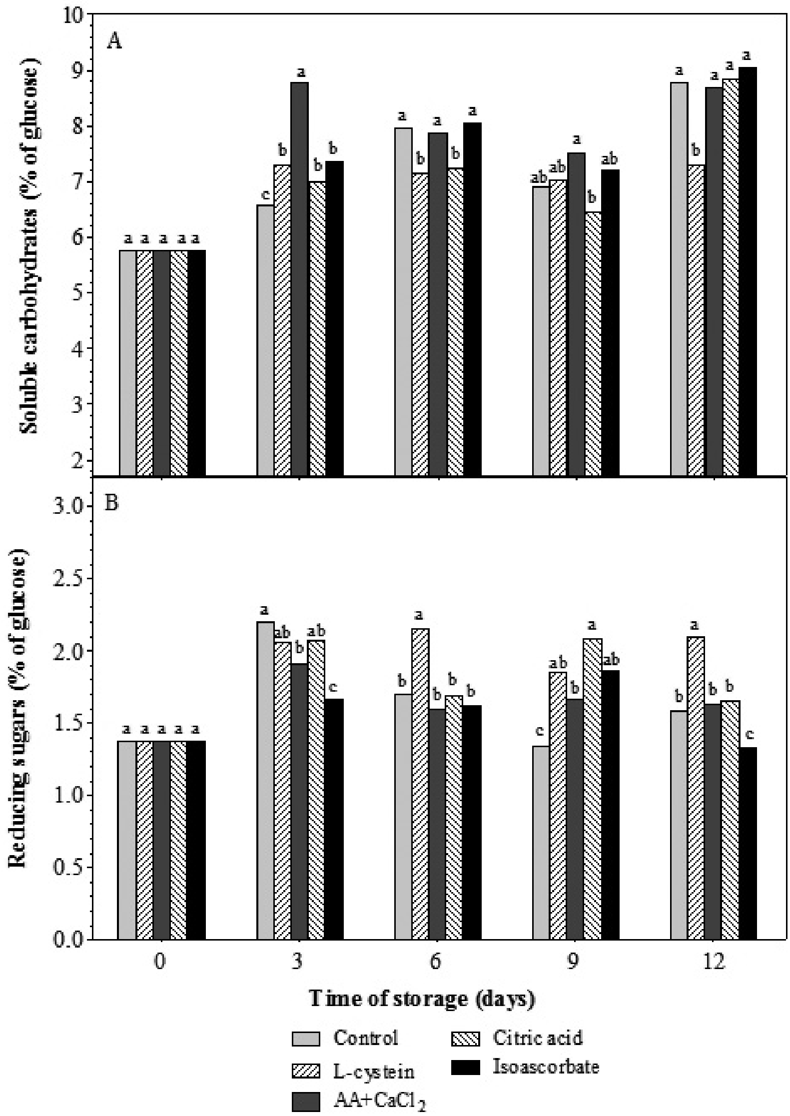


FIGURE 3 - Content of soluble carbohydrates (A) and reducing sugars (B), of 'Aurora-1' peaches submitted to minimal processing and additive application, stored at 3ºC and 65% RH. AA = ascorbic acid. $CaCl_2$ = calcium chloride.

Different letters in the same day indicate significant differences among treatments according to Tukey's test with a *P* value of 0.05.

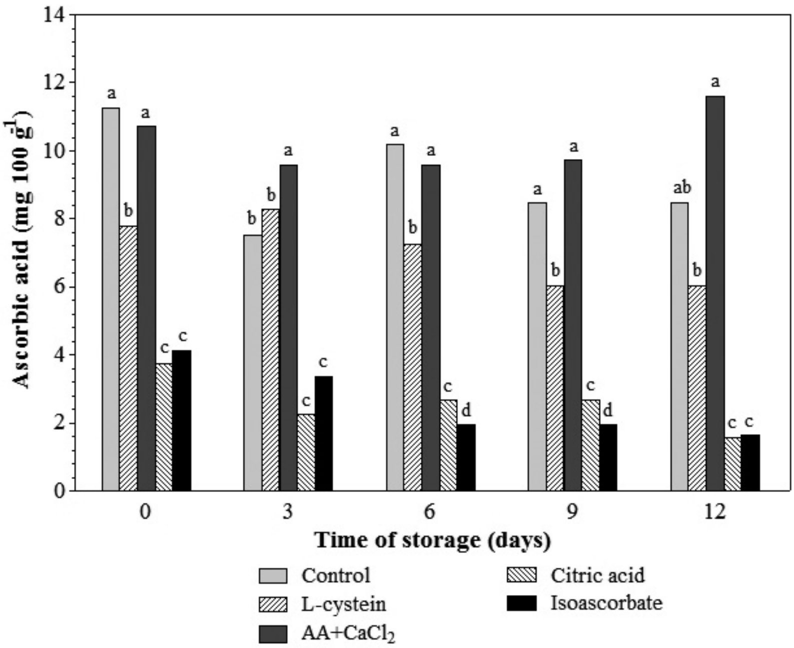
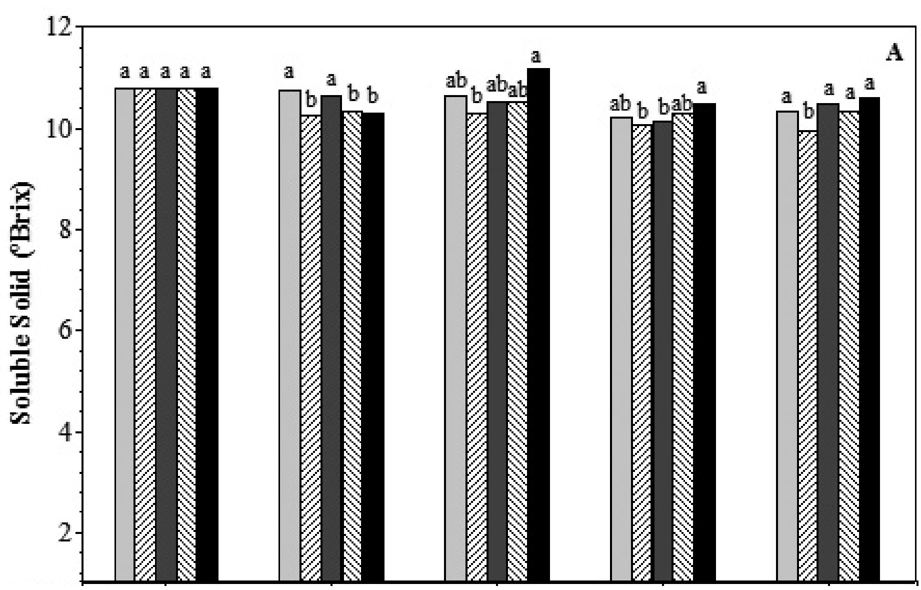


FIGURE 4 - Content of ascorbic acid of ‘Aurora-1’ peaches submitted to minimal processing and additive application, stored at 3ºC and 65% RH. AA = ascorbic acid. $CaCl_2$ = calcium chloride.

Different letters in the same day indicate significant differences among treatments according to Tukey’s test with a *P* value of 0.05.



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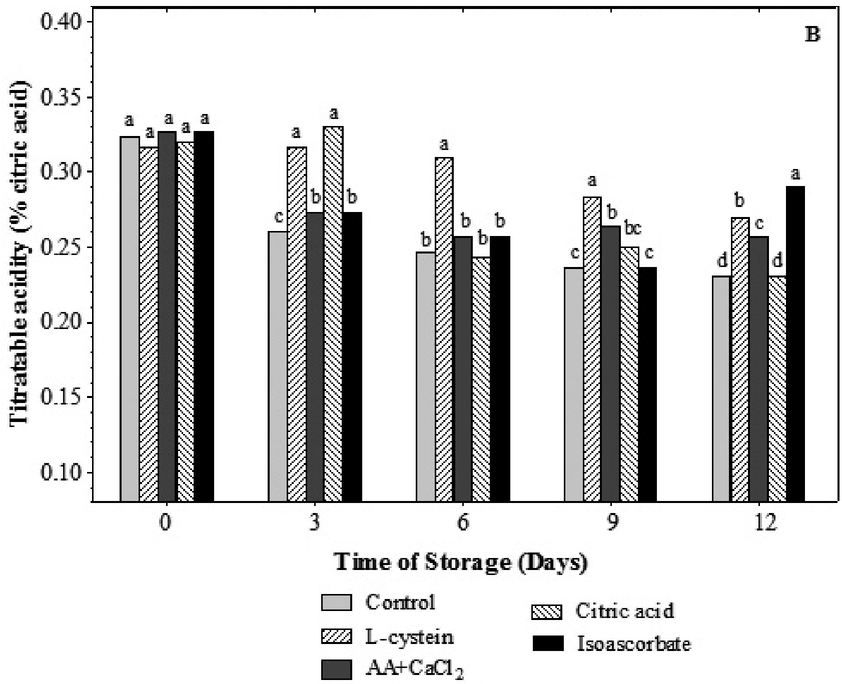
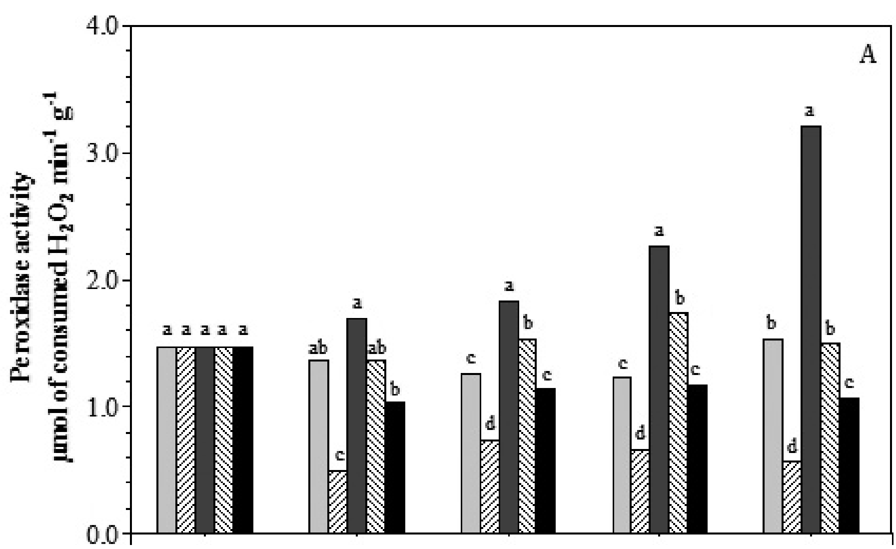


FIGURE 5 - Total (A) and soluble and (B) pectin contents of 'Aurora-1' peaches submitted to minimal processing and additive application, stored at 3ºC and 65% RH. AA = ascorbic acid. $CaCl_2$ = calcium chloride.

Different letters in the same day indicate significant differences among treatments according to Tukey's test with a *P* value of 0.05.



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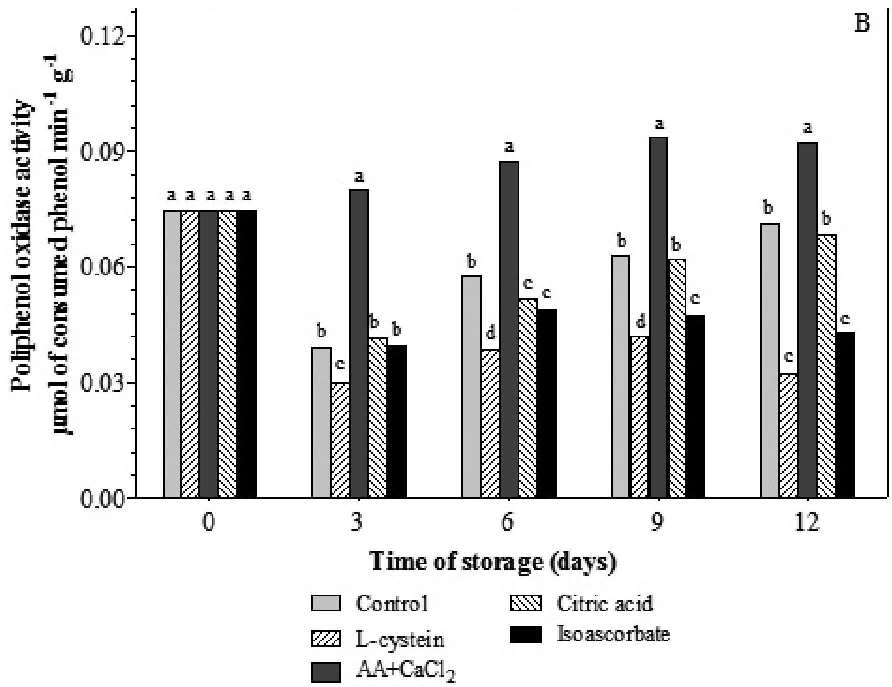

FIGURE 6 - Peroxidase (A) and polyphenol oxidade (B) activity of 'Aurora-1' peaches submitted to minimal processing and additive application, stored at 3ºC and 65% RH. AA = ascorbic acid. $CaCl_2$ = calcium chloride.

Different letters in the same day indicate significant differences among treatments according to Tukey's test with a *P* value of 0.05.

CONCLUSIONS

1-L-cysteine has provided better maintenance of fresh cut products of the chemical composition and with lower enzyme activity of browning, not being limited by the characteristic fruit odor.

2-The antioxidant ascorbic acid, 2% (control), gave proper external appearance and efficient in maintaining ascorbic acid, better ratio soluble solids / acidity at the end of the storage.

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